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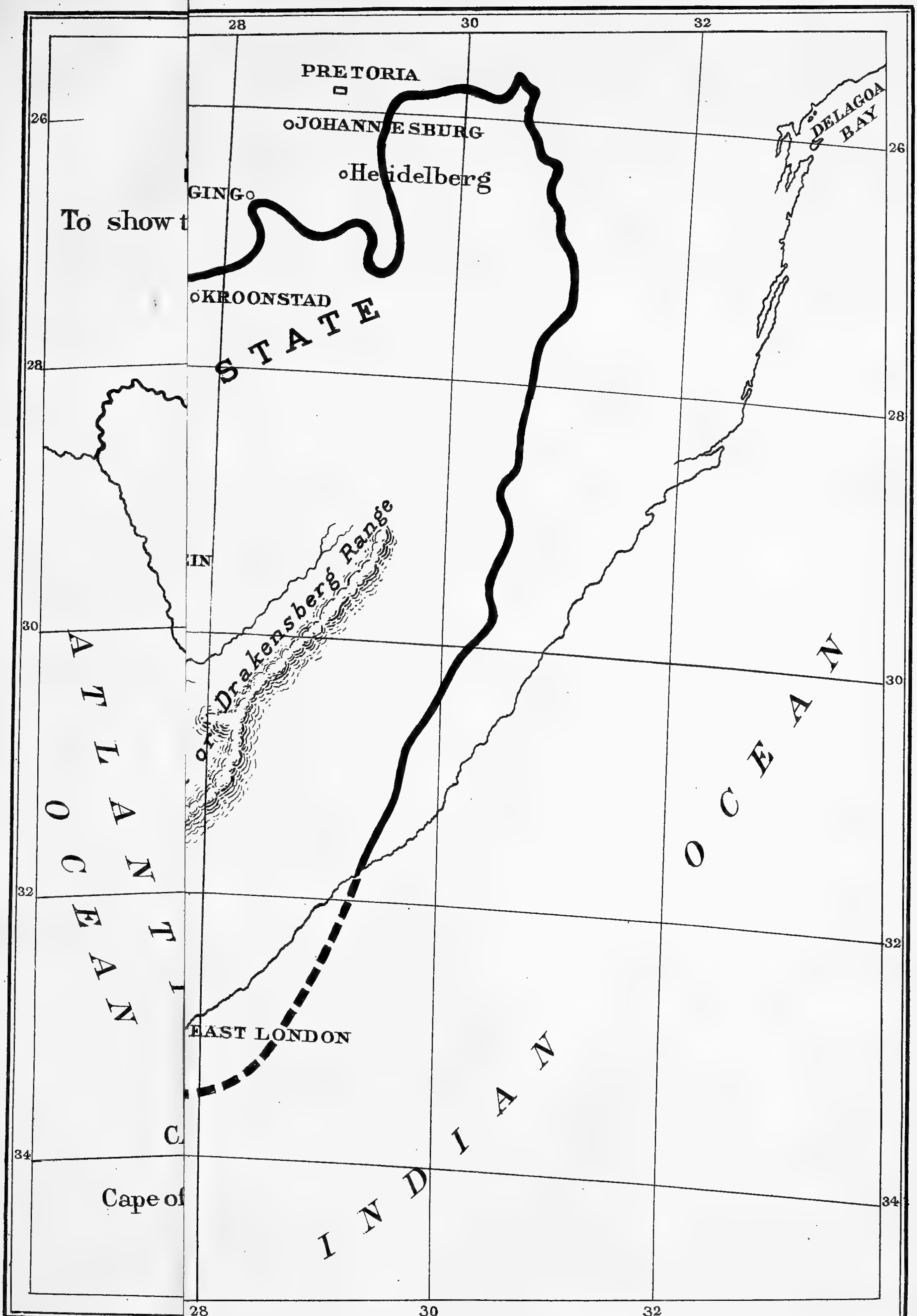

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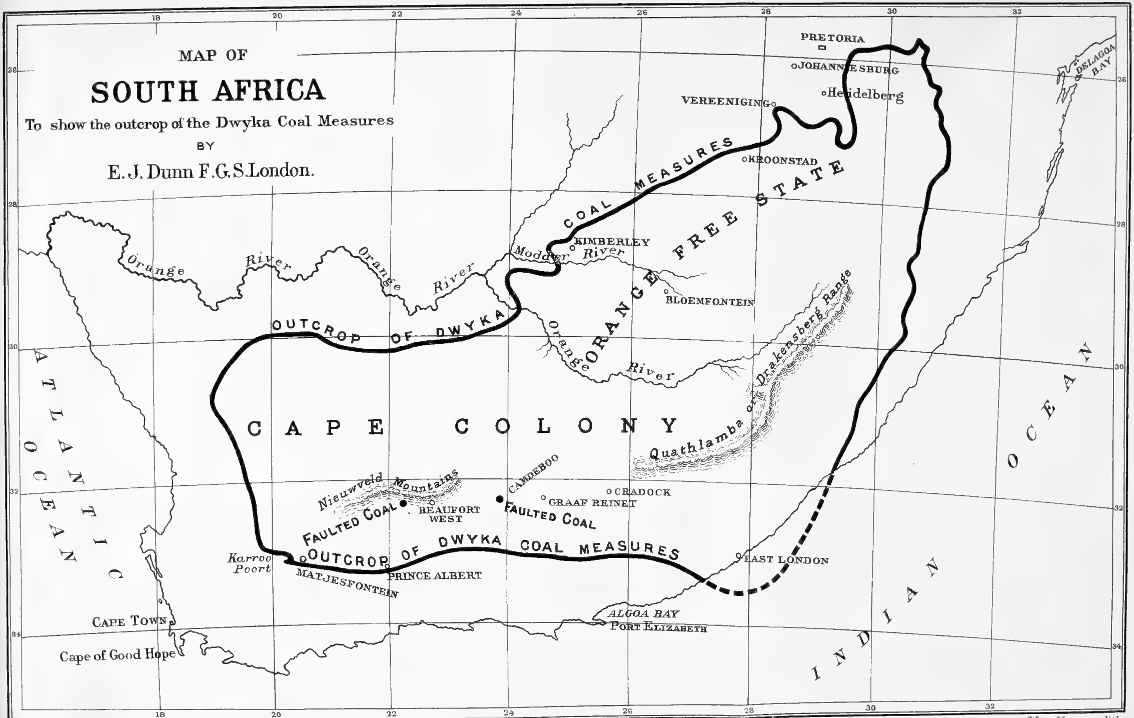

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E. J. DUNN, THE DWYKA COAL MEASURES

TRANSACTIONS

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NOTES ON THE MODE OF GROWTH OF *TUBICINELLA TRACHEALIS*, THE BARNACLE OF THE SOUTHERN RIGHT WHALE.

By Dr. R. Marloth.

(Read September 29, 1898.)

At the meeting of this Society held on the 28th of July, 1897, Dr. F. Purcell exhibited specimens of two kinds of barnacles found on whales captured in the neighbourhood, viz., *Coronula Diadema*, the coronet barnacle, from a humpback whale (*Megaptera boops*), and *Tubicinella trachealis* from a Southern right whale (*Balæna australis*).

In the discussion of the exhibits and of the mode of life of these parasites, the question was raised by what means these parasites were able to penetrate into the epidermis of the whale, seeing that their base was quite unarmed, their mouth being turned outwards towards the water. It occurred to me at the time that there might be some chemical process at work, but such a surmise was not of much value unless it could be proved experimentally. I had no opportunity of doing this last year, but when this year, in May, a right whale was captured in False Bay, I secured a piece of its skin with a number of *Tubicinellas* in it, and conducted a series of experiments in order to test the theory.

Before stating the results of these experiments, I think it desirable to explain the mode of life and growth of the parasites as far as known at present.

The most comprehensive work on the *Cirripedia* is from Charles Darwin,* who published a monograph of the class in 1854. From his book most of the following details are taken. Many members of the order are common on the rocks of the coast, on floating timber and ships' bottoms, being known under various names, according to their shape and colour. Owing to the fixed condition of their shells and their external resemblance these animals were believed to be molluscs until 1850 Vaughan Thompson recognised their crustacean nature by discovering their metamorphosis.

The young larvæ when leaving the egg exhibit their true relationship very well. They move about freely until they find a suitable resting-place, where they attach themselves by means of their

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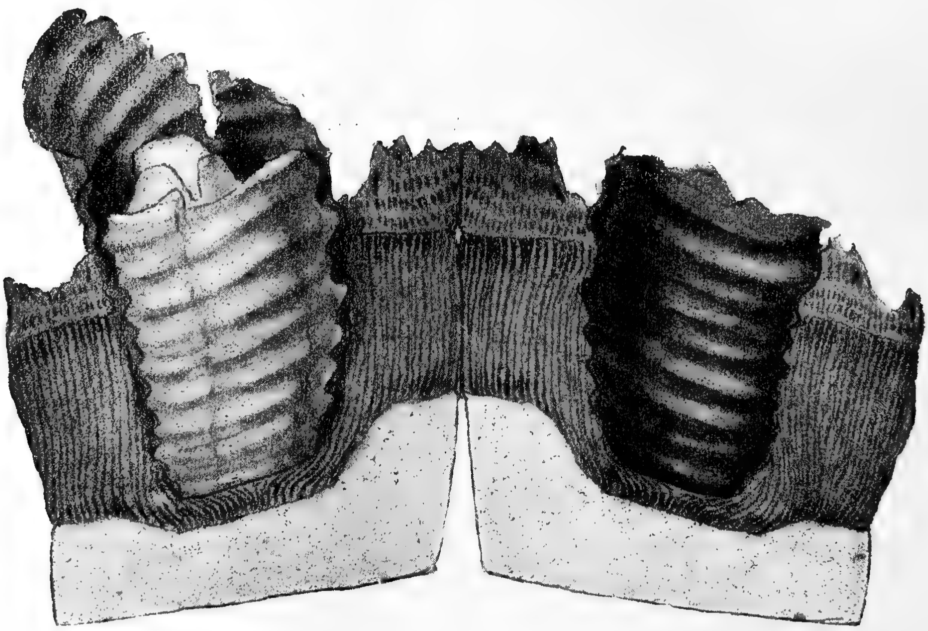


TUBICINELLA TRACHEALIS IN A PIECE OF WHALE SKIN, THE FRONT PORTION OF THE PIECE FOLDED BACK (natural size).

1. Sheath of hardened epidermis, projecting beyond the surface. 2. Outer surface. 3. Vertical section through epidermis. 4. Corium.

antennæ, or rather organs corresponding to the antennæ of the crawfish, but assuming quite a different function. The larva changes at first into a kind of pupa, and finally into the complete cirripede. When this takes place they are still very small, only gradually reaching their final size. In order to attach themselves to suitable objects the cirripedes possess a so-called cementing apparatus. By means of a certain secretion they fix themselves on their support.

* 'Charles Darwin.' A monograph on the sub-class *Cirripedia*, with figures of all the species, the *Balanidæ*. London, 1854.

Darwin does not say by what means the young cirripede forces itself into the epidermis of its host, but he describes in a detailed way the mode of growth of the parasite settled in the skin. By a comparison of specimens of different size, he came to the conclusion that the tubular shell grows at its base downwards and in a tangential direction, producing in this way the lengthening as well as the widening of the shell. As, according to Darwin, the shell is gradually pushed out of the skin, its outer edge must soon project beyond the level of the skin, and as it is very brittle it continually breaks away at the outer edge. If the whole growth of such a shell from its infancy, when it is hardly one-fiftieth of an inch in diameter,

PIECE OF WHALE SKIN WITH SIX TUBICINELLAS (half natural size).
1. Surface of epidermis. 2. Vertical section through epidermis. 3. Corium.

until it is of full size, *i.e.*, about 1 inch in diameter, could be preserved and put together, it would form a conical tube at least 6 inches long. How much longer the cylindrical tube would be which one would obtain by putting together the fragments of shells breaking away during the life of the adult animal, is, of course, impossible to say, as one does not know how long these cirripedes live and at what rate the longitudinal growth continues.

In all its stages the shell is provided with circular ridges which make it impossible for it to slip out of the skin. If one assumes that each ridge remains surrounded by, and in contact with, those layers of the epidermis in which it was formed originally, one should either find that the base of the shell had penetrated into the skin to that extent, viz., 4½ inches below the epidermis, or, as this is not the case, "*that the epidermis of the whale had ceased being formed under these specimens, whilst it had gone on being formed around and between them, to the thickness of four or five inches, and that it had subsequently disintegrated to this same thickness on its outer side, which processes would account for the summit of the shell being still on nearly a level with the surface of the whale.*" Darwin adds that he cannot believe this to have taken place, and continues: "The view which seems to me most probable is, that the rapid downward growth of the shell, besides indenting the whale's skin, at the same time slowly pushes the whole shell out of the skin, and thus continually exposes the summit to the wear and breakage which seems to be necessary for its existence. On this view, the very peculiar form of *Tubicinella,* which is retained during life, namely, the slightly greater width at top than at bottom is beautifully explained, viz., for the sake of facilitating the protrusion of the shell; for the ordinary conical shape of senile cirripedes, with the apex upwards, would have rendered the pushing out of an imbedded shell almost impossible; on the other hand, we can see that the likewise very peculiar, concentric, prominent belts may be necessary to prevent too easy protrusion."

If one remembers that the tubular shell rests with its lower edge on the soft inner skin, the corium, and that its basal surface is not closed with any hard substance, but simply with a membranous diaphragm, while the sides of the shell are provided with such prominent ridges it is difficult to imagine that it could be pushed out of the epidermis in this way. In fact, having removed a number of living specimens from the skin in which they were imbedded, I consider this pushing out as impossible. The skin around each shell is quite indurated, the ridges of the shell have their upper edge slightly turned upwards, and the shells adhere so firmly to the skin that one has to use considerable force in order to break them out even after splitting the surrounding body of skin lengthways.

The observation, however, which I have made, enables us to understand the actual process. We saw that the larvæ of the cirripedes attach themselves to their permanent support by means of a cementing apparatus. Such a cementing arrangement appears quite sufficient for those species which live on rocks, shells, wood, or any other dead material, but it is evidently quite insufficient to account for their permanent adherence to the live skin of an animal. Supposing even they succeeded in attaching themselves, they would soon be thrown off as the outer layers of the epidermis became deteriorated and worn away. But the *Tubicinella* has not only to attach itself, but also to penetrate into the epidermis to a depth of one inch and a half, and that although its base is formed by a delicate membrane.

Seeing this, it occurred to me that the animal possibly secreted some fluid which possesses the power of dissolving the epidermis. Such secretions, which contain peptonising ferments, *e.g.*, pepsine or pepsine-like bodies, and which are capable of rendering soluble the albuminous matter of animal bodies are well known in the vegetable kingdom as well as among animals. The sundew, and many other so-called insectivorous plants digest the albuminous matter of insects and other animals in this way, and the same is done by many arachnids and insects with their prey.

In order to test this theory, I removed some living *Tubicinellas* from the skin of the whale, placed their lower side in direct contact with pieces of boiled albumen (white of an egg), and poured sea-water into the vessels until the base of the shell was immersed.* After some time, varying from half an hour to twenty-four hours, I analysed the liquids. The soluble albuminoids were removed by saturating each liquid with sulphate of zinc, allowing it to stand for twenty-four hours, and filtering it. The filtrates were treated with hydrate of potash and sulphate of copper, and in each case I obtained positive reactions for the presence of peptones. This proved that a peptonising ferment diffuses through the basal membrane of the animal, and this fact explains the peculiar structure of the animal as well as that of the skin of the whale at the infested parts of its head. The young *Tubicinella* simply dissolves the epidermis with which it is in contact, absorbing the peptonised liquid. As it continually grows at its lower end it gradually descends in this way into the epidermis, the digesting of the epidermal layers taking place at the same rate as the downward growth.

When the parasite has reached its maturity, its shell is just as long as the epidermis is thick, viz., about one inch and a half, a thin layer of epidermis, about one-tenth of an inch in thickness remaining underneath each parasite between its base and the corium of the skin.

The presence of the peptonising ferment having been proved, it is not necessary any more to assume that the epidermis stops growing underneath each parasite. On the contrary, its uniform growth would produce exactly the structure of the epidermis as we find it. If the parasite did not secrete such a ferment, the layer of epidermis

* The *Tubicinellas* remained alive for two or even three days.

underneath it would gradually increase in thickness. At the same time the epidermis is permanently wearing off at its outer side, as is well demonstrated by its rough or rather torn and lacerated surface. The result of both processes would be that the parasite would be gradually but completely removed from the skin. And this actually takes place with the shells of the dead parasites, their place being afterwards indicated by a smooth depression in the epidermis. The living *Tubicinella*, however, cannot be got rid of in this way, for as it dissolves that part of the epidermis with which its base is in contact, at the same rate at which new epidermal tissue is being formed underneath it, the layer of epidermis which separates it from the corium remains of the same thickness, and the parasite retains its place, its shell disintegrating at its outer end at the rate at which it grows at its base.

DO THE MINING OPERATIONS AFFECT THE CLIMATE OF KIMBERLEY?

By J. R. Sutton.

(Read October 27, 1898.)

In essentials diamond-mining differs little from any other enterprise whose object is to obtain possession of minerals lying at any depth beneath the surface of the earth. Shafts have to be sunk, and tunnels driven, and the diamond-bearing rock ("Kimberlite" or "blue-ground") has to be excavated and hauled to the surface for treatment before its wealth can be proved, in much the same way as though the quest were gold or iron. But diamond-mining differs from most other extensive mining operations in this: that Kimberlite being for the most part easily pulverable by ordinary atmospheric influences continued long enough, is more advantageously and cheaply treated by spreading it, as soon as it leaves the mine, over the ground, where sun and rain can act freely upon it and disintegrate it, than it would be by crushing, or by any other process having the same objects. The depositing sites for blue-ground fresh from the mines are known as *Floors.* The floors belonging to the De Beers and Kimberley Mines extend, practically without interruption, some four miles east and west, and from one to two miles north and south; and in order that they shall be as convenient as possible they are cleared of every trace of vegetation—trees, bushes, and grass all being sacrificed. The blue-ground is spread upon the floors to an average depth of about 10 inches, and remains there for a period which may run into many months until it is sufficiently disintegrated to be ready for washing and sorting. It is seldom that any floor is clear of blue-ground for many consecutive days; for the tipping of fresh material follows closely upon the removal of the old. Thus the floors-area, so far as vegetation is concerned, may be regarded as a small desert of blue-earth and rock, with here and there large mounds of the waste material from which the diamonds have been extracted. Kimberley extends along the southern boundary of this desert, and the village of Kenilworth (Griqualand West) touches it on its northern edge. Surrounding the whole is the virgin veldt of the country, consisting of thorn-bushes at intervals, and a coarse, starved-looking grass, with the red sand upon which it grows in evidence everywhere.

Now although the veldt is at best scarcely more than half-covered with vegetation, and the climate therefore as much influenced by the soil as by the vegetation upon it, yet it seemed *à priori* likely that the climate might be affected by the drastic clearance of such vegetation as there was, and also by the substitution of blue-ground for red over the floors. Such is the problem, and a solution of some of its leading aspects is attempted in this paper.

Relative Thermal Properties of Kimberlite and Red Sand.

The thermal properties of blue-ground as compared with red sand have first to be considered.

Two small patches, each about 30 inches square, were laid out side by side in the most exposed spot available, one of weathered, decomposed, virgin blue-ground, the other of red sand. These were made as level and smooth as possible. The depth of the deposit of blue-ground was about 3 inches, the space beneath and surrounding it being red sand. A mercurial Board of Trade thermometer was placed in the midst of the blue patch, the centre of its spherical bulb being almost exactly 1 inch beneath the surface, and another exactly similar and similarly situated in the centre of the red patch. These thermometers were both inclined at an angle of about 30° from the vertical for convenience in reading, and kept in place by a thin wooden prop behind. A thin wooden lath also covered each column and scale as a protection against possible hail and missiles. The readings were taken at VIII., XIV., and XX. civil time. A spirit radiation thermometer of the ordinary pattern was also placed in a horizontal position over each patch, and supported by the thinnest wooden forks strong enough to carry it, the centre of the spherical bulbs being almost exactly three-quarters of an inch above the surface. These were also read at VIII., XIV., and XX., and readings of the minimum were also taken as well. The experiment lasted from July 4th continuously till September 30, 1898, and may be regarded as including more or less all types of Kimberley weather. These were the best arrangements I was able to make for the purpose. There is no doubt, of course, that if larger patches could have been laid out, say each of 30 feet square, or better still, if simultaneous observations could have been taken, one set on the open veldt and the other in the midst of a depositing floor, better results must have been obtained. However, the figures given in Table I. will show the general tendency of the climatic effects of the two soils.

TABLE I.

Relative Thermal Properties of Blue-Ground and Red Sand. Mean Values.

A.—Radiation Temperatures at $\frac{3}{4}$ inch Above Surface.

1898.	Minimum.		VIII.		XIV.		XX.	
	Blue.	Red.	Blue.	Red.	Blue.	Red.	Blue.	Red.
	°	°	°	°	°	°	°	°
July 4th-31st........	23·7	22·9	29·9	29·5	66·9	65·7	35·1	34·2
August..............	32·7	30·2	42·6	40·8	84·9	83·1	46·1	43·2
September 1st–17th ..	35·3	32·1	47·8	46·0	89·2	85·7	50·5	47·3
September18th-30th..	39·5	37·1	60·5	61·2	93·8	91.4	54·8	51·5
July 4th–Sept. 17th ..	30·3	28·0	39·2	37·9	79·4	77·4	43·0	40·8

B.—Earth Temperatures at 1 inch Beneath Surface.

	VIII.		XIV.		XX.	
	Blue.	Red.	Blue.	Red.	Blue.	Red.
		°	°	°	°	°
July 4th–31st......................	33·0	31·8	63·1	65·3	42·4	40·6
August	44·3	43·5	81·7	83·7	55·9	53·3
September 1st–17th	50·4	49·5	90·1	91·8	61·9	59·1
September 18th–30th	60·8	62·2	100·0	101·3	69·8	66·3
July 4th–September 17th	41·6	40·7	76·7	78·8	52·2	49·9

C.—Comparative Elements of Influence.

	July. Hours.	August. Hours.	September. Hours.
Amount of Cloud (0–10) *	0·6	1·7	1·7
Duration of Sunshine †	$298\frac{1}{2}$=92%	297=86%	$301\frac{3}{4}$=84%
Mean Maximum Air Temperature	65·6°	72·5°	78·0°
Mean Minimum do.	32·7°	38·5°	42·2°

* From observations taken at VIII., XIV., and XX. civil time. The mean amount of cloud for the year is about 2·5. At Cordoba it is 4·5, and at Adelaide 4·8.

† As recorded by the Jordan Photographic recorder. According to a paper recently published in the *Quarterly Journal of the Royal Meteorological Society* by Mr. R. Curtis, describing some comparative observations made in England between the sunshine recorded by this type of instrument and that by the standard Campbell-Stokes burning recorder, it is claimed that the latter records the greater amount. With a sky in which cumulus prevails this would always be the case, because the record of the burning recorder is not a series of points, but a succession of large overlapping images—isolated clouds thus not receiving their true and sufficient angular dimensions on the trace. The record of the photographic recorder, on the other hand, is a series of narrow transverse lines.

Previously to September 18th neither of the experimental patches had emerged from the morning shadow cast by some adjacent gum-trees at VIII. From that time until the end of the month the red patch was either in partial shadow or full sunshine at viii., while the blue was in shadow or partial shadow at the same time. For this reason the VIII. observations after that date are not to be taken in the comparisons, the rest of the observations being nevertheless quite trustworthy.

The general conclusions to be drawn from Table I. are:—

1. The air is always warmer above the surface of the blue-ground than it is above the red sand.

2. Beneath the surface the blue-ground is always warmer by night and cooler by day than the red sand.

3. Finally, blue-ground is the better reflector and therefore the worse absorber: heat passes less readily, in or out, across the bounding surfaces of its particles. The uniformly greater temperature of the air just above its surface is a reflection effect by day, and an effect of actual warming by contact and conduction during the night.

The soil of many of the gardens in and about Kimberley is little besides blue-ground taken from the waste material of the heaps of tailings. That they should often be so flourishing may be partly due to the more equable thermal properties of blue-ground. Of humus they have obviously not a trace to begin with. Fruit-trees generally blossom much earlier in the spring in Kimberley, which is built almost entirely on *débris* from the mines, than they do in Kenilworth, where there is not any of this material; and a certain succulent plant known locally as the wild tobacco develops more luxuriantly upon the tailing-heaps than it ever does upon the native sand. A mixture of red sand and blue-ground seems also to make a good soil for a garden.

Effects on Climate.

The great differences in the thermal properties of blue-ground and

encroaching very little into the spaces which should be left blank by clouds. It follows as a necessary consequence that the maximum amount of sunshine in the diurnal range is displaced too near to noon by the Campbell-Stokes instrument.

Clouds being relatively rare at Kimberley, it is doubtful if a Campbell-Stokes recorder of the very best construction could record more sunshine than the Jordan instrument. And here it may not be out of place to add that Kimberley is perhaps one of the most sunny places in the world. The mean sunshine for the year is about 76 per cent. of the greatest amount possible, Allahabad (India) having perhaps 70 per cent., Cordoba (S. America) 62 per cent., Adelaide (S. Australia) 60 per cent., and St. Aubin's (Jersey) 39 per cent.

red sand would make it almost certain that the climate of the vicinity must be materially affected by the considerable area of blue-ground exposed on the depositing floors. To test this I have compared the daily maximum temperatures of Kimberley and Kenilworth for the years 1894, 1895, and 1896, making use of 1,075 pairs of observations for the purpose. The Kimberley observations were kindly placed at my disposal by Mr. G. J. Lee,* F.R.Met.S., F.R.M.S.; the Kenilworth observations were taken by myself.

Table II. shows the mean differences of maximum temperatures, Kimberley *minus* Kenilworth, month by month for the three years. A *plus* sign indicates that the Kimberley temperature was the greater, a *minus* sign that it was less.

TABLE II.

MEAN DIFFERENCES BETWEEN THE MAXIMUM AIR TEMPERATURES OF KIMBERLEY AND KENILWORTH.

	1894.	1895.	1896.	Mean.
	°	°	°	°
January	+2·7	+2·9	+5·8	+3·8
February	+1·1	+1·6	+4·9	+2·5
March	+0·6	+0·1	+3·0	+1·2
April	−1·7	−1·9	+0·3	−1·1
May	−2·2	−3·0	−0·5	−1·9
June	−2·7	−3·0	−0·8	−2·2
July	−2·4	−2·3	−1·1	−1·9
August	−1·2	−1·4	+0·3	−0·8
September	+0·6	+0·2	+2·0	+0·9
October	+0·6	+4·8	+5·1	+3·5
November	+3·8	+6·4	+6·9	+5·7
December	+2·4	+5·0	+6·8	+4·7

Some of the monthly differences are doubtless due to faults of exposure at both places. In September, 1895, the Kenilworth thermometers were transferred to a new, large, louvred screen, which, as tested by a slung thermometer, gave much more accurate results; the effects of radiation from the ground being largely, if not altogether, eliminated. The greater differences since that time are due to this alteration. The Kimberley thermometers were in the same position throughout the period. They were mounted under a somewhat modified Glaisher stand.

* Mr. Lee died in May last. Though not in any broad sense a meteorologist, yet he had taken regular climatological observations at his own second-order station for many years. Few men have had greater opportunities than he of amassing wealth, but the sordid pursuit of riches had for him no attractions. Living without ostentation, an earnest lover and devout worshipper of nature. Kimberley society scarcely knew of his existence; and Kimberley newspapers, characteristically, reported his death in grudging lines as that of a "local astronomer and weather-prophet"!

It is curious that the monthly differences in both December, 1894 and 1895, should be less than the November before and the January after, and in all probability the same thing would show in the mean results had there been no change of exposure at Kenilworth.

The numbers in the table would appear to indicate that the Kimberley days are warmer in summer and cooler in winter than those of Kenilworth. The great number of trees about Kenilworth may, perhaps, contribute something to this result; but it seems more likely to be due to an inherent defect in the Glaisher stand, however it may be modified: *i.e.*, to the utter lack of protection which it can afford against the effects of radiation from the ground in such a climate as ours. How effective radiation may prove as a source of error in temperature observations, unless properly guarded against, will be seen from Table III., wherein a comparison is made between the approximate maximum surface-soil temperature at a depth of 1 inch and the maximum temperature of the air.

TABLE III.

MEAN MONTHLY MAXIMUM TEMPERATURE OF THE AIR AT KENILWORTH COMPARED WITH THE MEAN SURFACE-SOIL TEMPERATURE AT 2 P.M.*

	Soil Temperature at 1 inch beneath Surface.		Monthly Maximum Temperature of the Air.		Differences.	
1897.	Mean at xiv. S	Greatest observed S′	Mean T	Absolute T′	S−T	S′−T′
	°	°	°	°	°	°
January ..	98·7	113·8	84·9	94·7	+13·8	+19·1
February ..	110·7	117·8	91·3	99·8	+19·4	+18·0
March	97·5	112·8	83·5	92·8	+14·0	+20·0
April	95·0	104·9	83·4	92·2	+11·6	+12·7
May	76·2	86·2	72·5	81·5	+ 3·7	+ 4·7
June	63·3	69·0	65·2	72·7	− 1·9	− 3·7
July	66·7	76·5	67·6	75·1	− 0·9	+ 1·4
August ..	80·9	88·2	73·0	83·3	+ 6·1	+ 4·9
September .	92·0	104·8	78·1	91·2	+13·9	+13·6
October ..	104·2	119·3	85·3	96·6	+18·9	+22·7
November .	110·3	123·7	86·4	100·6	+23·9	+23·1
December .	112·4	126·8	91·7	97·5	+20·7	+29·3
Means ..	92·3°		80·2°		+11·9°	
Extremes .		126·8°		100·6°		+26·2°

* In October, 1898, it was ascertained that the depth of the bulb of the thermometer with which these observations were made had increased from 1 inch to nearly 2 inches beneath the surface. This may be accounted for partly by an actual sinking of the thermometer, and partly by a possible accumulation of drift sand upon the site.

The tendency of these numbers is to show that the lower the temperature of the air the nearer does it approach the temperature of the ground. And doubtless if the temperature of the mathematical surface of the ground could be ascertained the effect would be still more marked.

It is obvious that if we wish to get a true idea of the relative temperatures of Kimberley and Kenilworth sources of error due to faults of exposure must, as far as possible, be allowed for. The method adopted after sundry trials was to consider the mean monthly error at both places to be a constant throughout any assigned month. And thus the mean difference *d* between the Kimberley and Kenilworth maximum temperatures for that month shall be a constant quantity, which, if applied with its proper sign to the Kenilworth maximum on any day in that month, will give the true relative difference for the same day between the maxima of the two places. The method answers equally well for the months before or after the change in the exposure of the Kenilworth thermometers. The process will be best understood by the annexed Table IV., representing a specimen month of readings in full.

In this table—

Column 1. Contains the dates.

,, 2. The direction of the wind at 2 p.m.

,, 3. The maximum air temperatures of Kimberley (K).

,, 4. The maximum air temperatures of Kenilworth (K′).

,, 5. The differences between the maxima of Kimberley and Kenilworth (K − K′) + or − according as K><K′.

,, 6. The corrected differences (cor. K − K′) obtained from column 5 by applying to each of the differences shown in column 5 a correction equal to the mean value of column 5. For example: the mean value of column 3 in the table is 67·7°, and of column 4 is 68.2°. The mean difference K − K′ of these is − 0·5°, which is manifestly the mean value of column 5. Deducting this quantity from each of the numbers in column 5 we get column 6, *i.e.*:—

$$-0{\cdot}3^\circ - (-0{\cdot}5^\circ) = +0.2^\circ$$
$$+0{\cdot}4^\circ - (-0{\cdot}5^\circ) = +0{\cdot}9^\circ$$

and so on.

These calculations were made for each month, and the numbers from column 6 then arranged into groups according to the direction of the wind. The derived mean monthly differences are shown in Table V.

TABLE IV.

Specimen Month of Comparative Maxima.

May, 1896.	Direction of Wind at XIV.	Maximum Temperatures.		Differences.	
		K	K′	K−K′	Cor. K−K′
		°	°	°	°
1	N.W.	76·9	77·2	−0·3	+0·2
2	W.N.W.	79·2	78·8	+0·4	+0·9
3	N.W.	78·3	78·0	+0·3	+0·8
4	N.W.	77·4	76·5	+0·9	+1·4
5	S.W.	61·0	60·5	+0·5	+1·0
6	S.S.W.	59·1	58·8	+0·3	+0·8
7	E.	64·4	65·5	−1·1	−0·6
8	N.	69·6	68·5	+1·1	+1·6
9	E.	66·2	67·0	−0·8	−0·3
10	E.N.E.	56·0	57·0	−1·0	−0·5
11	N.N.W.	63·4	65·0	−1·6	−1·1
12	S.W.	60·5	61·2	−0·7	−0·2
13	N.W.	65·0	66·5	−1·5	−1·0
14	N.N.W.	68·0	67·5	+0·5	+1·0
15	N.W.	70·2	70·8	−0·6	−0·1
16	N.N.W.	74·8	74·8	0·0	+0·5
17	S.	70·4	70·5	−0·1	−0·4
18	S.	67·6	67·8	−0·2	−0·3
19	S.	66·2	67·8	−1·6	−1·1
20	S.	67·1	68·0	−0·9	−0·4
21	W.S.W.	67·6	70·0	−2·4	−1·9
22	W.	70·6	70·8	−0·2	+0·3
23	N.W.	72·0	72·0	0·0	+0·5
24	W.	67·9	69·5	−1·6	−1·1
25	S.W.	59·9	60·8	−0·9	−0·4
26	S.E.	60·9	61·5	−0·6	−0·1
27	N.W.	66·0	67·0	−1·0	−0·5
28	S.	66·6	67·5	−0·9	−0·4
29	N.E.	68·4	68·8	−0·4	+0·1
30	N.N.E.	68·0	68·8	−0·8	−0·3
31	N.W.	68·1	69·2	−1·1	−0·6
Means .	..	67·7°	68·2°	−0·5°	..

Table VI. represents these means further arranged into quadrants; Quadrant 1 including all wind directions from N. to E.N.E., Quadrant 2 all from E. to S.S.E., Quadrant 3 all from S. to W.S.W., and Quadrant 4 all from W. to N.N.W.

Table VII. represents the same thing, excepting that quarters of a year are taken instead of months, and also that the number of times the wind was observed in any quadrant is added.

TABLE V.

Mean Monthly Corrected Differences of Maxima arranged according to the Direction of the Wind.

	January.	February.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
N.	+1·03	+0·23	+0·17	+0·38	+0·48	+0·20	−0·30	+0·23	+0·48	+0·83	+0·08	−0·46	+0·31
N.N.E.	−1·71	+1·49	+0·15	+1·20	+0·23	+0·57	+0·20	+0·45	−0·15	−0·08	−0·63	+0·90	+0·14
N.E.	−0·40	0·00	−1·30	−0·34	+0·27	−0·23	−1·40	+0·10	−0·15	+1·10	−1·15	−1·27	−0·35
E.N.E.	−1·05	−0·70	+0·40	+0·50	−0·85	+0·70	−0·20	..	..	−1·17	−0·20	−2·40	−0·46
E.	+0·15	+0·02	−1·18	−0·44	−0·53	−0·67	−2·00	−2·45	−1·60	..	+1·20	+0·23	−0·40
E.S.E.	−2·90	−0·30	..	..	..	..	..	..	..	..	..	−0·40	−0·37
S.E.	..	−1·90	−4·40	..	−0·23	..	+3·50	..	..	..	+1·20	−0·60	−0·36
S.S.E.	−3·20	−1·12	+1·35	+0·80	−2·30	−1·00	−0·95	..	..	−1·85	−0·40	+0·60	−0·57
S.	−1·48	−1·46	−2·90	−0·78	−0·84	−0·62	−0·28	−1·00	−1·40	−1·50	−1·30	−0·95	−1·09
S.S.W.	+0·90	−0·50	+1·02	−0·65	+0·80	+0·16	+0·05	−0·50	−1·04	+0·34	−0·53	..	+0·08
S.W.	−3·10	..	−0·85	−0·18	−0·38	+0·33	+0·15	−1·50	−0·60	−0·30	+0·62	−0·47	−0·35
W.S.W.	−0·98	−0·90	−1·10	−1·15	−0·23	−0·15	+0·34	−0·71	−0·22	−0·72	−0·56	−0·38	−0·46
W.	+0·11	+0·59	+0·51	−0·19	+0·04	+0·13	+0·11	−0·02	−0·57	+0·08	−0·13	+0·35	+0·11
W.N.W.	+0·56	+0·05	−1·15	−0·22	−0·25	+1·17	−0·39	+0·02	+0·47	−1·07	+0·27	+0·48	−0·03
N.W.	−0·02	..	+0·52	+0·09	0·00	−0·24	−0·19	+0·11	+1·50	+0·45	+0·44	+0·28	+0·20
N.N.W.	+0·42	−0·19	+0·48	+0·46	+0·32	−0·34	+0·16	+0·30	+0·50	+0·47	−0·14	+1·47	+0·23

TABLE VI.

Mean Monthly Corrected Differences of Maxima arranged according to Quadrants.

	January.	February.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Quadrant 1	+0·13	+0·48	−0·06	+0·22	+0·31	+0·16	−0·30	+0·29	+0·23	+0·31	−0·33	−0·41	+0·12
,, 2	−0·65	−0·42	−0·91	−0·86	−0·66	−0·75	−0·10	−2·45	−1·60	−1·85	+0·40	+0·11	−0·44
,, 3	−0·50	−1·05	−0·61	−0·57	−0·51	−0·11	+0·10	−0·71	−0·58	−0·52	−0·36	−0·48	−0·47
,, 4	+0·17	+0·25	+0·33	−0·02	+0·06	−0·02	−0·04	+0·15	+0·34	+0·15	+0·01	+0·45	+0·15

TABLE VII.

MEAN MONTHLY CORRECTED DIFFERENCES OF MAXIMA ARRANGED QUARTERLY IN QUADRANTS.

	FIRST QUARTER.		SECOND QUARTER.		THIRD QUARTER.		FOURTH QUARTER.	
	Times Observed.	Mean Differences.	Times Observed.	Mean Differences.	Times Observed.	Mean Differences.	Times Observed.	Mean Differences.
		°		°		°		°
Quad. 1	93	+0·16	85	+0·24	59	+0·16	61	−0·16
,, 2	32	−0·58	18	−0·40	8	−1·06	19	−0·04
,, 3	39	−0·72	53	−0·37	62	−0·38	61	−0·47
,, 4	100	+0·26	109	+0·00	145	+0·14	131	+0·19
	264		265		274		272	

Table VIII. gives a yet more condensed grouping, arrived at by drawing an East and West line, and calling all winds which cross it with increasing latitude northerly (N.), and all which cross it with decreasing latitude southerly (S.), west winds being classed with the former and east with the latter. In other words, all winds of Quadrants 1 and 4 are N., and all of Quadrants 2 and 3 are S.

TABLE VIII.

MEAN MONTHLY CORRECTED DIFFERENCES OF MAXIMA ARRANGED QUARTERLY ACCORDING TO THE WIND'S INCREASE OR DECREASE OF LATITUDE.

	FIRST QUARTER.		SECOND QUARTER.		THIRD QUARTER.		FOURTH QUARTER.		TOTAL.	
	Times Observed.	Mean Differences.	Times Observed.	Mean Differences.	Times Observed.	Mean Differences.	Times Observed.	Mean Differences.	Times Observed.	Mean Differences.
		°		°		°		°		°
N.	193	+0·21	194	+0·10	204	+0·14	192	+0·08	783	+0·14
S.	71	−0·66	71	−0·38	70	−0·46	80	−0·36	292	−0·49

The evident interpretation of Tables V., VI., VII., and VIII. is that northerly winds raise the temperature of Kimberley above the normal, whereas southerly winds do the same for that of Kenilworth. It must not be inferred, however, that the numbers given in these tables show absolutely by how much the maximum temperatures are modified by particular winds; that could only be determined if we knew what would be the temperatures if the floors did not exist. Not only that, but the iron roofs of the houses are much more liberally distributed in Kimberley than they are in Kenilworth, and this must also exert some influence. Yet considering how largely secondary influences enter into and disturb normal meteorological phenomena, it is perhaps surprising that the final results should develop with so much regularity.

NOTES ON A JOURNEY IN GERMAN SOUTH-WEST AFRICA.

By J. C. Watermeyer.

(Read January 26, 1899.)

The object of the journey was an inquiry into the agricultural and pastoral prospects of the country.

The German Protectorate on the west coast of South Africa is bounded by Angola on the north, and the Kalahari Desert and Cape Colony on the east and south. It is a territory of about 320,000 square miles in extent. The northern portion is occupied by the Ovambos; Damaraland is inhabited by two classes, the Hereros or Beestdamaras, the wealthy class, and the Bergdamaras, a poorer class, looked down upon by the Hereros, and treated by them as slaves; Great Namaqualand is inhabited by several tribes of Hottentots, Bushmen, and Bastards. The Witbooi tribe has proved the most powerful, and Hendrik Witbooi, their chief, was, even after the German occupation, looked upon as their great general, for offensive and defensive purposes.

Six days after sailing from Cape Town, we reached and disembarked at the mercantile settlement at the mouth of the Tsoachaub River, about 18 miles north of Walfish Bay. From the Orange River northwards a barren, sandy waste reaches inland from the coast for a distance of from about 6 to 40 miles. A belt of shifting sandhills a few miles in width is a prominent feature of this sandy tract, and at the mouth of the Tsoachaub River, where the strip of sand is at its narrowest, the shifting sandhills terminate.

From the Tsoachaub mouth we started on our journey into the interior, our means of transport being an ox-waggon. The first six or eight miles of our journey took us across the sandy waste, and we now proceeded in the vicinity of the river over a no less barren, though less sandy, region, until we finally crossed the river about 20 miles from its mouth. Up to this point we had been making gradual ascent, and now had to descend into the bed of the river, which is here skirted by rocky declivities, the rocks being composed of mica-schist intersected by veins of dolerite and crystalline limestone.

The Tsoachaub River, like most South African rivers, only flows in the rainy season, *i.e.*, during the summer months, but although the river-bed is dry for the rest of the year, water may generally be found by digging into the sand to a depth of a few feet. The vegetation on the banks of the river is fairly luxuriant. Amongst the herbage were noticeable grasses of various kinds, saltbush, and mesembriaceæ, whilst amongst the trees and shrubs the most prominent were the kameeldoorn, mimosa, and tamarisk. Having ascended the mountain on the north side of the river, a height of somewhat over 1,000 feet, we proceeded in a north-easterly direction towards Omaruru, over a bare plateau on the north-west side of the Kau River, which flows in a south-westerly direction and joins the Tsoachaub River. The geological features of this plateau are mica-schist and limestone, passing over into sandstone, interspersed with granite.

At a place called Aukas, we crossed the Kau River for the first time. Here we saw, together with other varieties of acacias, one variety known as the Ana-tree, the pods of which are largely used as cattle food in very dry seasons. In the limestone which exists here, forming a substratum, as in other parts of the country, water is found at a depth of 10 feet and less. Usually where an outcrop of this limestone occurs on the surface, shallow wells have been sunk into it, and a sufficient supply of water has been obtained.

After a journey of thirteen days we reached Omaruru, a distance of 144 miles from the Tsoachaub mouth, and about 3,600 feet above sea-level. This was formerly a mission and trading station; now, in addition to this, a detachment of troops is stationed there. The mission and trading stations are situated on the north side of the Omaruru River, the military camp has been built on the south side. Here the efforts of the missionaries have shown what can be done in the way of cultivation, with energy and care. In the missionary's garden and other gardens were to be seen vegetables of various descriptions in promising condition, together with grape-vines, orange-trees, pomegranates, and date-palms. The officer in charge of the military station had also laid out a large extent of garden ground on the opposite side of the river, upon which much attention was being bestowed. After the rainy season, when the river has ceased to flow, the river-bed is made use of for the cultivation of cereal crops; the results are usually very good, but occasionally an unexpected rainfall brings the river down before the crops are matured, and the harvest prospects are ruined. The natives in the vicinity also do some cultivation on the river banks, growing principally maize and pumpkins, which, with the milk from their cattle, form their principal food.

The northernmost point of our journey was Omburo, a mission station about 18 miles north of Omaruru, about 4,000 feet above sea-level. The geological formation here, as in the vicinity of Omaruru, is still granitic, and I was told that the granite extends into Ovamboland.

At Omburo a hot spring occurs in the river-bed on the upper side of a doleritic dyke which passes across the river. The temperature of the water we found to be 76·5° C. After returning to Omaruru we continued our journey in a south-east direction, towards Windhoek. About 15 miles from Omaruru we passed a hot spring, in limestone, at Omapyu. The temperature of the water is stated by Dr. Schinz to be 61° C. We had no opportunity of measuring it.

Proceeding towards Okahaudja, a mission station 76 miles south-east of Omaruru and 4,000 feet above sea-level, the granite gradually disappears, giving place to mica-schist. Between Omaruru and Okahaudja some beautiful scenery is met with, hilly country alternating with level plain, and the winding river-bed not far off, with its extensive alluvial banks, in some parts overgrown and in other parts only scantily covered with beautiful forest trees. Here also several Herero encampments exist, with their small plantations of pumpkins, maize, corn, and tobacco. At Okahaudja the gardens were well cultivated, stocked with fruit and vegetables. Lucerne and cereals were found to be successfully grown here, and the grape-vine and fig-tree grew luxuriantly.

Between Okahaudja and Windhoek the granite is completely lost sight of, mica-schist, quartz, and sandstone composing the principal rocks in this vicinity.

Windhoek was reached ten days after leaving Omaruru, the distance covered being about 120 miles. This is the principal settlement in the country, being the seat of government and the largest commercial centre. The white population, excluding the military stationed here, did not exceed a couple of hundred at the time of our visit, but by immigration the number is rapidly increasing. The total white population in the Protectorate at the time of our visit was estimated at about 3,000.

Windhoek lies about 5,000 feet above sea-level. It is situated in a narrow valley amongst hills of mica-schist. In the hills on the north side of the village there are five hot springs issuing from limestone. Relatively to each other these springs lie approximately in a straight line, at about the same height, and at intervals of a few hundred yards. It is most probable that these springs are all from the same source, but the peculiarity is that their temperatures vary considerably. Taken in order from east to west, the temperatures, all measured within an hour, were found to be 52° C., 78° C., 69° C., 69° C., and 63° C. Assuming that they are from the same source, it is evident that the water has, in its passage upwards, been differently influenced as to temperature, at the different points, by the geological formation through which it has passed. This water was found to contain 63 grains of solid substances per gallon, mineral matter consisting of alkaline carbonates and sulphates, a trace of chlorides, and a little lime, probably in the form of sulphate. Being hot springs, and sulphate of lime being less soluble in hot than in cold water, the water was not so hard as would have been the case had it issued from the limestone in the cold state. Below the springs there is a deposit of crystalline sulphate of lime on the surface of the soil, which must be taken to have been deposited from solution. The water of these springs is used for domestic supply, and, when cold, for irrigating the few gardens. Cold springs also exist in the limestone which crops out in the valley below the hot springs.

Beyond the range of hills north of Windhoek, and within half an hour's walk, lies a small pastoral settlement in a valley considerably larger than the one in which Windhoek is situated. This settlement is known as Klein Windhoek. The vegetables and fruit grown here, as also the milk, butter, and eggs produced, find a ready sale in Windhoek. At Klein Windhoek there are several springs, mostly cold, but some of them tepid. The deep alluvial soil of the valley is well suited for gardening purposes, but the supply of water available does not allow of very extensive cultivation. The streams which drain the valleys of Windhoek and Klein Windhoek carry an immense amount of water during the rainy season; these two streams unite at a distance of about two miles west of Windhoek, and it has been estimated that during an average rainy season about 494,000,000 cubic feet of water are carried down into the Tsoachaub River by them. We had an opportunity of observing the rainfall at Windhoek during the month of January, and found it to be 4 inches. The total rainfall for the summer months of January, February, March, and April, 1897, amounted to 15·5 inches. Considering that Windhoek is not a specially favoured portion of Damaraland as regards rainfall, and allowing for the rain falling during the months of November and December, it will be seen that Damaraland is not badly off. The rainfall of the period in question was not considered to be unusually high. The greatest rainfall for one day hitherto measured in Damaraland is recorded to be $2\frac{1}{2}$ inches, measured at Omaruru. We experienced a fall of half an inch in fifteen minutes, and again 1·4 inches in an hour and forty minutes, in Windhoek. This shows the heaviness of the downpour, the showers from the thunder-clouds being generally of short duration, but sharp.

From Windhoek we visited Otjimbinque, a mission station 87 miles west of Windhoek, lying about 3,000 feet above sea-level. The geological formation at and around Otjimbinque is granitic, the mica-schist begins to disappear at Otjiseva, 22 miles west of Windhoek, giving place to sandstone. Near Otjiseva, in mica-schist, there is a considerable deposit of staurolite crystals. Granite begins to appear at Barmen, and becomes more noticeable as Otjimbinque is approached. A peculiarity of the granitic hills about Otjimbinque is that they are capped by a deposit of white crystalline limestone, presenting a remarkable appearance, for the line of contact is very distinct, and noticeable at a considerable distance.

At Barmen, 42 miles from Windhoek, there are hot springs issuing from quartzite, one having a temperature of 65° C. and one a temperature of 48·5 C. At Klein Barmen, 7 miles further on, there is a hot spring with a temperature of 61° C.

The village of Otjimbinque lies on the north of the Tsoachaub River, and is divided into two portions by the Omnsema River, which, coming from the north, here joins the Tsoachaub River. The place has been much neglected as regards cultivation of the soil, the old garden of the mission station has been practically given up, and the place and surroundings present a very bare appearance, having of late years been to a great extent denuded of the natural growth of trees and shrubs.

We found Otjimbinque a very hot place, notwithstanding the fact that we had some cooling showers of rain whilst there. It has the reputation of being the warmest portion of Damaraland, and we experienced a temperature of 38° C. (100° F.) in the shade. I may here remark that the humidity of the air in Damaraland in summer is very low, a difference between dry and wet bulb of 15° C. (27° F.) being nothing unusual; in fact we measured a difference of 19·9° C. (36° F.) at 3 p.m. one day at Otjimbinque, when the dry bulb showed 34·6° C. (94° F.) and the wet bulb 14·7° C. (58° F.).

Measurements of the temperature of the sand on hot days were found very interesting; the highest temperature of sand measured by us was 60° C. (108° F.), the temperature of the air in the shade being 30·7° C. (87° F.).

Between Otjimbinque and Okahaudja the country is very hilly, but it also contains a considerable extent of well-wooded alluvial soil, suitable for cultivation. The distance between Otjimbinque and Okahaudja is 73 miles, and in this distance, passing from the granite to mica-schist, there were noticeable sandstone, clay-slate, dolerite, and limestone.

After returning to Windhoek from Otjimbinque we proceeded from there eastwards to Gobabis, a military station near the eastern boundary of the Protectorate. Having travelled about 15 miles, continually ascending, from Windhoek, to a height of about 5,500 feet, we passed away from the mica-schist and entered upon sandstone formation, with lime-tufa and crystalline limestone. Then commenced a gradual descent to Gobabis, which lies 4,400 feet above sea-level. For the next few miles the country is somewhat undulating, then a huge grassy plain is entered upon, later on giving place to stony bushveld, and then again becoming open and grassy. In these parts the natives possess large herds of cattle, but few sheep.

As we approached the White Nosob River our way lay along a sandy flat, with very extensive alluvial soil, to some extent cultivated by the natives. Between 50 and 100 miles from Windhoek the soil not immediately along the river is at first sandy, with a subsoil of lime-tufa, sometimes marly, then crossed by veins of dolerite, then a gravelly karoo soil covered with gannabush, which is one of the principal sheep-fodder bushes in this Colony, and then it becomes hilly and stony and sandy again.

At Witvley, about 100 miles from Windhoek, the limestone tufa is very much in evidence, and a considerable extent of country is low-lying and marshy. For the next thirty miles, as far as Gobabis, which lies on the Black Nosob River, the way is very sandy and heavy for transport, as all the eastern portion bordering on the Kalahari is; the underlying limestone frequently shows itself, and is pierced for water-supply. Here veins of sandstone and quartz conglomerate were very noticeable, crossing the flats as well as traversing the hills. At Gobabis the water-supply is obtained from wells, 10 feet in depth, in the sandstone. The distance from Windhoek to Gobabis is about 135 miles; the time occupied in covering it was ten days.

From Gobabis we proceeded south-west to Rehoboth, and at distances of 12 and 18 miles we passed two watering-places, in limestone which crops out of the sand. About twenty-eight miles from Gobabis, on the White Nosob River, a few miles north of its junction with the Black Nosob River, lies Kaukarus, a settlement of Bechuanas. The people had just been very unfortunate here; most of them were or had been suffering from malaria fever, and their gardens had been partly carried away by the flood of the river, what remained being destroyed by cattle which had obtained access through the rents in the fences caused by the flood. In addition to the usual pumpkins, melons, and maize, these natives also cultivated Kaffir corn and sugar-cane. After leaving this place we traversed some very good grass country, but about 70 miles from Gobabis the aspect is very bare. Here there is a large pan on a bed of limestone, which was dry when we reached it, but water was found in holes made in the limestone bed.

From here, for the next 25 miles, until we reached Hatsamas, on the Schaap River, we passed over a huge grassy plain, sparsely covered with kameeldoorn. Just before reaching Hatsamas the plain narrows and passes into a valley between sandstone hills. The soil in this valley is a good sandy loam, in parts marly, and fairly rich in humus.

On arrival at Hatsamas we had to undergo a period of quarantine of fourteen days, owing to the suspected and afterwards confirmed presence of rinderpest on a farm higher up the river. Whilst here we had ample opportunity of becoming acquainted with this locality.

In a narrow defile between the hills, through which the river runs, there is a good site for making a masonry dam, which would cover a large area with water and serve for the irrigation of a very extensive tract of arable land.

In this locality, in addition to the quartzite and sandstone, there are also occurrences of limestone, granite, and clay-slate. Here we experienced some very heavy rain: during nine days we had a rainfall of 4·7 inches, in the month of April.

Before going further, as the journey from Hatsamas to Rehoboth really introduces us to the southern portion of the Protectorate, I may just pause to review shortly and sum up with a *résumé* of what I had seen so far, describing the general geological characteristics of Damaraland in a few words. To the north and west of Windhoek the rocks are for the most part granitic or mica-schists, it is only south and eastward that quartz and sandstone actually preponderate. Dolerite is of occasional occurrence, and limestone occurs everywhere, either crystalline or tufaceous; where the hot springs are met with it occurs as travertive. The alluvial soil along the river-sides is very suitable for agricultural purposes, but water for irrigation must be provided, by means of dam-making. Large tracts of country, especially north and eastward, are well wooded with kameeldoorn and other acacias, or otherwise we have splendid grass country very suitable as cattle pasture ; but here again the water difficulty presents itself, for there are miles upon miles of grass-veld which is useless as grazing ground because of its being too far away from water for stock. Here by water-boring and well-sinking a great deal could be done. Damaraland is not very suitable for sheep-rearing for wool, because of the thorny shrubs, and also because of the seed of the klitzgras, which, getting into the wool, knots it and causes much trouble, depreciating its value.

As regards precious minerals, gold has been discovered in the Omaruru district, and copper in the districts of Omaruru and Otjimbinque, but, probably owing to expense of working, no development to speak of has taken place.

After our fortnight's quarantine at Hatsamas we continued our journey to Rehoboth. The first part of the way lay over sandstone formation, of a hilly nature, then we reached a large sandy and grassy plain, well wooded with kameeldoorn and hakjesdoorn. About 30 miles from Hatsamas the soil becomes gradually clayey, and after crossing the Usib River, 35 miles from Hatsamas we came upon a hard clay soil covered with low karoo bushes, principally the gannabush. This part of the country strongly resembles our north-western Karoo.

Rehoboth is a mission station, chiefly occupied by the Bastards, who gain a livelihood by cattle and sheep rearing and transport riding. It is situated about 4,600 feet above sea-level. Below the sandstone and shale of this vicinity the limestone evidently still exists, for there is an extensive outcrop of it in the village of Rehoboth, and out of this rises the water-supply of the village, in the form of hot springs, the temperature of which is 52° C. The journey from Gobabis to Rehoboth, a distance of 140 miles, occupied nine days.

From Rehoboth we travelled south-eastwards, skirting the Oanob River for some distance, until we crossed the Usib River just before it joins the Oanob, and passing through good alluvial sandy loam for about 12 miles. After leaving the river we passed on to a sandy soil covered with grass and trees. At Lekkerwater, about 37 miles from Rehoboth, the soil is again of a very clayey nature. After leaving Lekkerwater we crossed seven sandy plateaus, separated by seven ranges of sandhills. These sandy plateaus are poor in vegetation, the most plentiful growth being that of the tsammas, a small melon, which in the absence of water forms a useful substitute, and is very much in requisition, both for man and beast. Having crossed this sandy tract we came upon a formation principally composed of limestone tufa, and at a distance of 70 miles from Rehoboth we reached Bitterwater, a natural pan on a bed of limestone, which was dry at the time. The water in the pits is quite useless; it is briny and bitter, probably containing a considerable amount of magnesia salts in solution. From here to the mission station Hoachanas, about 5 miles further on, we passed over a bare patch of clay and sandstone rock *débris*, sparsely grown with karoo bushes. The missionary stationed here has done a great deal for the conservation of water, which is obtained from springs in plentiful supply. His garden is very carefully tended, and his vines, fig-trees, mulberries, and date-palms, together with his vegetable garden, combine to form a beauty-spot in an otherwise unpicturesque landscape. As he has found the proportion of lime in the marl of his garden ground too great, he has gone to the trouble of carting humus, from a distance of about 7 miles, to mix with the marl. The Hottentots under his charge do not take example by his industry, for although maize and cereals grow well here, they are too indolent to go in for extensive cultivation.

From Hoachanas as far as Witvley, about 40 miles, we travelled over limestone, clay-slate, and sandstone, with a good deal of dolerite, with poor grazing for cattle, but sufficient for the maintenance of sheep and goats. Near Witvley the soil is more sandy, and good grass again appears. Here, in a narrow valley, there is good alluvial clay soil, somewhat marly, and the surface on either side of the valley consists of lime tufa. After leaving Witvley we again crossed several sandy plateaus similar to those north-west of Hoachanas, and after passing these we left the last plateau by a sudden descent of about 30 feet, and found ourselves at Rietmond, occupied by Hendrik Witbooi's people. In this descent it is noticeable that under the sand the limestone occurs, and below this there is a ferruginous sandstone rock. It may therefore be reasonably assumed that the limestone underlies the whole of these sandy plateaus, which are looked upon as perfectly waterless. At Rietmond water issues in springs from the ferruginous sandstone.

From Rietmond to Gibeon the descent is gradual, over sandstone. The country here has for the most part a barren appearance, but in parts the grazing for sheep is good, gannabush and saltbush being plentiful.

We reached Gibeon, 175 miles from Rehoboth, in ten days. Gibeon is a mission and military station. It lies at an elevation of some 3,300 feet above sea-level, on the banks of the Fish River—the largest river in Great Namaqualand—which usually carries water all the year round, and runs southwards, emptying itself into the Orange River. Gibeon is at present the home of Hendrik Witbooi, whose tribe, in spite of all the trouble given to the Germans when fighting for supremacy in their country, has been, since his surrender, looked upon as the most loyal of all the Hottentot tribes.

Near Gibeon there is an occurrence of blue-ground, but no diamonds have as yet been found there.

From Gibeon, after crossing the sandstone hills, a sandy flat is traversed until the river is reached again. After crossing the river we passed over sandstone and clay-slate, with occasional dolerite, as far as the Klein Broekkaross or Little Geitsigubib Hill, about 28 miles south of Gibeon. The hill is about 420 feet high, is composed of clay-slate and dolerite, and has a capping of sandstone. Wherever the bed-rock was exposed at the riverside it was found to be composed of large slabs of ferruginous clay-slate, externally oxidised to the state of red ferric oxide, whilst internally the colour was blue, the iron being in the lower stage of oxidation, as ferrous oxide.

From here to Ganikobis, 30 miles, the soil is mostly a brackish clay soil, with here and there patches of sand or marl, dotted with pebbles of quartz, sandstone, and ironstone. Ganikobis is a Hottentot location on the banks of the Fish River; it was at one time in the occupation of Hendrik Witbooi. Here, in limestone conglomerate in the river embankment, there is a hot spring, with a temperature of 43·5° C. Between this spring and the running water of the river there is a cold spring. From Ganikobis to Berseba the formation is everywhere the same karoo veld, with much bush and little grass. Near Berseba we made a halt for the purpose of ascending the Great Broekkaross Mountain, the Geitsigubib proper.

The top of the mountain is about 5,000 feet above sea-level, but as the plateau below rises to 3,000 feet, the ascent presented no great difficulty. We ascended by way of a ravine, which is apparently the only outlet for the drainage of a large plateau, which we found to be at a height of about 600 feet. This plateau is surrounded by a circular mountain chain of approximately uniform height, which gives it the appearance as of the crater of a huge extinct volcano. The rocks of this plateau are to a great extent basaltic. On this mountain we found several fine specimens of the koker-tree (*Aloe dichotoma*). From here we proceeded to Berseba, a small mission station. Here also the water occurs in a limestone bed. Quite recently a discovery of blue-ground has been made in this vicinity.

The first stage of the journey from Berseba to Keetmanshoop lies over a bare stony karoo, as far as the point at which the Fish River is crossed, 12 miles from Berseba. Here the configuration of the country suddenly changes, but as we passed over this part by night I cannot say much about it, though it appeared to me that the part reached early next morning was similar to that traversed during the night. When daylight broke we found ourselves on a very brack clay soil, covered with a crisp layer of efflorescent salt, apparently alum. The hills round about were mostly low and conical, composed of blue shale, which rapidly falls to pieces on exposure to air. Closer examination of these hills showed that the shale was very pyritic, and also was much intersected by veins of dolerite. The vegetation was very scant, nothing but very hardy bushes and a coarse, woody grass, unfit for fodder, growing here. We reached the first grazing ground at a distance of 14 miles from the place where we crossed the river, and the first water at Huninodis, about 7 miles further on. At this place the water is obtained from wells in clay beds, at a depth of 9 to 12 feet. This water has a strong taste of alum.

From here to Keetmanshoop we passed over a level plateau dotted with dolerite hills, and lost sight of the shale formation almost completely. The soil is more or less sandy, and at intervals single dolerite boulders make their appearance above the ground. We reached Keetmanshoop after a journey of ten days from Gibeon, the distance covered being 125 miles. The village lies on decomposed basaltic rock, principally dolerite, traversed by veins of clay-slate. It is situated in a depression on the north-west side of a low range of dolerite hills. Through an opening between these hills there is a passage, or "poort," at the lowest point of this depression. On this side of the poort the Zwartmodder spring appears, the underground water of the north-west drainage area evidently being blocked by the impermeability of the rock composing this range of hills, and being forced to the surface here. Wells have been sunk in the veins of clay-slate above the spring, and water is found at the same level.

I had to remain at Keetmanshoop whilst my companion proceeded southwards to the Orange River, and on his return we left here for Bethanien, which lies about 85 miles north-west. We did not, however, go direct thither, but made a couple of deviations southwards, in order to visit some farms. The first of these was Seeheim, on the Fish River, about 30 miles south-west of Keetmanshoop. For the first 23 miles the formation is the same as that of Keetmanshoop. Hereabouts we came upon a perfect forest of *Aloe dichotoma*, some very large specimens among them. At Slangkop clay-slate and shale predominate. Slangkop is a high peak, the lower part being composed of shale and the upper part of sandstone. Here there are a number of springs issuing from a low hill composed of shale, which is partially hidden by loose, wind-blown sand. The water is very brack, evidently containing much common salt and alum. From Slangkop to Seeheim the formation is claystone, with some lime-tufa and blue crystalline dolomite. From Seeheim we visited de Naauwte, a spot on the Leeuw River, 12 miles south-east of Seeheim. Here, where the river passes through a poort in a range of dolerite hills, there is a good place for a masonry dam. There is a considerable extent of irrigable land below the site of the dam, but it is rather sandy and much exposed to wind, which blows with considerable force here.

From de Naauwte we returned to Seeheim, and then journeyed to Inachab, a farm on the Koinkiep River, 43 miles west of Seeheim. For the first part of the journey the way lies over red sandstone, very rough and stony ground, across undulating country. In the vicinity of Inachab the soil is more sandy, and good grass veld is met with. The farm Inachab is situated in a wide valley, between sandstone hills; the soil is a good marl, but somewhat brack in patches. Beneath the sandstone, by the sinking of wells, shale has been found to exist, and, making an excursion down the bed of the river for some miles, we were able to notice the formation more clearly, shale existing below, then red sandstone, and above this a capping of dolomite.

From Inachab to Bethanien, a distance of 47 miles northwards, we continued travelling over sandstone formation, strewn with fragments of dolomite, sometimes passing over tracts where the dolomite predominated, in the form of large slabs, then again over very sandy ground. In the neighbourhood of the Bethanien the grass was splendid, and the sheep-fodder bushes surpassed in luxuriance any I have ever seen.

Bethanien, a mission station, is situated in a valley bordering on the Koinkiep River. The alluvial soil is a sandy loam. The occurrence of dolomite is extensive here, and a plentiful water-supply is obtained from springs issuing from limestone conglomerate underlying the dolomite. This water-supply suffices for the domestic requirements of the inhabitants, and also for the irrigation of a large extent of arable land which was under cultivation at the time of our visit.

Bethanien is one of the oldest mission stations in Great Namaqualand. It lies 2,800 feet above sea-level. The journey from Keetmanshoop, including detention at the places we visited, occupied fourteen days, the distance travelled being 125 miles.

From Bethanien we journeyed northwards to Grootfontein, the first 26 miles of the journey, as far as Aussis, being along the Koinkiep River. The soil for the most part was either sandy, with substratum of limestone, or hard limestone conglomerate. To a considerable extent the country is very grassy, and affords excellent pasture for sheep and cattle. Along the river there are numerous Hottentot settlements, and the Hottentots appear to live a very easy and contented life, rearing sheep, goats, cattle, and horses. The absence of agriculture, as compared with similar Herero settlements in Damaraland, was very noticeable.

At Aussis we again came upon granitic formation, which extends northwards to a little beyond Kujas, and westwards is traceable through the sand-belt to the coast. Kujas lies 25 miles from Aussis, and the journey thither took us through beautiful grassveld. Limestone was not entirely absent, but not of frequent occurrence here.

Journeying northwards from Kujas the granite diminishes, and at a distance of 12 miles it has quite disappeared. The grassveld still continues, until we reach a sudden ascent of about 120 feet from the lowlying country along the river, up to a vast plateau, upon which Grootfontein lies. The surface rock at the top of this ascent is dolomite, which is traceable all along the way to Grootfontein, a distance of 42 miles from here. Where the dolomite is not so plentiful the sandstone again appears, with substratum of clay. Grass is scanty along this part, but sheep-bushes abound. The last 27 miles of the journey to Grootfontein is over hard and stony karoo, the only vegetation being sheep-bushes. Water is obtained by digging through the clay stratum into limestone beneath. At Grootfontein clay-slate predominates, but there is also much limestone. Water is there found in wells in the clay-slate. It contains much alum in solution.

Sheep-rearing is the chief industry of the Bastards, who are the occupants of Grootfontein. This place lies about 4,200 feet above sea-level. It is 114 miles distant from Bethanien. The time occupied by our journey was seven days.

From Grootfontein we visited Namseb, 14 miles further north. This is all good sheep country of karoo formation. A few miles west of Grootfontein we also visited a farm where there is an extremely strong spring issuing from limestone. This spring is sufficient for the irrigation of a large extent of good humus soil, overlying limestone conglomerate. The farmer living here could show no results as yet, as he had been there not quite a year, during which he had had to build his house, open up the spring, and make a dam.

From Grootfontein we returned to Kuyas, and from there started for the coast, to embark for home at Angra Pequena. We accomplished the distance of 200 miles in thirteen days.

From Kuyas to Kubub, a distance of 63 miles, the formation is granitic, with beautiful grass-veld, but little water. Kubub is the last place along the route from Keetmanshoop to the coast at which good grazing and good water are obtainable. A little grazing is still procurable further on, but of indifferent quality. At a distance of 42 miles from Kubub, westwards, in the sandbelt of the coast, which is between 30 and 40 miles in extent here, a well has been dug at a place called Ukama, and this is the last water obtainable before reaching Angra Pequena. The distance from Ukama to Angra Pequena is 31 miles, and travelling through the heavy sand is so difficult that this journey occupies two and a half days. Shortly before Ukama is reached the belt of sand is entered upon, and this extends right down to within a couple of miles of the coast, where solid rock predominates. A few granitic ridges and boulders appear at intervals above the sand on the journey through this desert, but where the drifting, wind-blown sand begin such ridges are covered by the sand, forming apparent sandhills, which are seemingly not always in the same position, the explanation being that these rocks and ridges are alternately uncovered and re-covered, one day some and the next day others being overwhelmed and hidden by the ever-moving sand.

There is no grazing to be had here, so transport riders have to bring loads of grass to feed their oxen in the sandbelt, depositing some of it along the route for the return journey. At Angra Pequena there is no fresh water; until lately the settlers there were dependent for their supply on what was obtainable monthly upon arrival of the steamer from Cape Town, or on condensers consisting of glass frames placed slanting over shallow tanks containing sea-water, from which the condensed moisture was collected drop by drop. Now a steam condenser has been erected, and water is obtainable even for the draught cattle, which formerly had to accomplish a five days' journey from Ukama and back without water.

Angra Pequena is a very small mercantile settlement. A few individuals have to reside there, as it is the port of Great Namaqualand, but those whose lot is cast there have a dreary existence. We were very pleased, in spite of the hospitality of the few inhabitants, when the steamer which was to carry us away from here was sighted.

As regards the general characteristics of Great Namaqualand, it is not so well watered nor so well wooded as Damaraland, but it is to a very considerable extent good grassy country, well suited for cattle and sheep, and in parts for horses. In many places it greatly resembles our Karoo. It appears that the growth of sheep-bushes is much more luxuriant than in our Karoo; but it may be that this is merely because hitherto they have not been taxed, as pasture, to the same extent as in our parts.

As regards the geological features, as far as I was able to ascertain by personal observation, sandstone preponderates, and Karoo shales are widely distributed. The sandstone in the north-east and south-east carries limestone beneath it, whilst dolerite is frequent chiefly in the south-east. Granite appears to exist only in the western portion, covering a large area, and the occurrence of mountain limestone, also westwards, and traceable for such a distance, is interesting.

DESCRIPTIVE CATALOGUE OF THE COLEOPTERA OF SOUTH AFRICA.

EDITED BY L. PÉRINGUEY.

(Read January 26, 1899.)

FAMILY LATHRIDIIDÆ.

BY REV. FATHER M. J. BELON,
Member Entom. Soc. of France, &c.

Very little is known of the *Lathridiidæ* of the South African fauna. Thirty years ago Motschulsky (Bullet. Soc. d. Natur. d. Moscou, 1866, iii., and 1867, i.) described from this part of South Africa seven species which are partly synonymous with or local varieties of cosmopolitan species, and which he implies are natives of the Cape of Good Hope. Of these seven species two belong to the genus *Enicmus*, four to the genus *Corticaria*, and one is a *Melarophthalma*.

Thanks to the courtesy and generosity of Mons. A. Raffray, Consul-General for France at the Cape, and Mr. L. Péringuey, Assistant Director of the South African Museum of Natural History of Cape Town, I have been able to examine some examples of the South African species of this interesting but too much neglected family of Coleoptera, and, at the expressed desire of Mr. Péringuey, I now venture to give the result of my investigations, in the hope that this, perforce, incomplete descriptive catalogue of the family *Lathridiidæ* may induce collectors in South Africa to devote special attention to the discovery of new forms.

Thus far seven genera and eighteen species are known to occur in South Africa. Only one species is recorded from Natal; the others—ten of which, however, may be considered as peculiar to the South African region—have been captured in a few places in the Cape Colony, mostly in or near Cape Town.

Several of the insects included in this family are either myrmecophilous, or live in ants' nests; the greater part, however, dwell under stones, especially in slightly moist places, under bark of trees, or in decaying vegetation or vegetable refuse and dead leaves.

Family LATHRIDIIDÆ.

General facies variable, usually oblong or ovate; maxillæ bi-lobate; labial palpi two or three-jointed, maxillary palpi four-jointed, last joint large, more or less rounded or conical; antennæ with eight or eleven joints, first and second joints thicker than the third, the three, two or ultimate ones enlarged and forming a club varying in shape; frontal part with a distinct clypeal suture; labrum short, covering the mandibles, which are short and not prominent; elytra covering the abdominal segments; abdomen with five or six free segments, the first of which is usually longer than the others, while the second, third, and fourth are short; anterior coxæ more or less globose or conical, separated or contiguous; intermediate ones separated, rounded, posterior ones transverse, widely separated; tarsi three-jointed, third joint usually equal in length to the other two, and provided with simple claws.

The family *Lathridiidæ* is differentiated from among the *Coleoptera clavicornia* mainly by the structure of the tarsi. It has not the abbreviate elytra characteristic of the *Pselaphidæ* or of the trimerous group of *Staphylinidæ*. It cannot be mistaken for *Coccinellidæ*, which are also trimerous, because the Lathridiidous beetles have neither the last joint of palpi securiform, nor the second joint of tarsi bi-lobate.

The family is distributed over all parts of the world. It is divided into three tribes containing about twenty-seven genera, but the following synopsis includes only those represented in South Africa :—

Synopsis of Tribes and Genera.

A. Anterior coxæ more or less separated by the prosternum. In the genus *Holoparamecus* they are very little divided); frontal part even, smooth, or hardly punctulate, separated from the clypeus by a single arcuate line; abdomen with five segments only in both sexes. Merophysiini.
Antennæ nine to eleven-jointed, club distinctly bi-articulate; elytra without longitudinal punctate striæ, and having only a fine juxta-sutural stria on each side .. .. *Holoparamecus.*

B. Anterior coxæ more or less separated by the prosternum; forehead uneven, sculptured in sundry ways, punctate, often furrowed and tuberculate, and divided from the clypeus by a transverse depression; abdomen five-segmented in both sexes. Lathridiini.
a. Prothorax with median dorsal costæ entire or interrupted.
b. Antennæ ten-jointed; scutellum indistinct; elytra fused together; upper and under sides covered with a white chalk-like substance *Metophthalmus.*

b^1. Antennæ eleven-jointed; scutellum transverse and very distinct; elytra free .. .. *Lathridius.*

a^1. Prothorax even, more or less densely punctate, often sulcate or foveolate in the middle of the disk, and without longitudinal costæ.

c. Antennæ inserted near the eyes, which are large; scutellum transverse and very distinct .. .. *Enicmus.*

c^1. Antennæ inserted rather far from the eyes, which are small; scutellum punctiform, hardly discernible .. .. *Cartodera.*

C. Anterior coxæ contiguous; prothorax and elytra more or less pubescent and without any costæ; antennæ eleven-jointed with the club generally tri-jointed; when the club is bi-jointed the abdomen has six segments in both sexes. CORTICARIINI.

d. Abdomen with five segments only, at least in the female; body rather elongate .. .. *Corticaria.*

d^1. Abdomen with six segments in both sexes; body shorter *Melanophthalma.*

TRIBE MEROPHYSIINI.

Reitt., Stett. Ent. Zeit., 1875, p. 300; Belon, Rev. Franc. d'Entom., 1897, p. 108.

In this tribe are included a few myrmecophilous genera (*Colovocera*, *Reitteria*, *Displotera*, and *Merophysia*) which have not as yet been met with in South Africa. It is, however, probable that representatives of this remarkable little group, which is characterised by eight-jointed antennæ, the club of which is formed by the ultimate joint only, will be discovered eventually there in ants' nests.

For the present one genus *Holoparamecus* and one species only is known to represent the tribe in South Africa.

GEN. HOLOPARAMECUS, Curt., Entom. Magaz., i., 1833, p. 186.

Body oblong, slightly convex; antennæ inserted under the margin of the anterior angles of the frontal part, number of joints varying from nine to eleven, two apical ones forming an oval, rather stout club; eyes rounded, lateral; prothorax cordiform and varying in sculpture at middle before the base; scutellum transverse, very distinct; elytra with a thin juxta-sutural stria (except the sub-gen. *Tomyrium*).

The number of antennal joints varying in some species, and even according to sexes, the genus has been divided in four sub-genera.

Sub-Gen. CALYPTOBIUM, Aubé,
Annal. Soc. Ent. d. Franc., 1843, p. 242.

This sub-genus, which includes about one dozen species spread over the world, including several regions of Africa, is distinguished from *Holoparamecus* proper by having eleven-jointed antennæ in both sexes.

Holoparamecus (Calyptobium) raffrayi, Bel.,
Annal. Soc. Ent. Belg., 1893, p. 440.

Very closely allied to *H. niger*, Aub., and almost of the same colour and size, but differentiated by the basal pattern of the prothorax. It is elongate, somewhat convex, shining, piceous black, with the antennæ and legs testaceous; antennæ eleven-jointed, the two basal joints stouter and longer, three to nine much more slender, short and transverse, scarcely oblong, nearly equal, tenth and eleventh forming a rather valid club obliquely truncate at tip; eyes extending laterally from the insertion of antennæ to the margin of the thorax; pronotum cordate, a little wider than long, rounded laterally in front, not deeply, but under a strong magnifying glass distinctly punctulate; in front of the base are two transverse, slightly impressed lines (the anterior less, the posterior more conspicuous) limited on each side by a deeper and wider longitudinal groove, and divided by a slender median line without any central raised ridge; elytra oblongo-ovate, vaguely punctulate, sutural stria impressed. Length about 1 mm.

Hab. Cape Colony (Cape Town), captured under stones in April or May.

Tribe LATHRIDIINI.

Reitter, Stett. Entom. Zeit., 1875, p. 313; Belon, Rev. Franc. d'Entom., 1897, p. 110.

Gen. METOPHTHALMUS, Woll.,
Insect. Mader., 1854, p. 192.

Body sub-ovate, partly covered with a white, chalk-like substance; head bi-tuberculate or bi-sinuate on the upper side; antennæ ten-jointed, inserted at the anterior angle of the frontal part, the two apical joints or the ultimate one forming an ovate, rather stout club; eyes rather small and situated above the lateral margin of the hind part of the head; thorax uneven and with two dorsal interrupted median costæ; scutellum indistinct; elytra soldered, coarsely puncato-striate.

Key to the Species.

Elytra darker, pitchy black, elongate, parallel from the base to two-thirds of the length; thorax reddish ferruginous .. .. *peringueyi.*

Elytra and prothorax reddish ferruginous, distinctly ovate, and at their widest at about the middle .. .. *capensis.*

METOPHTHALMUS PERINGUEYI, Bel.,
Annal. Soc. Ent. Belg., 1898, p. 441.

Elongato-ovate; head and thorax reddish ferruginous, elytra darker, piceous black; under side, pronotum and lateral margins of the elytra covered with a white, chalk-like substance; head arched in front, bare on the upper side, and with two more or less oblong rounded tubercles in the centre; antennæ ten-jointed, rather short, third joint minute, transverse, fourth conspicuously elongate, fifth and following ones a little shorter than the fourth or hardly longer than broad, ninth transverse, sub-globose, not fitting against the tenth, which is abruptly wider, three times as long, and alone forming the club; prothorax transverse, covered on the upper side with a white chalky pulverulence except on the lateral margins, which are narrowly denuded, likewise the dorsal costæ, the basal tubercles and the intermediate area; it is twice as wide as the head, a little more attenuate in front than behind; the lateral margins about the middle are sub-angular or rounded, and the posterior angles are obtuse; elytra elongate, parallel from the base to two-thirds of the length, and from there ovate, not wider than the thorax, and having eight deep and very coarse longitudinal series of punctures; the suture and alternate intervals are raised and form conspicuous costæ; the shoulders are not depressed, but obtusely angular, and are covered with a narrow strip of chalky-white pulverulence, the lateral interval is covered in the like manner for two-thirds of the length. Length 1–1·2 mm.

Hab. Cape Colony (neighbourhood of Cape Town, Devil's Peak). I have seen two examples, which are perhaps male and female, because they differ in the outline of the lateral margin of the thorax, the one being sub-angular, the other somewhat evenly rounded.

The antennal single-jointed club differentiates this pretty little species, as well as the following one, *M. capensis*, from all the European representatives of the genus, and also, I believe, from all the other *Metophthalmi*, except *M. exiguus*, Woll., from which however, it differs by the relative proportion of the third and fourth joints of the antennæ.

Metophthalmus capensis, Bel.,
Annal Soc. Ent. d. Belg., 1898, p. 442.

Oblongo-ovate, entirely reddish ferruginous; under side, pronotum, and lateral margins of the elytra covered with a white chalky substance, the same as in the preceding species; head arched in front, bare on the upper side, and having two more or less rounded small tubercles in the middle; antennæ ten-jointed, rather short, and similar in shape to those of *M. peringueyi;* pronotum transverse and also covered with a white, chalky substance; it is twice broader than the head, a little narrower than the elytra, angulate or almost rounded at middle laterally, and conspicuously more attenuate in the anterior than in the posterior part, the angles of which are obtuse; elytra covered with the chalk-white substance in the same manner as *M. peringueyi*, distinctly ovate, widest at about middle, and having eight longitudinal series of coarse punctures; the suture and alternate intervals are cariniform; the shoulders are not depressed, but a little obtusely angular. Length 1–1·2 mm.

Hab. Cape Colony (neighbourhood of Cape Town, Muizenberg, at the foot of liliaceous plants in sandy dunes).

Very closely allied to *M. peringueyi*, owing to the peculiar shape of the antennæ and the chalky-white vestiture. I am satisfied that it is quite distinct from the latter on account of the shape of the elytra, which is oval, not parallel.

Gen. LATHRIDIUS, Herbst,
Käfer, v., 1793, p. 3.

Body ovate, more or less convex; antennæ eleven-jointed, inserted upwards at the anterior angle of the forehead, club formed by the two or three ultimate joints; eyes rounded, rather large, and lateral; thorax very uneven, sinuate laterally, and having in the middle two longitudinal costæ; scutellum distinct, transverse; elytra ovate, free, striato-punctate.

Two cosmopolitan species of this genus have been met with in South Africa. They belong to the second section of the genus characterised by the tempora rather elongated behind the eyes, and the deep lateral constriction of the thorax.

SUB-GEN. CONINOMUS, Thoms.,

Skand. Coleop., v., p. 217; Belon, Rev. Franc. d'Ent., 1897, p. 127.

Key to Species.

Antennal club bi-jointed; elytra with the alternate intervals carinate, carinæ neither transversely interrupted nor tuberculate .. *constrictus*

Antennal club tri-jointed; elytra with the alternate intervals more or less costate, transversely impressed behind the base and in the middle, third interval abruptly tuberculate beyond the middle, and the fifth before the apex .. .. *nodifer*.

LATHRIDIUS (CONINOMUS) CONSTRICTUS, Gyll.

Elongate, little convex, more or less brownish testaceous, shining; antennæ and legs lighter; antennal club two-jointed; thorax as long as wide or a little longer, the two median longitudinal costæ more or less distinctly raised, sides deeply constricted behind the middle; elytra punctato-striate with the alterning intervals more or less distinctly costiform, and without any transverse interruption or tubercle. Length 1·5–1·8 mm. (2 mm. in South Africa).

The two examples I have seen differ from the European types in being a little longer, almost 2 mm., and by the tempora, which are quadrate and parallel instead of being convergent from behind.

Hab. Natal (Estcourt).

LATHRIDIUS (CONINOMUS) NODIFER, Westw.,

Introd. Classific. Ins., i., p. 155, pl. xiii., fig. 23.

Ovate, elongate, shining black or piceous, with the antennæ and legs more or less ferruginous, and sometimes entirely testaceous; antennal club three-jointed; thorax longer than wide, transversely depressed near the base, surface very uneven, two longitudinal carinæ along the centre, sides rounded in front, and provided behind the middle with a deep incision and constriction; elytra oblongo-ovate, transversely depressed behind the base and in the middle, strongly punctato-striate with the alternate intervals more or less costate, the third one after the median part, and the fifth before the apex have a tubercular swelling impressed laterally; the hind tibiæ of the male are deeply notched at about three-quarters of the length in the inner side. Length 1·8–2 mm.

Gen. ENICMUS, Th., Skand. Col., v., p. 233.

Body ovate, more or less convex; antennæ eleven-jointed, inserted upwards at the anterior angle of the forehead and rather close to the eyes, which are rounded, large, and lateral, the three apical joints form an elongate, loose club; thorax even, more or less densely punctate, transversely impressed before the base, sulcate or foveolate in the middle of the disk, but without longitudinal costæ; scutellum transverse, very distinct; elytra free, striato-punctate, with the seventh interval more or less costate.

The prosternum in *Enicmus* proper is sharply cariniform between the anterior coxæ. I have seen no representative of this sub-genus from South Africa.

Sub-Gen. CONITHASSA, Thoms., Skand. Coleopt., v., p. 221; Belon, Rev. Franc. d'Entom., 1897, p. 131.

In *Conithassa* the posternum is not so much raised and not produced between the anterior coxæ. The following species is spread abundantly all over the world, and the structure and outline of the prothorax are most variable.

Enicmus (Conithassa) minutus, Linn., Syst. Natur., ii., p. 675, n. 12.

Permidius flavicornis, Motsch., Bull. Mosc., 1866, iii., p. 245.
Permidius basalis, Motsch., *loc. cit.*, p. 246.

This species is easily identified in spite of its variableness; the thorax usually as long as broad, and a little narrowed towards the base, is rugosely punctate, and has two longitudinal foveæ in the centre which often unite and form a median shallow depression or furrow; it has besides a rather deep transverse impression in front of the base, the lateral margins are more or less lobate in the anterior part and rounded or truncate; the oval elytra, which are not much elongate, are glabrous, coarsely punctato-striate, with the punctures impinging transversely over the intervals which are raised in rounded costæ, at least near the base; the punctuation of the first abdominal segment is fine and very dense, but coarse and denser on the metasternum; the post-coxal foveolæ have sharply plicate margins; the colour is often testaceous, or turns partly to brown and to black, while the antennæ and legs are ferruginous; the basal joint of the antennal club is not thicker at the base than the apical part of the eighth joint. Length 1·2–1·4 mm.

Hab. Cape Colony (Cape Town and neighbourhood, Stellenbosch).

I am satisfied that two examples captured at Stellenbosch by Mr. Péringuey belong to this cosmopolitan species. They have the same colour and the other insignificant characters given by Motschulsky to differentiate his *Permidius flavicornis* and *P. basalis;* but although the South African specimens do not agree absolutely with the description of the two alleged species, they have on the upper and under side the distinctive characters of the European *E. minutus.*

Gen. CARTODERA, Thoms.,
Skand. Col., v., p. 219.

Body elongate, narrow, and more or less depressed; antennæ eleven-jointed, inserted upwards at the anterior angle of the forehead, often remotely from the eyes, which are small and lateral, the two or three apical joints forming an elongate, not much dilated club; thorax even, more or less rugosely punctate, without longitudinal costæ on the disc, and usually without foveolæ; scutellum punctiform, hardly distinct; elytra free, elliptical or linear, striato-punctate, and having narrow interstices; anterior coxæ hardly divided by the narrow prosternum, and sometimes contiguous.

Cartodera watsoni, Woll.,
Trans. Ent. Soc. Lond., 1871, p. 253.

C. bi-costata, Reit., Verh. K. K. Zool. Bot. Gess. Wien, 1877, p. 183.

C. godarti, Bel., Ann. Soc. Lin. Lyon., 1881, p. 147.

This remarkable and most elegant minute insect is distinguished at first sight owing to its very elongate head, oval thorax and bicarinate elytra. I have one example in my collection labelled "Cape of Good Hope." As this species is found in various parts of Africa, its capture in Cape Colony is not surprising. It is possibly of American origin, as it occurs in Mexico, Venezuela, and Chili.

TRIBE CORTICARIINI.

Reitt., Stett. Ent. Zeits., 1875, p. 410; Belon, Rev. Franc. d Entom., 1897, p. 114.

Two genera only, including eleven species, are known to occur in the Cape Colony. When these minute insects are more carefully searched for, there is little doubt that the number of South African species will be considerably increased.

GEN. CORTICARIA, Marsh.,

Ent. Britt., 1802, i., p. 106.

Body rather elongato-ovate, usually pubescent on the upper part; antennæ eleven-jointed, inserted upwards at the anterior angles of the forehead, the three apical joints forming an elongate, loose club; eyes globose, lateral, usually prominent and large, rarely small, coarsely granulate; prothorax without longitudinal median costæ, often foveolate before the base; lateral margins more or less denticulate; scutellum distinct; elytra striato-punctate; abdomen six-jointed in the male, five-jointed in the female.

Corticaria proper are principally characterised by the elytra clothed with a somewhat long, erect or curved pubescence, and by the metasternum as long as the first ventral segment.

The three following species belong to this group, but as I have been able to examine one only, I do not venture to give a synopsis of them.

CORTICARIA PUBESCENS, Gyll.,

Insect-Suec., iv., p. 123, n°. 1.

Entirely or partially brownish-ferruginous on the upper side, under side often black; antennæ and legs always lighter in colour; all the joints of antennæ are distinctly longer than broad; thorax sub-cordate, much narrower than the elytra, widest in the anterior part at about one-third of the length, more or less denticulate laterally, and having normally a median, rounded, somewhat deep fovea near the base; elytra a little irregularly striato-punctate, the punctures coarse and rugose; fifth ventral segment hollowed in both sexes in a round, median fovea; fourth segment of the female also foveolate in the middle.

Hab. Cape Colony (Stellenbosch) in November. In a male of this species the basal fovea of the thorax is almost obsolete. This is a mere aberration.

CORTICARIA CAPENSIS, Motsch.,
Bullet. Mosc., 1867, i., p. 51.

Size of *C. pubescens*, but more robust, elongate, sub-convex, sparsely pubescent, rufo-testaceous, with the antennæ and the legs of a lighter colour; eyes black; thorax transverse, rounded, convex, deeply rugoso-punctate, and having a large rounded fovea impressed behind, sides very much arcuate, crenate; elytra, obsoletely striate, with the intervals wide, slightly plane, and closely punctate. Length $\frac{1}{2}$ lin.; width $\frac{1}{3}$ lin.

I have not seen any example of this *Corticaria*, but on careful consideration of the diagnosis, it seems highly probable that it is synonymous with *C. pubescens*, Gyll.* Motschulsky says nothing of the structure of the antennæ and of the fifth ventral segment, which leads one to believe that these organs are quite similar to those of the last-named species. This author adds that *C. capensis* is shorter than *C. pubescens*, that the thorax is more transverse with the sides more marginate and more deeply crenate, the punctures of the elytra are coarser and transversely rugose, and the striæ are less hollow, except the juxta-sutural one, which is strongly defined; the pubescence is less dense and disposed in rows.

Hab. Cape of Good Hope.

CORTICARIA TENUICORNIS, Motsch.,
Bullet. Mosc., 1867, i., p. 77.

Colour and size of *C. fulva*, but a little narrower; antennæ slender; elongate, sub-depressed, sparsely pilose, ferrugineo-testaceous, base of antennæ, elytra, and legs a little lighter in colour; eyes black; head and thorax closely rugoso-punctate, the latter

* *C. pubescens* seems to have spread all over the world.—L. P.

transversely quadrate, a little narrowed behind, and having a deep transverse fovea, sides arcuate and crenulate with small teeth; elytra a little broader than the thorax, slightly ampliate at middle, closely striato-punctate, intervals narrow, sub-convex, sparingly pilose. Length $\frac{4}{5}$ lin.; width $\frac{1}{3}$ lin.

According to the author himself, this species must be very closely allied to *C. fulva.* I think that the Cape insect is not sufficiently distinct from the cosmopolitan and very variable *C. fulva.* Motschulsky says nothing about the antennæ and the sexual character of the fifth ventral segment. If the structure of these organs is the same as in *C. fulva*, it will be easy to distinguish the present species from its congeners *C. pubescens* and *C. capensis*, because in the antennæ of *C. fulva* all the joints are not elongate, the seventh and eighth are hardly as long as wide; besides the two first joints of the antennal club are not obconic and very attenuate towards the base, but proportionally shorter and rounded and dilated in the base itself. The fifth abdominal segment of *C. fulva* has not the large rounded fovea characteristic of both sexes of *C. pubescens*, but has instead a transverse impression rather distinct and deep in the male, and more or less obsolete in the female. Comparing the two species, Motschulsky says that *C. tenuicornis* is "hardly smaller than *C. fulva*, the median antennal joints are more slender, the pubescence on the elytra is less elongate and less closely set; all the intervals are narrower, and the lateral ones are somewhat raised."

Sub-Gen. ADASIA, Bel.,
Rev. Franc. d'Entom., 1897, p. 147.

In this sub-genus are included the species with short, thin, decumbent, and often scanty elytral pubescence; the fifth ventral segment has generally a single little fovea in the male, and sometimes also in the female.

Corticaria (Adasia) serrata, Payk.,
Faun. Suec., i., p. 300, No. 31.

A few examples of this common and cosmopolitan species taken together in the Cape Colony represent three types of colouration; the normal one, *i.e.*, rufescent on the thorax and blackish on the elytra, and two others in which the whole body is either dark or uniformly pale testaceous.

Body oblongo-ovate and convex; eyes contiguous with the front margin of the thorax, and without any temporal tubercle at the back of them; eighth joint of the antennæ sub-globose, ninth and tenth about equal, transverse, dilated, and rounded from the very base; thorax transverse, rather rugosely punctate, and with a pre-scutellary fovea, broadest laterally before the median part, but narrowed towards the base; lateral margin sharply denticulate, especially behind; elytra more or less strongly striato-punctate, with the intervals transversely regulose. Length $1\frac{3}{4}$–2 mm.

Hab. Cape Colony (Stellenbosch).

Motschulsky has described the two following species as specifically distinct from *C. serrata;* I believe, nevertheless, that they do not essentially differ.

Corticaria (Adasia) quadricollis, Motsch., Bull. Mosc., 1867, i., p. 59.

According to Motschulsky, "the thorax is narrow and the colour darker than in *C. laticollis*, Mannerh. (=*C. serrata*, Payk.); it is elongate, hardly shining, covered with scattered punctures, and of a dark ferruginous colour; the mouth, the antennæ, which are short, and the legs are rufo-testaceous; head short, triangular; eyes black, prominent; thorax broader than the head by one-third, almost quadrate, densely punctulate, and having behind an obsolete, rounded, small fovea, sides hardly arcuate; elytra one-fourth wider than the thorax, elongato-ovate, closely punctato-striate, with the intervals transversely rugose.

Hab. Cape of Good Hope.

Corticaria (Adasia) adustipennis. Bull. Mosc., 1867, i., p. 59.

The author describes this species as being the size of *C. serrata* but narrower, thorax more cordate, shining, strongly but not closely punctured; the basal fovea is deep, and the lateral crenulation finer; elytra a little wider than the thorax, sub-parallel with the striæ regularly punctate; the intervals are transversely rugose and disappear towards the apex.

Hab. Cape of Good Hope.

Gen. MELANOPHTHALMA, Motsch., Bull. Mosc., 1866, iii., p. 269.

Body ovate, short, convex, more or less pubescent; antennæ eleven-jointed, inserted upwards at the anterior angles of the forehead, the two or three apical joints forming the club; eyes globose, lateral, more or less prominent, coarsely granulate; thorax without discoidal costæ, usually transversely furrowed or foveate near the base, sometimes, however, without prescutellary depression; scutellary depression distinct; elytra striato-punctate; abdomen six-jointed in both sexes.

Melanophthalma proper is characterised by the tempora of the head being a little prolonged behind the eyes; the fore tibiæ are single in both sexes, and the first abdominal segment has the post-coxal impressed lines.

Synopsis of Species.

Antennal club bi-jointed.
Head and thorax ferruginous; elytra black or wholly ferruginous *fuscipennis.*
Body wholly black, except the second to ninth joints of the antennæ, which are testaceous .. .. *capicola.*

Antennal club tri-jointed.
Body wholly black, except the legs and the base and club of the antennæ, which are piceous red .. .. *picina.*
Body more or less ferruginous, antennal club infuscate .. .. *transversalis.*

Melanophthalma fuscipennis, Mannerh., Germ. Zeits., v., p. 62, No. 58.

Ovate, rather short, convex, briefly pubescent; head, thorax, antennæ, and legs rufo-testaceous; elytra black or piceous brown, seldom rufo-ferruginous; antennal club bi-jointed; thorax transverse, slightly rounded on the sides, narrower than the elytra at the base, hind angles almost straight; the surface is not closely but moderately punctate, and there is a slight ante-scutellary impression, often obsolete; elytra not closely punctato-striate, with the intervals sub-convex, rather broad, and indistinctly punctulate; fore tibiæ and tarsi simple in both sexes. Length 1–1·5 mm.

I have seen only one example from Frere, Natal. It is wholly ferruginous, and probably immature. I imagine that this small and elegant species, the home of which is in Southern Europe and Northern Africa, is not uncommon in South Africa.

MELANOPHTHALMA CAPICOLA, Bel.,

Rev. Franc. d'Entom., 1898, p. 161; Ann. d. Belg., 1898, p. 446.

Oblongo-ovate, rather convex, shining, briefly pubescent, entirely black, except the second to ninth joints of antennæ, which are testaceous; head moderately punctate; eyes prominent, separated from the anterior margin of the thorax by some short but distinct tempora; antennæ short, joints three to eight small, hardly longer than broad, ninth very little thicker, transverse but not fitting against the club, which is abruptly bi-articulate; prothorax transverse, narrower than the elytra, obtusely angulate in the middle of the sides, not closely but moderately punctured, and having a transverse groove in front of the base; elytra with the striæ punctured like the interstices; first ventral segment having three oblique post-coxal lines. Length 1·5 mm.

Hab. Cape Colony (Cape Town and neighbourhood).

The bi-jointed club of the antennæ causes this species to be included in the first group of the sub-genus, and distinguishes it from the species following, which is compared by Motschulsky to *M. sericea*, Mannerh., and should therefore belong like it to the *Melanophthalma* with a three-jointed club.

MELANOPHTHALMA PICINA, Motsch.,

Bull. Mosc., 1866, iii., p. 285.

"Size of *M. sericea*, but narrower, colour nearly black; oblongo-sub-ovate, sub-depressed, shining, punctate, hardly pubescent, base of antennæ and legs rufo-piceous; eyes large, black; head sub-oblong, rugosely punctulate; thorax hardly broader than the head, sub-transverse, remotely punctate, broadly impressed transversely at base, obliquely narrowed in front and behind, sides distinctly angulate, sub-obtuse in the posterior part; elytra nearly twice broader than the prothorax and three times as long, sub-ovate, broadly truncate in front, deeply striato-punctate, intervals narrow, a little raised, sparingly pilose, with the hairs seriate. Length $\frac{1}{2}$ lin.; width $\frac{1}{5}$ lin.

"*Hab.* Cape of Good Hope."

This form, which is unknown to me, is probably a dark variety of *M. sericea*, Mann. (=*transversalis*, Gyll.), unless Motschulsky has mistaken the number of the joints of the antennal club. He says also that the sides of the thorax are distinctly angulate; such is not the case in *M. capicola* or *M. transversalis*.

Melanophthalma transversalis, Gyll., Ins. Suec., iv., p. 133, n°. 11.

Ovato-oblong, a little convex, briefly pubescent. Body dark testaceous-brown, or rufo-ferruginous, sometimes with the suture and the lateral margins of the elytra infuscate; antennæ lighter testaceous, club three-jointed, infuscate; thorax transverse, slightly rounded laterally, narrower than the elytra at the base, and with the hind angles almost straight and sub-acuminate; surface more or less strongly but not closely punctate, and with an arcuate, sometimes obsolete, transverse depression before the base; elytra striato-punctate, with the intervals often more or less partly punctulate in rows; fore tibiæ and tarsi simple in both sexes. Length 1·3–2 mm.

Hab. Cape Colony.

I have seen one example of this species which is easily distinguishable from *M. distinguenda* by the dark, three-jointed antennal club and by the sides of the thorax, which are not angular, but on the contrary, are rather rounded. It is also separated from *M. capicola* and *M. picina* by the usually light ferruginous red colour which is sometimes infuscate on the suture only, and on the lateral margins of the elytra.

I have not yet received from South Africa *M. distinguenda*, Com., it is, however, highly probable that this species, which has spread all over the world, and is met with in several regions of Africa, is also represented in the southern part of that continent.

Sub-Gen. CORTICARINA, Reitt., Verhandl. K. K. Zool. Bot. Ges. Wien, 1880, p. 68.

This sub-genus differs from the preceding one by the absence of tempora behind the eyes, which are contiguous to the anterior margin of the thorax; the first ventral segment lacks the post-coxal lines of the former group, but often the fore tibiæ of the male have inwardly a pre-apical tooth.

Synopsis of Species.

Elytra clothed with long, erect pubescence; thorax about twice narrower than the elytra, and having a more or less defined transverse groove before the base .. .. *trichonota.*

Elytra clothed with very short, decumbent pubescence; thorax almost as broad as the elytra, and with a nearly obsolete prescutellary small fovea or depression.. .. .. *fulvipes.*

Melanophthalma (Corticarina) trichonota, Bel.,
Annal. Soc. Entom. Belg., 1898, p. 448.

Entirely reddish-ferruginous, with the ultimate joint of the antennæ alone a little infuscate; broadly ovate, shining, convex, elytra covered with long, erect pubescence; head and thorax equally moderately punctate; no tempora behind the eyes, which are nearly contiguous with the anterior margin of the pronotum; all the joints of the antennæ are elongate, the three apical ones are little enlarged and form a loose club; prothorax about twice narrower than the elytra, transverse, more or less impressed with a transverse groove before the base; the lateral margins are rounded, broaden before the middle, and are a little more narrowed towards the base; elytra ovate, rounded, and sub-truncate at tip, more coarsely striato-punctate than on the head and thorax, interstices almost without punctures, pubescence alternately longer and erect; metasternum a little shorter than the first ventral segment, and with rather coarse but not very close punctures; first ventral segment punctulate in like manner, truncate between the posterior coxæ, and almost equal in length there to the three segments following, which are short, of equal length, and have each a transverse row of punctures. Length 1·9 mm.

Hab. Cape Colony (Uitenhage).

Melanophthalma (Corticarina) fulvipes, Com.,
Coleopt. Novoc., 1837, p. 39, n°. 82.

Briefly oval, convex, usually little pubescent; body testaceous, more or less deeply coloured, with the under side either infuscate or ferruginous; antennal club tri-jointed, usually light testaceous like the joints of the funiculus; thorax transverse, very little narrower than the elytra, rounded on the sides, with the hind angle obtusely acuminate, hardly foveate or depressed in front of the scutellum and with the surface strongly punctate; elytra rather strongly punctate, with the intervals hardly punctulate; metasternum straightly truncate between the hind coxæ. Length 1–1·3 mm.

Hab. Cape Colony.

Although the only example of this species found by Mr. Péringuey has the antennal club partly infuscate—an anomaly which is exceedingly rare even in examples from southern parts and of dark colour—this species is easily distinguished from the preceding one by the proportional width of the thorax, and the absence of long, erect pubescence on the elytra.

INDEX TO FAMILY *LATHRIDIIDÆ.*

CAPE NATIONAL FORESTS.

By D. E. Hutchins.

(Read August 31, 1898.)

We are now importing yearly 5,000,000 cubic feet of timber, mostly pine (average of last two years, 4·93). This comes from four sources: Germany and Russia, Sweden, and America. Of these sources of supply, it is only in Germany that the forests are being scientifically conserved and worked with a regard to the future. The present value of the German forests, capitalised at 2½ per cent. (which is a fair, all-round estimate, though some of them yield as much as 5 per cent.), amounts to the enormous sum of £100,000,000 sterling! The prices obtained for wood in Germany have more than doubled during the last half-century. These are average prices. In some localities the competition of coal and iron has reduced the value of wood.

In Russia, an impecunious Government has leased large areas of forests to factories and mill-owners, who are destroying it so rapidly that the climate is becoming impaired. The Russian famine of four years ago was caused by drought, attributed by local scientific authorities to the rapid destruction of the forests.

In Sweden most of the forest is in the hands of private owners. It is steadily going the way of all such forest. Much of the wood that reaches the Colony from Sweden is, within my observation, young and immature. Witness the wooden sleepers imported by Government a few years ago.

The forests of America are in process of rapid destruction. The period at which the destruction will be so far advanced as to stop exportation has been variously estimated at from twenty to fifty years. To some extent this point will depend on the growth of the sentiment in favour of scientific conservation, the first effect of which will be a diminution of supplies. There is a strong and rapidly growing feeling in America in favour of national forests. Large areas of forest lands have been quite lately set aside for this purpose. The forest reserves established under the Act of March 3, 1891, amounted to 60,851 square miles. These became final in

March, 1898. Further extensive reservations were made by President Cleveland on the very eve of his retirement.

So far then as these four sources of supply are concerned, an early exhaustion of three is to be looked for, and the fourth (Germany) in the future will want all its timber for home use. What have we then to take their place? Very little abroad. The remaining forests of the cold temperate zone are less accessible, and can only be worked economically with a considerable rise in present prices.

In Great Britain, Dr. Nesbit tells us, out of 3,000,000 acres of woodlands only 2 per cent., or ninety square miles (about the area of the Knysna forest region), are the property of the State. England pays £17,000,000 yearly for imported wood, of which about £14,000,000 is for wood that could be grown equally well in the British Isles.

In the warm temperature zone the forests are chiefly composed of hardwoods, which though precious locally and for certain uses, are not likely to long affect the general timber supply of the world. It is true that there are vast stores of hardwood, mostly eucalypt, in Australia, and that some of this, chiefly jarrah and karrie, is now coming to South Africa for sleepers and wood-paving. The combined karrie and jarrah imports during the last four years averaged 63,000 cubic feet yearly, *i.e.*, only one-eightieth of our present total wood imports. Australia itself imports pine wood on much the same scale as South Africa. The Colony of New South Wales imported for home consumption pine or allied soft wood:—

1895–96	£287,398
1896–97	318,411

In the tropics the forests are composed almost entirely of hardwoods that can never take the place of pine and deal for house-building purposes. Though a tropical pine exists, it is little more than a botanical curiosity. Tropical countries will never produce pine timber, much less export it.

We have therefore to look for a rise in the price of imported wood; and when the time comes, a rapid enhancement (for reasons stated above) of the £250,000 we now pay yearly for imported wood. It behoves us therefore to plant largely, and at once, so as to reduce as soon as possible this heavy drain on the country—to set our house in order against the day when this drain will be still further increased. The exact proportion that the wooded area of a country should bear to the whole cannot be dogmatically laid down, but it is accepted in the forest schools and universities of Europe: 1. That the proportion of woodlands to the total area of a country should not be less than 25 per cent. in populous countries like Europe. 2. The woodlands of a country to be scientifically worked and effectively maintained must be either owned or managed by the State. The latter proposition may sound bureaucratic, and to trench on that liberty of the subject on which an Englishman prides himself; but this is not so. It is simply an outcome of the fact that forest management to be effective must be perpetual. It is accepted, equally in the military Republic of France, in Imperial Germany, in Austria, and even in demôcratic Switzerland, where no official can legally be appointed for more than three years at a time. As the outcome of this principle the valuable forests, owned by municipalities in France, Germany, Austria, and Switzerland are managed by the Government forest officers, the net forest revenues only being paid to the owners. And as a result, the very considerable municipal forests of these countries form part of the effective and permanent forest areas of these countries. Italy, Spain, Sweden, and the minor States follow the same policy more or less completely. The proportion between the area under forest and the total area of a country is an important consideration. What that proportion should be will, of course, vary with the circumstances of the country. A damp insular country suffers less from the want of forest than a dry inland country. England pays the foreigner £14,000,000 yearly for imported wood which, on almost every ground, would be better produced at home. Climatically, however, England suffers nothing from the loss of its forests. But for inland or arid countries the loss of forest means loss every way. Germany and Russia have 26 per cent. and 42 per cent. respectively of their area under forest. In Russia the forests are badly distributed. In Germany the forests are well distributed, and are a perpetual source of wealth and strength to the country: of wealth in the wood they produce; of strength in the million or so of strong men who work in, and live by the forests. Now in Germany the forest reserves are most jealously guarded. It is held that there are some minor defects of distribution, but that the total area cannot be reduced, and that 25 per cent. is the minimum quantity of forest area necessary for a country situated as is Germany. It is calculated that one million people live directly on the forests of Germany, and three millions indirectly, *i.e.*, on forest industries. Directly and indirectly the German forests support 12 per cent. of the population. The area under forest in Cape Colony (including the Transkei) is barely over $\frac{1}{4}$ per cent.

(0·29 per cent.), or, in other words, to raise Cape Colony to the European and Indian standard its woodlands would have to be multiplied eighty-six times. Sad indeed is it to reflect that small as these national forests are, they are held on an uncertain tenure—a tenure that would satisfy no prudent landowner or business man of any sort.

The following table shows the area under forest in Cape Colony, compared with that in some other countries:—

Countries.	Area under Forest in Acres.	Percentage under Forest of Total Area of Country.
Russia in Europe	527,427,000	42
Sweden	42,366,000	42
Austria	46,856,000	31
Germany	34,350,000	26
Norway	18,920,000	25
India	140,000,000	25
France	20,750,000	16
Portugal	1,666,000	5
Great Britain and Ireland	2,790,000	4
Cape Colony	353,280	0·29

From this it will be seen that Cape Colony stands far below these other countries in its proportion of forest, while the climate of the country is such that it ought to have a percentage under forest at least equal to Germany. Dryness is the characteristic of the climate, and imported timber has to come 6,000 or 7,000 miles by sea.

Nine-tenths of the wood required is pine. For the last two years the average importation, in million cubic feet, has been: Pine, 4·57; pine and all other woods, 4·93. Pine plantations can be produced all over the south-west districts at from £2 to £3 per acre. The pine sowings on the Tokai Flats have cost about £1 5s. per acre, and at Uitvlugt £2 5s. 6d., while £8 per acre would be a moderate price for producing an average timber plantation under less favourable circumstances. It is necessary to augment the forest reserves by every possible means, and the readiest and most remunerative way to do this is by means of pine sowings. With these figures before us, it seems incredible that in Cape Colony the area of woodlands is only ¼ per cent. of the total area of the country. Though this is a sad figure, the case is not quite so bad as might appear at first sight. It is only the fertile coast districts that can ever carry a population at all comparable to that of Europe, and thus have a like demand for wood. The coast districts possess at present the whole area of indigenous forest—areas that are being extended and enriched by the more or less complete application of sound Forest Conservancy. But in the south-west districts the indigenous forest that once clothed the mountains of the sea-board has been almost obliterated by mismanagement, and it now remains to restore, as quickly and as economically as possible, a certain area by means of plantations. The railway system of the country, and the various centres of population indicate where these forests can most economically be placed.

Following the example of Germany and Central Europe, we should form: (1) Village plantations like that of Worcester, to be paid for on the £ for £ principle jointly by Government and Municipalities, to remain the property of the Municipalities, but always managed by the Government forest officers; (2) larger Government plantations, like those at Tokai and Uitvlugt, near Cape Town, at Ceres Road and Fort Cunynghame, adjoining the railways, and managed and owned by Government. Such plantations, to be economical, must be situated within minimum rainfall limits of 15 or 20 inches per annum. At some distance inland these rainfall limits can only be secured by going a certain distance from the railway on to the mountains. The Cedarberg mountains are a case in point.

Is planting profitable? The Worcester plantation is the only one of the plantations that is as yet old enough to have produced a marketable crop. At the end of the first crop this plantation, which is only 60 acres in extent, showed a net profit of £4,338 after deducting all expenses of formation and management, or £3,438 allowing interest at 3 per cent. on the cost of formation.

As a further example of the profits derivable from a blue-gum plantation on a farm, the following extract from "Tree-planting, 1893," may be cited: "As an illustration of the value of a blue-gum fuel copse let us take the case of a few acres planted near the homestead of a farm. An ordinary household in fairly well-to-do circumstances uses four or five tons of coal, or its equivalent, per year. One acre of blue-gum copse in fair growth will yield continually ten tons (dry weight) of wood fuel per year. The cutting up of the small wood yielded by the copse is not expensive; but let us suppose that of this ten tons of wood nearly one-half goes in working expenses, and that from 1 acre of blue-gum copse we only obtain the net equivalent of five tons of coal: we arrive then at the conclusion that 1 acre of blue-gum copse will keep a household always comfortably supplied with fuel free of cost. What this free fuel means, in pounds, shillings, and pence, will of course depend on circumstances. To a household in the suburbs of Cape Town it means about £15 a year. In many other Colonial towns where wood has to be brought from a distance it means more. At Knysna the cost of transport makes wood fuel dearer than at Cape Town.

WORCESTER PLANTATION: BLUE-GUM.

	Receipts.			Expenditure.		
	£	s.	d.	£	s.	d.
1892.						
Up to December, 1892, the account stood—Receipts	9,695	13	9	...		
Gross expenditure since formation of the plantation, including railage on wood to Kimberley	...			9,287	14	1
1893.						
Receipts, Kimberley Contract	3,246	17	2	...		
Local sales	263	18	8	...		
By expenditure—Railway transport on timber	...			1,623	8	7
Working expenses at Worcester	...			253	7	3
1894.						
Receipts, Kimberley Contract	2,817	17	7	...		
Local sales	381	12	10	...		
By expenditure—Railway transport on timber	...			1,408	18	10
Working expenses at Worcester	...			562	9	7
1895.						
Receipts	1,497	0	5	...		
Local sales	577	6	1	...		
By expenditure—Railway transport on timber	...			748	10	3
Working expenses at Worcester	...			257	16	10
Interest for 15 years on £2,000 at 3 per cent.	...			900	0	0
BALANCE (net profit)	...			3,438	1	1
	18,480	6	6	18,480	6	6

To many a farmer free fuel means the saving of the scanty indigenous trees on his farm—the beauty, the shade, the water, and the shelter for stock, produced by these trees. To every one who has the means we would counsel the planting of an acre of blue-gum copse near the house or homestead. It will render the surroundings more healthy and pretty. Under favourable circumstances it will cost about £7 (planting 5 feet by 5 feet), and will repay its cost twice over the first year. It may be allowed to grow untouched for ten to twelve years, and then cut over gradually during the next ten years; and so on, in perpetuity, one-tenth of an acre being cut over and ten tons wood harvested, each year."

The Uitvlugt Forest Reserve is the Epping Forest of Cape Town. Situate within four miles of the heart of the city, it comprises 8,000 acres in one solid block, stretching from behind Rondebosch across to Maitland and northwards along the line of railway. It should be the future playground of the citizens of Cape Town, like the beautiful forests dotted round Paris. Already it is the only large area remaining unfenced near Cape Town. Game is increasing, and the money beginning to come in for shooting licences will enable us to do more towards preserving the game. It is the only spot in South Africa where re-foresting has been conducted on a large scale by the inexpensive process of simply ploughing the land and scattering the seed broadcast. From six to eight tons of cluster-pine seed are used yearly in this work, and it is easy to imagine oneself in Germany as one walks for half a day over acre upon acre of young pines, stretching over the rolling flats as far as the eye can reach, and bounding the horizon on every side. And we have here what they have not got in Germany—long stretches of the estate covered with *Acacia saligna*, the golden wattle of West Australia, bursting into blossom. The wind blows loaded with the sweet scent, the colouring is most vivid, and with the backing of Table Mountain and the hum of the city in the distance, the shadows and sunshine on the mountain and the soft spring air, I know of no prospect more enchanting in this beautiful Cape Peninsula.

Though cluster-pine closely grown in dense plantations will be quite a different wood from that of the sparsely grown firewood tree, and be largely used for house-building, as is indeed now the case at Genadendal, there is one employment for which the coarsest and roughest cluster-pine timber can always be used. I refer to railway sleepers. Lately we imported wooden sleepers. Now we are importing costly iron sleepers, and misusing for sleepers the Knysna yellow-wood, that ought to go into flooring boards. No doubt one of the most important uses for cluster-pine timber in the future will be for railway sleepers. It will be interesting therefore to consider what yield of cluster-pine sleepers might be expected from a plantation, say, on the Cape Flats, and also what would be the cost of such sleepers. As regards yield, there are no old regular plantations of cluster-pine on the Flats. Measurements have therefore been taken in the most regular cluster-pine plantations that could be found elsewhere. Two determinations have been made at Newlands and one at Plumstead. The first Newlands sample area yielded an average acre-increment (firewood and timber combined) of 178 cubic feet. The second sample area has given an acre-increment of 170 cubic feet. Both sample areas were taken through woods of even density and fair growth, both were only eight years of age. Older trees would undoubtedly have given a higher acre-increment. From the Plumstead trees an acre-increment as high as 300 cubic feet was obtained. The better portions of the Uitvlugt Reserve present a growth which is nearly or quite equal to that obtained from the sample areas at Newlands. However, making allowances for lesser growth generally on the Flats, and for a considerably lesser growth on certain of the shallow soils of the Flats, it seems fair to assume a general average increment of 100 cubic feet of wood per acre per year for cluster-pine plantations on the Flats.

A simple calculation shows that if two-thirds the area of the Uitvlugt Reserve, or 5,524 acres, were planted with cluster-pine, there would be produced annually 138,400 sleepers, assuming with an annual acre-increment of 100 cubic feet, that five-eighths of the wood production would be timber fit for sleepers, and that a sleeper contains $2\frac{1}{2}$ cubic feet. This is considerably above the annual supply of sleepers now obtainable (but which will be less hereafter) from the Knysna forests. They could be supplied from Uitvlugt at a fraction of the cost from Knysna, or of the imported sleeper, and would appreciably cheapen the cost of railway construction in this portion of the Colony.

The working expenses of timber put on to the railway trucks at Worcester averaged during 1895 $1\frac{1}{3}$d. per cubic foot. The cost of transport from the more distant parts of the Uitvlugt Reserve would average 3d. or 4d. per sleeper for the whole area. The plantation charges amount to £11 7s. 8d. per acre at the end of thirty-five years, *i.e.*, 3,500 cubic feet are produced at a cost of £11 7s. 8d., equal to 0·78d. per cubic foot, and the cost of the wood in a sleeper is thus 0·78d. by 2·46 cubic feet, equal to 1·92d., say twopence per sleeper. The manufactured cluster-pine sleeper put on the railway at Uitvlugt would cost 11d., or 2s. 7d. creosoted on the spot, at Knysna rates :—

	£	s.	d.
Plantation charges	0	0	1·92
Felling, dressing, and loading into trucks (Worcester rate of 1·3d. per cubic foot)	0	0	3·20
Transport as above	0	0	2
Sawing 8 feet superficial at 3s. 6d. per 100 feet	0	0	4
Creosoting, *vide* quotation for half-round sleepers	0	1	8
Total	£0	2	7·12

The Uitvlugt Forest Reserve may be expected in thirty-five years to yield 7,733,600 sleepers at a cost to the country of 2s. 7d. each. The same sleepers imported have cost 5s. 6d. each. (Average cost from May, 1882, to January 1891, *vide* report of Superintendent of Sleepers for 1891.) Blue-gum and black-wood sleepers cut from local forests in Tasmania are produced at a cost of 2s. 6d. each delivered on the railway. The actual yield from seventy acres of mixed forest, of medium quality, at Uitvlugt, is reported thus by the district forest officer : "An area of seventy acres mixed pine and wattle plantation has been cut over ; only half the wattle was cut, as the bark on the remainder was too light for tanner's use. The yield was 60,630 lb. bark, and brought in a net revenue of £45 9s. 6d., or 13s. per acre. The firewood from the barked wood from 30 acres has been sold, fetching £64, or £2 2s. 8d. per acre. The value of the Port Jackson bark on trees still standing, I estimate, is worth 6s. per acre, and the wood 18s. The cluster-pine, taking its value as firewood only, I estimate at £2. Adding these amounts together gives £5 19s. 8d. as the present selling value of the crop of this class of plantation. The plantation is ten years old, so the annual income is 12s. per acre."

So much for the vigorous-growing common woods. Special trees are being grown in the Government plantations to meet special wants. There is no really elastic wood like ash or hickory in South Africa. Various kinds of ash are now being cautiously tried. When we cross the Gamtoos River and say goodbye to sneezewood, the only other durable natural timber in South Africa is Clanwilliam cedar. For bridges, fencing-standards, and other outdoor work a durable timber is in constant demand. Imported pine, even when creosoted, is but a temporary expedient for such imperishable timbers as sneezewood and Clanwilliam cedar. While those two woods are not being lost sight of, we are growing, as durable timbers, in the plantations : jarrah, karrie, rostrata gum, sugar gum, tereticorni gum, iron barks, and other durable gums, as well as the camphor-tree, the two pencil cedars, the catalpa, and various cypresses yielding durable fragrant and easily worked woods.

One hundred miles nearly due north of Cape Town begins the rugged and lofty Cedarberg Range. I hope very soon to see the restoration of the once fine cedar forests going forward at the rate of an acre a day. Last summer fire was successfully excluded from the whole of the demarcated forest area. The Clanwilliam cedar (*Callitris arborea*) is noteworthy as being the only valuable indigenous timber that lends itself easily to reproduction from broadcast sowings *in situ*. Seed is obtainable at the same price as pine seed. This cedar is the only indigenous timber that is at the same time durable, easily worked, and not liable to shrink, crack, or warp on seasoning. It has at the same time a most delicious fragrance when cut, and is no doubt one of the valuable timbers of the world. Trees of large size were formerly obtainable.

The exact influence of forests on climate is a much controverted point. This may be taken as established: that the general action of forests is to moderate temperatures and to more evenly distribute subsoil moisture. Forests render days cooler and nights warmer. They dry up swamps and subsoil moisture, but keep the soil moderately moist at the surface by protecting it from sun and wind. They have a slight and varying influence on the direct rainfall. Their chief and most beneficent influence is as storers of moisture. This they do in three ways:—

1. Their foliage stopping sun and wind checks evaporation.
2. The forest soil-humus has wonderful water-absorbing powers. It holds about ten times as much water as a sandy soil.
3. The forest subsoil is penetrated and opened up by the deep-reaching roots of forest trees. Roots of vigorous forest trees will penetrate pot-clay and burst asunder massive rock.

The effect of all this is to retain in our midst the water that would otherwise rush off to the sea. Who that has watched South African rivers in flood has not been impressed by the wealth of water, and indeed soil too, rushing purposelessly away to the ocean? The country is mountainous and elevated, and a large part of its rainfall is thus practically lost. The actual rainfall is often enough if only we could keep it from running away into the sea. Our coast districts average as much rain as the east of England, our dry Karoo has as much rain as central Spain, but our sun is hotter, our winds more powerful and drying. Hence the wonderful climatic utility of forest in South Africa!

Says that accurate observer Gilbert White of Selborne:—"Trees perspire profusely, condense largely, and check evaporation so much that woods are always moist; no wonder therefore that they contribute much to pools and streams." In South Africa, on account of the hotter sun and more drying winds, the protective or water-conserving action of forest is greater than in England. Several cases have been brought to my knowledge in South Africa where streams have dried up or diminished after clearances and have again increased in strength with the restoration of the forest. At Knysna the roads are only kept dry enough to be passable by cutting, and by keeping cut, at considerable expense, the forest bordering the roads. To produce its full moisture-conserving effect the forest must be dense and composed preferably of slow-growing species.

This then is the action of forest on moisture under ordinary climatic conditions. Under certain extreme conditions of drought trees will lower and exhaust the little remaining subsoil moisture, while their watery exhalations will have little appreciable effect in moderating the parched atmosphere, and their protective covering to the soil is of no use since all superficial moisture has vanished. In America and other countries there usually exists a belt of poor open forest between the dense forest of the fertile country and the treelessness of the quite arid country. It is probable that in the open forest of this intermediate zone the trees exhaust more moisture than they conserve, at any rate during droughts, and can thus only subsist in a sparsely scattered condition. Scattered trees and open forest in most cases exhaust more moisture than they conserve. Hence the erroneous conclusions not infrequently drawn by unskilled observers as to the true action of complete, viz., dense forest. Very fast-growing trees such as the casuarina in India, the blue-gum and other eucalypts in South Africa, use up enormous quantities of water in their vegetative process, and usually (especially as young trees) exhaust more moisture than they conserve. This has happened with the casuarina plantations in Mysore and the Braamfontein plantations near Johannesburg. A common effect of blue-gum planting may be referred to here. The blue-gum is a native of a cool, damp climate. When planted in a dry, warm climate it is singularly active in drying up marshes, wells, springs, and all moisture that is within reach of its powerful vegetation functions. We see here in fact the struggle for existence of a young vegetative giant too often misplaced by man!

To obtain the maximum water-conserving action of forest dense masses of slow-growing trees (preferably of the pine class) should be planted. All trees, the water-exhausting trees such as eucalypts especially, pour vast quantities of water vapour into the atmosphere. When and how that vapour will condense into precious rain and grateful cloud it is the province of the meteorologist to study. It will be readily seen that only large forest areas will ordinarily produce an appreciable effect in this way on the rainfall, and this effect is exceedingly difficult to determine by instrumental observation. Similarly, the effect of trees in causing "drip" and attracting thunderstorms is not easily measured and is usually but partial and local. The certain and beneficent action of forest, as we have seen, is in arresting the rush of water to the sea and preserving it from evaporation. To a country situated as in South Africa, there is here a positive and practical gain that bulks largely in considering the utility of national forests.

The way to make national forests the health, wealth, and glory of a community is clear. Make them now while the gold and diamonds supply the funds, and they will remain with us—a perpetual source of public weal, like the forests of Germany, when the gold and diamonds are done. Peru made railways in the rich early guano days. It is possible to make too many railways, to overstimulate agriculture in a climate of scanty and uncertain rainfall; but a strong forest policy is open to no misgiving. We now spend a quarter of a million yearly on imported wood. We shall soon spend more. £250,000 yearly at 3 per cent. represents a capital of £8,333,300, which is more than one-fourth the National Debt of the Colony.

Nor is this all: one million people, as we have seen, live directly on the forests in Germany; three millions indirectly. Not only are we sending one quarter of a million pounds sterling out of the country yearly, but we are keeping from us the population that would be supported by the expenditure of this money in the country—a population that need not be coloured, like the mine labourers, but white, as the farmers and the bulk of the wood-cutters at Knysna.

I hope I have succeeded in showing that national forests are worth more to this country than is generally supposed. One hears much of fruit-culture. Many of our leading men have put their hands deep into their pockets over fruit. One can scarcely open a daily paper without some reference to the fruit industry. Young men come out from England to seek a fortune in fruit-growing. Almost every farm has its patch of fruit trees. I know too much of the climates of California and Cape Colony not to believe in fruit-growing myself. But after all, what is fruit compared to forestry! Mr. Merriman, in his speech of last May to the Horticultural delegates, estimated the total value of the fruit produced in Cape Colony at £100,000. Our most successful fruit-grower has assured me that this is its outside value. Now look at the forest figures. During the last two years we have paid an average of £269,349 for wood imported into Cape Colony. Nearly the whole of this wood will be produced at a fraction of this figure in Cape Colony itself when the national forests have reached the modest figure of about 50,000 acres, or 78 square miles only (assuming an average acre-increment of 100 cubic feet for pine plantations). The average value of the imported wood, nearly all sawn pine, is about 1s. per cubic foot. On good arable ground in the south-western districts sawn pine-wood can be produced, as we have seen, at from 4d. to 6d. the cubic foot. This is from *in situ* sowings. But even where transplants have to be used and young trees planted, the cost under favourable circumstances is not much more. In the larger forest nurseries, notably at Fort Cunynghame, near King William's Town, young forest trees are now produced ready for transplanting at a cost of only 7½d. per 100.

Taking Germany as our model, with one-fourth of its area forest worth at the present day £100,000,000, it is certain that we have but to follow in the footsteps of Germany to cover our National Debt by means of a national asset—the State forests. As compared with Germany, we have a climate that is not always favourable to the tree growth, but this may be said to be more than compensated for by the rapid growth of trees in the favourable districts.

Most important of all, when we have got our forests we must learn how to keep them. For the last fifteen years the Forest Department has laboured at building up the Forest Reserves, and this work of forming the national forests has been highly supported by Parliament. The last Estimates voted for the Forest Department totalled £60,135. In the settled parts of the country all that remains of the indigenous forest has been brought under systematic management, and plantations of the more valuable exotic timbers are going forward at the rate of about 5½ million trees yearly on 1,800 acres. Three and a half million trees on 1,049 acres are the figures for the Western Conservancy for 1897. But there is a danger, more especially in a British community, where the sentiment in favour of national forests is not so strong as on the Continent of Europe, that, yielding to temporary pressure, slices of the national forests may be alienated. Lately it has been ascertained that there is a flaw in the Forests Act, and that such alienations are possible. In Australia it has been found advisable to remove the railways from political control. Forests, far more than railways, demand a settled policy and fixed governance. After all railways can be made, bought, and sold like any other commodity. Not so forests. Their restoration may be a work of several generations, and involve an expenditure out of all proportion to what was obtained from their alienation. The re-foresting of the Table Mountain range from Tokai to Cape Town is a case in point.

A few years back the Inspector-General of Forests to the Government of India went on a tour through some of the Australian forests, and before leaving addressed a pregnant letter to the Government of Victoria. What he most insisted on was the necessity of at once demarcating the national forests and rendering them safe from alienation, an inviolable national property. I look forward with confidence to the time when the national forests of the country will, after the railways, be its most precious possession, its most thriving industry. He said *inter alia:* "The forests of a country must be looked upon as a capital left in trust for the whole community: the interest alone should be consumed. It is easy of proof, both by historical evidence gathered from all parts of the globe and by the result of modern scientific inquiries, that a certain proportion of a country must be maintained under forest cover in order to secure the permanency of national progress and prosperity. The percentage of forests which it is necessary to maintain varies considerably with local conditions, but the fact remains that it is easier to deforest the superfluity of forest land than to recreate forests where they have been devastated and are found wanting. It is consequently a matter of great importance that the Government of a new country should make up its mind as early as possible, both with regard to the extent of permanent forest reserves and their final situation, *that the areas selected should be made inalienably safe for serious special reasons of State,* and that they should be treated for the one purpose of permanent retention under forest cover."

That forests can thrive where agriculture is difficult or impossible, one has only to recall the steep, richly wooded slopes of the lofty Amatolas, the similarly beautiful forest with its gigantic yellow-wood trees in the barren Knysna country, and, perhaps most striking of all, the cedar-trees of Clanwilliam, growing on the absolutely bare rocks of the stupendous Cedarberg Range; while at Genadendal we see an introduced tree, the cluster-pine, hardier than any of the indigenous trees, spreading itself self-sown up the rocky mountain-side, in spite of fires, drought, hot winds, and climatic vicissitudes that are too often the despair of the agriculturist.

NOTES ON THE DWYKA COAL MEASURES AT VEREENIGING, TRANSVAAL, Etc.

By E. J. Dunn, F.G.S. (Lond.)

(Plate I.—Map.)

Situation, Etc.

The Vereeniging coal-mines are situate on the north side of the Vaal River where the railway crosses the river between Johannesburg and Bloemfontein. Height above sea-level at the station is 4,750 feet. The surface below which the coal occurs is fairly level. On the south side of the river is the Cornelia coal-mine, about 1½ miles distant from the Vereeniging shaft. These mines are opened up and worked on a large scale, having a daily output of about 1,000 tons of coal. I am indebted to the courtesy of the owners and the manager, Mr. Goodwin, for the opportunity of examining the geological evidence laid bare in the workings.

Geology.

Along the railway line from Elandsfontein to Vaal River, the Rand Beds of auriferous conglomerates, quartzite, shales, and intercalated diabase rocks are crossed for a few miles, then a belt of Lydenburg Beds (dolomite) until 2 miles south of Meyerton Station, where the Dwyka conglomerate crops out and the coal measures. Southward from this the Dwyka conglomerate and accompanying coal measures go underfoot, and they do not crop out again at the surface for hundreds of miles; they reappear on the south side of the basin running from Matjesfontein past Prince Albert to Grahamstown. The western, southern, and eastern extension of the Dwyka conglomerate was laid down in my report to the Cape Government in 1886, and the northern limit is now added in the accompanying plan.

The Dwyka conglomerate is directly overlaid by the black carbonaceous shales all round the enormous area enclosed by that rock; at Kimberley these shales attain a thickness of 240 feet, and some of the beds carry 9 per cent. of carbon. At Vereeniging the coal seams lie either immediately upon the conglomerate or there is black shale intervening for a few feet with black shale again above the coal. It follows that the Dwyka conglomerate is a splendid bench mark; below its main body it is useless to search for coal, but above it, either directly or in some cases perhaps at a considerable height above it (because the conglomerate was in places unevenly deposited, and was probably levelled up before the coal seam was deposited), the coal measures and coal were laid down.

North of Kimberley the Dwyka conglomerate is exposed, and near the Vaal River again on the south bank at varying distances up to Parys in the Free State, then it turns northward, passing 2 miles south of Meyerton Station, and again crosses the Vaal to the south bank a little east of Vereeniging, continues along the Vaal River until south of Heidelberg, where it encloses the South Rand coal-field on the north side of the Vaal, as shown on Mr. Sawyer's geological plan of that area, turns south and crosses the Vaal River into the Free State, then turns northward and passes a few miles east of Heidelberg, Transvaal, and on to the Wilge River, then turns easterly and passes to the south of Middelberg, turns up towards Steenkamp's Berg, and thence runs south-easterly along the east slope of the Drakensberg, past the Slangapies Berg and southward through Zululand to the junction of the Mooi and Tugela Rivers in Natal. This gives a total length of the area occupied by the Dwyka conglomerate and its accompanying coal measures of 800 miles from Middleberg, Transvaal, to near Karroo Poort, Cape Colony, and an extreme width of 350 miles between Kimberley and East London. Outside of this area outliers occur at many places, the Zyferfontein and Boksberg coal-fields in the Transvaal belonging to this same horizon, and east of Boksberg undisturbed Dwyka conglomerate exists, while the denuded material from the conglomerate covers considerable areas of the older rocks on the north side of the Vaal River.

The length of the outcrop of the Dwyka conglomerate and accompanying black shales, coal, &c., exceeds 2,000 miles. In 1886 the black shales and other strong indications of coal, and in places thin seams of coal, also were known. Now with the light thrown on the subject by the Vereeniging and other extensive coal-mines along the northern edge of the area, the argument formerly advanced that the poverty of the outcrop in coal argued against coal in quantity existing in workable seams further into the basin falls completely to the ground, for such coal seams as are now being worked within the northern rim of the area are simply phenomenal, ranging for 6 feet of workable coal to over 60 feet.

In 1886 the probability of Sub-Karroo coal was predicted on geological grounds alone. The realisation far exceeds the most sanguine expectations, for at the horizon indicated excellent coal in seams of abnormal thickness is being turned out in thousands of tons weekly in the Transvaal and Natal.

These great seams that are being worked so extensively in the Transvaal dip away underfoot in the Free State, and should be cut at about 1,500 feet at Bloemfontein. In the Cape Colony a bore where the railway crosses the Orange River from Kimberley should cut the coal measures within 300 to 400 feet or less. The dip of the coal measures from Kimberley is southwards, and near De Aar on the one side of the high ground and Cradock on the other are the likeliest points upon the Port Elizabeth to Kimberley line at which bore-holes should succeed.

Mr. A. R. Sawyer, of Johannesburg, has not only bored extensively over the South Rand coal-field, but he has also sunk a large shaft 582 feet deep here, and opened out upon a seam of coal 54 feet thick having a thin parting of sandstone 12 feet from the top. This coal is reported of excellent quality. Here sandstone, shale, and dolerite, to a thickness of over 100 feet, intervene between the coal and the Dwyka conglomerate below, but they appear quite conformable, and this negative fact has no weight against the positive evidence afforded at Vereeniging. Mr. Sawyer most fully endorses the view that his coal seam is of Sub-Karroo age, and his borings amply confirm this view. At Vereeniging the results of over twenty borings were placed at my disposal, and out of these eight showed the coal resting directly upon the Dwyka conglomerate, in the others black shale from 1 to 19 feet thick intervened.

At Vereeniging the Dwyka conglomerate consists of angular fragments, boulders, pebbles, &c., of quartzite, sandstone, shale, chert, dolomite, diabase, &c., and conglomerates both from the Rand Beds and the Lydenberg Beds, all such materials as might be derived locally, and ranging in size from grains of sand up to two and three hundredweight a piece. This material lies scattered without order or arrangement through a fine light grey clay, which is used extensively for making firebricks, &c., and locally termed fireclay. This Dwyka conglomerate shows by its general condition, by the forms of the included boulders, &c., and by the striated faces of the pebbles, boulders, &c., that it is of glacial origin. There appears to be a rude kind of bedding observable where this conglomerate is excavated for making firebricks as though it had been deposited in water. However deposited, there can be no doubt as to its being of glacial origin.

The very important point is that the upper portion of the conglomerate *shades by degrees into a carbonaceous shale* in places, further, *root-markings of carbonised matter* penetrate into the conglomerate at right angles to the almost horizontal surface, and these embrace, in some cases, boulders covered with striations.

The Dwyka conglomerate in fact forms the "underclay" or "seat-stone" of the coal seam in which plants actually grew, and this has hitherto been supposed not to occur in South Africa—it certainly does not occur in the Stormberg coal-field.

But the Dwyka conglomerate does not only form the floor on which, in some cases, first black shale then coal was deposited, but through the seam of coal itself, at many levels between the floor and the roof, pebbles and boulders also of glacial origin are met with, some weighing over a hundredweight each.

Then again, what is still more conclusive, the roof of the coal at Vereeniging is formed by a bed of conglomerate from 1 inch to 18 inches thick, and this, though generally of small pebbles of quartz and shale of greenish colour, contains strewn through it many larger boulders, pebbles, and angular fragments, some of them not only of the forms characteristic of glaciation, but also well striated.

Here is a case of coal being deposited under conditions the reverse of what is generally held to be favourable to the growth of such a luxuriant vegetation as would be required to furnish many feet of coal. For while the basal glacial conglomerate was as yet newly deposited, vegetation flourished upon it, then coal became deposited; while this was in progress glaciated pebbles were dropped into the seam, and then above all glaciated material was again deposited, some of the boulders being partly in the coal, partly in the conglomerate above it.

The section of the main shaft at Vereeniging is as under:—

Surface soil	2·0
Grey soft shales (pyrites)	30·0
Black micaceous shales and pyrites forming beds up to 6 inches thick (calamites abundant at base)	30·0
Conglomerate (glacial)	1·0
Good coal	9·0
Black carbonaceous shale	5·0

Floor Dwyka conglomerate, shading into carbonaceous shale at top.

On the south side of the mine the section of the Cornelia shaft is alluvial sand and clay, pebble bed at base	51·3
Clay shale	3·9
Soft micaceous sandstone	106·7
Dark grey carbonaceous shales	7·6
Soft micaceous sandstone	1·0
Dark grey carbonaceous shale	42·8
Coarse grit	4·8
Dark grey carbonaceous shale	27·10
Dark micaceous shale	77·0

Coal	1·9
Grit and pyrites	·6
Dark carbonaceous shale	21·0
Coal	6·0
Micaceous shale	1·3
Sandstone and dark carbonaceous shale	44·9
Coal (inferior)	22·0
Sandstone and shale	8·0
Conglomerate	1·0
Coal (good)	13·0
Shale	5·0
	446·6

Floor Dwyka conglomerate.

At No. 10 bore-hole, near Cornelia shaft, the section is alluvial sand and clay, with pebble bed at base	52·0
Shale	8·0
Coal (inferior)	3·0
Shale	2·0
Coal (inferior)	18·0
Micaceous sandstone	14·0
Dark micaceous sandstone	30·0
Coal	11·0
Shale	2·6
Coal	8·6
Shale	4·6
Conglomerate (coaly partings)	8·0
Coal	13·0
Shale	·6
Sandstone and conglomerate	5·0
Coal	4·6
Shale	3·0
Carbonaceous shale	1·0
Conglomerate	·6
Coaly shale and pebbles	5·6
	194·6

Floor Dwyka conglomerate.

These three sections will serve to show how variable the constituents of these coal measures are within even a very limited area.

It is a remarkable feature of the Ecca Beds and the Dwyka conglomerate that wherever they are cut even hundreds of miles apart the sequence of the beds is much the same, and that beds having certain characteristics are easily recognised at vast distances apart. For instance, at Grahamstown, above the black and soft light-coloured shales there is a bed of what is called "Hone Stone" —shales that break up into angular, narrow strips about 1 inch thick. This very same peculiarity recurs at the junction of the Vaal and Orange Rivers, also at Pietermaritzburg and elsewhere. Again the black shales are invariably overlaid by lighter coloured softer shales, a thin cherty band occurs some distance from where the black shale is met with at Grootfontein, and this is again met with at the junction of the Orange and Vaal Rivers. These facts indicate that over an immense area and under exactly similar conditions these beds were deposited, possibly in a very extensive shallow lake.

In my 1886 edition of the *Geological Map* I included within the Stormberg coal measures all the coal outcrops then known, but recent facts necessitate an alteration of the boundary, and it will be interesting to make out the proper extension northward of the Stormberg coal measures.

The Coal Seam.

At Vereeniging the coal seam is as follows: At the base is the Dwyka conglomerate known locally as "fireclay"; it is about 50 feet thick and rests upon Lydenburg Beds. This conglomerate is thickly studded with boulders, pebbles, &c., that are striated and glaciated. The upper portion shades gradually into a carbonaceous sandy shale in some places, and is thickly penetrated with root-marks runnin vertically into it, the general surface being fairly horizontal. This is a true "underclay" or "seatstone," and it is locally termed "fire-clay" because the upper portion when separated from the stones is made into firebrick, &c. This conglomerate is rudely bedded.

Above the conglomerate in places there is a bed of black shale with plant remains. The top of the shale is uneven, and then comes the coal seam, which ranges from 6 feet to 15 feet thick and averages 9 feet. The coal is much laminated and hard; thin bands of iron pyrites occur near the top of the seam. A thin parting of sandstone 1 inch thick occurs about 3 feet below the roof. (A similar parting is found in Mr. Sawyer's 54 feet coal seam).

Pebbles and boulders are found embedded in the coal at al horizons; these are in some cases clearly glaciated.

Above the coal is a band of conglomerate from 1 inch to 18 inches thick, with small pebbles principally, but at frequent intervals pebbles of large size and some boulders occur, some of them partly embedded in the coal and partly in the conglomerate forming the roof of this coal seam. Many of the pebbles are striated and glaciated.

Just above the conglomerate are black micaceous shales thickly studded with the interlaced stems of calamites, the former plant now represented by a flattened thin seam of coal. There must have been a dense forest of these plants to supply the prodigious number of prostrate stems. In width these casts range up to over 12 inches, and in length up to 60 feet. The stems are fluted lengthways, and at every 2 or 3 feet are joints and bud-marks. Above are more shales, &c., very carbonaceous as a rule.

In the coal seam Mr. Leslie found a stem about 7 inches through standing vertically in the coal and probably where it grew.

The coal from this seam is said to run about 15 per cent. ash.

Near the Cornelia shaft in No. 10 bore on the south side of the rivers the section gives a thickness of 58 feet of coal, though some of the seams are of inferior quality.

The Stormberg coal seams present quite a contrast to the seams worked at the northern end of the Dwyka coal measures. The former are lean, the compound seams seldom exceeding 6 feet of coal, and the ash exceeds 20 per cent. In the Vereeniging, Middleburg, and South Rand coal-fields the coal seams range from 6 feet up to 60 feet, representing a mass of vegetation hundreds of feet in thickness; and this implies an exuberant growth of plants of a phenomenal character, and the percentage of ash of these coals never reaches 20 per cent.

The Stormberg coal seams occur at an horizon *above* the Karoo Beds and the Ecca Beds, the whole thickness of which intervene between the Stormberg coal seams and the underlying Dwyka coal seams. This represents a vast epoch in time, and in consequence the flora is very distinct in the coal measures of the one horizon from those in the other.

Fossils.

Mr. Leslie, of Vereeniging, who very kindly allowed me to examine his collection of fossils, and who showed me over the various localities, takes a keen interest in the fossils from a buff-coloured sandstone that occurs higher up in the series than the carbonaceous shales; here he obtained Nœgerathiopsis Hislopi (found also at Kimberley), Myiston cyclopteroides, two or three species of Glossopteris, Phyllotheca, Sigillaria Brardi, Calamites, &c. Mr. Sawyer at the Rand coal-field has obtained Sigillaria Brardi right in the coal itself. The above fossils are all to be seen in the Geological Society's collection at Johannesburg, Mr. Draper having secured some excellent examples.

None of the above fossils have been noticed in the Stormberg coal measures where the prevalent forms are Pecopteris, Thinnfeldia odontopteroides, Podozamites elongatus, Tæniopteris Daintreei, Baiera Schencki, Equisetaceæ, &c., and the very characteristic ferns with bifurcated stems. These fossils so characteristic at the Stormberg are not met with at Vereeniging.

Messrs. Seward and Zeiller, from an examination of the fossil flora obtained at Vereeniging, &c., by Mr. Draper, and as a result of their thoroughly accurate determinations, decided that such fossil plants were from a much older horizon than the Stormberg, and though they had never seen the locality were able to correct the mistakes of local observers.

At Wesselton diamond-mine near Kimberley a piece of sandstone from these Ecca Beds was found with well-preserved fossil fish on it. Mr. Gardner Williams has the specimen. At Kimberley mine small sauroid remains have been found from time to time in the grey shales above the black shales.

Conclusion.

When my 1886 report was written there was no workable coal known to occur within the margin of the area outlined by the Dwyka conglomerate (Pl. I), and the northern limit of the conglomerate remained to be filled in. Now this northern course of the conglomerate is known, and it is found that within these bounds, and above the Dwyka conglomerate sometimes resting directly upon it, there are coal seams of enormous thickness and apparently extending over immense areas. Formerly the question was, Do coal seams of workable character occur at the horizon of the Ecca Beds? This question is now most fully answered in the affirmative by such extensive deposits as are worked at Vereeniging, Middelberg and the South Rand coal-fields.

The question remaining now is, How far south do these abnormally thick seams of coal extend? This is partly answered by the occurrence of great bodies of broken coal, fireclay, iron pyrites in large nodules, and black shales with impression of glossopteris and calamities all mixed together in faults at the Camdeboo and near Beaufort West. It is scarcely to be expected that over an area 800 miles long, and from 150 to 350 miles wide, an unbroken seam of coal exists, but that there are great areas within the margin of the Dwyka conglomerate of workable coal is now proved at the northern end, and systematic drilling would doubtless soon result in proving extensive coal seams to exist in other portions of the basin.

At East London probably the coal may be found nearest to the seaboard; Port Elizabeth might draw supplies from near Cradock, and Cape Town from near Beaufort West; but unless active operations in the way of boring are undertaken it is very certain that the Sub-Karroo coal will not supply fuel at a cheaper rate to the railways nor assist the development of Cape Colony by furnishing fuel for passing merchantmen and ships of war, provide fuel for pumping water on to the Karroo soil, nor supply household grates with fuel at reasonable rates.

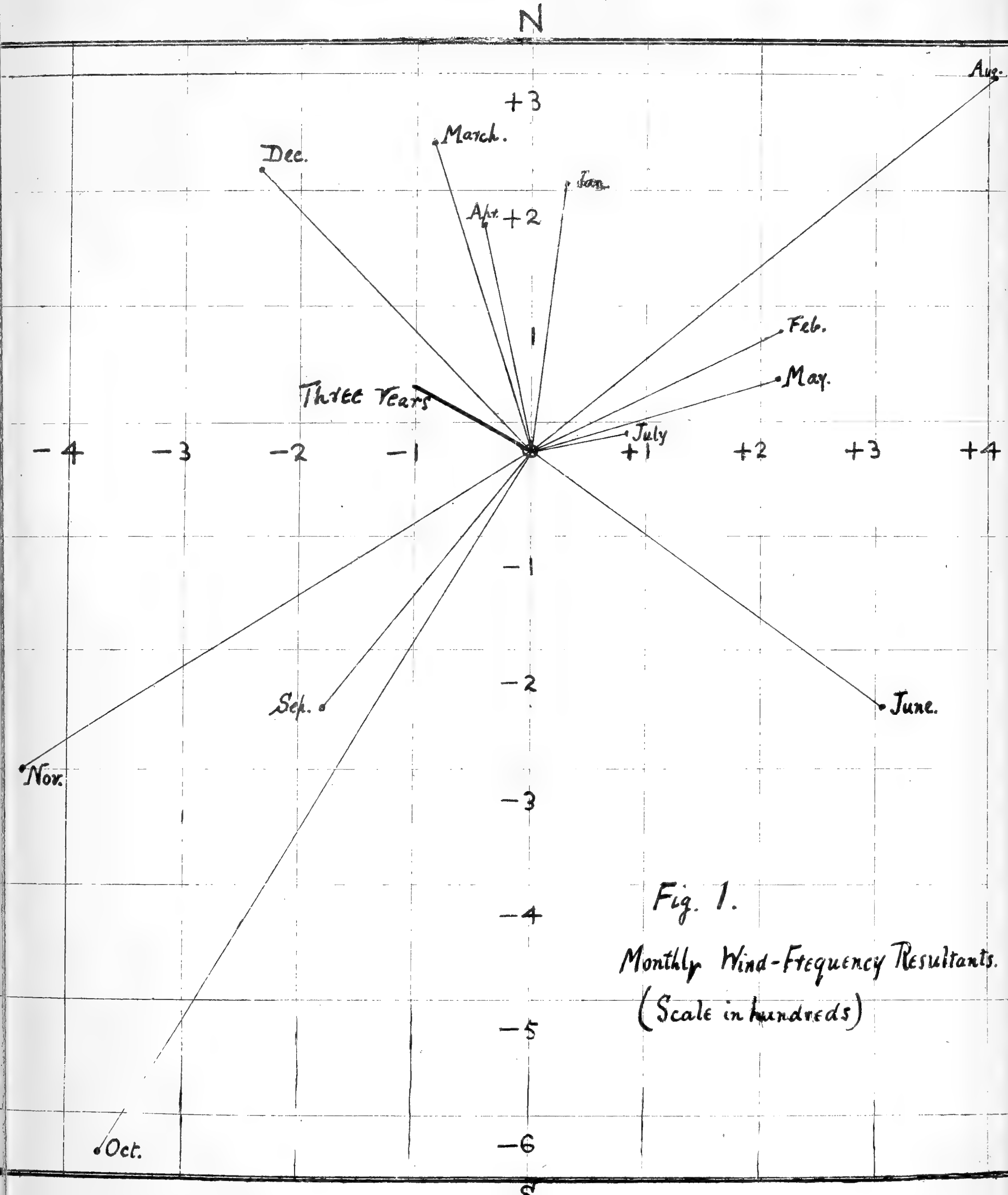
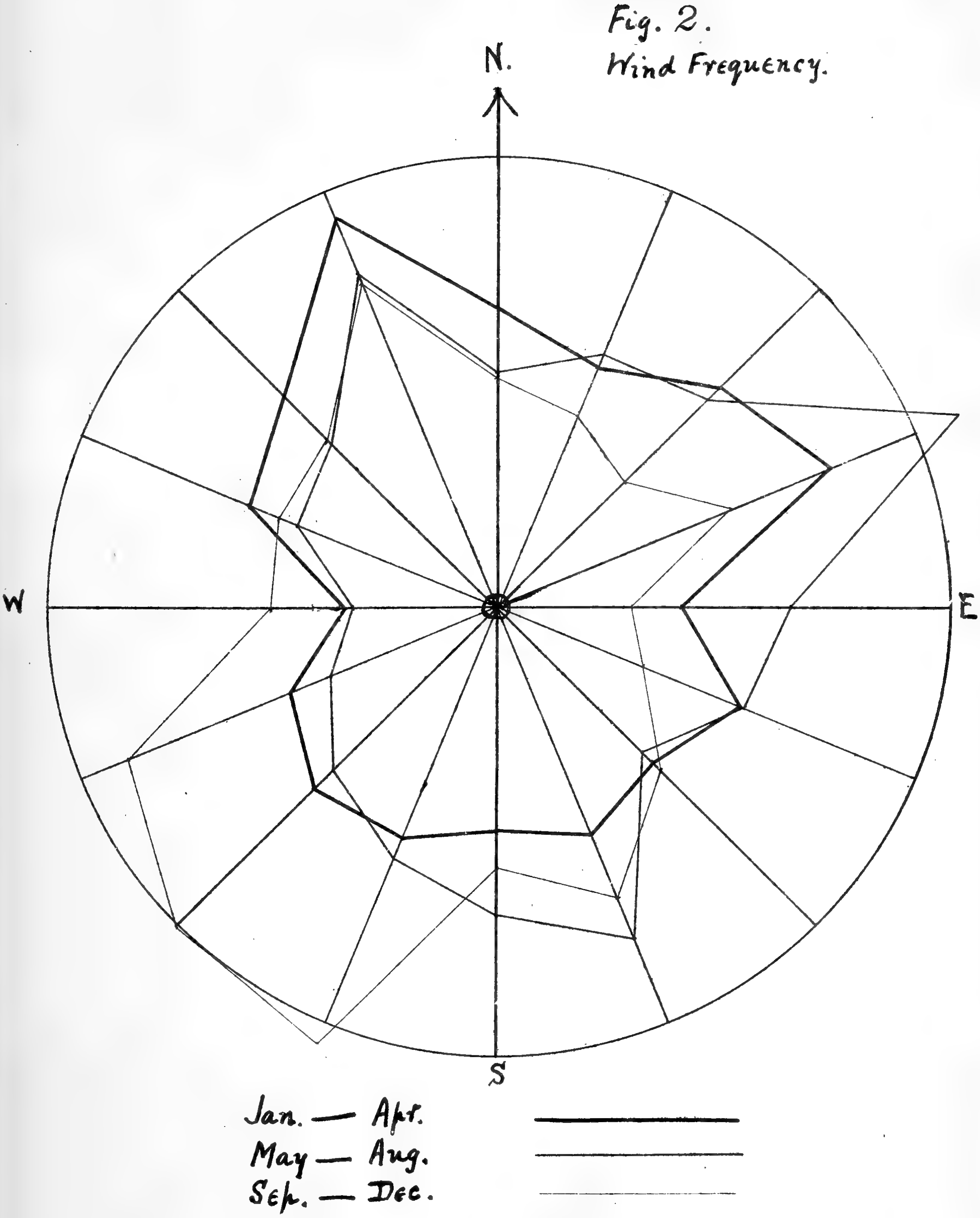


Fig. 1.

Monthly Wind-Frequency Resultants.
(Scale in hundreds)

West, Newman photo.

J. R. SUTTON, THE WINDS OF KIMBERLEY.



West, Newman photo.

J. R. SUTTON, THE WINDS OF KIMBERLEY.

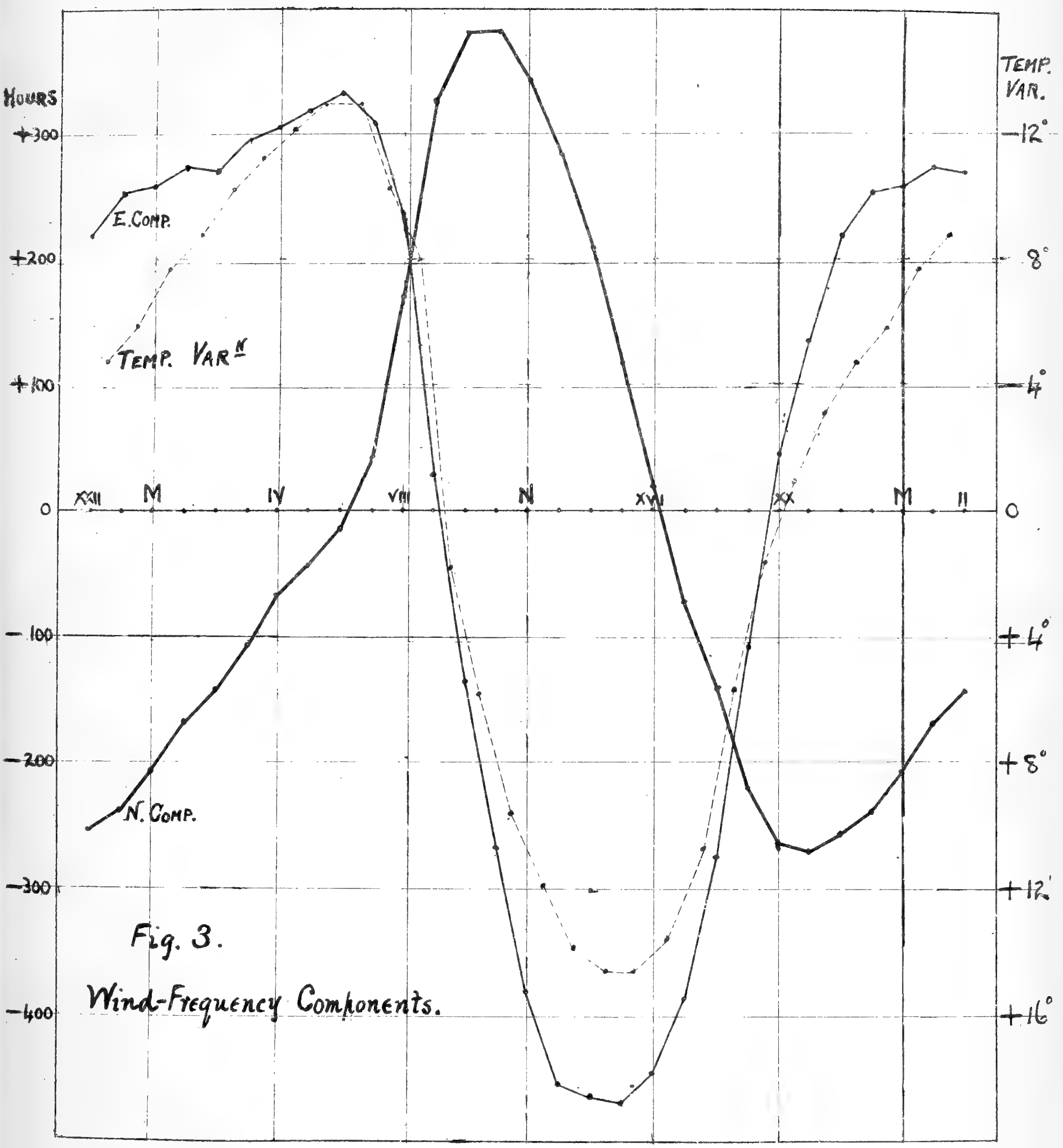


Fig. 3.

Wind-Frequency Components.

West, Newman photo.

J. R. SUTTON, THE WINDS OF KIMBERLEY.

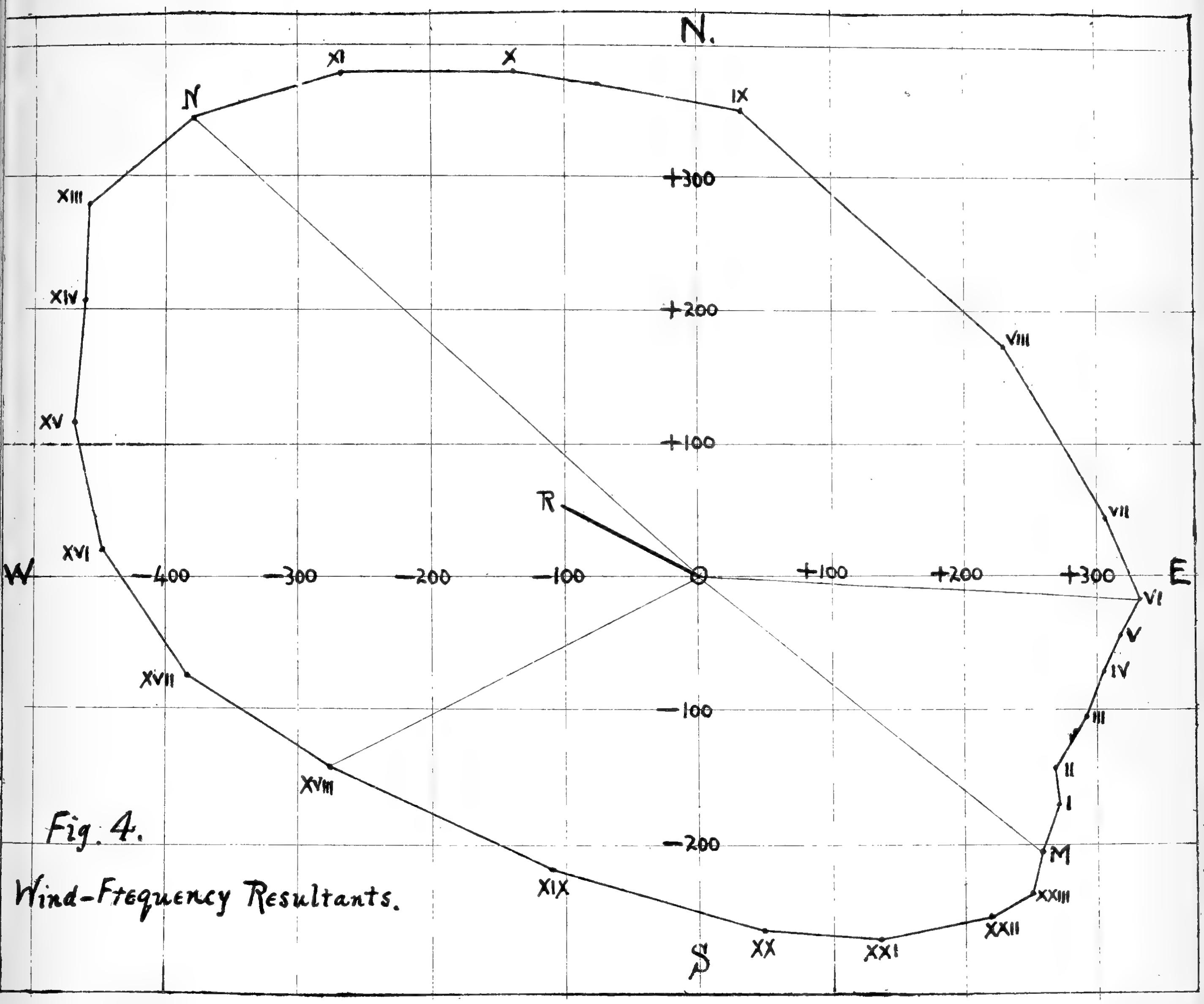


Fig. 4.
Wind-Frequency Resultants.

West, Newman photo.

J. R. SUTTON, THE WINDS OF KIMBERLEY.

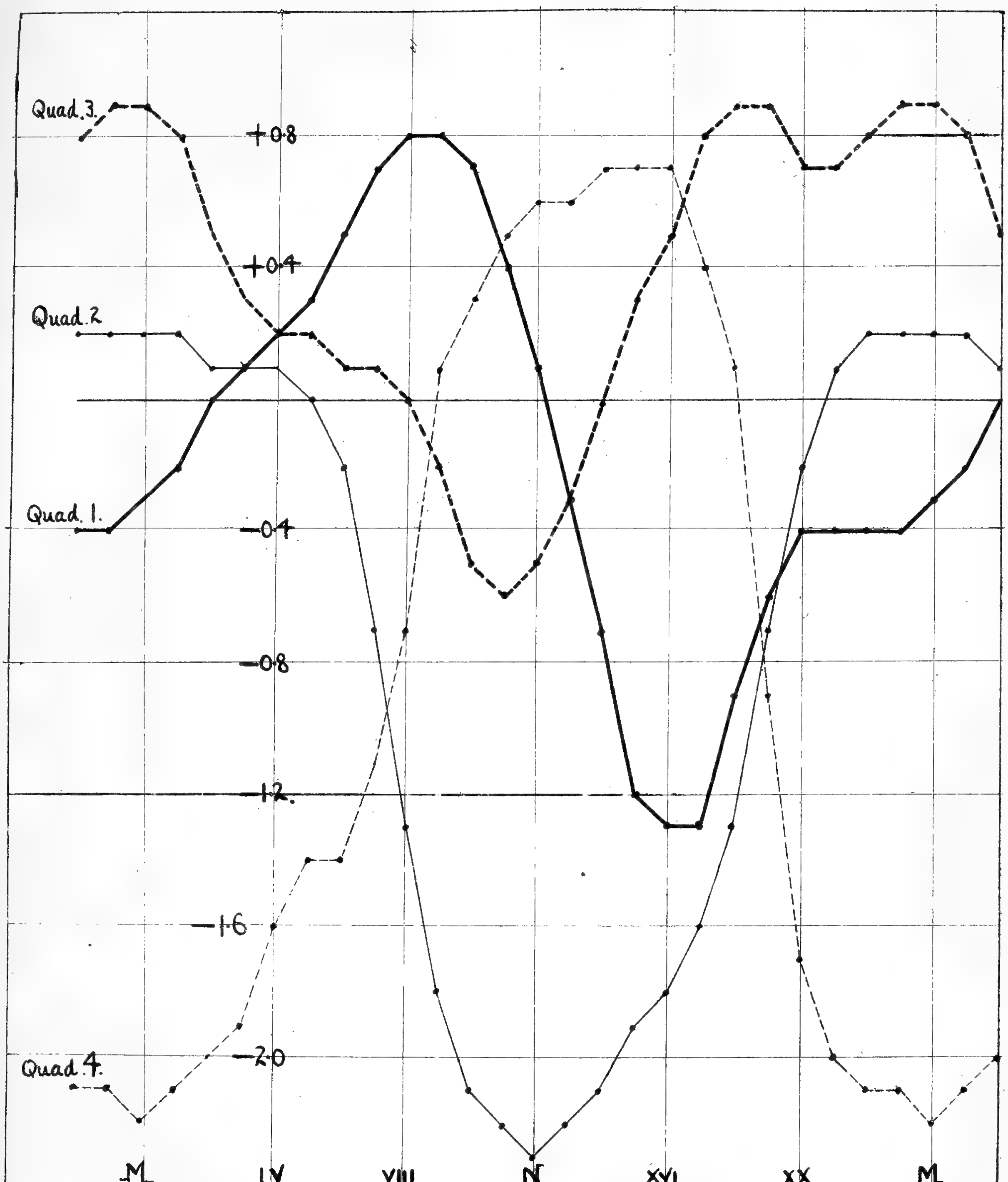


Fig. 5. Variation of Wind Velocity from the Normal Curve.

West, Newman photo.

J. R. SUTTON, THE WINDS OF KIMBERLEY.

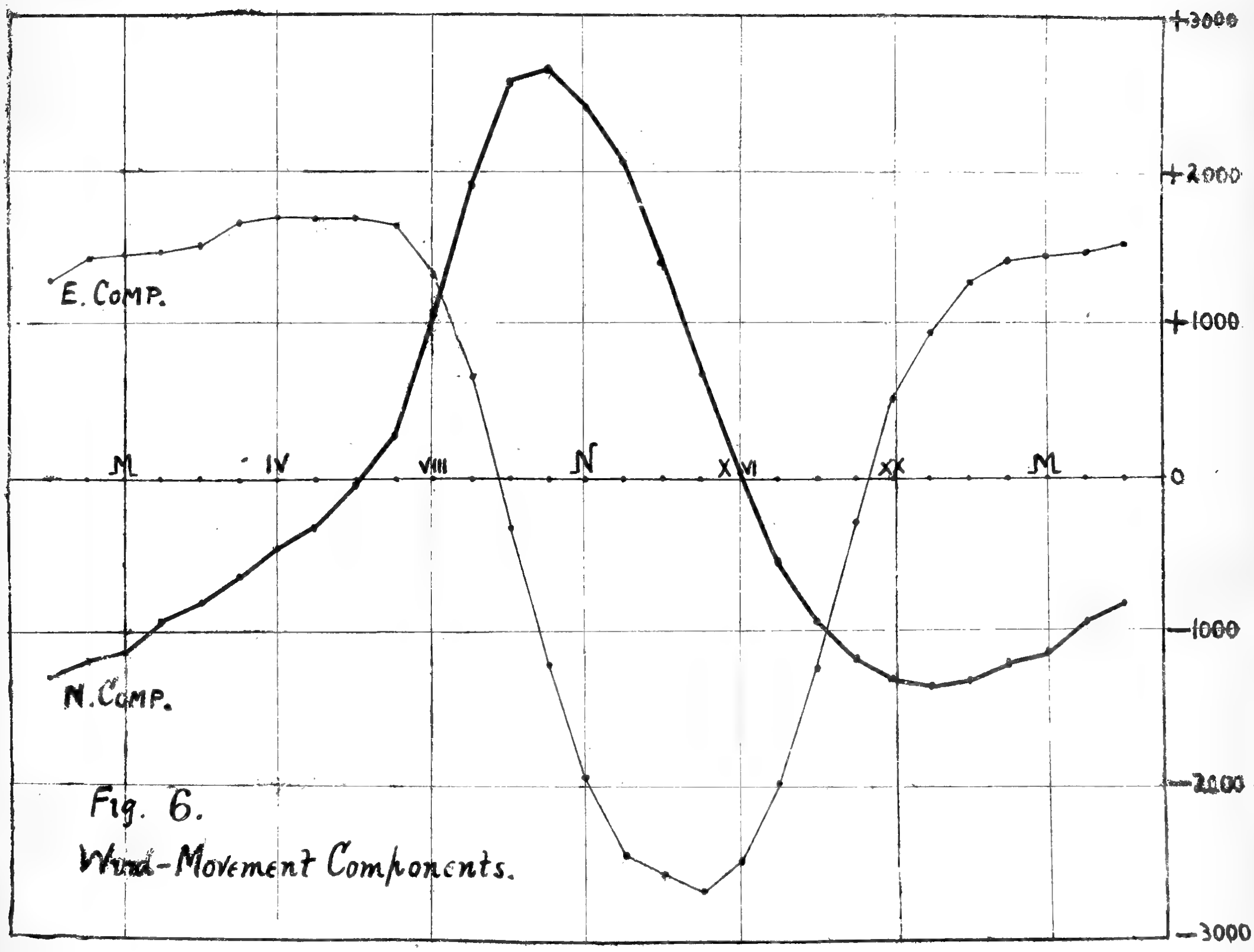


Fig. 6.
Wind-Movement Components.

West, Newman photo.

J. R. SUTTON, THE WINDS OF KIMBERLEY.

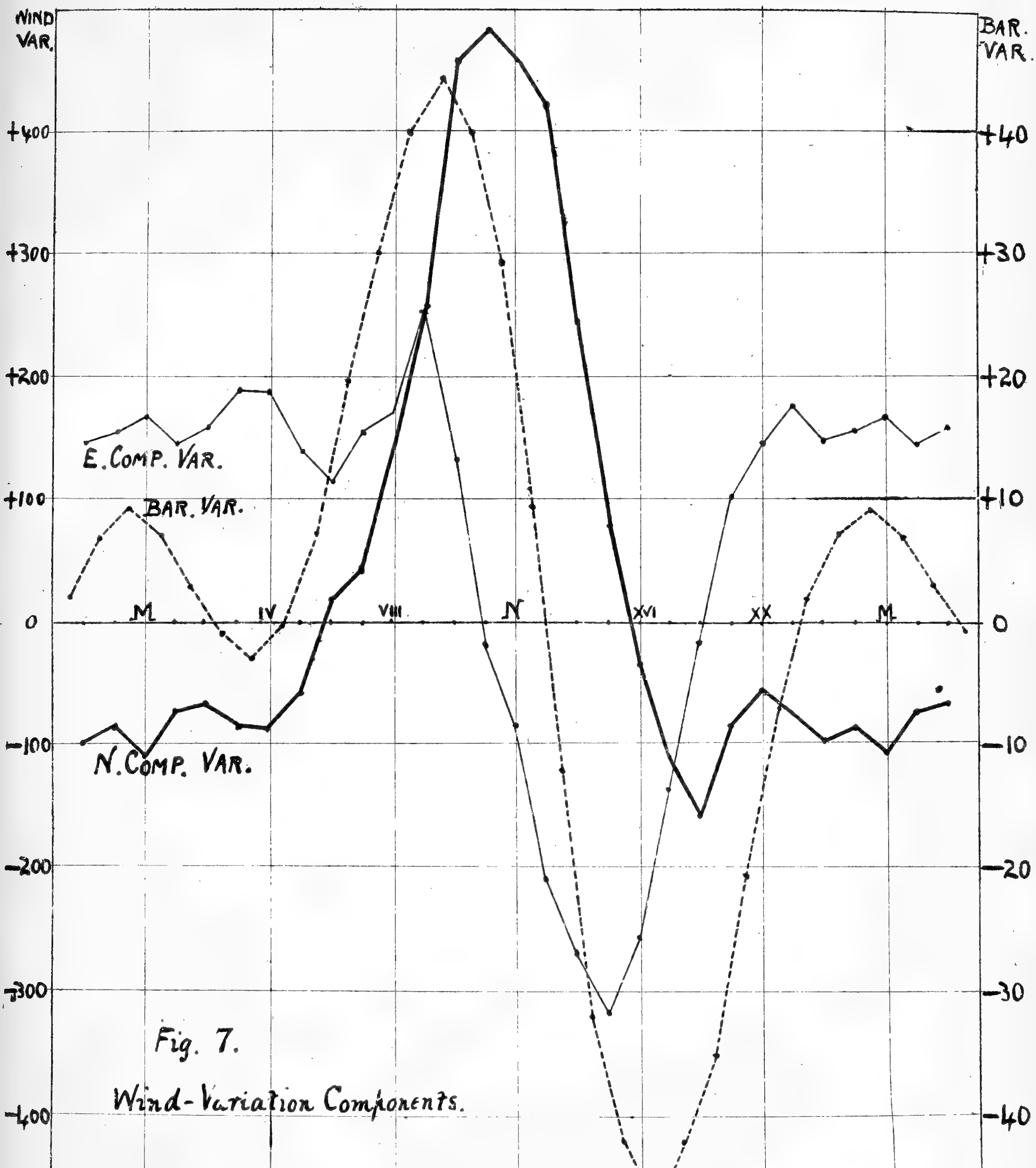


Fig. 7.

Wind-Variation Components.

West, Newman photo.

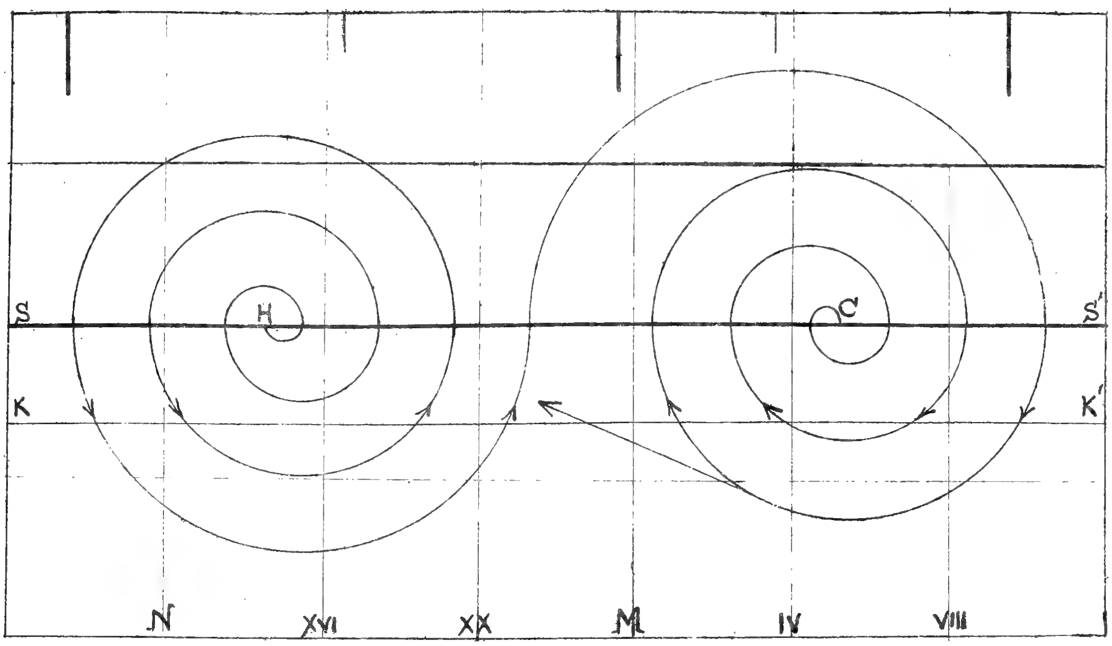


Fig. 8. Wind Scheme.

West, Newman photo.

J. R. SUTTON, THE WINDS OF KIMBERLEY.

THE WINDS OF KIMBERLEY.

By J. R. Sutton, B.A., Cantab.

(Plates II–IX.)

Introduction.

Hourly observations of wind direction were commenced at Kenilworth (Kimberley) in February, 1896, and the object of the present paper is to attempt a preliminary sketch of the results obtained between that time and the end of February, 1899. It is true that as a general rule three years is all too short a period from which final conclusions can be drawn as to the true mean values of the principal meteorological elements. There are, however, weighty reasons for the course here adopted.

First, that continuous observations of the winds have not hitherto, so far as I know, been attempted at any place on the great South African plateau; and indeed few of any importance in the whole country. This most unfortunate fact makes it almost imperative that a first approximation, at the least, to the position we occupy in the general wind-circulation of the globe should be made public as early as may be.

Secondly, that the vicinity of Kimberley is perhaps the site, *par excellence,* in the whole world upon which land winds can be most easily and advantageously studied in their physical relationships. In the majority of cases something more than the fitness of the site determines the position of a meteorological observatory. Considered, quite erroneously of course, as a science of minor importance, meteorology is as a rule attached in a subordinate capacity to the routine of institutions intended primarily for the study of astronomy, and so must be conducted in places chosen with reference not to its own requirements, but in accordance with those of a study differing absolutely from itself both in kind and in degree. Thus it comes to pass that the nearest approach to meteorological observations of the first class yet made in South Africa have been those of the astronomical observatories of Cape Town and Durban. The qualifications of the former may be dismissed in a very few words; saving for the study of local details its geographical position, meteorologically speaking, is the worst possible. A very much smaller mass than Table Mountain close by would be fatal to the general utility of its wind registers. Durban I have not seen, although from maps and descriptions it would appear to be as good a site as one could expect for a coast station, for all meteorological observations saving those of the winds. A perusal of the most excellent Annual Report of the Government Astronomer to the Colony of Natal establishes this very clearly. But I have attempted the construction of wind-roses from the data of the Natal Reports with most indifferent success. The drawback seems to be that Durban is screened almost completely from winds having a westerly component by hills at the back.

Granting that every place has both an annual and a diurnal wind circulation peculiar to itself, either or both may be obliterated or masked by perturbations set up in consequence of geographical conditions. Thus, on a coast, land- and sea-breezes may intervene; in the interior of continents mountain masses may deflect the wind currents and even reverse them altogether, or smaller perturbations may be introduced by the vicinity of lakes and large rivers. Kimberley possesses none of these drawbacks: it is very nearly on the central line of the continent; the land is gently undulating and little cultivated; there are neither large rivers nor lakes anywhere near, and neither hills nor mountains of any importance for hundreds of miles. It is to be expected, then, that the train of causes operating on the movements of the atmosphere over Kimberley should be the simplest conceivable, and that it would not be necessary (as in the case of India, for example) to make a number of more or less approximate assumptions as to the precise weight to be attached to numerous and widely varying perturbations, before laying bare such a train of causes in its rudimentary aspects.

Lastly, the Kenilworth observatory has no guarantee of permanent existence: it may come to an end at any time, and the chance never occur to me or to any one else of discussing the observations. Such a possible fate is to be deplored, but it has to be reckoned with, and for that reason this sketch has been attempted with what may be accounted a minimum of material.

Instruments, Etc.

Kenilworth is situated about three miles N.N.E. of Kimberley in approximate E. long. 24° 40′, S. lat. 28° 40′, at an altitude of something less than 4,000 feet above sea-level. It lies on one of the gentle slopes characteristic of the undulating veld of Griqualand West, and is rather lower than the crest upon which the greater part of Kimberley is built. Though thickly wooded, the trees do not yet offer any impediment of importance to the free circulation of the air at a moderate height.

Observations of wind directions are derived from the automatic records of an Osler anemometer mounted with its vane about 36 feet above the ground. It has had a fair exposure hitherto, albeit this advantage is not likely to last very much longer unless it can be raised considerably higher. The friction of the various parts is considerable, though not greater, apparently, than that of other instruments of the same class. It is indeed less than that of a small, and very much lighter, vane mounted close by. Of the wind-pressure records from the same instrument little need be said, more especially since they are not used here. The motion of the vane is communicated by means of a rack and pinion to an aniline pencil beneath, which writes the directions continuously upon a moving band of paper controlled by clockwork. In the lighter winds of less than, say, five miles per hour the vane remains fairly steady approximately parallel to the direction, the pencil record being then a clear, if crooked, line ; but with higher velocities the vane may swing rapidly and continuously as much as 40° on either side of its mean position, making the pencil-record a broad shaded band. In the latter case the medial line of this band is taken as the true direction of the wind. The charts are changed every twenty-four hours, as punctually as possible at 10 p.m. As originally constructed the instrument only allowed a transverse motion of the pencil equal to a range of 675° for the vane, and in consequence the pencil was sometimes pushed out of gear, portions of the record being thereby lost. To guard against this, charts and pencil-rack were both altered to admit a range of 1260° in the vane, with satisfactory results. In general the portions of the record lost as above were interpolated in either of two ways, according as the vane carried the pencil gradually and slowly, or by one swing across the chart out of gear. In the former case it was assumed that the changes were also gradual for the hours of lost record; in the latter case that the vane had swung at once to the point at which it stood when the accident was discovered.

Observations of wind velocity are derived from the records of a Robinson anemometer of the standard Kew pattern, mounted on a post at a height of 40 feet. At first the velocity was only registered on dials, no hourly record being taken. In March, 1897, however, Mr. Henderson, of the De Beers Crushing Mill, constructed a counting apparatus for me by means of which an automatic record could be written with a pen upon a Richard drum. This very ingenious contrivance admits of a wide range of speed multiplication; as used, and found most convenient, the pen rises once for each two and a half miles of wind, falling to zero and rising again, and so on. It has worked uniformly well, the only break in the records occurring for a few hours when a screw of the shaft connecting the cups with the dials had worked loose. Until the repairs were completed the velocities were interpolated from as many interim readings as could be made. The charts can run for twenty-four hours, but for a portion of the time the pen would be running over the brass strap binding the chart to the drum. For some considerable time the charts were changed at the same hour as the Osler charts, the mileage to be added for the time during which the pen was on the brass strap being taken from the readings of the dials. This was found, however, to give not quite correct values, and latterly, in consequence, the charts are changed an hour or so earlier each day, eight being used in a week. A small correction is sometimes necessary to the registered hourly velocities because the hour-lines are not quite truly centred. There seems to be very little friction in this instrument.

The barometric records are taken with a Beckley Photo-barograph (by Messrs. Negretti and Zambra), the ordinates being converted into true hourly air-pressures by comparison with three readings per diem of a large station standard mercurial barometer.

The temperatures of the air and of evaporation are read directly from the hourly registrations of a set of Negretti and Zambra's reversing thermometers, supplemented in a subordinate capacity by the indications of a Thermograph and a Hygrograph, both by MM. Richard, of Paris.*

Wind Direction.

The first circumstance to be investigated is the relative frequency of the winds, referred to the sixteen principal directions, for each month and for each hour. For this purpose the mean direction of the wind during each whole hour was determined as nearly as possible, and entered in its proper column in the summary. Only those hours are excluded in which the vacillation of the vane made

* For a fuller description of the various instruments see the introduction to the Kenilworth observations, published, by permission of the directors of the De Beers Consolidated Mines, Ltd., in the annual report of the Meteorological Commission of the Cape Colony for 1898. The site is not a very good one for temperature observations.

this mere guesswork. Calms, which are comparatively rare, are included equally with the others. Some difficulty was experienced in assigning the direction in those cases where the mean hourly direction fell very nearly between two of the sixteen directions, and there seems to be no doubt that a certain amount of bias displayed itself from time to time favouring some of the points in question at the expense of those adjacent. It might be expected that such a bias, not being deliberate, would rectify itself in time, but the gradual accumulation of the numbers to the final totals did not completely bear out the expectation. At the same time it may be claimed that no error large enough to materially alter the true monthly or hourly resultants was introduced in this way.

Table 1 gives the number of hours of wind, irrespective of velocity, for each of the sixteen principal compass points during each month from the three years' observations. Fig. 1 is a graphical representation of what may be called the resultant wind-direction calculated for each month, and for the whole year, from the numbers of Table 1. It is formed by drawing rectangular axes NOS, EOW, through the origin O, and projecting the number of hours of each wind upon them. Thus each direction multiplied by its numerical coefficient will have two components, one upon the axis NOS, and the other upon EOW. All components falling along EOW in the direction OE are conventionally *plus*, and all in the direction OW *minus*. Also ON and OS are in the same way conventionally *plus* or *minus* respectively. The final resultant is formed from the components by the principles of the parallelogram of velocities. Consider, for example, the wind numbers for January, and let N, E, S, W, represent the respective components measured along ON, OE, OS, OW; R being the final resultant. Then we have—

$$N = 185 + (227 + 144) \cos 22\tfrac{1}{2}^\circ + (149 + 161) \sin 45^\circ + (107 + 195) \sin 22\tfrac{1}{2}^\circ$$
$$E = 97 + (195 + 130) \cos 22\tfrac{1}{2}^\circ + (161 + 93) \sin 45^\circ + (144 + 110) \sin 22\tfrac{1}{2}^\circ$$
$$S = 105 + (173 + 110) \cos 22\tfrac{1}{2}^\circ + (141 + 93) \sin 45^\circ + (138 + 130) \sin 22\tfrac{1}{2}^\circ$$
$$W = 59 + (107 + 138) \cos 22\tfrac{1}{2}^\circ + (149 + 141) \sin 45^\circ + (227 + 173) \sin 22\tfrac{1}{2}^\circ$$

$$\therefore N—S = 228{\cdot}1$$
$$E—W = 30{\cdot}6$$
$$\text{Whence } R = \surd \{ (228{\cdot}1)^2 + (30{\cdot}6)^2 \} = 230{\cdot}14$$
$$\text{And } \tan \theta = \frac{N—S}{E—W} = 7{\cdot}46 = \tan 82^\circ\ 22'$$

The components for each month found in this way are given in Table 2. But it must be noted that neither the components, nor their resultants, of themselves are to be interpreted as necessarily revealing the prevailing directions of the wind. Such a conclusion can only be drawn when the tabular numbers from which they are derived show also a distinct and overwhelming majority for one direction over each of the others. Should there be, say, two directions, each containing preponderating numbers, then the resultant will lie between them, and may (almost certainly will, in the case of valley winds, or of land- and sea-breezes) lie along a direction from which relatively few of the winds come. Referring again to Table 1, it will be seen that although certain directions do prevail at the expense of the others month by month in a moderate degree, yet any preponderance for the whole year is comparatively insignificant. Month by month, then, we may take it as a rule that the prevailing direction is approximately that of the resultant, and such that (see Fig. 1) it blows from the denomination of the month to the origin of the figure with a frequency and proximity proportional to the space described, whereas for the year it is not so.

Table 3 gives Table 1 in a condensed form, the wind numbers being arranged in quadrants. It both smooths and emphasises the monthly variations of Table 1. Apparently, however, Table 4, in which the numbers of Table 1 are arranged in periods of four months —a condensation suggested by Fig. 1—is more advantageous. From this we conclude that the prevailing directions are north-north-westerly from January to April, easterly from May to August, south-westerly from September to December. Fig. 2 is a graphical representation of this feature, and Table 5 the components. It appears to be extremely likely that if sufficient observations can be taken it will be found that the wind in the course of the year backs with uniform angular velocity clockwise round the compass.

Of the 25,898 hours of wind analysed throughout the three years the final resultant contains the small components of only 50 hours to the north, and 100 hours to the west, being exceeded in magnitude by those of every separate month with the exception of July. The resultant of each of the three years, also, is much greater than that of the final resultant of the three together; moreover, neither bears the least resemblance to either of the others. They are :—

	N.	E.
March–Dec., 1896, and *Jan.–Feb., 1899	+255·4	−1273·3
1897	−500·3	− 244·6
1898	+295·2	+1417·7
Mean	+ 16·8	− 33·4

* January and February, 1899, are added, to complete a year, to the ten months March–December, 1896, and so as to avoid breaking up the full years 1897, 1898.

The total lack of resemblance between these four pairs of components is further illustrated in Table 6, in which the hourly wind frequency for each year is shown separately. It may be observed that an extra week of anticyclone weather would have been sufficient to transfer the final resultant of the combined three years bodily into the opposite quadrant.

There is apparently no escape from the conclusion that while sometimes one and sometimes another direction may preponderate from year to year, there is nothing to definitely establish the existence of a prevailing wind at Kimberley. On the face of it there is nothing remarkable in this fact, if it only be remembered that the place is in the great southern anticyclone belt, midway between the trades and the brave west winds of the southern ocean. Apart from that it is completely at variance not only with the popular idea, but also with every account touching upon the subject (the *Challenger Report* included) yet published. Universal opinion for many years past has assigned us an overwhelming excess of northerly winds, some extreme views asserting there is nothing else. Theories even have been propounded explaining why the wind is so very northerly: wherein we learn that the trades being deflected from the ocean by the excessive heat of the African interior curve round and run southward along the centre of the southern table-land, for want, it seems, of elsewhere to go! Fortunately we shall be in a position later on to see how it is that the idea of a prevailing north wind arose, and why it has no foundation in fact.

Assuming then that no prevailing direction exists, we may proceed to investigate the salient features of the winds of Kimberley as a local phenomonon unperturbed by outside influences. We will consider first whether the diurnal changes are more clearly defined than the annual. Table 7 shows at once that they are. Evidently the tendency of each wind is to blow with its maximum frequency an hour or two later than the wind tabled next it, and the consequent inference must be that the undisturbed vane makes one complete, counter-clockwise rotation per diem. There is a slight departure from, and exaggeration of, the rule in the case of east and east-southeast winds, but the directions on each side fall into line precisely as if the maxima were perfectly regular throughout. Furthermore, perceptible, though relatively unimportant, maxima do occur in both these directions near the required times. Standing out very clearly is the lack of southerly winds during the morning, and of northerly winds during the evening,—the almost entire absence of easterly winds by day and of westerly winds by night. With the object of making the daily changes clearer, and of eliminating the influence of the irregularities in the totals at the foot of the columns, each number has been reduced to proportional parts of a thousand in Table 8. Here we elicit the remarkable fact, to be further touched upon when the velocities come to be considered, that the highest percentages at the times of maximum frequency occur in the case of those winds whose maxima are at, or near, noon. Indeed only these run into three figures. It is partly a result of this that the lowest percentages at the times of minimum frequency occur at midday to those winds whose maxima are at or near midnight. There is, however, a considerable contrast between the curves for the two classes: the former having a long-drawn-out minimum with a rapid rise to and fall from maximum; the latter an equally long-drawn-out maximum with a rapid fall to and rise from minimum.

The hourly components of wind-frequency are shown in Table 9. They are calculated from Table 7 in the same way as Table 2 is calculated from Table 1. Their interpretation may be best illustrated by an example: For the hour ending at noon the components in Table 9 are: N = +344·2; E = −378·1. This means that for that hour during three years the northerly components exceeded the southerly by 344·2 hours, and the westerly exceeded the easterly by 378·1 hours. The results are shown graphically in Figs. 3 and 4.

In Fig. 3 the heavy line is the north component curve; the other is the east component curve. The portions of both curves are conventionally positive above the zero line (upon which the hours are marked), and negative below. Thus for all portions of the curves above the line the directions prevailing are northerly and easterly, but southerly and westerly for all portions below. We see, according to the figure, that the east component reaches its greatest positive and negative excursion at the respective hours ending 6 a.m. and 3 p.m.—say at mean times 5.30 a.m. and 2.30 p.m.—these hours, as it happens, being the times of the mean minimum and maximum temperatures of the day. In other words, the vane is swinging from east to west with a rising temperature, and *vice versâ.* The dotted line in the figure is the diurnal temperature variation *inverted.* That is, it represents the consecutive hourly values of M—t where M is the mean daily temperature, and t the temperature at any hour. By suitably choosing the scales of hours and degrees, the curves can be made to look very much alike. That the east and west swing of the vane is a direct effect of the temperature is scarcely to be doubted. The barometric curve (see Table 12 and Fig. 7) follows the east component curve by some two hours so far as the portion included in the daylight hours is concerned, but the night maximum of the former has no corresponding feature on the other. The north component curve, on the other hand, passes through its maximum and minimum points shortly after the two hours of mean temperature; but apart from this there is no obvious connection between it and either the temperature or the pressure curve. The long-drawn-out maximum of the winds prevailing at night, and the shorter but sharper maximum of the day winds, previously alluded to, here receive at least a partial explanation from the fact that the diurnal temperature is below its mean value for a longer period than it is above.

Fig. 4 displays in one curve, and on the same scale, the resultants of the component curves of Fig. 3. In this figure northerly components are measured vertically upwards or downwards, according as they are positive or negative, easterly components being measured horizontally to the right or left in the same way. The resultant wind for any hour is supposed to be moving inwards from the number denoting the hour to the origin of the co-ordinates. Thus, during the hour ending 9 a.m. the mean resultant direction of motion is almost due south, *i.e.*, the resultant wind is northerly. The curve is very nearly an ellipse, having its major axis on the line joining the hours ending at noon and midnight. It is a curious and possibly significant fact that if the times of maximum, minimum, and mean temperature be marked upon the curve, the line joining the times of maximum and minimum will intersect the line joining the times of mean temperature almost at the origin.*

The angular velocity of the resultant varies considerably, being greatest for an hour or two after sunrise, and for about the same interval after sunset. For each quarter of a day the mean angle described is approximately—

From midnight to 6 a.m.	36°
,, 6 a.m. to noon	140°
,, noon to 6 p.m.	70°
,, 6 p.m. to midnight	114°

the east and west vibration showing itself by far the more influential. This point may be investigated in a rougher, if not less interesting way by tabulating the mean actual movement of the vane direct from the automatic registers for each quarter of a day. The method followed here was to consider the exact points (as nearly as they could be ascertained) at which the pencil crossed the respective

* To prevent confusion, these lines are not drawn. Should the reader wish to insert them, it must be remembered that the horary numbers marked round the curve stand for the hour *ending* at the time indicated. Thus, 8.30 a.m., for example, should be taken as the *mean time* of the point IX.

hour-lines of midnight, 6 a.m., noon, and 6 p.m. as the points of departure and arrival, the total angular deviation of the pencil in each interval being entered in its proper column. The results showing the mean movement for each day, and each quarter of a day, during each month, are shown in Table 10. If it be distinctly borne in mind that an instantaneous reading of wind direction cannot be trusted to give information equally trustworthy with that of a mean hourly reading, the agreement between Table 10 and the more formal values of Table 9 will be sufficiently satisfactory. It is evident that the angular velocity of the vane is much greater in summer than in winter, the diurnal mean for the year being rather less than one-third that of the sun. The remaining two-thirds, due to perturbations—*e.g.*, storms—and partly no doubt to instrumental faults, have no appreciable effect upon the velocity of the resultant, although they must considerably reduce its length throughout the day. Instances in which the vane travels backwards are probably more common after noon than before. They seem to occur either when the vane has advanced more rapidly than usual for a few hours previously, or when, upon the dying away of some disturbance deflecting the air current, the vane takes the shortest cut to its normal position. That there is not, however, any material difference between summer and winter in the diurnal frequency-curves of the different wind directions is demonstrated by Table 11, in which the numbers are ratios per thousand arranged in quadrants; the months of December and January for three years providing the summer values, June and July the winter. The greatest differences are in Quadrant 4 (including all winds from west, west-north-west, north-west, and north-north-west) the summer curve here being appreciably flatter. Any other months give just the same sort of information. Perturbations are seldom of long duration, the longest "set-in" wind on record not perhaps lasting three days; and even when they occur their effect is confined almost exclusively to the addition of a practically constant number to each hour for the set-in direction. Whence it is that the frequency-curves retain their shape unaltered.

Wind Velocities.

Hitherto we have dealt only with the simple directions of the wind irrespective of the corresponding velocities. It is usually the custom to discuss the two together, ignoring the directions as a separate factor, especially in dealing with the rectangular components, although it is not easy to see why. Table 12 will demonstrate that there is some advantage in making a distinction between the two. It is constructed from two years' observation of velocity and direction together—for, as we have seen, hourly observations of velocity were not commenced until March, 1897. There are seventeen columns:—

1. The hours of the day.
2. The mean hourly velocity.

3, 4, 5, 6. The mean hourly velocity for each quadrant of directions.

7, 8, 9, 10. The hourly departure, Q_n—M, from the mean velocity M of the same hour (where Q is a quadrant and n its number) smoothed in threes by Bloxam's process.

11, 12, 13, 14. Numbers such as those of Table 7, but for two years instead of three, also arranged in quadrants.

15. The hourly values of the humidity of the air for the year 1898.

16. The mean hourly rate of evaporation from a free water surface.

17. The hourly values of the mean barometric pressure of the air.

It is to be understood, of course, that every particular value in the table is, with the exception of those in the humidity and pressure columns, for the hour ending at the time indicated on the same row by the first column. In the humidity and pressure columns the values apply to the hour.

The diurnal curve of wind velocity contains two maxima (at 2 p.m. and 10.45 p.m.),* and two minima (at 5 a.m. and 7.30 p.m.). The second maximum is of more than ordinary interest. It is strongly marked in the winds of the second and third quadrants, but is not so conspicuous in those of the first and fourth. In the diurnal curve of evaporation from a free water surface there are also, as it happens, two maxima in the hourly rates falling at the same hours as those of the wind velocity. The first is obviously due to the high wind velocity and low humidity during the warm hours of the day. Now the humidity curve rises rapidly, particularly during the winter months, from just before sunset until about 8.30 p.m., after which, for three hours or so, the rate of increase is not large. The second maximum in the rate of evaporation is not, therefore, difficult to understand. This matter, however, is merely mentioned in passing.

Columns 11–14 give essentially the same rule as Table 7. But the chief interest of Table 12 is to be looked for in columns 7–10. The numbers they contain are in remarkably regular sequence, and would doubtless be even more so in a more extended series. They discover in a most decided fashion the important fact that for any hour of the day the mean velocity of the wind from any quarter decreases relatively to mean diurnal curve, with the deviation of the

* The actual value of the second maximum is only approximate in consequence of the uncertainty introduced by the obstruction to the record of the brass strap between the hours XXI. and XXII.

vane from its normal position. The inference seems to be that over and above instrumental faults which may contribute something to the result, storms, and other disturbances occurring here, are, on the whole, little else than exaggerations of normal conditions. The curves illustrating columns 7–10 are shown in Fig. 5.

The fact will now be readily appreciated that because the winds which prevail during the middle of the day come from between north-east and north-west, and also because the velocities are greater when the directions are normal, these, if only through the dust they raise, will attract the most attention from the "man in the street," who as a rule only notices what is forced upon him. The published accounts owe their inspiration in the main to the observations taken for the Meteorological Commission of the Cape Colony by amateur observers. Now the hour of observation is 8 or 9 a.m., and a glance at Table 7 will be sufficient to prove that either of those hours will return a great preponderance of winds lying between north and north-east. Thus we see how it comes about that both scientific and unscientific observation have independently evolved the same totally incorrect conclusion.*

The number of miles of wind recorded from each direction, irrespective of the duration, for each hour during two years is given in Table 13. It will be seen that the highest values occur about midday—as might be expected from Table 12—and that on the whole the columns containing the highest numbers also contain the lowest. The components of Table 14 are calculated from Table 13 exactly as those of Table 9 from Table 7. Fig. 6 is a graphical representation of the results of Table 14. So far as its critical points are concerned it is substantially a reproduction of Fig. 3, each component possessing only one pair of simple maximum and minimum points, temperature affinities being equally apparent in the east component curve, and barometric affinities, so it seems, equally lacking in both curves.

By dividing the directions into quadrants we get the following total mileages in two years :—

Quad.	1................................	32,674 miles
,,	2................................	25,122 ,,
,,	3................................	31,325 ,,
,,	4................................	25,970 ,,
	Total.........	115,091 ,,

* Dr. Buchan gives the following yearly totals for Kimberley derived from observations made at 8 a.m. and 8 p.m.: N., 87; N.E., 72; E., 57; S.E., 15; S., 51; S.W., 24; W., 28; N.W., 20.

The inference would be a prevalence of northerly winds. The observations are evidently quite honest, but they are insufficient.

These numbers show, even more convincingly than Table 14, how small is the total unbalanced excess of air passing over Kimberley. Small even as it is, only amounting to about five miles per day on an average throughout the two years, it would no doubt have been very much less in the three years comprised in the investigation of directions.

At this stage we may look at Figs. 3 and 6 in a different light: we may assume the former to represent a system in which the air is moving with any constant velocity; the latter as a system formed from the second by the intrusion of air-currents of variable strength from whatever cause arising. Table 15 is constructed from Tables 9 and 14 for the purpose of comparing the effects. Here column 1 contains the hours, columns 2 and 5 the mean hourly component movements for a year, columns 3 and 6 the mean relative component frequencies—or, which comes to the same thing, the mean movement at a constant velocity of 6·6 miles per hour,—columns 4 and 7 are the departures of the variable velocities observed from the constant velocities assumed, column 8 is the resultant departure, being equal to the square root of the sum of the squares of corresponding numbers in columns 4 and 7 (decimal places being omitted throughout). The actual magnitudes of the numbers, regardless of sign, in columns 2 and 5, are in almost all cases greater than those of columns 3 and 6, as might be expected from the fact mentioned in reference to the values of columns 7–10 of Table 12.*

Fig. 7 gives a graphical representation of the values V– C, *v–c*, found in Table 15, the curve of barometric variation being also inserted. Some of the minor irregularities might possibly disappear in a greater number of years of observation. But as it stands it places the north component variation in as uninfluential a position as the north components of frequency and movement. The east component curve, on the contrary, is of remarkable interest. If its asperities be not smoothed by future research, then it undoubtedly contains three pairs of maxima and minima. The three maxima *precede* by respectively lengthening intervals, the first (lesser) barometric minimum, and the two barometric maxima, the most pronounced minimum of the east component variation being also in advance of the most pronounced barometric minimum; whereas the north component variation seems to *follow*, with a curious exception at 8 p.m., the diurnal pressure tides. Now we have seen that the east and west swing of the vane coincides with the variations of tem-

* Recollect that the component frequencies are derived from the registers of three years, the component movements from only two. For the purposes of this comparison the former are accounted standard forms for any year.

perature. Judging by the diagram is it not highly probable that the secret underlying the double diurnal oscillation of the barometer is to be looked for behind the complicated variations introduced as east components of wind-frequency and air-movement by the simple application of the sun's heat? At any rate this aspect of the problem is worth further inquiry.* The greatest excess variation from the east is followed by the greatest excess variation from the west; and, as it were, in response, the barometer also executes its greatest vibration. If it be not cause and effect, the coincidence is remarkable. However this may be, the diurnal northing and southing of the air, at any rate, both in duration and amount, is quite a secondary effect, indicating no more, perhaps, than an attempt to restore the equilibrium disturbed by the east and west exchanges.

From Tables 7 and 8 it is evident that the normal wind of Kimberley moves inwards, at any time, from a moving radiant always situated some 30° or 40° in front of the point where a vertical circle through the sun cuts the horizon; the only departure being, as already noted, in the case of easterly winds, which, so far as the observations go, have one maximum somewhat earlier, and thus contribute to the third maximum of the east component variation. These consecutive directions may all be included in the scheme of Fig. 8, wherein each instantaneous direction is tangential to a spiral circling *outwards* from the area of highest temperature and *inwards* to the lowest. The simplest conception of the diagram is to imagine it, together with the hour numbers, an appendage of the sun encasing the earth (which rotates inside it), S and S′ overlapping. H is the area of greatest heat nearly facing the sun, C that of greatest cold, K K′ the path described by Kimberley through the system with a velocity approaching 1,000 miles per hour. The arrow-heads show the direction of wind motion.

The hypothesis demands that the diurnal wind system shall be an anti-convection current; but since the text-books frequently state that wind must blow from cold to warm areas this seems at first sight an impossibility. While it is easy to draw a similar spiral of opposite curvature which shall equally represent the hourly motions, and yet shall be, in a sense, a convection current, the one mechanical consideration fatal to such a construction is that a current running in to H, say from the south (H being south of the equator), must first curve to the left, and then gyrate clockwise round H. Now it is quite certain that if the sun could remain vertically over one spot true convection currents must eventually be established, but it is not

* See, however, Mr. H. F. Blanford's paper "On the Winds of Calcutta" in the *Indian Meteorological Memoirs*, vol. i. p. 18.

necessarily so under existing conditions. For consider what goes on in the vicinity of the sub-solar point. The air here near the ground is being heated with great rapidity and is expanding in all directions outwards and upwards. Before the process, however, has gone sufficiently far to allow the lower air to expand enough to set up an outflow overhead and a convection current below, the sub-solar point has shifted to the west, the motive power is on the decline, and hence only the beginnings of the establishment of convection currents are ever manifested. The pushing-out process may be expected to make itself felt right up to the borders of the great circle of which H is the pole; and it is worthy of note that the greater maximum of the barometric tide shows itself on the western edge of the same circle, the lesser maximum falling some 30° behind the eastern edge. Throughout the space containing H, lying between these two tidal crests, the wind variations are in perfectly regular sequence.

In the cold hemisphere we have, to start with, an opposite state of things. At the cold spot C the air is contracting inwards and downwards, but with far less intensity than the expansion near H. By first intention, then, the expanded air will tend to move into the cold hemisphere. The contraction increases the pressure at the cold spot, being aided, perhaps, by the greater barometric crest lying some 45° away. The greatest effect of the contraction will therefore make itself felt not at C, and still less towards S′, but further to the west. In sympathy with this the lesser crest which might have remained on the border of the warm hemisphere moves eastward until the gradients on each side of the lesser minimum are equalised. It must not be thought that I am trying to manufacture a satisfactory explanation of the cause of the barometric tides; the important fact to be insisted upon is that the circulation inaugurated about H is developed well into the cold hemisphere by the asymmetry of the barometric maxima and by the contraction in front of C. Once there the directions will shift normally as in a clockwise circulation in consequence of the tendency to an indraught about the depleted space. The deflecting force is no doubt small, but on the other hand the winds are light, and hence the more easily turned. With stronger currents the right-handed gyration about C would be much less pronounced—always supposing the motion imparted from the outside—and this it seems explains why, when at 11 p.m. the wind velocity attains its second maximum, the wind directions tend to fly off centrifugally from the right-handed gyration. The straight arrow in the figure is an attempt to represent this. It stands for the intrusion of the abnormal maximum frequency of easterly winds about 11 p.m. The actual depletion to the west of C will depend more upon the rate of fall of temperature than upon its actual degree. The space over which it extends will be much larger and much less clearly defined than the corresponding space about H, the wind-frequency maxima being less pronounced accordingly.

It must not be imagined for a moment that Fig. 8 represents the path of any particle of air. Such an idea would imply velocities of upwards of a thousand miles an hour, which are, fortunately, out of the question. We are simply asked to understand that as Kimberley describes its diurnal rotation, its mobile air covering takes up successively the directions of motion of those portions of the imaginary vortex-system through which it may be passing. Each particle will tend to describe a spiral it is true, but in no individual case will the actual path accurately resemble that of the diagram, although the mean path of all the particles may do so in general shape.

It seems to follow that the diurnal wind system of Kimberley must be exceedingly shallow, not extending many thousand feet above the earth's surface, and this is supported by the motion of the clouds which, with few exceptions, travel along paths radiating from somewhere between north and west, irrespective of the wind directions below.

If the wind system of Fig. 8 is a correct interpretation of the Kimberley winds, it must be of universal application; and should, when allowances have been made for latitude (north or south), for prevailing winds, land- and sea-breezes, &c., apply to every place lying within 45° of the equator, if not beyond. The winds of Adelaide certainly seem to come within its scope, and possibly also those of Cordoba, although these latter have not yet been fully tested.* Meanwhile it may not be out of place to remark that a strong prevailing wind blowing, say, from the north, would increase the northerly winds both in frequency and strength, deflecting the east and west winds to the south, and probably cut off southerly winds altogether.

Wind-Roses.

The remainder of this inquiry deals superficially with the variations in the four elements of barometric pressure, air temperature,

* Cordoba lies in the deep valley of the Rio Primero. A few miles to the west are some considerable ranges of hills, and 300 miles further are the mammoth peaks of the Andes. See "Frequencia Relativa Media Annual de los Vientos" in the *Anales de la Oficina Meteorólogica Argentina*, vol. ix. p. 353. Few nations equal Argentina either in the quality of its meteorological observations, or in the sumptuous volumes in which they are published.

moisture, and cloud, corresponding to the various deviations from the normal wind directions. The first three of these are for the hours 2 and 8 (a.m. and p.m.), but there are no observations of cloud at 2 a.m. In the present section the instantaneous wind directions *at* the hours named are used.

1. Pressure.—The method of reduction first attempted was the very simple one of adding together every pressure under assigned wind directions, and taking the mean for the whole three years. The resulting curves, however, were extremely irregular. The reason was not at first obvious, but a second examination of the work showed that certain directions happened to prevail say in a winter month with its customary high mean pressures, and other directions, say in a summer month with its customary low mean. To avoid this element of confusion, the process was adopted of drawing separate curves for each of the four hours of every month, and then reducing each curve by the simple addition or subtraction of a number, constant for that particular curve, to the mean pressure of the three years, the assumption being made, and supported to some extent by the monthly results, that each monthly curve resembled every other in shape. In this manner the effect of a greater or less number of directions from any assigned compass-point was eliminated. Finally the results were "bloxamed" in sets of three. Table 16 gives both smoothed and unsmoothed values.

The mean pressures of the day have a primary maximum with winds from the south-east, and a secondary maximum with those from the north-west; a primary minimum with winds from the west-south-west, and a secondary minimum with those from the north-north-west. There appears to be, as well, a tendency for the wind accompanying the highest pressure to radiate from a point which vibrates to and fro along a small arc of the horizon in the course of the day.

2. Temperature.—Table 17 gives the temperature results calculated in the same way as the last. The mean temperatures exhibit one maximum with winds slightly to the north of north-north-west, and one minimum nearly south-south-east. But while the minimum temperature seems to accompany the wind of greatest air-pressure, the maximum travels with the sun (see the smoothed values), through pretty well a right angle. If future inquiry prove this to be a general law the passage of the warm point back to the north-north-east between 8 p.m. and 2 a.m. must be very rapid, and its hourly rate well worth study.

3. Dew-points.—The dampest point is nearly midway between north-east and north-north-east, the driest point being exactly

opposite.* Both have a tendency to shift against the sun before noon and with the sun afterwards. It is curious that there is a wider range in the amount of moisture carried by the winds at night than there is by day. The reverse holds with the temperatures, in which the greatest ranges are by day, following in this respect the same law as the pressures.

If a line be drawn N.N.E.–S.S.W., all winds from the east side come with an average pressure above the mean, and all from the west with an average pressure below. This has a further bearing on the facts revealed in Fig. 7. The mean temperature line is nearly E.–W., and the line of mean dew-points E.S.E.–W.N.W.

4. Cloud.—Only the cloudiness of the sky with reference to particular winds is here considered, no account being taken of the sort of cloud. Table 19 gives the average amount of cloud accompanying each wind at 8 a.m., 2 p.m., and 8 p.m., together with the mean of the three hours; also smoothed values of each with their smoothed mean, which last, plotted to scale, might be called the normal curve. The last three lines give the departures from the normal. Northerly winds are accompanied by the most cloud, and southerly winds by the least. This feature is contributed to in two ways: firstly, because in the diurnal range the cloudiness is greater at 2 p.m. (when northerly winds are prevalent) than at 8 a.m. or 8 p.m.; and secondly, because the ruling directions of cloud motion have a very large northerly component. The set-in south-easterly winds, when they occur, moreover, are in the main anticyclonic, with clear skies. But over and above this we have the most significant result that, relatively to the normal curve, the cloudiness of the sky increases with the deviation of the vane from its normal position.

In conclusion, it should be said that the whole of the material of this paper has been worked up in spare time, and chiefly by lamplight; so that, while every effort has been made to ensure accuracy, if a few numerical errors have crept in, it is no more perhaps than might be expected. Some eminent professional meteorologist in the future will, I trust, be able to make a fuller discussion of the winds of Kimberley, and with a lighter handicap. The wind-roses alone will repay the most elaborate treatment, and particularly, I believe,

* The behaviour of the dew-point at 6 p.m. is very anomalous. The prevailing winds at this time are south-westerly, which, for the hours included in Table 18, are shown to be the driest. But the dew-point curve attains its second maximum about 6 p.m.! It would seem, then, that the law of Table 18 does not apply to the sunset hours. Certainly the circumstance calls aloud for investigation. I hope to discuss this, together with some other points of interest not included here, later on. It is somewhat of a mystery where the increase of moisture at sunset comes from.

for the hours of 6 p.m. and 11 p.m. In view of the fact that time has prevented the inclusion of these in this general sketch, all minor, even if important, details have had, *a fortiori*, to be severely left alone.

APPENDIX.

The general outline of this paper was complete before I had the good fortune to consult a remarkable paper by Mr. F. Chambers "On the Diurnal Variations of the Wind and Barometric Pressure at Bombay." * Much of the argument therein contained seems to want further proof; but there is no doubt that the plea for anti-convection currents is most ably maintained. As opposed to this we have the theoretical opinions of W. von Siemens some seventeen years later.† The latter compares the atmosphere to a number of adjacent chimneys in which heated air rises with great rapidity, and although these are described as having elastic walls, yet in no place, apparently, has this property been brought into requisition. For "disturbances are balanced by means of ascending currents," and, moreover, "if the heating of the lower strata of air takes place within a limited area, a local outflow" [*upflow* seems to be meant] "occurs, reaching to the uppermost regions of the air." While there is no difficulty at all in understanding that the heated air of the whole torrid zone must rise and flow off polewards, even if observation had not confirmed it, it does not seem so clear that the same result must follow from local and limited heating. Observational confirmation, at any rate, is quite wanting. Still less is there any solid foundation for the further statement that "the maximum and minimum air-pressures are effects of the temperature and velocity of currents of air in the higher strata of the atmosphere." It is much more antecedently probable that the latter will be eventually explained by the principles of the Wave Theory than by causes so remote and changeable.‡ However that may be, it is quite certain

* *Philosophical Transactions*, vol. 163, pp. 1–18. Read before the Royal Society, June 19, 1873. See also *Proceedings of the Royal Society*, vol. xxv. pp. 402–411.

† "On the General System of Winds on the Earth." *Phil. Mag.*, Dec., 1890.

‡ *Vide* "On the Vibrations of an Atmosphere Periodically Heated," by Max. Margules, translated from the *Sitzungsberichte der König. Akad. der Wissensch. zu Wien*, 1890, in Prof. Cleveland Abbe's *Mechanics of the Earth's Atmosphere*. Also a paper by Lord Rayleigh, translated (from English into American) from the *Phil. Mag.*, Feb., 1890, in the same volume.

that, if the chimneys are to stand, the diurnal changes of wind-direction cannot be due to an outflow beneath of air from a heated region and inflow to a cold. The following simple calculation (which may or may not be new) has some bearing on the problem:—

Suppose the climatic and geographical conditions peculiar to Kimberley to prevail for the same latitude in a narrow zone completely round the world; that is, let the temperatures and pressures throughout have the same maxima and minima and the same daily variations. At any instant mark the twenty-four points at which the times are whole hours, and on each point imagine a cube of air, whose volume at 32° F. is 1,000 (in any small units), to be situated. By virtue of the expansions—supposed equal in all directions—due to the mean temperature at each point for the hour, the cubes will have expanded from the volumes at 32° F. to the volumes shown by column 2 in Table 20. For all temperatures below the mean these volumes may be regarded as contractions from the mean volume at mean temperature, and for all temperatures above the mean as corresponding expansions. Suppose the temperature and pressure to change, hour by hour, *per saltum*, so that, for $7\frac{1}{2}$ degrees of arc on each side of the hour points, the temperatures and pressures are the same as that at the hours. Also let n of the cubes, at mean temperature, placed end to end, occupy each of the areas whose centre is at any hour. Column 3 shows the length of each base for the times indicated in column 1, column 4 the departure from the mean length, column 5 the base areas, and column 6 the departure from the mean area.

Now, taking only statical conditions into account, of the total length of the bases (equal to $n \times 244{\cdot}8$ units), $n \times {\cdot}365$ units will be pushed by expansion westward from the hot hemisphere into the cold; * and $n \times {\cdot}278$ units eastward. The bases will cover $n \times 1255{\cdot}1$ square units in the hot hemisphere, and $n \times 1242{\cdot}0$ square units in the cold. Whence by comparing the whole pressures, in respect of the cubes of air in question, upon the bases in each hemisphere we have the mean pressures in the hot and cold hemispheres in the respective ratio of 1·00 to 1·02. But the mean barometric pressure in the hot hemisphere is 26·1337 inches, and in the cold hemisphere it is 26·153 inches, *i.e.*, in the ratio of 1·000 to 1·001. The result seems to show that in the given zone the hypothesis that the expansion is equal in all directions would require the transfer of more air into the cold hemisphere than barometric observations warrant.

* Agreeing with the fact that the air-temperature begins to rise before sunrise. The most energetic expansion is in the direction of the primary barometric maximum, the least energetic expansion being towards the secondary maximum.

The answer is simple. If the units be yards the mean height of each cube would be 10·2 yards, and there would be a measurable difference between the pressure at this height and that at the bottom. Hence the expansion by heating would be easier upwards than outwards. On the other hand, the contraction by cooling would be more energetic inwards near the ground than downwards, resulting in an indraught throughout the whole cool hemisphere, and thereby assisting to some extent the outward expansion opposite. It seems scarcely likely that the excess of upward over outward expansion can extend to the highest limits of the atmosphere, but it is not unlikely that much of it intermixes with the constant north-westerly current above, in the cloud strata, and is thus drawn off as an outflow. If, however, expansion be wholly upwards, and contraction wholly downwards, the base of each cube will at first remain unaltered in size and shape, together with the pressure upon it, the tops of the cubes rising by different amounts, but also remaining in a surface of equal pressure; and no transfer of air can ensue, either above or below, until the high crest of the expanded air falls away from its altitude. Curiously enough, von Siemens maintains that in a surface of equal pressure, such as that in which our expanded and contracted cubes are supposed to lie, there can be no sliding away down the slope of equal pressure by the higher portions. The statement is doubtless only statically true, for it leaves out of account the fact that a free particle on an expanding surface is by the mere acquisition of motion projected by the earth's rotation into an elliptical orbit with a focus at the earth's centre of gravity. Consequently the atmospheric chimney must tend to bend over at the top in the direction of the equator, giving relief to the pressure at its base. The total effect is probably not great, yet it may partially explain the differences in the two calculated results above. On the whole, the case for an actual spiral outflow near the ground, from the hot to the cold hemisphere, seems to be not only possible, but very probable.

TABLE 1.

WIND FREQUENCY IN HOURS: MONTHLY TOTALS.

MONTH.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
January	185	144	161	195	97	130	93	110	105	173	141	138	59	107	149	227
February	111	127	157	191	90	165	158	123	112	88	117	65	84	120	118	161
March	176	131	153	175	79	125	87	109	101	117	156	149	75	145	168	220
April	128	117	153	151	98	100	102	152	132	124	102	99	89	163	167	233
May	119	146	173	237	134	119	66	140	258	138	122	66	54	104	147	186
June	76	109	100	187	173	169	165	262	102	148	97	108	88	102	86	143
July	107	126	127	290	88	111	81	164	161	157	177	106	61	146	116	195
August	174	164	188	275	183	132	102	156	98	103	69	81	84	81	117	202
September	94	86	65	147	81	92	148	210	118	202	206	164	104	122	120	178
October	88	56	68	107	62	93	111	195	181	297	287	243	97	114	74	122
November	110	111	92	108	58	66	85	108	128	297	241	245	113	123	109	145
December	170	162	129	139	66	62	118	118	99	151	167	143	137	115	170	258
	1538	1479	1566	2202	1209	1364	1316	1847	1595	1995	1882	1607	1045	1442	1541	2270

TABLE 2.

MONTHLY COMPONENTS OF WIND FREQUENCY.

MONTH.	N.	E.
January	+ 228·1	+ 30·6
February	+ 101·1	+ 220·9
March	+ 263·2	− 87·0
April	+ 190·4	− 44·7
May	+ 63·9	+ 216·1
June	− 221·1	+ 308·5
July	+ 19·2	+ 80·8
August	+ 324·3	+ 404·6
September	− 275·3	− 178·5
October	− 608·1	− 373·0
November	− 274·6	− 441·9
December	+ 239·2	− 236·6
Three Years	+ 50·3	− 100·2

TABLE 3.

WIND FREQUENCY IN HOURS ARRANGED IN QUADRANTS: MONTHLY TOTALS.

MONTH.	N.–E.N.E. Quadrant 1.	E.–S.S.E. Quadrant 2.	S.–W.S.W. Quadrant 3.	W.–N.N.W. Quadrant 4.
January	685	430	557	542
February	586	536	382	483
March	635	400	523	608
April	549	452	457	652
May	675	459	584	491
June	472	769	455	419
July	650	444	601	518
August	801	573	351	484
September	392	531	690	524
October	319	461	1008	407
November	421	317	911	490
December	600	364	560	680
	6785	5736	7079	6298

TABLE 4.

Wind Frequency in Hours: Four-Monthly Periods.

Period.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
January–April	600	519	624	712	364	520	440	494	450	502	516	451	307	535	602	841
May–August	476	545	588	989	578	531	414	722	619	546	465	361	287	433	466	726
Sept.–Dec.	462	415	354	501	267	313	462	631	526	947	901	795	451	474	473	703

TABLE 5.

Four-Monthly Wind Components.

Date.	N.	E.
January–April	+ 782·8	+ 119·8
May–August	+ 186·3	+ 1010·0
September – December	– 918·8	– 1230·0

TABLE 6.

Wind Frequency in Hours: Yearly Totals.

Period.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
March–December, 1896, and Jan.–Feb., 1899	500	477	472	505	240	328	305	523	592	629	604	727	504	653	614	873
1897	474	481	428	634	336	454	509	715	559	749	757	515	316	476	544	700
1898	564	521	666	1063	633	582	502	609	444	617	521	365	225	313	383	697
Mean	513	493	522	734	403	455	439	616	532	665	627	536	348	481	514	757

TABLE 7.

Wind Frequency: Diurnal Variation.

For the Hour Ending	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
I.	33	64	57	147	82	92	82	129	78	90	67	38	20	22	39	41
II.	31	53	82	144	78	82	91	119	84	74	69	37	23	25	39	47
III.	34	63	80	164	75	89	87	105	78	81	58	35	21	27	41	45
IV.	36	77	93	167	68	82	82	110	73	74	51	38	27	23	34	48
V.	39	69	105	183	69	85	74	107	70	57	59	39	27	25	35	39
VI.	50	70	113	189	71	73	72	115	62	55	63	31	28	22	30	44
VII.	76	91	132	147	60	70	79	105	56	52	56	35	26	22	29	48
VIII.	110	116	126	119	46	56	86	68	51	50	55	31	25	29	36	85
IX.	147	141	76	66	19	50	56	63	31	50	42	42	33	44	58	164
X.	162	103	52	30	16	40	35	48	36	48	47	53	39	54	83	234
XI.	130	75	36	25	11	26	29	42	37	46	47	64	46	87	116	260
Noon	100	61	31	17	10	15	32	33	30	56	43	83	60	135	136	232
XIII.	75	50	31	16	5	11	22	36	34	46	57	112	72	156	147	197
XIV.	67	43	40	12	8	13	19	37	44	50	68	122	90	151	128	171
XV.	68	34	39	17	16	19	17	31	45	65	88	142	108	125	130	123
XVI.	61	42	30	29	19	16	18	34	54	80	127	150	92	111	113	102
XVII.	58	40	35	36	22	21	21	43	59	125	137	126	91	99	77	89
XVIII.	49	43	50	48	29	34	20	54	71	141	143	119	58	73	70	71
XIX.	42	46	49	72	57	44	37	68	93	151	146	80	36	58	49	50
XX.	40	40	51	81	90	70	56	83	101	144	123	54	32	46	34	36
XXI.	44	31	56	105	86	93	58	95	105	133	105	49	28	33	28	31
XXII.	31	46	65	114	93	101	74	96	107	127	75	44	28	26	21	33
XXIII.	31	33	76	131	94	88	83	106	103	115	78	40	16	23	32	38
Midnight	24	48	61	143	85	94	86	120	93	85	78	43	19	26	36	42
Total	1538	1479	1566	2202	1209	1364	1316	1847	1595	1995	1882	1607	1045	1442	1541	2270

TABLE 8.

Relative Wind Frequency: Diurnal Variation.

For the Hour Ending	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
I.	21	43	36	67	68	68	62	70	49	45	36	24	19	15	25	18
II.	20	37	52	65	64	60	69	64	53	37	37	23	22	17	25	21
III.	22	43	51	74	62	65	66	57	49	41	31	22	20	19	27	20
IV.	23	52	59	76	55	60	62	60	46	37	27	24	26	16	22	21
V.	25	47	67	83	56	62	56	58	45	29	31	24	26	17	23	17
VI.	33	47	72	86	58	54	55	62	39	27	33	19	27	15	20	19
VII.	49	62	84	67	50	51	60	57	35	26	30	22	25	15	19	21
VIII.	71	76	80	54	38	41	65	37	32	25	29	19	24	20	23	37
IX.	96	95	49	30	16	37	43	34	19	25	22	26	32	31	38	74
X.	105	70	33	14	13	29	27	26	23	24	25	33	37	37	54	103
XI.	84	51	23	11	9	19	22	23	23	23	25	40	44	60	75	115
Noon	65	41	20	8	8	11	24	18	19	28	23	52	57	94	87	102
XIII.	49	34	20	7	4	8	17	19	21	23	30	70	69	108	95	87
XIV.	44	29	26	5	7	10	14	20	28	25	36	75	86	105	83	75
XV.	44	23	25	8	13	14	13	17	28	33	47	88	103	87	84	54
XVI.	40	28	19	13	16	12	14	18	34	40	68	93	88	77	73	45
XVII.	38	27	22	16	18	15	16	23	37	63	73	79	87	69	50	39
XVIII.	32	29	32	22	24	25	15	29	45	71	76	75	56	51	45	31
XIX.	27	31	31	33	47	32	28	37	58	76	78	50	34	40	32	22
XX.	26	27	33	37	74	51	43	45	63	72	65	36	31	32	22	16
XXI.	29	21	36	48	71	68	44	51	66	67	56	30	27	23	18	14
XXII.	20	31	42	52	77	74	56	52	67	64	40	27	27	18	14	15
XXIII.	20	22	49	59	78	65	63	57	65	58	41	25	15	16	21	17
Midnight	16	33	39	65	70	69	65	65	58	43	41	27	18	18	23	19
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

TABLE 9.

Hourly Wind-Frequency Components.

Hour Ending	N.	E.
I.	− 172·9	+ 274·4
II.	− 147·4	+ 272·0
III.	− 107·4	+ 294·6
IV.	− 69·0	+ 303·2
V.	− 45·6	+ 321·2
VI.	− 17·1	+ 334·1
VII.	+ 46·2	+ 307·7
VIII.	+ 173·9	+ 231·6
IX.	+ 325·7	+ 32·5
X.	+ 382·7	− 137·7
XI.	+ 383·4	− 269·0
Noon	+ 344·2	− 378·1
XIII.	+ 282·2	− 456·5
XIV.	+ 208·3	− 462·0
XV.	+ 117·3	− 467·0
XVI.	+ 23·4	− 448·9
XVII.	− 74·1	− 386·1
XVIII.	− 139·5	− 275·8
XIX.	− 222·4	− 109·7
XX.	− 265·8	+ 48·0
XXI.	− 271·8	+ 137·2
XXII.	− 255·5	+ 222·5
XXIII.	− 238·1	+ 251·4
Midnight	− 210·4	+ 260·2
Total	+ 50·3	− 100·2

TABLE 10.

Mean Angular Movement of the Vane in Six-Hour Periods.

Month.	O.–VI.	VI.–Noon.	Noon–XVIII.	XVIII.–XXIV.	O.–XXIV.
	°	°	°	°	°
January	+ 35·8	+ 59·7	+ 22·4	+ 30·6	+ 148·5
February	16·1	89·2	+ 27·6	35·8	168·7
March	23·6	44·3	+ 39·5	28·7	136·1
April	29·5	52·7	+ 8·2	13·1	103·5
May	20·6	42·7	+ 14·3	7·9	85·5
June	2·6	51·3	− 5·4	18·3	66·8
July	1·5	45·8	+ 1·0	13·2	61·5
August	20·1	61·0	+ 11·4	15·8	108·3
September	11·5	54·1	− 0·7	26·5	91·4
October	41·6	53·3	+ 9·4	21·6	125·6
November	27·8	37·7	+ 11·2	29·1	105·8
December	28·6	34·6	+ 40·6	19·3	123·1
Year	+ 21·6	+ 52·2	+ 14·9	+ 21·7	+ 110·4

TABLE 11.

A Comparison of the Summer and Winter Values of the Diurnal Variation in Relative Wind Frequency. Quadrants.

For the Hour Ending	N.–E.N.E. Quadrant 1.		E.–S.S.E. Quadrant 2.		S.–W.S.W. Quadrant 3.		W.–N.N.W. Quadrant 4.	
	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.
I.	46	43	64	66	35	34	31	16
II.	52	46	66	58	28	36	29	17
III.	51	56	73	51	23	40	29	15
IV.	57	53	66	50	24	42	26	18
V..........	58	58	66	51	23	36	25	16
VI.	62	62	59	50	22	35	29	15
VII.......	66	58	57	55	23	29	25	20
VIII. ...	67	62	44	50	22	31	33	20
IX.	55	64	31	35	22	31	55	39
X.	49	58	25	23	21	33	64	56
XI.	37	43	15	18	24	34	79	77
Noon ...	27	28	13	16	30	37	86	97
XIII. ...	24	25	8	14	38	36	85	101
XIV. ...	26	23	11	16	45	39	75	100
XV.......	27	22	15	17	50	47	65	93
XVI. ...	21	28	14	15	63	59	61	76
XVII. ...	21	29	18	19	73	64	52	63
XVIII...	27	34	25	22	78	66	35	46
XIX. ...	30	36	35	41	78	59	24	28
XX.......	31	30	49	61	73	50	18	22
XXI. ...	35	28	60	67	64	46	17	20
XXII....	39	35	63	67	56	42	19	18
XXIII...	47	39	59	69	51	38	16	16
Midnight	48	39	63	68	39	36	23	17

TABLE 12.

WIND VELOCITIES: DIURNAL VARIATION.

For the Hour Ending	Mean Hourly Velocities in Miles per Hour.					Departures from the Mean Hourly Velocity in Smoothed Values.				Direction Numbers in Hours.				Mean Relative Humidity.	Mean Yearly Totals of Evaporation.	Mean Barometric Pressure.
	Total.	Q_1	Q_2	Q_3	Q_4	Q_1–M	Q_2–M	Q_3–M	Q_4–M	Q_1	Q_2	Q_3	Q_4	1898.	Inches.	Inches.
														%		
I.	5·7	5·5	5·8	6·5	3·5	−0·2	+0·2	+0·8	−2·1	216	293	158	60	64·8	2·166	26·143
II.	5·6	5·6	5·7	6·1	3·9	0·0	+0·1	+0·5	−2·0	224	291	150	63	67·7	2·118	26·139
III.	5·4	5·6	5·5	5·6	3·4	+0·1	+0·1	+0·3	−1·9	243	285	145	55	68·3	2·071	26·137
IV.	5·4	5·6	5·5	5·6	3·4	+0·2	+0·1	+0·2	−1·6	264	276	129	56	68·7	2·055	26·140
V.	5·2	5·4	5·2	5·4	4·3	+0·3	0·0	+0·2	−1·4	280	271	125	50	71·9	1·982	26·147
VI.	5·1	5·6	5·0	5·2	3·8	+0·5	−0·2	+0·1	−1·4	311	257	115	47	72·1	2·071	26·159
VII.	5·5	6·2	4·9	5·5	3·5	+0·7	−0·7	+0·1	−1·1	326	236	114	49	69·8	2·456	26·170
VIII.	6·3	7·1	4·8	6·5	6·3	+0·8	−1·3	0·0	−0·7	346	197	112	73	59·1	2·690	26·180
IX.	7·1	8·0	5·3	6·9	6·9	+0·8	−1·8	−0·2	+0·1	339	143	108	138	52·1	2·703	26·184
X.	7·9	8·6	5·7	7·2	8·4	+0·7	−2·1	−0·5	+0·3	269	106	117	230	45·3	3·370	26·180
XI.	8·1	8·5	5·8	7·5	8·6	+0·4	−2·2	−0·6	+0·5	214	78	124	304	40·4	4·028	26·169
Noon	8·3	8·3	6·1	7·8	8·9	+0·1	−2·3	−0·5	+0·6	159	67	145	352	37·4	4·773	26·149
XIII.	8·5	8·4	6·2	8·1	9·2	−0·3	−2·2	−0·3	+0·6	137	57	166	354	34·8	5·353	26·128
XIV.	8·5	7·7	6·3	8·6	9·1	−0·7	−2·1	0·0	+0·7	126	64	192	333	34·1	5·708	26·108
XV.	8·5	7·4	6·6	8·8	9·2	−1·2	−1·9	+0·3	+0·7	120	70	231	294	33·6	5·753	26·098
XVI.	8·2	6·6	6·7	8·8	8·9	−1·3	−1·8	+0·5	+0·7	121	76	266	259	33·9	5·308	26·093
XVII.	7·6	6·5	5·6	8·3	8·2	−1·3	−1·6	+0·8	+0·4	135	90	297	201	38·7	4·309	26·097
XVIII.	6·6	5·4	5·2	7·7	6·5	−0·9	−1·3	+0·9	+0·1	151	119	304	153	45·2	3·087	26·105
XIX.	5·8	5·3	5·2	6·7	4·9	−0·6	−0·7	+0·9	−0·9	161	166	303	96	51·0	2·284	26·119
XX.	5·7	5·5	5·5	6·3	4·0	−0·4	−0·2	+0·7	−1·7	164	225	269	68	53·6	2·207	26·133
XXI.	5·8	5·4	6·0	6·5	3·3	−0·4	+0·1	+0·7	−2·0	182	252	244	47	56·5	2·112	26·142
XXII.	6·03	5·4	6·2	6·8	4·2	−0·4	+0·2	+0·8	−2·1	194	266	214	53	57·9	2·168	26·147
XXIII.	6·14	5·8	6·3	7·0	4·1	−0·4	+0·2	+0·9	−2·1	195	276	196	58	59·2	2·397	26·149
Midnight	6·05	5·6	6·3	7·0	3·6	−0·3	+0·2	+0·9	−2·2	197	293	179	58	62·5	2·167	26·147
Day	6·6	6·4	5·6	7·1	7·5	−0·2	−1·0	+0·5	+0·9	5074	4454	4403	3451	53·3	75·336	26·140

TABLE 13.

Hourly Wind Movement in Miles.

For the Hour Ending	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
I.	98	219	213	668	397	402	367	539	239	344	354	85	23	43	42	103
II.	73	165	338	684	360	297	451	543	213	263	338	95	23	56	52	114
III.	77	178	326	787	328	376	402	472	181	272	294	58	6	60	63	57
IV.	76	208	401	791	315	320	385	488	159	257	226	83	22	38	46	87
V.	62	195	429	815	332	295	309	466	164	220	200	89	28	37	62	86
VI.	150	218	480	897	285	222	277	448	134	164	237	64	29	34	55	61
VII.	255	352	686	734	201	205	351	391	135	146	252	89	24	41	25	82
VIII.	526	623	724	579	132	193	396	231	169	163	291	109	48	30	53	325
IX.	952	824	605	318	37	237	233	254	104	250	236	157	70	95	106	682
X.	1099	682	370	162	75	154	177	200	152	220	262	210	116	144	256	1407
XI.	959	474	232	155	40	88	146	182	134	225	285	290	155	286	602	1581
Noon	661	364	223	76	64	52	136	159	137	260	262	468	217	477	798	1630
XIII.	510	334	174	129	28	40	111	174	127	197	400	622	302	636	914	1394
XIV.	424	260	206	80	47	70	96	193	190	245	548	670	342	764	782	1140
XV.	432	199	167	86	114	97	82	172	200	331	763	734	538	636	720	806
XVI.	315	187	168	123	140	68	121	184	232	402	1051	650	514	490	606	691
XVII.	286	200	192	201	87	107	116	194	268	632	948	622	442	390	332	486
XVIII.	216	169	237	200	124	154	80	260	336	652	779	618	231	217	213	337
XIX.	160	191	234	273	233	162	154	312	353	689	606	380	70	138	120	141
XX.	129	175	222	360	360	294	181	410	395	599	530	180	45	84	63	82
XXI.	157	127	211	486	430	359	200	526	381	563	466	166	19	25	41	72
XXII.	86	180	253	526	443	366	401	451	422	606	319	108	48	37	21	118
XXIII.	128	107	274	617	451	427	347	503	360	554	383	65	23	19	66	127
Midnight	102	153	244	602	500	425	417	499	307	401	399	137	13	39	61	98
Total	7933	6784	7609	10349	5523	5410	5936	8251	5492	8655	10429	6749	3348	4816	6099	11707

TABLE 14.

Hourly Wind-Movement Components.

Hour Ending	N.	E.
I.	− 903·1	+ 1493·4
II.	− 775·8	+ 1512·6
III.	− 633·3	+ 1672·6
IV.	− 451·7	+ 1705·8
V.	− 309·8	+ 1685·5
VI.	− 30·0	+ 1696·8
VII.	+ 285·3	+ 1658·9
VIII.	+ 1050·0	+ 1357·6
IX.	+ 1952·1	+ 653·5
X.	+ 2599·0	− 340·7
XI.	+ 2656·6	− 1222·6
Noon	+ 2432·3	− 1926·6
XIII.	+ 2084·1	− 2422·2
XIV.	+ 1405·8	− 2564·9
XV.	+ 683·8	− 2686·4
XVI.	+ 31·2	− 2494·4
XVII.	− 546·0	− 1969·8
XVIII.	− 920·2	− 1243·0
XIX.	− 1148·3	− 277·8
XX.	− 1273·5	+ 504·2
XXI.	− 1344·4	+ 954·2
XXII.	− 1318·5	+ 1271·6
XXIII.	− 1213·0	+ 1409·4
Midnight	− 1135·7	+ 1473·9
Total	+ 3176·9	+ 1903·6

TABLE 15.

Component Variations from a Wind-System of Constant Velocity.

For the Hour Ending	North.			East.			Resultant.
	Variable Movement.	Constant Velocity.	Difference.	Variable Movement.	Constant Velocity.	Difference.	
v–c	v	c	v–c	v	c	v–c	R
I.	− 452	−379	− 73	+ 747	+ 604	+143	161
II.	− 388	−324	− 64	+ 756	+ 598	+158	170
III.	− 317	−236	− 81	+ 836	+ 648	+188	243
IV.	− 226	−142	− 84	+ 853	+ 667	+186	238
V.........	− 155	−101	− 54	+ 843	+ 707	+136	146
VI.	− 15	− 38	+ 23	+ 848	+ 735	+113	115
VII.......	+ 143	+102	+ 41	+ 829	+ 677	+152	157
VIII. ...	+ 525	+383	+142	+ 679	+ 510	+169	221
IX.	+ 976	+717	+259	+ 327	+ 72	+255	363
X.........	+1300	+842	+458	− 170	− 303	+133	477
XI.	+1328	+844	+484	− 611	− 592	− 19	484
Noon ...	+1216	+757	+459	− 913	− 832	− 81	466
XIII. ...	+1042	+621	+421	−1211	−1004	−207	468
XIV. ...	+ 703	+458	+245	−1282	−1016	−266	361
XV.......	+ 342	+258	+ 84	−1343	−1027	−316	327
XVI. ...	+ 16	+ 51	− 35	−1247	− 988	−259	261
XVII....	− 273	−163	−110	− 985	− 849	−136	175
XVIII...	− 460	−307	−153	− 621	− 607	− 14	154
XIX. ...	− 574	−489	− 85	− 139	− 241	−102	133
XX.......	− 637	−585	− 52	+ 252	+ 106	+146	147
XXI. ...	− 672	−598	− 74	+ 477	+ 302	+175	190
XXII....	− 659	−562	− 97	+ 636	+ 490	+146	173
XXIII...	− 607	−524	− 83	+ 705	+ 553	+152	152
Midnight	− 568	−462	−106	+ 737	+ 572	+165	196

TABLE 16.

Wind Characteristics of Pressure.

1. *Unsmoothed Values.*

Hour.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Mean.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
II. ...	26·099	26·127	26·135	26·147	26·160	26·164	26·168	26·157	26·148	26·119	26·098	26·101	26·102	26·116	26·131	26·118	
VIII.	26·124	26·150	26·146	26·150	26·157	26·168	26·173	26·173	26·154	26·109	26·103	26·079	26·105	26·105	26·127	26·122	
XIV.	26·140	26·153	26·174	26·180	26·182	26·214	26·206	26·181	26·164	26·176	26·138	26·120	26·123	26·118	26·130	26·114	
XX.	26·115	26·096	26·134	26·142	26·163	26·165	26·167	26·178	26·152	26·137	26·111	26·095	26·106	26·116	26·130	26·098	
Mean	26·123	26·140	26·145	26·149	26·163	26·169	26·172	26·169	26·153	26·135	26·114	26·107	26·115	26·115	26·129	26·116	26·138

2. *Smoothed Values.*

Hour.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Range.
II. ...	26·117	26·126	26·140	26·147	26·155	26·164	26·163	26·158	26·143	26·124	26·108	26·100	26·105	26·119	26·122	26·118	·064
VIII.	26·131	26·139	26·148	26·149	26·157	26·168	26·172	26·167	26·153	26·126	26·099	26·098	26·098	26·115	26·120	26·124	·074
XIV.	26·130	26·153	26·166	26·177	26·190	26·198	26·199	26·176	26·172	26·155	26·135	26·125	26·121	26·124	26·122	26·123	·078
XX.	26·106	26·119	26·132	26·152	26·158	26·165	26·170	26·163	26·153	26·133	26·118	26·106	26·103	26·117	26·116	26·115	·067

TABLE 17.

Wind Characteristics of Temperature

1. *Unsmoothed Values.*

Hour.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Mean.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
II.	65·4	65·4	66·1	65·7	64·4	63·0	61·7	60·9	61·5	62·1	63·4	62·0	64·1	65·4	64·7	66·3	
VIII.	66·5	65·8	64·8	64·8	62·6	61·8	60·7	59·9	59·1	63·7	59·3	60·6	62·1	64·6	65·2	66·3	
XIV.	65·2	64·3	64·1	60·6	60·9	61·2	57·2	60·4	58·6	58·5	60·8	63·2	64·4	66·7	65·8	66·4	
XX.	65·3	65·3	64·5	65·3	64·1	62·6	61·2	61·4	61·7	63·1	64·6	63·8	64·1	65·9	66·1	66·4	
Mean........	65·9	65·3	65·0	65·0	63·7	62·5	61·0	60·7	60·7	62·2	62·5	62·9	64·0	65·5	65·6	66·4	63·7

2. *Smoothed Values.*

Hour.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Range.
II.	65·7	65·7	65·7	65·4	64·6	63·0	61·8	61·3	61·4	62·2	62·5	63·1	63·5	64·7	65·5	65·5	4·4
VIII.	66·2	65·7	65·1	64·4	63·5	61·5	60·7	59·9	60·3	60·2	60·8	60·4	62·7	64·3	65·6	66·1	6·3
XIV.	65·7	64·6	63·5	62·3	60·9	60·1	59·9	58·9	59·0	59·6	61·6	63·1	64·4	65·3	66·0	66·0	7·1
XX.	65·6	65·0	65·0	64·6	64·0	62·9	61·8	61·5	62·2	63·2	63·8	64·3	64·3	65·3	66·1	65·9	4·6

TABLE 18.

Wind Characteristics of Moisture (Dew Point).

1. *Unsmoothed Values.*

Hour.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Mean.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
II.	47·0	47·5	46·7	46·0	45·4	42·8	41·0	40·0	41·2	39·5	41·0	43·0	43·0	45·4	44·9	45·6	
VIII.	45·5	45·4	45·4	45·6	44·7	43·5	40·2	40·7	40·3	40·3	40·1	40·1	41·6	42·0	44.8	44·6	
XIV.	45·1	46·1	45·9	47·4	46·4	45·0	41·8	43·2	41·6	41·6	42·2	41·7	42·3	43·1	43·2	45·1	
XX.	46·8	46·9	47·6	45·1	44·9	44·8	42·7	43·1	41·3	40·9	40·3	41·7	44·7	45·6	47·7	45·3	
Mean.	45·8	46·5	46·2	45·8	45·2	43·8	41·3	41·3	41·1	40·6	40·9	41·8	42·7	43·5	44·7	45·0	43·5

2. *Smoothed Values.*

Hour.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Range.
II.	46·7	47·0	46·5	46·0	45·0	43·0	41·2	40·7	40·3	40·6	40·8	42·1	43·6	44·5	45·3	45·7	6·7
VIII.	45·2	45·5	45·5	45·4	44·9	42·3	41·2	40·4	40·5	40·2	40·2	40·6	41·4	43·2	44·1	45·0	5·3
XIV.	45·3	45·6	46·3	46·5	46·4	44·8	43·4	42·0	41·9	41·9	41·8	42·1	42·4	43·1	44·0	44·6	4·7
XX.	46·4	47·1	46·3	45·5	44·9	44·2	43·5	42·2	41·6	40·8	40·9	41·5	43·5	46·0	46·4	46·7	6·3

TABLE 19.

Wind Characteristics of Cloud.

Hour.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Mean.
1. Unsmoothed Values.																	
VIII.	3·2	2·7	2·8	2·5	3·1	2·4	1·2	2·1	1·4	2·7	3·5	3·7	2·7	3·0	3·0	3·0	2·7
XIV.	3·9	4·1	3·9	5·7	5·6	3·1	1·5	1·7	2·1	3·1	3·2	2·5	2·8	3·3	4·0	4·0	3·4
XX.	4·7	3·7	4·0	2·4	2·6	2·4	2·0	2·3	2·0	1·5	2·2	3·4	5·2	4·9	3·6	4·6	2·7
Mean.	3·7	3·3	3·3	2·9	3·2	2·5	1·6	2·1	1·9	2·0	2·8	2·9	3·2	3·5	3·7	3·7	2·9
2. Smoothed Values.																	
VIII.	3·0	2·9	2·7	2·8	2·6	2·1	1·8	1·6	2·0	2·5	3·3	3·3	3·1	3·0	3·0	3·1	
XIV.	4·0	4·0	4·4	4·9	4·9	3·8	2·2	1·9	2·4	2·9	2·8	2·8	2·9	3·4	3·8	4·0	
XX.	4·5	4·2	3·2	2·8	2·5	2·4	2·2	2·1	1·9	1·9	2·1	3·0	4·2	4·5	4·3	4·4	
Normal.	3·7	3·4	3·2	3·0	2·9	2·5	2·1	1·9	2·0	2·3	2·6	2·9	3·2	3·5	3·6	3·7	
3. Deviation from the Normal.																	
VIII.	−0·7	−0·5	−0·5	−0·2	−0·3	−0·4	−0·3	−0·3	0·0	+0·2	+0·7	+0·4	−0·1	−0·5	−0·6	−0·6	−0·2
XIV.	+0·3	+0·6	+1·2	+1·9	+2·0	+1·3	+0·1	0·0	+0·4	+0·6	+0·2	−0·1	−0·3	−0·1	+0·2	+0·3	+0·5
XX.	+0·8	+0·8	0·0	−0·2	−0·4	−0·1	+0·1	+0·2	−0·1	−0·4	−0·5	+0·1	+1·0	+1·0	+0·7	+0·7	−0·2

TABLE 20.

VARIATIONS OF CUBIC VOLUMES OF AIR WITH TEMPERATURE.

TIME.	VOL.	BASE LENGTH.	VAR.	BASE AREA.	VAR.
I.	1044	10·145	– ·055	102 91	– 1·18
II.	1042	10·138	– ·062	102·78	– 1·31
III.	1040	10·132	– ·068	102·65	– 1·44
IV.	1038	10·125	– ·075	102·52	– 1·57
V.	1036	10·119	– ·081	102·39	– 1·70
VI.	1037	10·122	– ·078	102·46	– 1·63
VII.	1041	10·135	– ·065	102·71	– 1·38
VIII.	1053	10·174	– ·026	103·50	– 0·59
IX.	1065	10·212	+ ·012	104·29	+ 0·20
X.	1073	10·238	+ ·038	104·81	+ 0·72
XI.	1080	10·260	+ ·060	105·27	+ 1·18
Noon	1085	10·276	+ ·076	105·59	+ 1·50
XIII.	1089	10·288	+ ·088	105·84	+ 1·79
XIV.	1090	10·291	+ ·091	105·91	+ 1·82
XV.	1090	10·291	+ ·091	105·91	+ 1·82
XVI.	1088	10·285	+ ·085	105·78	+ 1·69
XVII.	1082	10·266	+ ·066	105·39	+ 1·30
XVIII.	1072	10·234	+ ·034	104·74	+ 0·65
XIX.	1064	10·209	+ ·009	104·22	+ 0 13
XX.	1059	I0.193	– ·007	103·90	– 0·19
XXI.	1055	10·180	– ·020	103·64	– 0·45
XXII.	1052	10·170	– ·030	103·44	– 0·65
XXIII.	1050	10·164	– ·036	103·31	– 0·78
Midnight	1047	10·154	– ·046	103·11	– 0·98
Mean	1062	10·200		104·09	

PLATES II. TO IX.

PLATE X.

View of the cliff on the east side of the ravine two miles west of Prieska village. Surface soil on the top lying on the glacial till, the upper part of which is much lighter in colour, owing to weathering, than the lower.

West, Newman collotyp.

ROGERS AND SCHWARZ: ORANGE RIVER-GROUND MORAINE.

PLATE XI.

A PART of the cliff shown in Plate X., showing the distribution of pebbles in the matrix. The surface of the pebble on which the hammer-head rests is well striated.

West, Newman collotyp.

ROGERS AND SCHWARZ: ORANGE RIVER-GROUND MORAINE.

PLATE XII.

A PART of the cliff on the western side of the ravine two miles west of Prieska. The granite boulder on which the hammer-head rests is the largest one in the cliff.

West, Newman collotyp.

ROGERS AND SCHWARZ: ORANGE RIVER-GROUND MORAINE.

PLATE XIII.

View of quartzite hill on Jackal's Water, rising from under the glacial conglomerate, which gives rise to the boulder-covered surface seen in the foreground. The "roche moutonnée" form of the quartzite is seen in the lower part of the hill, and the upper portion has the rough surface usually met with where compact rocks are exposed to great diurnal variation in temperature.

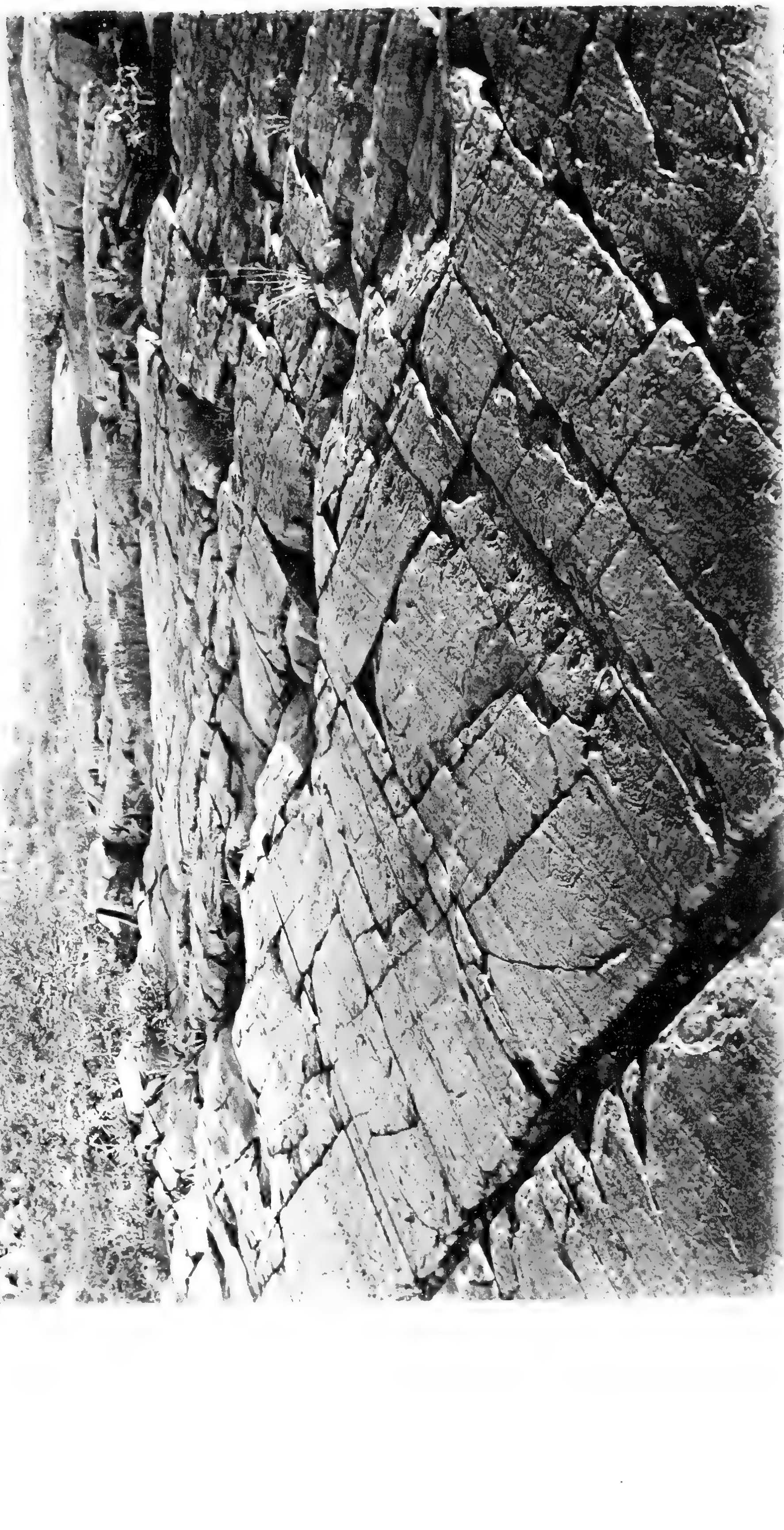
Plate XIII.

West, Newman collotyp

ROGERS AND SCHWARZ: ORANGE RIVER-GROUND MORAINE.

PLATE XIV.

Striated surface of one of the Jackal's Water "roches moutonnées." The cracks which cross the surface from the left side of the picture to the bottom are along the bedding planes of the rock. The other cracks are joints.



West, Newman collotyp.

ROGERS AND SCHWARZ: ORANGE RIVER-GROUND MORAINE.

PLATE XV.

Outcrop of felsite at Vilet's Kuil, showing rounded and striated surfaces of small hummocks rising from boulder- and pebble-covered ground (glacial conglomerate). On the small hummock on the left of the picture the lee-side can be seen.

West, Newman collotyp.

ROGERS AND SCHWARZ: ORANGE RIVER-GROUND MORAINE.

THE ORANGE RIVER GROUND MORAINE.

By A. W. Rogers, M.A. (Cantab), F.G.S. and E. H. L. Schwarz, A.R.C.S.

(Read November 29, 1900.)

(Plates X., XI., XII., XIII., XIV., XV.)

Covering a very wide area in the divisions of Prieska and Hope Town is a peculiar conglomerate. The first geologist whose notice it attracted was Wyley, who mentioned it in 1859.* He refers to a trap conglomerate near Hope Town, and his doing so shows that he recognised a resemblance between it and the rock he called trap conglomerate in the south of the Karroo. After the publication in 1868 of Dr. Sutherland's observations in Natal,† and his clearly drawn inference that the conglomerate there found at the bottom of the coal-bearing rocks had an origin like that of the glacial drifts in the northern hemisphere, the same idea was applied to the similar rocks of Cape Colony. Stow in 1872 ‡ described striated pebbles from Pniel, and also rounded and polished rock surfaces which he attributed to ice-action. In 1874 § he extended his observations of the polished rock surfaces over a large part of Griqualand West, and at the same time fixed the true position of certain boulder beds underlying the group of "olive shales." He was of opinion, however, that the phenomena which he had already described as glacial belonged to a recent or at least a post-Karroo stage of denudation. Hübner || in 1871 doubtfully referred the conglomerate near Bloemhof (O.F.S.) to the claystone porphyry of Bain. Mr. E. J. Dunn ¶ published an account of the glacial conglomerate of Hope Town in 1873, but did not at that time recognise its true position, and in the first two editions of his map, published in 1873 and 1875, he separates the Hope Town conglomerate from the trap conglomerate of the

* "Notes of a Journey in two directions across the Colony." Cape Town, 1859.

† "On the Geology of Natal." A paper read before the Nat. Hist. Assoc. of Natal; Durban, 1868. See also Q. J. G. S., xxvi., 1870, p. 514.

‡ "On the Diamond Gravels of the Vaal River." Q. J. G. S., xxviii., 1872, pp. 3–22.

§ "Geological Notes on Griqualand West." Q. J. G. S. xxx., 1874, pp. 581–670.

|| "Geognostische Skizze von den Süd-Afrikanischen Diamanten-Distrikten." Petermann's Mittheilungen, 17 Band, 1871, iii., p. 85.

¶ "On a Gold Prospecting Expedition, 1872." Cape Town, 1873.

south. In 1886,* in his report on the sub-Karroo coal, he called attention to the fact that the outcrops of the two types of conglomerate—the undisturbed on the north, and disturbed on the south — are continuous along the western part of the Colony. Mr. Dunn inferred from this, and the occurrence of certain black shales, that the conglomerates were contemporaneously formed in the north and south; but up to the present time the evidence is not sufficient to prove this, and they may well have been still forming in the north while the Ecca beds were being deposited in the south. In the same report Mr. Dunn described the occurrence of a scratched floor below the conglomerate near the junction of the Orange and Vaal Rivers, and attributed the scratches to the action of floating ice driven over the floor of a lake. After 1886 there was nothing of importance published about the Dwyka conglomerate until last year, when Dr. Molengraaff † found and described some glaciated rocks in the Vrijheid district of the Transvaal; he concluded that the phenomena were only to be explained by supposing that land-ice traversed the district.

The relationship between the Prieska glacial conglomerate and that known as the Dwyka conglomerate of the southern Karroo is still uncertain, and although we have no doubt that their outcrops are continuous, the discussion of the question must be left until further evidence has been obtained. It is chiefly from Mr. Dunn's use of the term "Dwyka conglomerate" that it has been applied to any conglomerate lying at the base of the Ecca beds or rocks supposed to represent them, but the evidence for the correlation of the beds in different parts of South Africa has not yet been sufficiently dealt with. In this paper we shall not use the name Dwyka conglomerate in reference to the Prieska rock where our own observations are concerned, but it is retained when the observations of others, who do so employ it, are mentioned.

The object of the present paper is to describe certain sections of the conglomerate, and the appearances seen on the lower slopes of the hills rising from below it in Prieska and Hope Town. We must first note that the conglomerate passes under the so-called Kimberley shales, or under the lowest sheets of dolerite at the bottom of the shales. The best localities for seeing this are at Uitdraai, about twelve miles east of Prieska Village, Groot Fourie's Kolk, and Springbok Poortje, in the south of Prieska, and at many places in the north of Britstown. We have found no evidence in

* "On a Supposed Extensive Deposit of Coal," &c. Cape Town, 1886.

† "The Glacial Origin of the Dwyka Conglomerate." Trans. Geol. Soc. S.A. Johannesburg, iv., p. 103, 1898.

favour of Green's idea* that the Kimberley shales rest upon the denuded surfaces of Dwyka conglomerate and Ecca beds. There appears to be only one important unconformity in these districts, namely, that at the base of the conglomerate, but still, as will appear later, if our view of the evidence is correct, the shales overlying the conglomerate must also be to some extent unconformable, however slight the gap may be.

About two miles from Prieska village the main road to the west crosses a dry ravine cut by storm-water running off the Doorn Bergen to the Orange River. A few yards below the point where the road crosses there is a cliff about 25 feet high on the western side of the ravine, and lower down there is a similar cliff on the eastern side. (Plate X.). The lower 20 feet of the sections show a blue mudstone, generally rather friable, but sometimes as hard as the matrix of the well-known Dwyka conglomerate of the southern Karroo. The mudstone contains numerous small fragments of various rocks and minerals, but on the whole it is a fine-grained hard mud with pebbles and boulders of various sizes (up to 2½ feet in diameter) imbedded in it. The inclusions are scattered through the rock without any definite arrangement in beds—in fact, in these two sections the rock shows no signs of bedding (Plates XI. and XII.). In shape the pebbles are angular, sub-angular, and rounded, the edges of the larger boulders are always more or less rounded. A large proportion of the pebbles and boulders are scratched, and flattened on one or more sides. They differ entirely from ordinary water-worn pebbles, and bear the closest resemblance to boulders found in the glacial tills and moraines, which are forming at the present day. The rocks which form the pebbles are very various Perhaps the most numerous in this locality are quartzites and hard jaspery rocks, but granite, gneiss, amygdaloidal melaphyre, diabase and dolomitic limestone are also abundantly represented. These are all known to exist *in situ* in the Prieska district west of the Doorn Bergen, but the pebbles in this section have very probably come from the country north of the Orange River, where, from Stow's account † and map, we know that they occupy large areas. An important point concerning the boulders of the conglomerate in the whole district is that they do not include any fragments of the post-Karroo dolerite, which is so frequently met with in the form of dykes and sheets in the districts south of the Orange River.

In the upper 5 feet or so of the sections the rock becomes softer and yellow in colour owing to the oxidation of the iron compounds in the originally blue clay.

* Q. J. G. S., xliv., 1888, p. 262. † Q. J. G. S., xxx., 1874.

Above the road, in the same ravine, is a smaller section showing horizontally bedded shales. These shales are soft, friable, dark blue shales weathering white, similar to the beds usually found overlying the conglomerate in the Prieska and Hope Town divisions. From their present position it is probable that they were deposited in a hollow in the conglomerate, for they are at about the level of the middle portion of the sections below the road, and there is no evidence of a fault which might have dropped them down. The occurrence of sands and muds in depressions in glacial tills is frequently described in modern or recently glaciated areas of the northern hemisphere. From the character of the conglomerate just described it is a legitimate inference that it is a true till formed by land-ice, and was not deposited on the floor of a lake or sea.

A very similar but less exposed section is seen near the Brak River, where it enters the Orange River some 15 miles north-east of Prieska village.

North-west and west of Prieska village there are several outliers of the conglomerate lying undisturbed in depressions in the ancient rocks forming the Doorn Bergen. These are of great interest in proving that the main contours of that range were in existence at the time of the deposition of the conglomerate. Many of the smaller ravines have been cut through both the conglomerate and older rocks quite irrespectively of the surface features which existed before the deposition of the conglomerate. But in the large valleys of the range, such as that on Nauw Gekneld and T'Dyzega on the north-east, and the Uitspansberg valley on the west, the position and form of the outliers proves that the recent valleys have been re-excavated along the lines of old ones which were filled with conglomerate.

The conglomerate is seen on the surface over a very wide area in the southern part of the Prieska division, and between Beer Vlei and Hope Town, but owing to the absence of river channels natural sections are never seen. The presence of the conglomerate is always indicated by the numerous weathered-out boulders scattered over the veld, often so abundantly that one cannot put a foot down without touching one or more of them. Very many of these boulders show numerous striæ, especially on their flat sides, but the scratches are not so fresh on them as on the stones taken directly from the conglomerate, owing to the action of the weather. Some of the boulders lying on the veld must weigh several hundred pounds.

In spite of the absence of natural sections, the character of the conglomerate is to be seen in the water-furrows dug by the farmers. The best sections we saw were on the western side of the Groot Modder Fontein pan (Doorn Fontein), and on Jonker Water. Unfortunately they only extend some 8 feet from the surface. At both these localities the boulders are enclosed in a shaly matrix, which is distinctly bedded, as if they had been dropped into their positions by ice floating in water covering a muddy bottom. The northernmost of the two localities is about 30 miles south of the till west of Prieska.

It is impossible at present to state the maximum thickness of the conglomerate, but we think it must be some hundreds of feet. If certain patches of shale at Groot Modder Fontein were never covered by another band of conglomerate, at that particular locality the thickness is small, probably under 30 feet. In view of the fact that shales containing few boulders were found at Roode Poort and Holgat's Fontein, some 10 miles from and at a higher level than the nearest outcrop of old rocks on Omdraai Vlei and T'Kuip, it is unsafe to conclude that the isolated patches of shales, which show no boulders in the limited portion seen, are really lying at the top of the conglomerate. In other words, the shale may have originally lain between two bands of conglomerate.

We have now to consider the evidence of glaciation offered by the rock surfaces underlying the conglomerate.

At Jackal's Water, in Prieska division, an outlier of conglomerate is underlain by granite and quartzite. On the west is a long range of low hills made up of quartzite and quartz schist. The quartzite is generally a very hard, massive rock, and at places where this rises from under the conglomerate its surface is smooth, rounded, and covered with scratches (Plate XIII.). The individual striæ are sometimes 2 feet in length, and cross each other at low angles, but their general trend is N.N.E.–S.S.W. (Plate XIV.). From the fact that the southern sides of the mounds, which are strictly comparable with the "roches moutonnées" of European geologists, are rough and unscratched, while the northern slopes are more gently inclined and are smoothed and striated, it is evident that the direction in which the ice travelled was from N.N.E.–S.S.W. One such "roche moutonnée" rises about 10 feet from the veld, and its long northern slope is about 60 feet in length. Plate XIII. shows a group of "roches moutonnées" with the boulder-covered ground at its foot. These boulders indicate the presence of the conglomerate, but the rock itself is not seen in section, although a few small outcrops of it are to be met with a few hundred yards off in the same outlier. Isolated boulders of rocks foreign to the locality are found scattered over the quartzite hills, and prove that the whole area was once covered with the conglomerate.

In the case of one rock at Jackal's Water, an almost perpendicular face about 8 feet high lies in the direction of the average trend of the striæ on the other rocks, and this face is well scored. Towards the upper part of this wall the scored and polished surface passes round the edge of the rock and is continuous with the polished top of it (Fig. 1). A similar feature has been observed in other more recently glaciated regions, notably Vancouver Island.* It is particularly noticeable that the lower parts of the hills alone show the striations. The upper portions have long since lost all trace of them owing to the action of the weather, and have the very rough surface characteristic of the hard rocks of this district which are exposed to the great variations in temperature and are unprotected by vegetation.

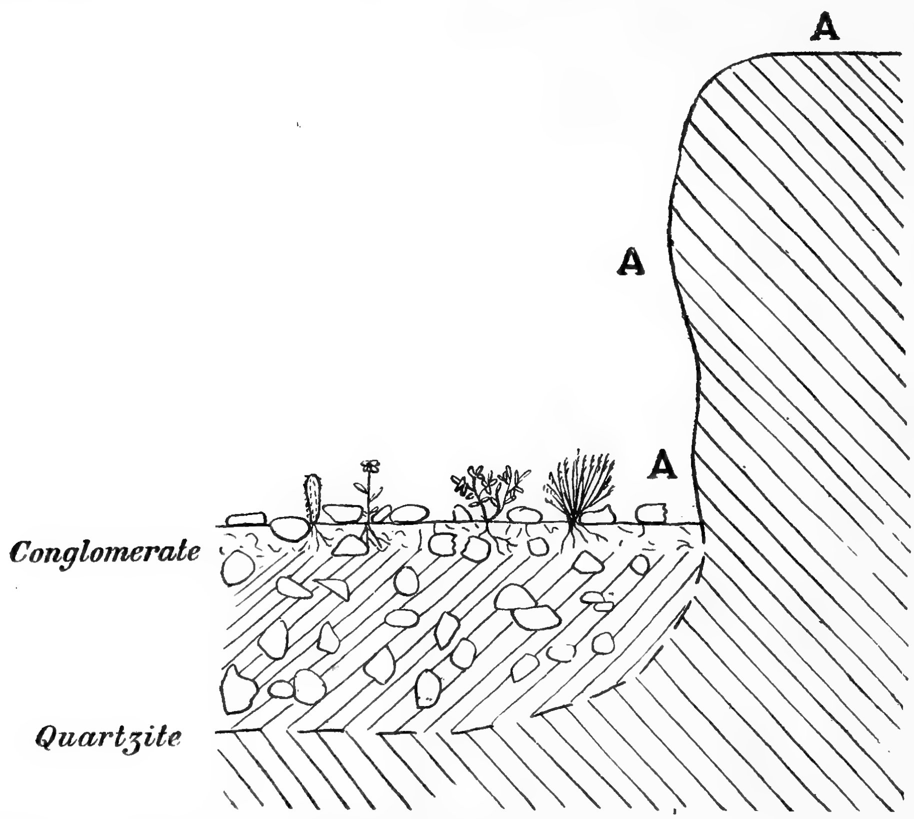


Fig. 1.—SECTION THROUGH THE VERTICAL STRIATED FACE OF QUARTZITE, JACKAL'S WATER. AAA, SCRATCHED SURFACE.

At Klein Modder Fontein, some 15 miles to the S.S.E. of Jackal's Water the same range of quartzite hills passes under the large area of conglomerate in the south of Prieska. The same phenomena are seen here as at Jackal's Water, but less well displayed. The direction of the striæ and smooth slopes here also indicates that the ice moved towards a point a few degrees west of south.

* G. W. Lamplugh: On ice-grooved rock surfaces near Victoria, Vancouver Is. Yorksh. Geol. and Polyt. Soc., vol. ix., pl. 6.

At Vilet's Kuil near Beer Vlei, in the division of Hope Town, is a mass of amygdaloidal felsites and breccias rising above the general level of the neighbourhood as a range of low hills. The surrounding low ground is occupied by the glacial conglomerate, which is a part of the large conglomerate area of the south of Prieska and Hope Town. The surface of the felsite where it emerges from the conglomerate is hummocky, and the northern slopes of the hummocks are smoothed and striated, while the southern are much steeper and rough (Plate XV.).

As in the case of the Jackal's Water hills, the lower portions of the felsite where it emerges from the conglomerate alone retain their glaciated surface, and the striæ become less distinct the further one goes from the conglomerate outcrop. It is unusual to find the striæ preserved at a greater distance than 200 feet from the conglomerate. One cannot doubt, however, that the whole surface was once covered with them.

At Vilet's Kuil the striæ run, on the average, about 10° east of south, and the lee side of the hummocks is on the south.

It is important to note that the only rocks we have met with which show the scratches are the quartzite and the compact felsite. The conglomerate outcrop touches other rocks, such as the magnetic jasper series of Doorn Berg (Griqua Town series of Stow), granite, gneiss, melaphyre and crystalline limestone. So far as our observations go none of these show striated surfaces, although on T'Kuip inliers of granite have the exact form of "roches moutonnées." The absence of striæ is certainly due to the comparatively rapid weathering of these rocks. The Griqua Town series resist the weather well on the whole, but their outcrops are always jagged and sharp, owing to the unequal resistance offered by the thin alternating beds. The granite, gneiss, and melaphyre have always a more or less deeply weathered crust, and the limestone has the peculiar rough surface produced by the solvent action of rain water.

In 1889, Stapff* published a critical account of what had been written up to that time on the Dwyka conglomerate, and came to the conclusion that the evidence for a glacial origin was not sufficient. Amongst other things, he remarked that the scratched surfaces could be explained in other ways than by glacial agency. We have shown above that the positions of the striated surfaces observed in Prieska and Hope Town are just where they should be if they extend under the conglomerate, viz., on that part of the older rock most recently exposed by denudation.

* "Das 'glaziale' Dwykakonglomerat Südafrikas." "Naturwissenschaftliche Wochenschrift," 1889. Berlin.

The plates accompanying this paper afford, we hope, sufficient evidence of the real nature of the striæ and hummocks, and will prevent any reference of the phenomena to subsequent movement of the rock-masses and resulting slickensiding. The low angles at which the striæ are inclined, and the absence of evidence of any considerable movement or disturbance in the conglomerate and horizontally overlying shales are alone sufficient to put such an explanation out of court: for many of the surfaces are inclined at an angle of less than 20°, and some are horizontal. From the nature of the case it is extremely improbable that the rocks have been so displaced as to bring highly inclined fault surfaces into a nearly horizontal position, so if these are slickensides the forces which gave rise to the faults must have been tangential thrusts of considerable magnitude, but it is impossible to admit that soft rocks of the nature of the conglomerate and shale of the north have been subjected to any disturbance of this sort.

It is sometimes suggested that the abrading action of wind-borne sand will account for such surfaces as we have described, but our experiences of sand-worn rocks does not at all bear out the suggestion. Wind-borne sand polishes rocks and eats out the softer parts more rapidly than the harder, whether these are in patches, as in granite, or in laminæ, as in some of the Doorn Berg rocks, but long, clearly marked scratches, sometimes $\frac{1}{10}$ inch deep, such as we are dealing with, are not, in our experience, produced in this way. Sand-worn rocks are frequently met with in the Colony, but are easily distinguishable from glaciated ones by any one who has seen both.

The appearances seen in the three localities, Jackal's Water, Klein Modder Fontein and Vilet's Kuil, at considerable distances apart, can be satisfactorily explained only on the supposition that the country was traversed by land-ice; and the presence of the till-like variety of the conglomerate in the same district, probably about the same localities, confirms that explanation. Unfortunately, as we mentioned before, the exact nature of the conglomerate at the three localities is unknown, that is, whether it is a true till or whether it is a stratified rock with glaciated pebbles. We only know that the rock contains numerous scratched pebbles and boulders; but this is a small point and does not affect the confirmation. It is evident that the country was depressed under water after the formation of the till of Prieska, and it is quite possible that sedimentary rocks were deposited on a floor consisting partly of till and partly of the floor from which the soft till had been removed, or on which no accumulation had taken place.

Fig. 3

Fig. 4

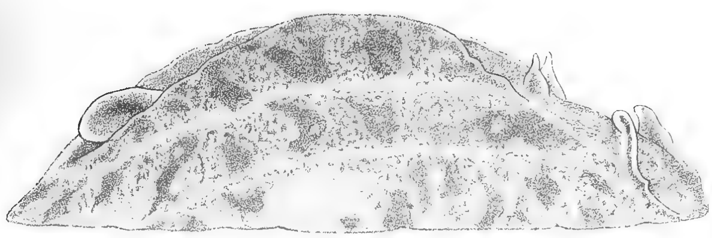


Fig. 2

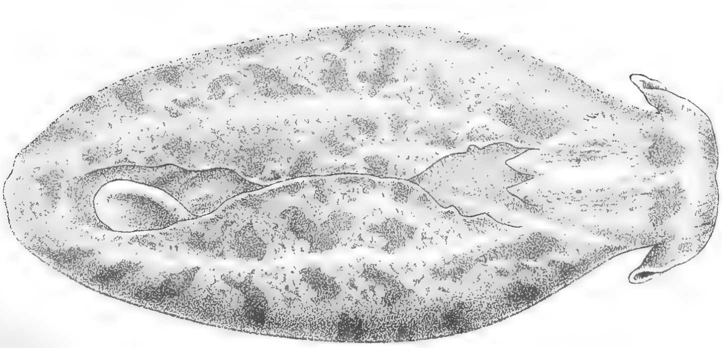


Fig. 1

West, Newman lith.

J. D. F. GILCHRIST: THE GENUS PARAPLYSIA.

Paraplysia Lowii.

THE GENUS *PARAPLYSIA* WITH DESCRIPTION OF A NEW SPECIES.

BY J. D. F. GILCHRIST, M.A., B.SC., PH.D.

(Read November 29, 1899.)

(Plate XVI.)

The classification of the Tectibranchiata is at present in a very unsatisfactory state as compared with many other groups of the Mollusca. This is the more to be regretted as this group of animals is one that shows an altogether peculiar aspect of the question of adaption, not only to external environment but particularly to changes of organisation brought about by new factors arising within the animal itself. I have elsewhere described some of these changes and attempted to assign them to their causes, but much yet remains to be done in the mere collection of facts before any final generalisation can be made. The mollusc now under our notice contributes something towards this end, and is therefore valuable not only as one more new species, but as a new factor to be considered in view of a much wider question.

GENUS *Paraplysia*.

Mr. Smith has described a mollusc, from Thursday Island, Torres Straits, which he regards as belonging to the genus *Aplysia*, giving it the specific name *piperata* (Zool. Coll. Alert, p. 89). Subsequently another somewhat similar form from Siam was found in the collection of the British Museum (Natural History), which I described as *Aplysia Mouhoti* (Ann. and Mag. Nat. Hist. (6), xv., May, 1895, p. 404). While assigning the animal to this genus I pointed out that these two species had several characters which marked them off from the other *Aplysiidæ*, and might entitle them to be placed in a new group. Mr. Pilsbry (Man. Conch. xv., p. 64) adopted this suggestion, and gave the generic name *Paraplysia* to this group. While this may be accepted provisionally, it will be seen, after examination of the specimens to be described, that some of the characters assigned to the group must be reconsidered. The features common to the two species (*A. mouhoti* and *A. piperata*) were: (1) The pleuropodia in both cases start from about the first third of the body and run backwards within a few millimetres of the end of the foot, being quite separate throughout their entire length; (2) In both, the mantle, shell, and visceral mass are much more posteriorly situated than in, *e.g.*, *A. limacina*, and, in co-ordination with this, the genital opening is peculiar in being located somewhat anteriorly to the mantle cavity; (3) The most striking point is the position of the rhinophora, which are situated close together between the anterior ends of the pleuropodia.

The genus *Paraplysia* was established and put on a level with that of *Aplysia*, *Dolabrifera*, *Notarchus*, &c., by Pilsbry, as possessing the following characteristics: General form oval; buccal tentacles rather large, widely separated and pointed; rhinophores small, conic, close together, situated between the anterior ends of the pleuropodial lobes. Pleuropodia arising at the anterior third of the animal's length, well separated at their origin and throughout, only uniting at their union with the foot very near to its posterior extremity. Mantle large, posterior exposed, with posterior excurrent siphon, and apparently covering the gills; the genital pore slightly in front of its anterior edge, not covered.

Shell about a third of the body, concave, subquadrate. The remarkable features of this type are: The position—unique in the Anaspidea—of the rhinophores between the anterior ends of the pleuropodial lobes, the latter being completely free; the posterior situation of the mantle and the short, oval form of the body. The posterior end of the foot is free from the viscal mass, which overhangs it.

Paraplysia Lowii, n. sp.

Turning now to the features of the animal to be described, it will be seen that these generic characters may require to be somewhat modified.

External Features (Pl. XVI. Figs. 1 and 2).—The general outline of the body (in the contracted condition after preservation in 2 per cent. formalin), while resembling the oval form of *P. piperata* and *P. Mouhoti*, approaches that of the more elongated form of the true *Aplysia* (*Tethys* of Pilsbry).

The pleuropodia also resemble those of, *e.g.*, *Aplysia depilans*, being as well developed vertically and longitudinally and free from each other throughout their entire length, but being, relatively to the total length of the body, somewhat longer. Their height is about one-third of their length. They begin at the anterior fourth of the body and end at a point near the posterior extremity.

At their anterior extremity they are separated from each other by a somewhat narrow space and at their posterior extremity by a space of about the same extent. In the former space lie the two rhinophora, and in the latter is the siphonal prolongation of the mantle. This latter space is much more marked than in *A. depilans*, and shows no indication whatever of any continuity between the ends of the pleuropodia.

The anterior tentacles are well developed and ear-shaped, being widely separated and situated at the ends of the broad frontal region.

The posterior tentacles or rhinophora are small, conical in shape, and situated directly between the anterior ends of the pleuropodia. The bases of the tentacles are in contact with each other and that of the left tentacle with the left pleuropodial extremity. The right tentacle is only separated from the right pleuropodial by the genital furrow.

The colouration of the tentacles is that of the body generally, with the exception of the extreme tips, which are of a yellow colour.

The genital opening (Pl. XVI. Fig. 3, g. o.) is situated a little posterior to the middle point of the body, and is just covered by the mantle (Pl. XVI. Fig. 3, m.) under the anterior free edge of which it lies. The mantle itself, which can be completely covered by the pleuropodia, is thus situated in the posterior half of the body, and occupies about half of this region (excluding that part which is prolonged as a siphon). In the centre of the mantle appears a minute shell aperture. The siphon is well marked, being about half of the length of the mantle proper, but does not extending to the posterior extremity of the foot.

The gill (Pl. XVI. Fig. 3, g.) is completely covered by the mantle (Pl. XVI. Fig. 3, m.), in which is embedded a shell completely devoid of any carbonate of lime (Fig. 4).

The osphradium is not readily distinguished externally, and lies under the anterior extremity of the gill where it joins the body.

The opaline gland (Fig. 3, o. gl.) is multiple and well developed, lying in the angle between the right pleuropodia and the body and extending from a point a little posterior to the genital opening to the free extremity of the gill.

The visceral mass is not distinctly separated from the foot posteriorly, but forms a sharp angle with it. The anus, however, being situated at some distance from the base of the siphon, at about a quarter of its length, a part of the rectum may be regarded as separated from the body—an approach to the condition so characteristic of *P. Mouhoti*.

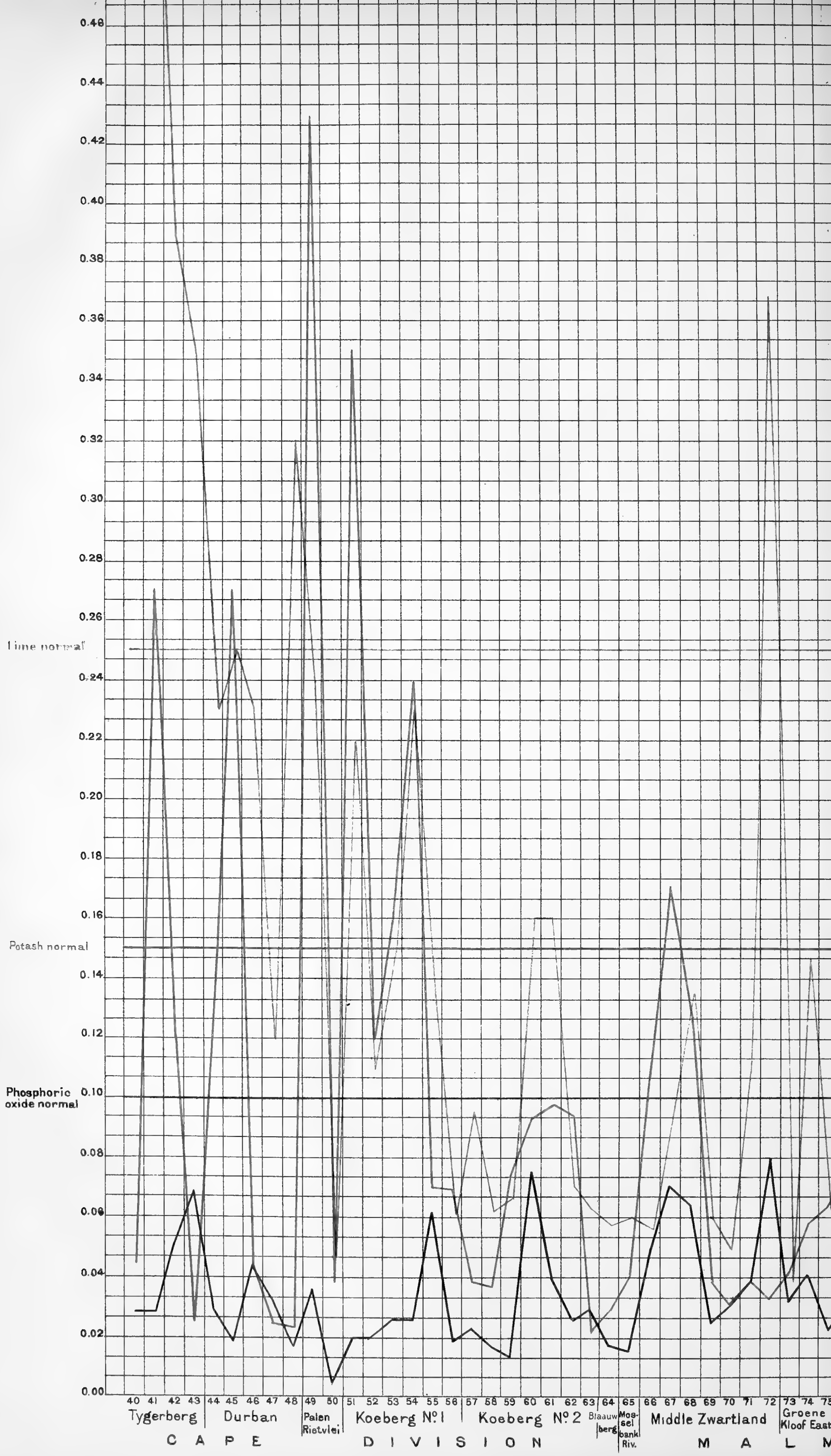
Colouration.—The body generally is of a dark olive-green, scattered irregularly in large angular patches, which are separated by fine reticulations of the same colour. The disposal of the patches are somewhat similar on each side of the body, and this similarity is further increased by the presence of two white lines, due to the absence of pigment, running longitudinally and parallel to each other along each side of the body. The upper begins at the anterior margin of the pleuropodia on a level with the rhinophora and runs parallel with the margin of the foot. The lower begins just behind the anterior tentacles, runs parallel with the upper line, and ends on the margin of the foot at a point a little in advance of the ending of the upper line.

On the inside of the pleuropodia the colouration consists of dark dots forming a small margin which merges into reticulate markings towards the body where, at the base of the pleuropodia and on the region between the mantle and the rhinophora, it consists of a number of separate dots. The mantle is closely covered with such dots merging into short lines, the whole forming a general appearance of radiation from the shell aperture as a centre. On the siphon these take the form of dark patches and lines running longitudinally to it. The mantle cavity is devoid of colour, as is also the region opposite the gills in which the opaline gland lies.

Systematic position.—The three species of the proposed genus agree in the peculiar position of the rhinophora, but they present several differences. *P. piperata* and *P. Mouhoti* differ from *P. Lowii* in the much more posterior position of the mantle region, more oval body, and in having the genital aperture under the mantle. That all three agree in the free pleuropodia is not a fact of much significance, and *P. Lowii* differs from the other two in having the pleuropodia much more developed in a vertical direction.

There is, then, only this one distinct point, viz., the position of the rhinophora, and that, though peculiar to the group, does not, in my opinion, justify the definite establishment of a new genus, though it may be convenient to retain it till some new light may be thrown upon this interesting group by further material for anatomical examination.

Only one specimen has as yet been secured, and for this as well as other new specimens of marine life we are indebted to the members of the East London Angling Society, the president of which, Mr. Low, takes an active interest in the scientific aspect of the Society's work.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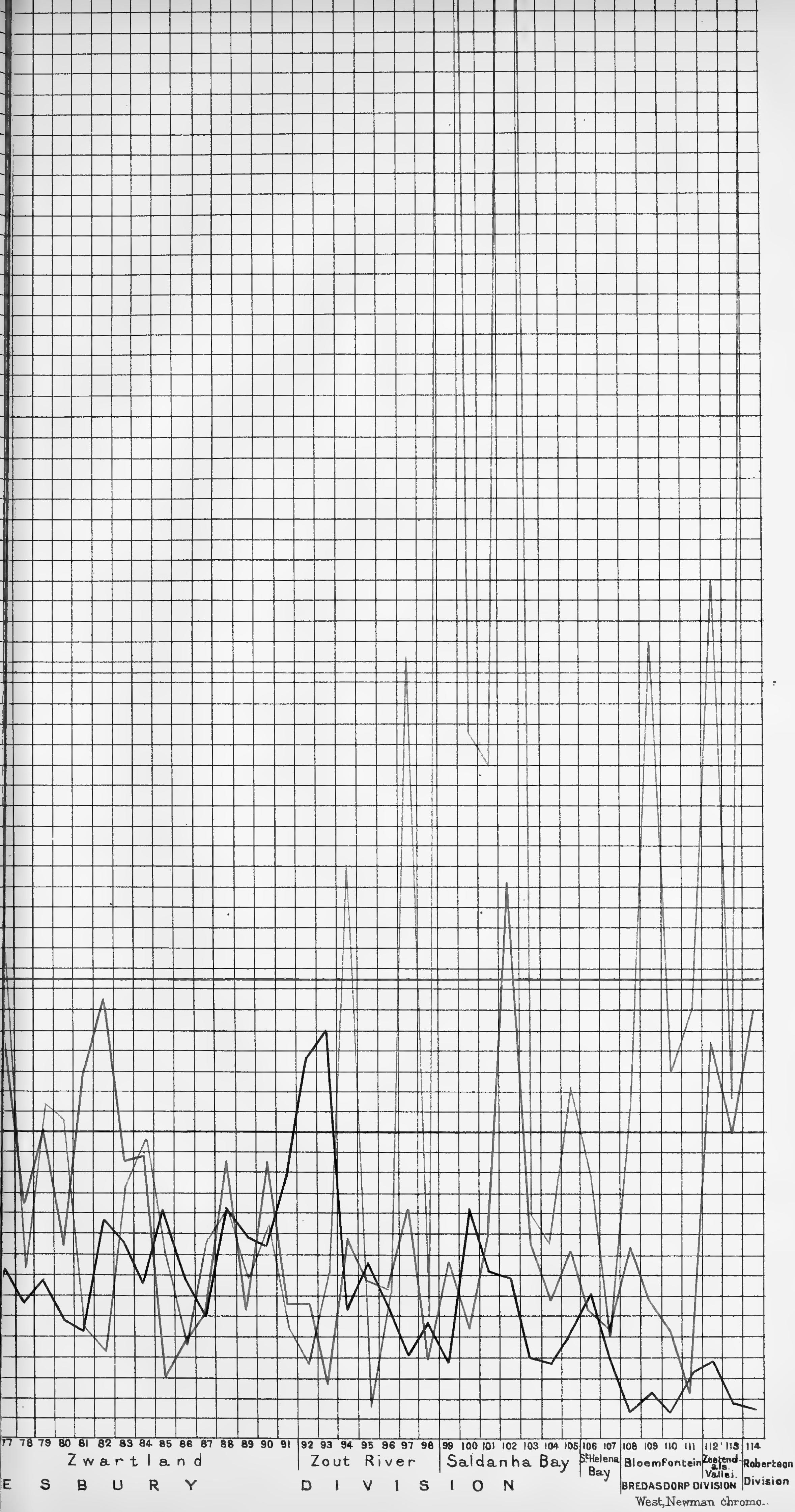

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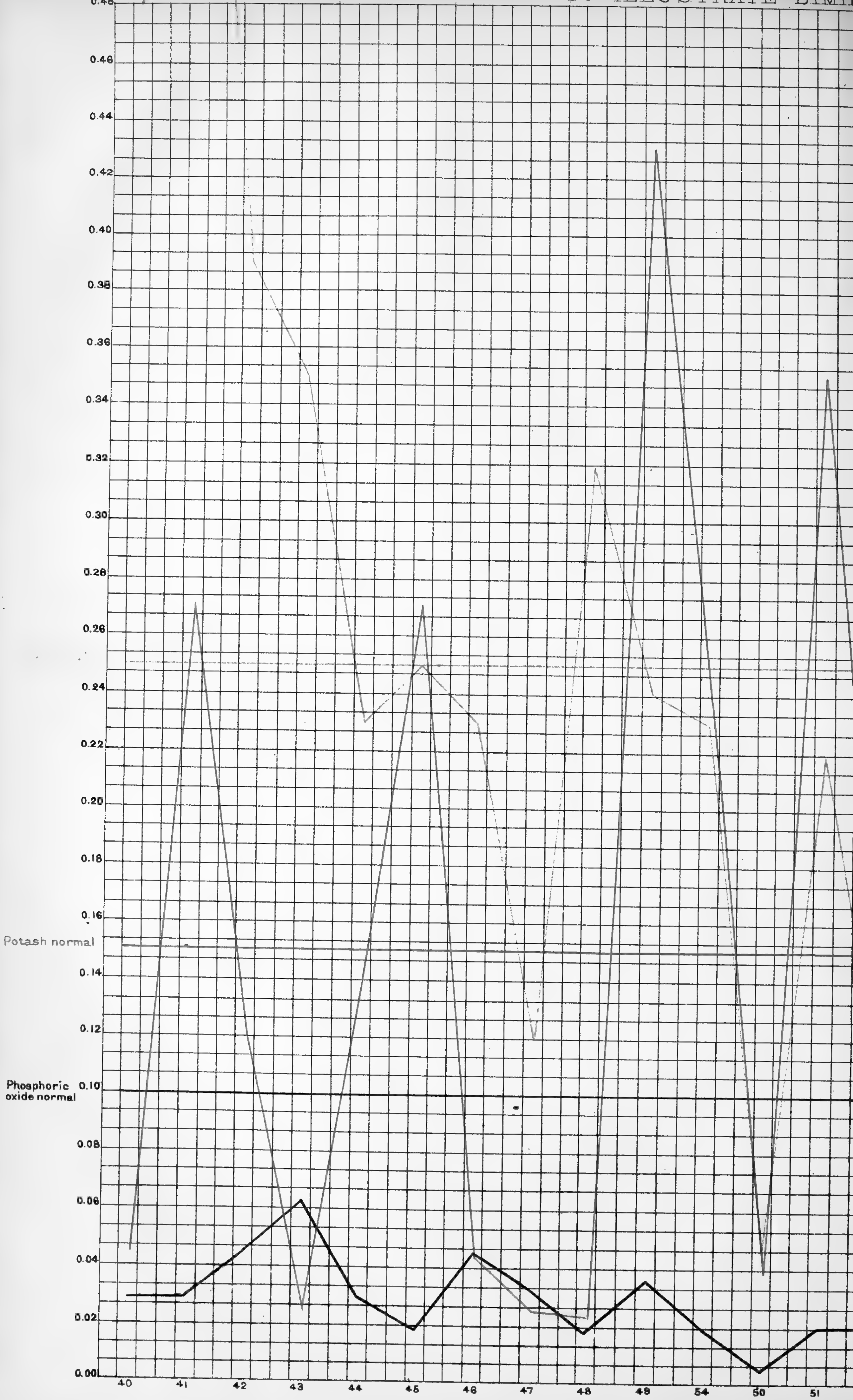

C.F. JURITZ ; CHEM. COMP. OF S

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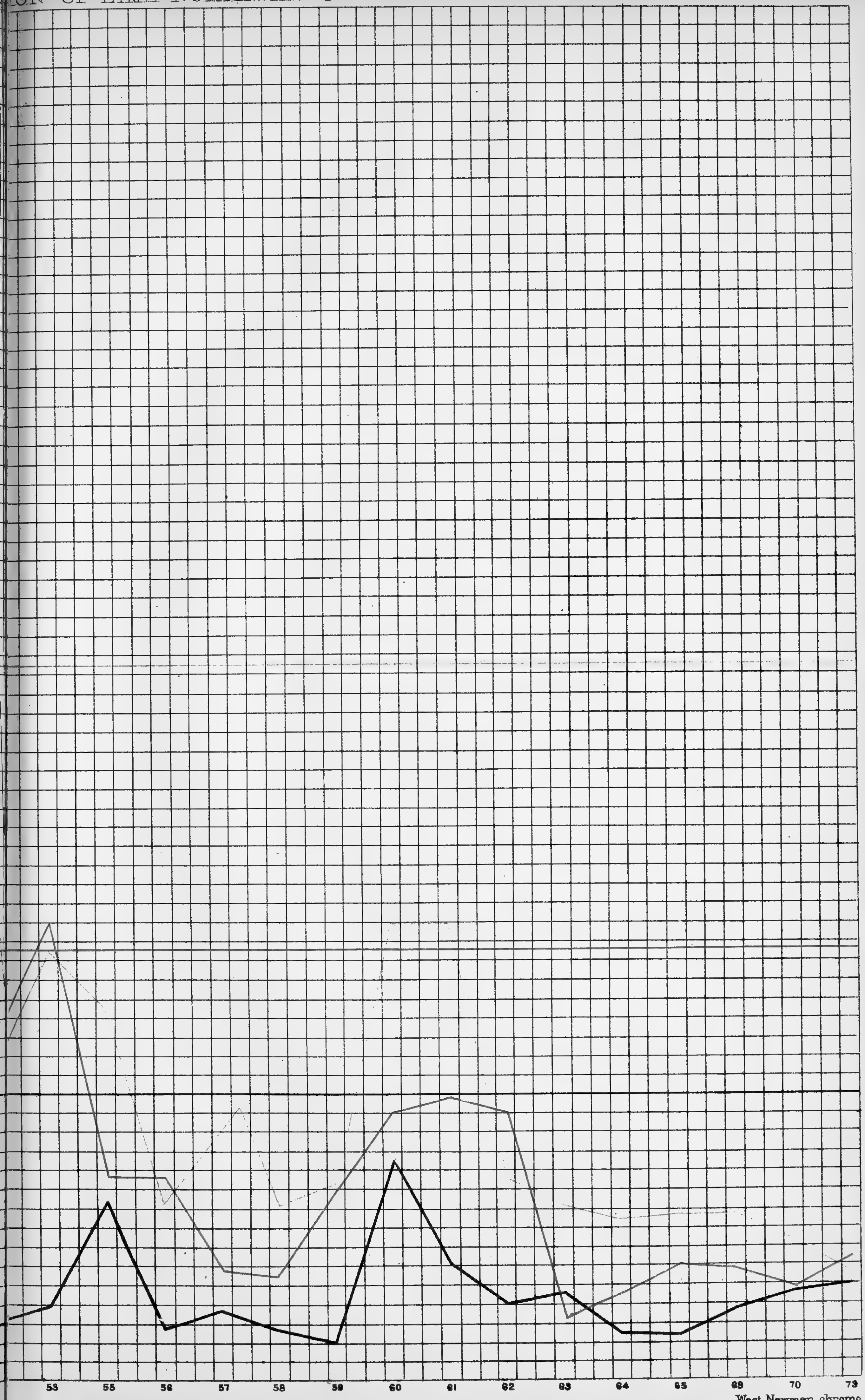

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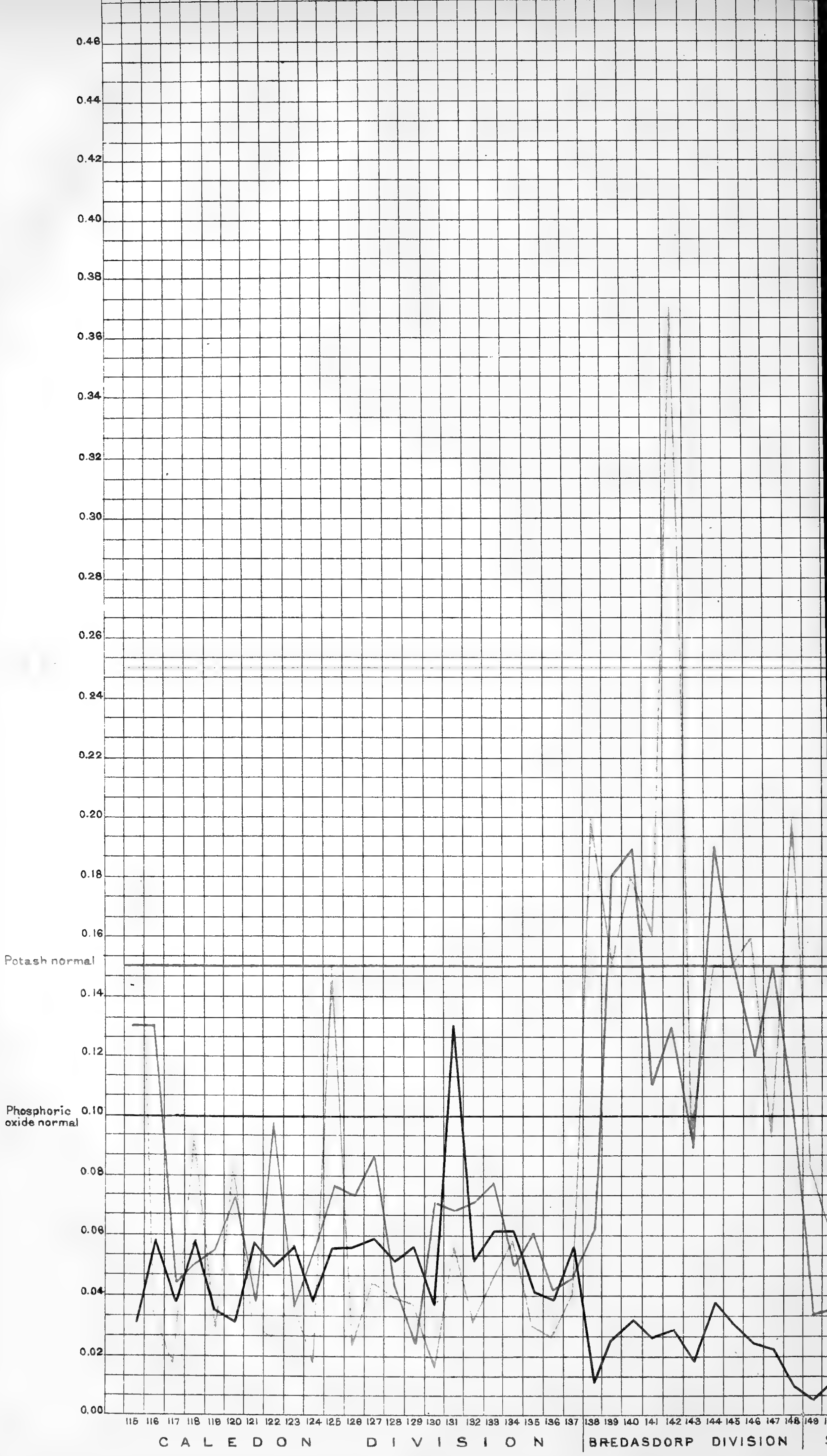

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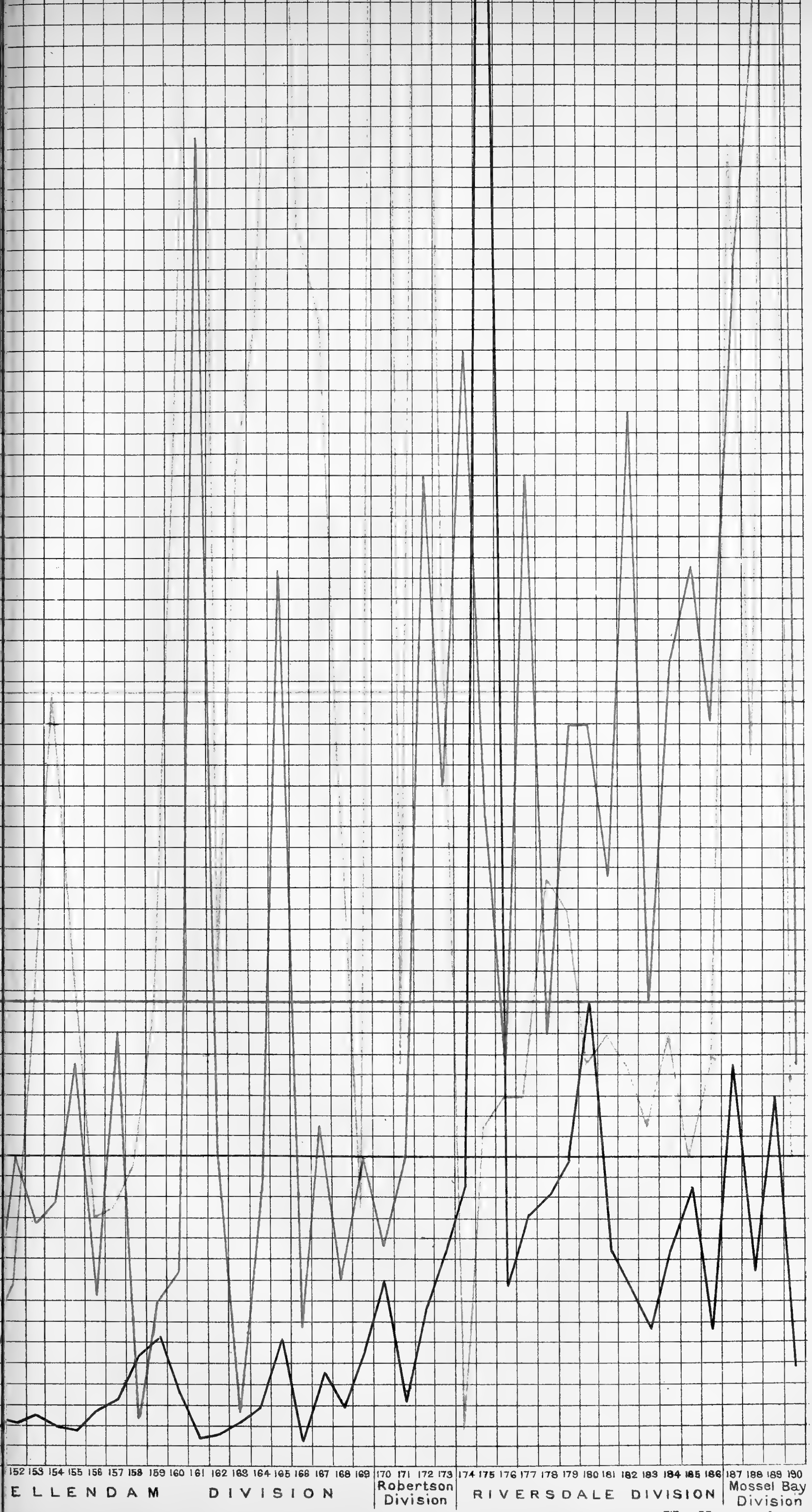

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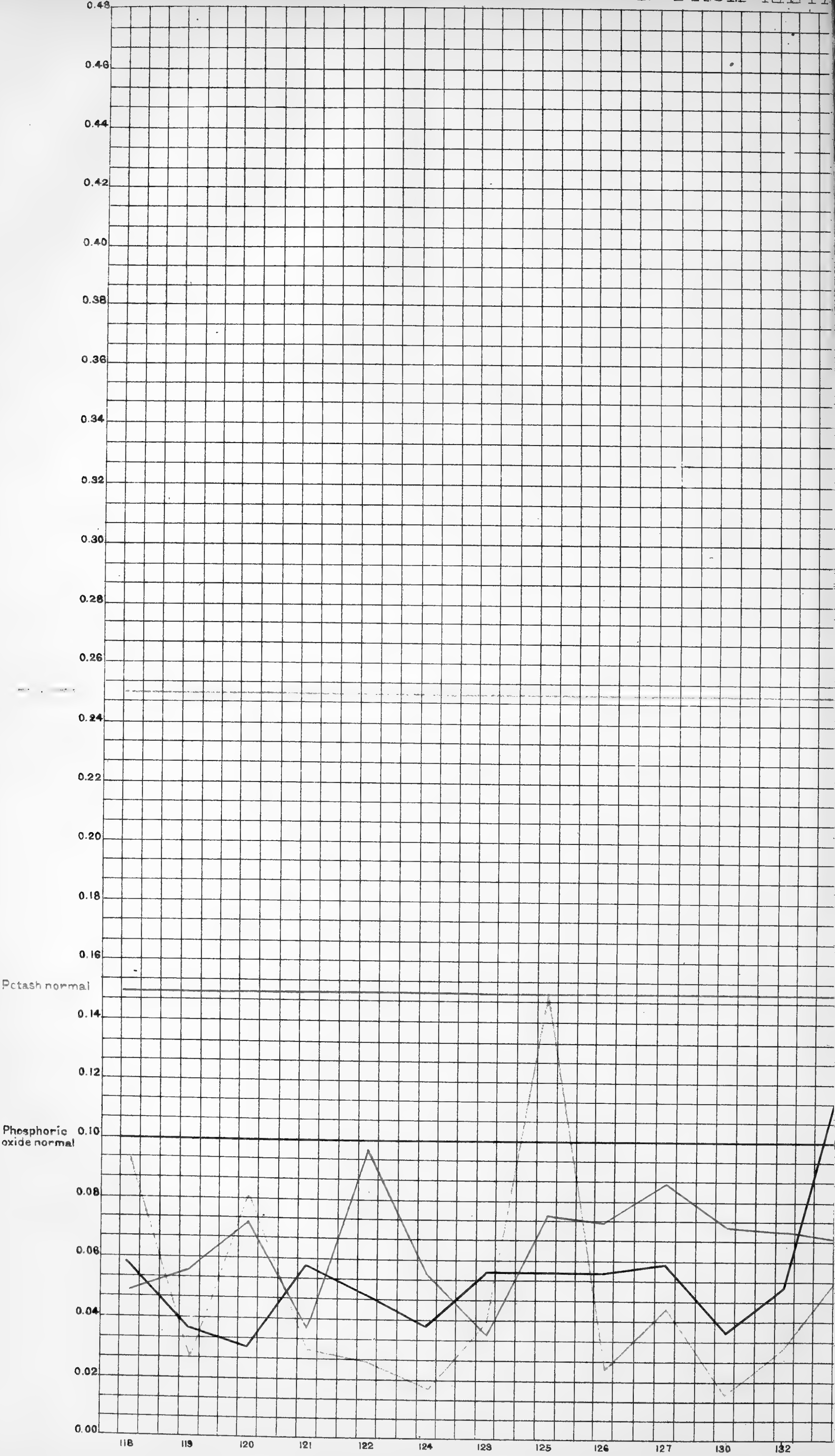
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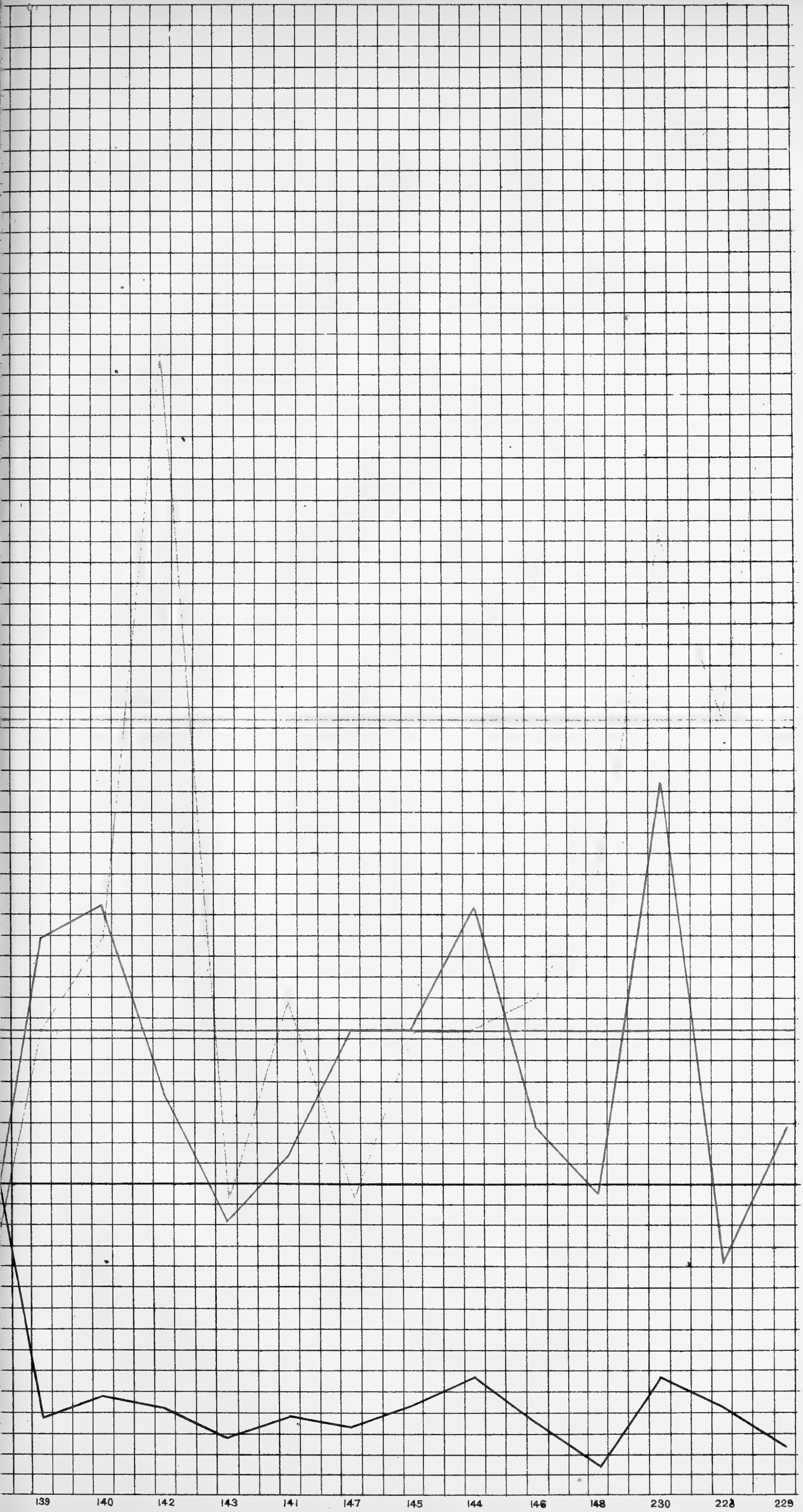
TEIN TO NEAR CAPE INFANTA.



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)F S.W. DISTRICTS OF CAPE COLONY.

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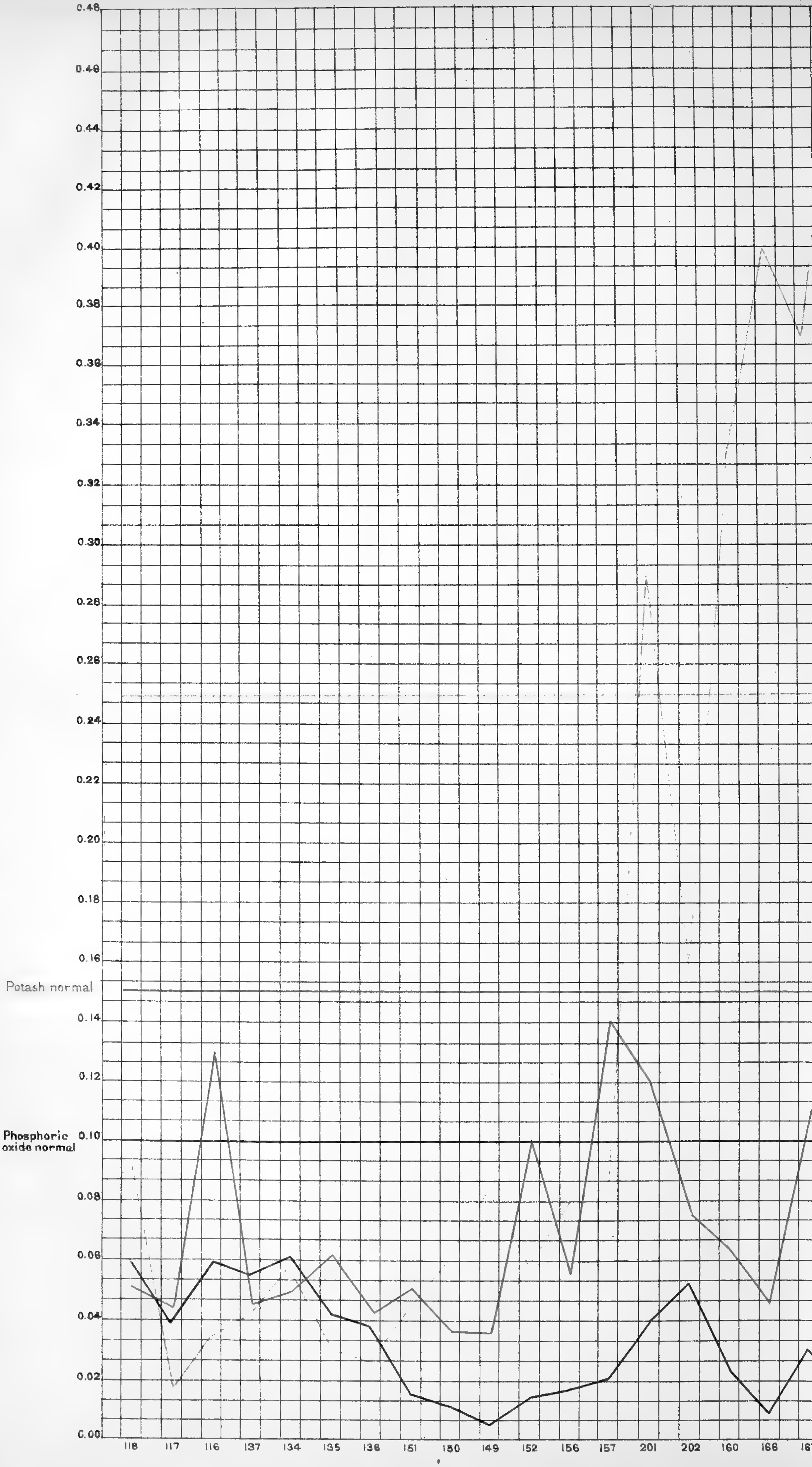
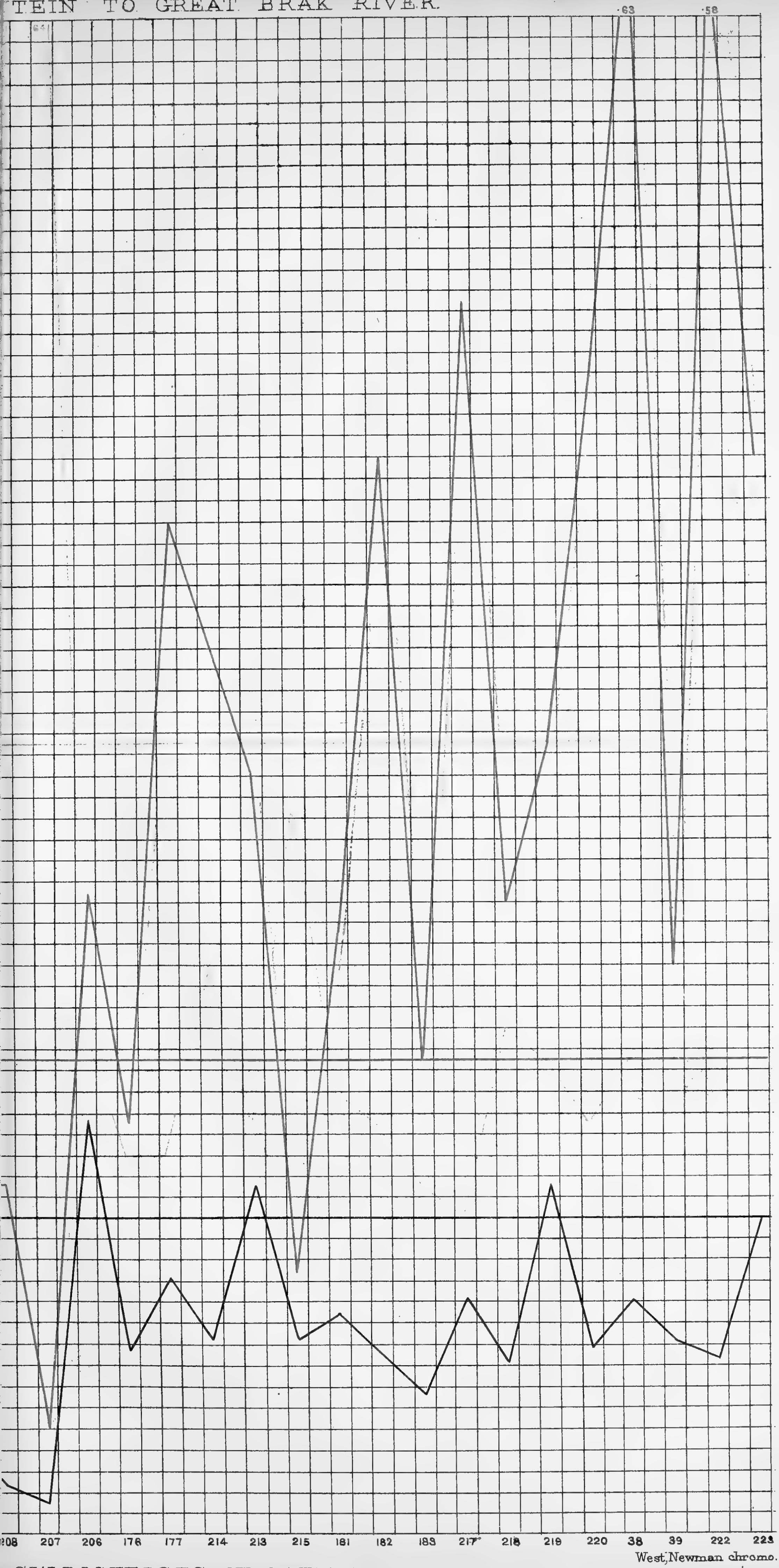


TEIN TO GREAT BRAK RIVER.



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S.W. DISTRICTS OF CAPE COLONY.

THE CHEMICAL COMPOSITION OF THE SOILS OF THE SOUTH-WESTERN DISTRICTS OF THE CAPE COLONY.

By Chas. F. Juritz, M.A.

(Read January 31, 1900.)

(Plates XVII., XVIII., XIX., XX., XXI.)

Amongst the many valuable papers read before this Society from time to time no record is to be found of any dealing with the chemical composition of the various classes of soil met with in the Colony. This may, perhaps, be regarded as surprising to scientific investigators in other lands: have we not heard, again and again, almost *ad nauseam*, the agriculturist described as the country's backbone, and has not the soil been termed, and quite rightly, the only permanent and reliable source of wealth in any country? Such being the case, how is it that we have hitherto heard so little about it? One reason is clearly the paucity of men capable of conducting scientific research in this Colony. For private investigators, except they be men of considerable means, the researches involved in the analysis of a country's soils are far out of reach, and, all the world over, the practice has been for such investigations to be conducted under Government auspices. Where these inquiries have been set afoot, moreover, they have been carried out through the media of Agricultural Departments. Now in this country the Department of Agriculture is just getting into its teens: very unambitious was its inauguration, and whatever error, if any, there has been in its subsequent development, it has assuredly *not* been on the side of forced growth. Hence, when an analytical laboratory was instituted—the indispensable adjunct to a Department of Agriculture—it was on an extremely modest scale. Scientific research was, for the first few years of its existence, looked upon as an Utopian ideal, and even now one requires to tread the way cautiously and warily. The object, at the initiation of the laboratory, was rather to provide means for analysing such articles as solitary farmers and others might chance to submit for the purpose. It was the individual who was to be served rather than the country at large. For a few years this principle had been maintained, and in this state I found the Government analytical laboratory upon being placed in charge of it eight years ago. Things were expected to move slowly, and drastic changes were not to be dreamt of, so I had to remain perforce content with gradual developments.

It is just about ten years ago that circumstances were brought to my notice which ultimately led to a systematic investigation into the chemistry of the soils of the Colony. Towards the end of 1887, while performing certain investigations in connection with my University Fellowship, I was struck by the exceedingly small quantity of phosphoric oxide in some samples of oathay from the Bathurst district, that I was analysing. To this deficiency I ascribed the poor condition of the crops. For some time, too, there had been noticed a prevalence of a bone disease amongst the cattle of the district, and the Colonial Veterinary Surgeon expressed the opinion that this disease was due to a lack of phosphates in the food of the animals. My investigations now confirmed that view, and in remarking thereon in a report dated the 24th of February, 1890, I observed "Judging from the analysis of the plants only, I should say that the soil of the Colony generally appears to be rather poor in phosphates." So small was the amount of phosphatic material in the crops analysed that it seemed a marvel that they ever attained perfection—if the term perfection may be applied to such dwarfed and sickly specimens as they were. A year later I reverted to the subject, and remarked, "I do not regard the matter as settled satisfactorily, and commend it to the attention of the Grahamstown Agricultural School, hoping that ere long proper investigations will be made and the mystery cleared up."

The facts brought to light in connection with the investigations just alluded to showed me how beneficial fuller information respecting the soils of our various districts would be. Towards the end of 1892, therefore, I made a direct recommendation to Government that investigations with the object of eliciting some such information should be undertaken without delay. The assurance of warm support was readily given, and the operations commenced, the virgin clay soils of the Cape Division being the first to be dealt with.

Shortly after this work had been put in hand the services of the Government Botanist were requisitioned from Durbanville, in connection with a parasitic disease (Erysiphe graminis) that had appeared amongst the wheat in that neighbourhood. In connection with Professor MacOwan's investigations five samples of soil from the infected area were submitted for analysis. Fortunately the analytical survey of the soils had by that time advanced sufficiently to enable a comparison to be made between the virgin and cultivated soils of the locality, and in the following table one may see to what extent soil exhaustion had gone on.

	Average composition per cent. of Virgin Soils.	Cultivated Soils.
Lime..................	·291	·194
Potash	·133	·127
Phosphoric oxide...	·031	·015

In other words, the soil had been exhausted of ·097 per cent. of lime, ·006 per cent. of potash, and ·016 per cent. of phosphoric oxide. Roughly we may say that cultivation had removed from each acre of the surface soil 1,940 lbs. of lime, 120 lbs. of potash, and 320 lbs. of phosphoric oxide. To look at the matter from another point of view: for every pound by weight of lime removed from the soil by a crop of wheat, 4 lbs. of potash, and 3 lbs. of phosphoric oxide are needed; relatively to the other plant-food constituents of the soil, therefore, as well as absolutely, the amount of phosphoric oxide, meagre enough even in the virgin soils, had been halved in the process of cultivation; the crops were, in fact, starved in respect of this one essential nutritive element, and were in consequence quite unfitted to resist the attacks of parasitic diseases.

Before proceeding with the actual details of the work done it may be advisable to say a word or two on the general subject of soil analysis. It may possibly appear superfluous to dilate on the use and benefits of analyses of soils when addressing a Society such as this, and yet I am by no means sure that it is so, for there have not been wanting men of scientific repute who have not only cast doubts upon, but have even openly ridiculed the worth of such investigations. Thus a well-known author, who has given much information to the world on agricultural industries as carried on in the Australian and South African colonies,* "does not hesitate to affirm that the subject of analysis of soil has occupied quite an exaggerated position of importance, not only with the unlearned, but also among those who ought to have known better. One individual," this author proceeds to observe, "often of no repute in the scientific world, resolutely and dogmatically takes the lead, and many follow, sheep-like, without inquiry. This has been painfully the case in connection with soil analyses. . . . It is quite impossible to determine with certainty in the laboratory, or by any other test than the growth of crops upon it, whether an ordinary agricultural soil is good or inferior." Again †—"No analyst, using the ordinary processes

* Wallace: Rural Economy and Agriculture of Australia and New Zealand, pp. 167, 168.

† Wallace: *Op. cit.* p. 169.

for soil analysis, can determine whether or not such infinitesimal amounts as are required by the crops are present, or are not present, in an available form in a soil," and so on.

Sir Charles Cameron, on the other hand, remarks, * "The kind and amount of benefit to be derived from the analyses of soils are becoming every day more apparent. We cannot, indeed, from the results of an analysis prescribe in every case the kind of treatment by which a soil may at once be rendered most productive or even improved. In many cases, however, certain wants of the soil are directly pointed out by analyses; in others, modes of treatment are suggested by which a greater fertility is likely to be produced, and, as one's knowledge of the subject extends, we may hope to obtain, in every case, some useful directions for the improvement or more profitable culture of the land."

At one time it was suggested that all that was necessary in analysing a sample of soil was to reduce it to a fine powder, and then to take some of the powdered soil and ascertain how much, say, of potash, phosphoric oxide, or of lime, as the case may be, it contained. If much, the soil was pronounced fertile; if little, barren. Such was the opinion entertained by men of high eminence in their day: an advance, certainly, upon the opinion previously held, that plants were fed by water, and water alone, but an opinion nevertheless, capable of improvement, and improvement came. Baron von Liebig already saw that these views were not quite correct when he said—in 1858†—that soluble constituents of the soil sometimes entered into a kind of combination with other substances in the soil, and so lost their solubility, and at the same time their capacity for circulating about in the soil. It was found, moreover, on the other hand, that from the rootlets of plants exuded an acid possessing the property of acting on some of the insoluble constituents rendering them available to the plant, and in 1866 Dr. Cossa, Professor of Chemistry at an Italian university, pointed out ‡ that if the method of determining soluble constituents in soil were to give trustworthy results they would have to simulate as closely as possible nature's own mode of dissolving the plant-food constituents in the soil. It was plain that to take *all* that the soil contains in the way of potash, lime, phosphoric oxide, and nitrogen, as being so much plant food was erroneous, and to take *only that which was soluble in water* as being available would be no less faulty. Different chemists proposed different methods of settling the difficulty, but

* Johnston and Cameron: Elements of Agricultural Chemistry and Geology, p. 3.

† v. Liebig: Ueber das Verhalten der Ackerkrume zu den in Wasserlöslichen Nahrungsmitteln der Pflanzen.

‡ Fresenius: Zeitschrift für analytische Chemie, vol. 5, p. 161.

there was no *organised* mode of solving the problem until, early in the seventies, the Congress of German Experiment Stations took up the matter. Numerous experiments were carried on in laboratories all over the country, and side by side with each of these experiments the soil itself was directly appealed to by actual cultivation. The outcome of these investigations was that the agricultural chemists of Germany, assembled in congress, resolved to adopt certain fixed methods of analysing the soil in such a manner as to approach as closely as possible to natural processes; and this they did, first of all, not by pounding the soil, but by *sifting* it, and so excluding from the portion actually analysed big fragments of bone and other materials that would give a fictitious value to the soil, and would be of too large size to be successfully dealt with by the acids excreted from the plants' roots. A *fixed weight* of the sifted soil was then taken for analysis, treated with a *definite quantity* of *diluted* hydrochloric acid of a *certain strength* for a *stipulated time* at a *fixed temperature* and under *specified conditions.* Subsequently it was found that, in order to extract the variably available phosphoric oxide, different solvents would be necessary; and for this specific purpose water was used, and a solution of citric acid in ammonia liquor. By these means three "grades," if the expression may be applied, of phosphoric oxide are distinguished. The most immediately valuable part is that which dissolves when a *definite weight* of soil is *continuously* shaken with a *certain volume* of water for *half an hour;* next, that soluble under specified conditions in the ammonium citrate solution; and lastly, that insoluble in the latter solution. These methods, which found their chief exponent in the experiment station at Halle, gained such worldwide repute that, at the special request of the United States Department of Agriculture, they were published in book form in 1892. This, as already observed, was the first attempt to organise methods of soil analysis into a practically applicable code. Since then the official agricultural chemists of the United States have also adopted a provisional uniform method, thus following the lead of Germany. France, Italy, and even Russia have in turn followed up, and the United States, in the person of Dr. Wiley,* have rendered great service by collating all the methods in use, and thus international agreement on the subject has been brought appreciably nearer. In England there has been no organised attempt to deal with the matter, and many analysts are still content to follow ancient methods; no wonder, then, that one sometimes hears soil analysis cried down. In 1894, however, Dr. Bernard Dyer recom-

* Wiley: Principles and Practice of Agricultural Analysis, vol. i.

mended the use of citric acid for the extraction of both potash and phosphoric oxide, and, when the value of this method has been properly tested, it is possible that England also may fall into line with the other countries which have adopted standard methods of extracting available plant food from soils.

All will agree that, for agricultural purposes, an analysis of a soil should show only those quantities of the constituents which are really available. That is exactly the ideal that the German and American chemists have been aiming at, and that Dr. Dyer is following up. To say that they have wholly succeeded would be asserting far too much; yet those who are so fond of decrying soil analysis aim all their shafts at a method which (though they know it not) has long been superseded, in Germany and the United States of America, by others whose object is to extract from the soil only those materials which plants themselves can take out. Some chemists have sought to do this in some ways, some in others, but a method of which Dr. Dyer's is a modification has been used at Halle for determining available phosphates in soils years ago, and for this purpose such a method is now officially recognised practically the whole scientific world over. In brief, the *principle* of extracting available plant-food constituents is generally admitted amongst chemists of standing, the *mode* of applying this principle being the only point of difference. A few isolated persons, unaware of the progress made in the subject, are contending that the *principle itself is wrong*, and the unfortunate thing is that many do not understand how wide of the mark the arguments employed really are. Here, too, to employ the critic's boomerang, it may be said that "one individual, often of no repute in the scientific world, resolutely and dogmatically takes the lead, and many follow, sheep-like, without inquiry."

A few words may be needed regarding the methods employed in our analytical investigations of the Colony's soils, and first of all the collection of the sample requires attention. While travelling about the Colony collecting soils we have frequently been asked to include in our list soils from cultivated lands on this or that farm; soils, therefore, that have been modified by various or repeated cropping—soils, moreover, that have been in all probability considerably altered by the use of manures. For the occupier of that little plot of land an analysis of such a soil will probably have some value, but for the country at large, or even for the surrounding district, it is absolutely valueless. Such a sample is not typical of any extended area, because it has been altered by the agency of man, and, as Dr. Wiley observes, "The physical and chemical analyses of soils are entirely too costly to be applied to samples which represent nothing but themselves." * As our analyses are intended to a certain extent to ascertain the agricultural value of the soils over wide areas it becomes necessary to include as far as possible only virgin soils that have not been subjected to modifying influences. The practice has been to take the sample sufficiently below the surface to keep it clear of the top growth and accumulations, and then to extend downwards to a depth not exceeding 12 inches. After having been spread out in the laboratory for some days the soil is digested with water and washed through a ½-millimetre sieve by the aid of a small brush, that which passes through being dried and the residue from the wash water after evaporation added to it. The combined weight of the two is then calculated in percentage of the original soil taken, and entered as "fine earth." This fine earth is utilised for the determination of lime, potash, and phosphoric oxide in the soil. The residue which does not pass through the ½-millimetre meshes is, after drying, sifted through a sieve with meshes 1 millimetre in diameter; what passes through is known as "coarse sand," and this is included together with the fine earth in determining moisture, organic matter, chlorine, and nitrogen. Regarding these latter determinations I do not propose to say much on this occasion, rather confining my remarks to the inorganic plant-food constituents of the soil, namely lime, potash, and phosphoric oxide.

The first step in the actual analytical process is the *treatment of the soil with acid.* Two hundred grammes of the fine earth are placed in a large flask and treated with 400 c.c. of hydrochloric acid of specific gravity 1·115; allowed to remain for five days at the ordinary temperature, shaking thoroughly from time to time. After the prescribed period of digestion has expired, the extract is filtered through a dry pleated filter into a dry flask. Two hundred and fifty c.c. of the filtrate are evaporated to dryness in a shallow porcelain dish at first over a small open flame, then on the water bath, and finally on a sand bath or in an air oven at 120° Centigrade until perfectly dry. During evaporation a few cubic centimetres of strong nitric acid are added to the extract. The dry residue is moistened with strong nitric acid and again evaporated to dryness: to expel the nitric acid the residue is moistened with hydrochloric acid and evaporated on the water bath to as near dryness as possible, taking care to stir towards the end so as to prevent the formation of crusts. This final residue, after warming in the air bath for an hour, is treated with warm water and a 20 per cent. solution of hydrochloric acid, and is then washed over into a 250 c.c. flask, boiled for fifteen

* Wiley: *Op. cit.* p. 65.

minutes, and after cooling the liquid is filled up to the mark with distilled water and filtered into a suitable bottle. This filtered soil extract is then employed for the actual estimations of lime and potash.*

For the *determination of lime* 50 c.c. of the extract (equal to 25 grammes of soil) are removed by means of a pipette into a 250 c.c. boiling flask: after adding two or three drops of rosolic acid solution, ammonia is added very carefully by means of a dropping tube until a pinkish colour makes its appearance in the supernatant liquid. It is then boiled until the pink colour almost disappears again, the alumina and oxide of iron being thus precipitated. After cooling the flask is filled up to the mark, thoroughly shaken, and the contents filtered into a 300 c.c. bottle. One hundred c.c. of this clear filtrate (equal to 10 grammes of soil) are removed by a pipette into a 300 c.c. Erlenmeyer flask; three to five drops of acetic acid are added and 20 c.c. of a 4 per cent. ammonic oxalate solution. The mixture is placed on a water oven for six hours and then filtered through double filter papers. The precipitate on the filters is ignited at first over a Bunsen flame and is then strongly heated in a furnace for ten minutes. After cooling it is weighed and the lime calculated as CaO.

In determining potash another 50 c.c. of the filtered soil extract is placed in a 250 c.c. flask and boiled. Five c.c. of a 10 per cent. solution of baric chloride are added, and the mixture is boiled for some time for the precipitation of sulphuric acid. A few drops of rosolic acid are next added, and the mixture is boiled with ammonia as in the case of the lime determination. When partly cooled down 2 or 3 grammes of crystalline ammonic carbonate are added, and the temperature is once more raised to boiling-point in order to separate lime and barium. After complete precipitation of the latter the liquid is cooled, the flask filled up to the mark, and the contents filtered. Of this filtrate 100 c.c. (equivalent to 10 grammes of soil) are placed in a platinum basin and heated to dryness on a water bath. The dish containing the residue is heated on asbestos sheet and then carefully over a small open flame until all ammonium salts have been expelled. The residue is then washed through a filter with boiling water into a glass dish. Two c.c. of a 10 per cent. solution of platinic chloride are added, and the mixture is evaporated to dryness on the water bath. After cooling, some dilute alcohol (81 to 82 per cent.) is added to the residue, and it is allowed to stand for at least half an hour. It is now filtered through a Gooch crucible by aid of a filter pump, washed first with

* It should be observed that the soils from the Riversdale and Mossel Bay Divisions were extracted by means of a modified process. The results in these cases are hence not quite on all fours with the others, and due allowance should be made in comparing them.

96 per cent., and then with absolute alcohol, and dried for two hours in a water oven. The weight of the crucible containing the potassic platinic chloride having been taken, the precipitate is washed through with boiling water and the crucible, after again washing with alcohol, is dried and weighed, and the difference between the two weighings taken as the amount of potassic platinic chloride. This amount, multiplied by ·193 gives the quantity of potash (K_2O) in the 10 grammes of soil taken.

For the determination of phosphoric oxide 25 grammes of the "fine earth" is placed in a marked 500 c.c. flask, 25 cc. of concentrated nitric acid are added, and the mixture is thoroughly shaken. Fifty c.c. of concentrated sulphuric acid are next added and the mixture is again carefully shaken up. It is then gently heated, shaking at frequent intervals. If this does not lead to complete oxidation more nitric acid is added and the heating continued. Finally the mixture is cooled and diluted to the mark with distilled water: it is then well shaken and filtered. Two hundred c.c. of the filtered solution (equivalent to 10 grammes of soil) are placed in an Erlenmeyer flask of suitable size, and very nearly neutralised with strong ammonia solution, a few drops of nitric acid being used to acidulate the mixture in case the limit is overstepped. Two hundred c.c. of molybdic solution—prepared by dissolving 150 grammes of ammonic molybdate in a litre of water, and adding this to a litre of nitric acid of specific gravity 1·20—are added, and the mixture is heated to a temperature of 50° C. for three hours in a water oven, and allowed to cool completely. The liquid is decanted through a small filter and the precipitate in the flask washed with diluted molybdic solution. It is then dissolved with warm 5 per cent. ammonia, and the resulting solution is at once very faintly acidulated with hydrochloric acid. From a burette is then added 20 c.c. of magnesia mixture, drop by drop, at the rate of 1 c.c. every five seconds, and then 25 c.c. of 5 per cent. ammonia. The mixture is shaken for a short time and allowed to stand for two hours. The precipitate is filtered through a weighed Gooch crucible and washed with 5 per cent. ammonia solution. The crucible is dried at first on an iron plate and then ignited in a furnace for fifteen minutes. It is then cooled and weighed, and from the weight of the precipitate contained the amount of phosphoric oxide in the soil is calculated.

I have detailed the methods employed in our investigations at some length, for two reasons: firstly, where vastly different results are arrived at by the employment of different methods, it is always desirable to be able to gauge the significance of the results from a knowledge of the method; and secondly, when investigations, such as these, extend over a number of years, it is better far by the employment of one uniform method throughout the whole series, to ensure that the results shall be strictly comparable with one another, than to risk the almost certain unconformity likely to be produced by the adoption of new methods: hence it is advisable rather to adhere throughout to the method of analysis resolved on at the outset, and to state that method clearly, than from time to time to adopt the new and improved methods which the advances of scientific thought and investigation may develop.

The portion of the Colony selected for our operations happened to be identical with that traversed a year or two later by the Geological Survey, and from our standpoint it is not a little to be regretted that that work did not precede ours, as we would have been greatly assisted thereby. The portion I allude to comprises the south-western districts of the Colony extending from St. Helena Bay to Mossel Bay, and is made up of the divisions of Malmesbury, the Cape, Caledon, Bredasdorp, Swellendam, Robertson, Riversdale, and Mossel Bay. Since then we have extended our operations to the Divisions of George, Knysna, Uniondale, Oudtshoorn, Prince Albert, Ladismith, and Worcester, while in the Eastern Province the Divisions of Cathcart, Komgha, Butterworth, Willowvale, and St. Marks have been dealt with. I say again, it is a pity that at the outset of our investigations we did not have the advantage of the map published with the 1897 Report of the Geological Commission, covering as it does exactly the area of our operations during the years 1894–96. It is with that area I propose to deal in the present paper, and it must be remarked that even now the area surveyed has not been sufficiently extensive to allow of general conclusions being drawn, and therefore it is perhaps somewhat unwise to venture upon statements which time may yet disprove.

I have profited by Dr. Corstorphine's kindness in being able, as it were, to superimpose upon the maps* showing the localities whence our samples were collected, the map published with the Geological Commission's report, illustrating the geological formation in the south-western corner of the Colony. As every endeavour was used, when collecting the samples, to locate the site whence each one was taken as accurately as possible, we have thus been enabled to refer every sample to the underlying geological formation with a view to deducing conclusions from the results of the analyses.

The area with which I propose now to deal includes part of the divisions of Malmesbury and the Cape, the Caledon, Bredasdorp,

* Reduced divisional maps were shown when the paper was read.

Riversdale, and Mossel Bay Divisions, and the southern part of the Divisions of Swellendam and Robertson. Within this area 212 samples of soil were collected. Amongst these the geological formations chiefly represented are the Malmesbury and Bokkeveld beds, 75 samples having been collected from the former and 76 from the latter. Besides these we have analysed 10 from the Witteberg beds and 6 lying on Table Mountain sandstone. In eighteen cases the underlying rock was granite and in one the soil rested upon a substratum of Dwyka conglomerate, while 26 soils were taken from areas covered by conglomerates and recent deposits. By far the larger number of soils analysed, therefore, came from the geological formations now termed the Malmesbury and Bokkeveld beds. True granite soils were very few in number, but, taken in conjunction with a number of granite soils analysed by Dr. Hahn, and published in the Vine Diseases Commission's report in 1881, some conclusions may possibly be drawn. It may therefore be of value to tabulate the percentages of lime, potash, and phosphoric oxide yielded by these analyses; they are as follows:—

Description of Soil.	Lime.	Potash.	Phosphoric Oxide.
1. Partly decomposed granite from Hout Bay	...	·014	·002
2. Partly decomposed granite from Groot Constantia	·025	·011	·009
3. Decomposed granite from Bellevue, Groot Constantia	...	·052	·053
4. ,, ,, ,,	·008	·020	·019
5. Decomposed granite from High Constantia	·002	·013	·019
6. ,, ,, ,,	·081	·043	·075
7. Decomposed granite (uncultivated, Red Constantia soil)	·037	·056	·014
8. Alluvial granite soil from Bergvliet ...	·281	·151	·172
9. From Hout Bay	·016	·002	·002
10. ,, ,,	·026	·012	·011
11. Groot Constantia	·009	·015	·001
12. ,, ,,	·069	·049	·011
13. ,, ,,	·039	·031	·019
14. Vlaggeberg, Eerste River	·018	·010	·011
15. ,, ,, ,,	·181	·017	·011
16. ,, ,, ,,	·063	·004	·007
17. Stellenbosch	·014	·019	·002
18. Somerset West	·034	·029	trace
19. ,, ,,	·080	·025	trace
20. Papkuilsfontein, Malmesbury	trace	·049	trace
21. ,, ,, ,,	·046	·028	·012

On looking through this table the one feature that is pre-eminently striking beyond all others is the difference in composition between the alluvial soil No. 8, and all the rest, which are primary granite soils. In the essentials of plant food it is far richer than any other soil. Excluding, then, that sample, we get the following as the average content of the remaining twenty primary granitic soils (I have added the maximum and minimum in respect of each constituent):—

Lime.			Potash.			Phosphoric Oxide.		
Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.
...	·037	1·81	·002	·025	·056	trace	·014	·075

That is to say, the average primary granite soil is poor in all three of the above-mentioned constituents, but of course it will be remembered that many of these soils have been under lengthened cultivation. The poverty of the soil is due to the fact that the minerals of which the granite is composed have not been completely disintegrated, and thus the plant food they contain, though present, is not present in a form available to the plant. For instance, in the case of soil No. 1, the felspar, from which the lime is derived, had remained undecomposed, and hence the sample contained no available lime. A comparison between samples 3 and 4 is interesting: though the former was richer in potash and phosphoric oxide, it was quite destitute of available lime; no wonder, therefore, that the vines on this patch were found to be sickly, whereas the quantity of lime in sample No. 4, small though it was, sufficed to maintain the vines in health. Compare also Nos. 5 and 6: on the latter soil the vines were in good condition, on the former they were diseased. A supply of lime was subsequently given to soil No. 5, and the disease disappeared at once. Between Nos. 11 and 12 a similar comparison holds good, with this in addition—that No. 11 is exceptionally poor in both phosphates and lime. Leaving out of account the alluvial soil No. 8, there is not one amongst the series that could be described as having a normal percentage of lime for agricultural purposes: there is a fair amount in No. 15, but all the others are decidedly poor in that constituent. Nos. 3 and 7 have a fair amount of potash, but here too all the others, excepting of course No. 8, are poor. Nos. 3 and 6 contain phosphoric oxide in fair amount, the rest are poor, some extremely so.

I may mention that I have regarded as poor any soil containing less than ·1 per cent. of lime, or ·05 per cent. of potash or phosphoric oxide, the normal amounts being ·25 to ·5 per cent. for lime, ·15 to ·25 per cent. for potash, and ·1 per cent. for phosphoric oxide.

I have referred to these analyses of Dr. Hahn's because the granite soils being, as it were, nearer home and their investigation occupying the earlier position in point of time, they form a convenient basis with which to compare later work.

For obvious reasons it will not be advisable to take the soils collected and analysed by us in their chronological order. Eighteen samples were collected from the granite formation which extends between St. Helena Bay and Koeberg. It was, however, thought that, as the granitic soils of the Cape Peninsula had already been to some extent explored, it would be advisable to go farther afield and enter upon a formation regarding whose soils very little, if anything, had up till then been learnt—from a chemical standpoint, of course. Hence, even while collecting soils from this granitic area, our aim was to confine ourselves as much as possible to the alluvial soils derived from the clay state lying to the east of the granite. It may, however, be well to give a complete list of the soils collected from the granite formation. Together with the results of the analytical examination they will be found comprised in the following table:—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—MALMESBURY							
Field-Cornetcy : Groenekloof East							
22. Alexanderfontein	·485	3·117	·0010	·129	·081	·035	·045
23. Rheboksfontein	·797	4·155	·0032	·117	·095	·098	·048
24. Platteklip.....................	·561	2·235	·0012	·035	·046	·102	·050
Field-Cornetcy : Zwartwater							
25. Drooge Vlei	7·254	9·262	·0058	·140	1·99	·492	·063
26. ,, ...	·932	2·136	·0057	·028	·156	·122	·028
27. Zwart Water	·776	1·810	·0025	·035	·125	·075	·033
28. ,, ...	·476	2·036	·0017	·028	·108	·054	·039
Field-Cornetcy: Schryvers							
29. Geelbeksfontein	1·852	16·259	·226	·325	1·159	·443	·180
30. Oostenwal.....................	·778	3·293	·0013	·042	·364	·124	·052
Field-Cornetcy : St. Helena Bay							
31. Patrijzen Berg...............	·468	1·121	·0009	·049	·062	·046	·027
32. Schuitjes Klip	1·008	2·533	·0093	·035	·015	·021	·050
33. Uitkomst	2·324	3·477	·0017	·091	·418	·105	·094
34. Noodhulp	1·855	2·553	·0011	·077	·165	·062	·046
35. Holle Vallei....................	1·278	4·823	·0024	·084	·043	·039	·027
36. Klip Rug	1·940	4·303	·0016	·112	·139	·060	·045

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—BREDASDORP							
Field-Cornetcy: Bloemfontein							
37. Avoca	·38	2·36	·015	·17	·32	·071	·013
DIVISION—MOSSEL BAY							
Field-Cornetcy: Before Attaquas Kloof							
38. Hartebeeste Kraal	3·52	5·68	·032	·056	·15	·63	·074
39. ,, ,,	·92	2·47	·0071	·031	·13	·18	·061

Scarcely any in the foregoing table can be classed as true granitic soils, either primary or alluvial. Nos. 22, 23, and 24 are alluvial clays, the last of the three being apparently, judging from its appearance, affected by the granite below; this also shows itself in the smaller amount of lime and higher percentage of potash. Nos. 25, 26, 27, and 28 are all clay soils, the last three being of a rather sandy nature: it is somewhat interesting to note that No 25, a stiff, grey-coloured soil, is locally described as "rust resistent," whereas this is not the case with sample No. 28, a sandy soil. When one reflects on the circumstances that the former of these two soils is well supplied with the essential fertilising ingredients of soils, and that No. 28 is the poorest of the four soils, one reason for the local opinion on the subject becomes evident. The crops grown under the advantages of the fertile soil are better able to remain proof against attack than those grown on soil such as that represented by No. 28, which just misses being a poor all-round soil. In the case of sample No. 25 the effect on the composition of the soil of the compacted blown sand underlying the immediate surface soil throughout extensive portions of the Malmesbury Division is clearly noticeable. No. 29 is a humus soil of considerable fertility—so productive, in fact, that fallowing is rendered unnecessary. The underlying limestone here, too, greatly aids the fertility of the soil. No. 30 is the first granitic soil on this list, but it is not a pure granite, being intermixed with the lime deposit; and here, as in some other cases, manuring is never practised. It is well known amongst many farmers in this neighbourhood that the limestone soils to a large extent withstand rust, and that at times, when the grain grown on sandy soil is almost completely ravaged, the crops standing on the lime soils are only slightly affected. Nos. 31 and 32 are rather sandy, but 33 is an alluvial clay soil; 34, 35, and 36 are sandy loams.

The foregoing samples are of too miscellaneous a nature to enable one to draw definite general conclusions, but it is noteworthy that the soils more or less affected by the underlying limestone, such as Nos. 25, 26, 29, 30, 33, are also proportionately richer not only in lime—as is but natural—but also in potash, than the other samples. The ultimate origin of the large amount of potash in soils of this nature is a point of some interest worth elucidating; it does not seem improbable that it is caused by the *débris* of granitic rocks being mixed with the compacted sand: from the blown sand the potash could certainly not be derived; least of all is such an idea plausible when we consider that the quantity of potash available in some of these soils ranges as high as 5 per cent. No. 29 is the only soil that can be called rich in phosphates; Nos. 24, 25, 30, 32, and 33 have a fair amount, but all the rest are decidedly poor in this respect.

The sample No. 37, taken from above a small outcrop of granite in the Bredasdorp Division, is an alluvial sandy soil derived from the surrounding hills, which are composed of Table Mountain sandstone; the amount of lime in this soil is satisfactory, and it has a fair quantity of potash, but is poor in phosphates.

From the mass of granite which, commencing north-west of Mossel Bay, extends over a considerable portion of the George Division, two samples were taken on the farm Hartebeest Kraal; they are numbered 38 and 39, the former a red and the latter a black soil. Both these samples contained a fair amount of lime, but No. 38 was very rich in potash, and indeed No. 39 was not unsatisfactory in this respect; the phosphoric oxide is moderate in amount in both cases. The preponderance of potash appears to be due to the felspar of the granite, but the question is still being investigated, inasmuch as a number of samples, taken further eastward, are at the present time under analysis.

Turning now to the Malmesbury clay slate beds, 75 samples were collected and analysed; these were distributed as follows:—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—CAPE *Field-Cornetcy: Tygerberg and Kuils River*							
40. Maastricht	1·33	15·50	·054	·128	·48	·045	·028
41. "	2·97	10·52	·057	·201	·64	·27	·028
42. Eversdal	1·37	6·94	·0053	·134	·39	·12	·044
43. "	1·75	7·64	·0028	·134	·35	·026	·062

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Durban							
44. Diemersdal	1·03	4·60	·021	·106	·23	·14	·028
45. ,, ...	1·22	6·67	·0074	·134	·25	·27	·019
46. Phesante Kraal	1·38	5·31	·0021	·089	·23	·043	·044
47. ,, ,, ...	·63	2·84	·0024	·123	·12	·025	·032
48. ,, ,, ...	1·12	5·79	·0060	·084	·32	·023	·017
Field-Cornetcy: Palen and Rietvlei							
49. Visser's Hok	1·61	4·16	·0024	...	·24	·43	·035
50. Government Land north of Visser's Hok.........	·27	·51	·0005	·056	·046	·039	·0038
Field-Cornetcy: Koeberg No. 1							
51. Vrymansfontein	·70	2·85	·0095	·056	·22	·35	·020
52. ,, ...	·44	2·11	·0053	·061	·11	·12	·020
53. Rondeboschjesberg	·94	4·00	·0021	·044	·15	·16	·026
54. Ongegund	1·19	3·92	·0064	...	·23	·24	·026
55. Altona	1·40	4·35	·0006	...	·13	·071	·062
56. Adderley	1·60	2·05	·0026	·061	·061	·070	·019
Field-Cornetcy: Koeberg No. 2							
57. Klein Olifant's Kop ...	·81	1·73	·0004	·061	·095	·038	·023
58. Kalkfontein	·62	1·64	·0018	...	·061	·036	·017
59. Uitkyk	·96	2·36	·021	...	·067	·065	·013
60 ,, ...	1·65	4·20	·0016	...	·16	·093	·076
61. ,, ...	2·04	2·67	·0028	...	·16	·098	·040
62. Dassen Vallei	·96	2·59	·0013	...	·070	·094	·026
63. Klein Dassen Berg	·236	·808	·0015	·035	·061	·021	·029
Field-Cornetcy: Blaauwberg							
64. Lange Rug	·836	2·167	·037	·028	·057	·030	·017
DIVISION—MALMESBURY *Field-Cornetcy: Mosselbanks River*							
65. Kalabas Kraal Station	·295	·846	·0006	·014	·059	·041	·016
Field-Cornetcy: Middle Zwartland							
66. Twee Kuilen...............	·49	1·90	·0003	·061	·056	·107	·051
67. ,, ...	·68	2·47	·0003	·078	·092	·171	·071
68. Vaderlandsche Riet Kuil	1·16	5·24	·0008	·095	·136	·128	·064
69. Bloemendals Fontein...	·142	1·069	·0004	·050	·059	·038	·025
70. Rheboksfontein	·906	2·911	·0014	·091	·049	·031	·030
71. Michiel Heyns Kraal ...	·668	2·296	·0011	·070	·108	·039	·038
72. ,, ,, ,, ...	7·160	15·358	·0056	·252	·369	·033	·080
Field-Cornetcy: Groene Kloof East							
73. Klipfontein	·172	·954	·0008	·067	·039	·042	·033
74. Karnemelksfontein	1·033	4·439	·0014	·089	·147	·059	·041
75. ,, ...	·294	2·157	·0006	·072	·062	·064	·022

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Honing Berg							
76. Holle Rivier	·936	2·495	·0009	·063	·064	·074	·032
Field-Cornetcy: Zwartland							
77. Witkei	·98	3·60	·0022	·117	·160	·130	·056
78. ,,	·80	1·86	·0347	·072	·056	·077	·044
79. ,,	1·05	2·79	·0010	·095	·108	·101	·051
80. Olifants Kuil	·62	2·68	·0004	·056	·104	·062	·038
81. Geel Kuil	1·23	4·02	·0007	·033	·036	·119	·035
82. New Rush	·60	2·99	·0012	·078	·028	·144	·071
83. ,,	·58	2·61	·0010	·084	·082	·090	·064
84. ,,	·59	2·53	·0031	·061	·098	·092	·051
85. Schildpad Vallei	·46	2·04	·0002	·067	·060	·020	·074
86. Hooi Kraal	·68	2·94	·0009	·084	·032	·033	·053
87. Zwartfontein	·35	1·72	·0005	·072	·064	·042	·040
88. Vogelstruisfontein	·73	5·17	·0002	·100	·076	·090	·076
89. Klein Zoutfontein	·37	1·63	·0003	·056	·052	·042	·066
90. ,, ,,	1·68	3·17	·0005	·156	·068	·090	·063
91. Zoutfontein	·31	1·76	·0002	·077	·036	·045	·086
Field-Cornetcy: Zout Rivier							
92. Haazenkraal	·243	1·060	·0050	·042	·024	·045	·124
93. Portugueeschfontein	·169	·586	·0005	·021	·053	·018	·134
94. Bosjesmans Kloof	·870	1·831	·0103	·091	·187	·066	·042
95. ,, ,,	1·084	7·898	·0042	·133	·010	·052	·058
96. Breek Muur	·703	1·548	·0020	·077	·046	·048	·042
97. Leliefontein	1·942	4·091	·0108	·126	·256	·075	·027
98. ,,	·394	1·204	·0009	·035	·039	·026	·038
Field-Cornetcy: Saldanha Bay							
99. Springfontein	·520	2·439	·0016	·035	4·715	·058	·025
100. Spanjaardsbosch	·415	·939	·0015	·049	·231	·037	·075
101. Cloeteskraal	1·165	2·594	·0006	·049	·220	·068	·055
102. Lang Riet Vlei	1·980	2·972	·0147	·070	1·826	·182	·053
103. ,, ,,	·577	1·312	·0022	·047	·073	·063	·027
104. ,, ,,	·203	·540	·0006	·028	·063	·046	·025
105. ,, ,,	·509	1·012	·0008	·028	·114	·061	·034
Field-Cornetcy; St. Helena Bay							
106. Muishondfontein	·413	·675	·0006	·084	.084	·042	·048
107. Eenzaamheid	·348	·666	·0010	·056	·034	·035	·027
DIVISION—BREDASDORP *Field-Cornetcy; Bloemfontein*							
108. Vogelstruis Kraal	·67	3·27	·0099	·15	·11	·063	·0092
109. Ronde Rivier	1·80	8·08	·045	·16	·26	·045	·016
110. Koude Rivier	·74	3·45	·012	·13	·12	·036	·0082
111. ,, ,,	·71	4·06	·0092	·12	·14	·016	·022

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Zoetendals Vallei							
112. Miere Kraal	·95	5·14	·014	·15	·28	·13	·026
113. Elands Drift	1·18	3·58	·0085	·15	·11	·10	·013
Division—Robertson							
Field-Cornetcy: Robertson							
114. Keur Kloof	1·11	4·51	·014	·11	·72	·14	·011

On comparing the map showing the various localities whence the foregoing samples were collected with the diagram (Plate XVII.), which illustrates the chemical composition of each sample a few broad features strike one. The first is this, that the amount of available lime averages ·5 per cent. in the soils about Durban, thins out to about ·1 per cent., and even less in the northern part of the Koeberg district, and remains fairly uniform as we go north to near Hopefield, the average percentage of lime in the 35 soils collected on the clay slate formation in the Field-Cornetcies, Koeberg No. 2, Blaauwberg, Mosselbank River, Middle Zwartland, Groene Kloof East, Honing Berg, and Zwartland being only ·078 per cent.; in other words, the average soil in the area just mentioned is decidedly poor in lime.

The following will show this more clearly: The four soils collected within the Field-Cornetcy of Tygerberg and Kuils River, Nos. 40 to 43, yielded an average percentage of ·47 of available lime. The next strip of country, lying to the north of this, and mainly within the Durban Field-Cornetcy, represented by the seven samples 44 to 49 and 54 gave an average of ·23 per cent. Next come Nos. 50 to 53, north of Durban, and constituting the southern portion of the Koeberg district; these give an average of ·13 per cent. of lime. The middle part of the same district, comprising Nos. 55 to 62—8 samples in all—yields an average of ·10 per cent. In the northern portion of Koeberg and the southern part of Zwartland we have the samples 63, 64, and 65, giving an average percentage of ·059. As we go further north we pass over samples 71 and 72, which are humus soils and probably also affected by the granite boss to eastward as well as the extent of granite lying to the west. Nos. 69, 70, and 73 represent the next area, and the average in this case is ·049 per cent. After this it becomes difficult to trace the gradation owing to the influence of the underlying limestone. A diagram (see Plate XVIII.) enables us to grasp the continuous diminution of lime at a glance.

About Hopefield and to the north-west of it there is again an increase of lime in the soil, clearly traceable to the compacted sand dunes previously referred to. In some cases—samples 99 and 102 for instance—the amount of lime is very large proportionately to the other constituents of the soil, for here, on the clay slate, the simultaneous increase of potash is not so noticeable as, for instance, in soils 25 and 29 where the underlying rock is granite.

Diverse from the changes in the lime content of the soil, strangely enough, is a marked increase in the phosphoric oxide as one travels northwards from Durban. Taking the clay slate soils of the Cape and Malmesbury Divisions as a whole one may conveniently divide them into three sections as regards the amount of phosphates the soil contains. First of all may be taken the area south of the farm "Uitkyk" in the Koeberg district, then the stretch of country between "Uitkyk" and the Great Berg River, expressly excluding the Zwartland soils, and finally the area covered by the Zwartland Field-Cornetcy. The first of these three areas comprises samples 40 to 58—19 in all; they average ·029 per cent. of phosphoric oxide. The samples taken from the next area are 34 in number, comprised in two sets, namely Nos. 59 to 76 and 92 to 107. In these the average percentage of phosphoric oxide is respectively ·041 and ·046: the former represents the country north, and the latter that south of Zwartland. The Zwartland area comprises the 15 samples 77 to 91, and they yield an average of ·058.

There is a diminution of potash, somewhat similar to that already noticed in the case of the lime, as we proceed from south to north within the area under consideration, but in this case it is not as striking nor as regular. Several of the southernmost soils contain a respectable proportion of potash—for instance, Nos. 41, 45, 49, 51, and 54, the percentage of potash in which averages ·32: these soils may all be said to be rich in potash. In the Zwartland area there is a noticeable difference in respect of potash between the western soils and eastern soils; the former, comprising Nos. 77 to 84, contain on an average ·102 per cent., the minimum being ·077, whereas the samples taken from the more easterly part of the Field-Cornetcy, Nos. 85 to 91 yield an average of only ·060 including a minimum of ·020.

Summarising our results with respect to the clay soils of the Cape and Malmesbury districts we may say that no less than 16 out of the 68 soils examined were poor in all three of the essential inorganic elements of plant food; there is one such poverty-stricken patch about the middle of the Koeberg district, represented by samples 50, 57, and 58, and two others of apparently wider extent in the northern portion of the same district and in the south of Zwartland; the former of these two is represented by samples 63, 64, and 65, and the latter by Nos. 69, 70, and 73. As many as 45 of the soils are poor in phosphoric oxide; five of these are poor in phosphoric oxide and potash (and this is notably the case with the farm Phesante Kraal, near Durban), while eight are poor in phosphoric oxide and lime, and, as already observed, 16 are poor all round, leaving a balance of 16 samples which show poverty in phosphoric oxide only. Eight samples were poor in lime only, three poor in potash only, and five poor in both lime and potash. There are, therefore, only seven samples that do not show a deficiency in respect of one or other of the three fertilising constituents, and even out of these seven, six are no better than fair all round, while the seventh—No. 102—is rich in lime, contains a normal amount of potash and a fair quantity of phosphoric oxide.

The six Bredasdorp soils examined were all, without exception, poor in phosphoric oxide; two of them—Nos. 108 and 110—particularly; all of these soils, however, yielded at least a fair amount of lime, but in three—Nos. 109, 110, and 111—the potash was likewise deficient. The average composition of these six soils is—lime ·17, potash ·065, phosphoric oxide ·016. The sample from the Robertson Division showed a good percentage of lime and a fair amount of potash, but phosphoric oxide was deficient.

We now come to the soils of the Bokkeveld beds, numbering 76. The following table shows the analytical results:—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—CALEDON.							
Field-Cornetcy: Upper River Zonder End							
115. Middelplants	·73	2·67	·55	·084	·270	·13	·033
Field-Cornetcy: Zwart River							
116. Zwart River	1·24	6·69	·0086	·15	·034	·13	·059
117. ,, ,,	·51	2·15	·093	·091	·018	·043	·038
Field-Cornetcy: Bot and Palmiet Rivers							
118. Riet Fontein	1·60	6·57	·0038	·17	·093	·050	·058
119. The Vlei	1·44	6·33	·0040	·15	·028	·056	·036
120. Lang Hoogte	2·04	11·71	·0038	·25	·083	·073	·032
121. ,, ,,	1·42	6·60	·0056	·15	·030	·038	·058
122. Avontuur	1·48	7·57	·017	·15	·026	·098	·049

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Caledon							
123. Muurton	·87	4·36	·0042	·11	·039	·036	·056
124. "	1·37	5·25	·018	·10	·018	·055	·038
125. Klein Steenboks River ...	1·27	4·94	·0042	·15	·150	·076	·056
126. Weltevreden	1·56	6·14	·0050	·15	·024	·073	·056
127. Dunghye Park	1·67	7·42	·0055	·20	·045	·087	·059
Field-Cornetcy: Uilenkraal							
128. Good Hope	1·28	5·21	·0070	·15	·040	·044	·051
129. Weltevreden	·84	3·22	·0027	·11	·038	·024	·056
Field-Cornetcy: Goudini							
130. Goudini	1·58	7·88	·0058	·20	·016	·072	·036
Field-Cornetcy: Lower River Zonder End							
131. Roode Vlei	1·93	7·98	·0034	·17	·058	·068	·13
132. Jongens Klip	1·93	7·04	·0064	·18	·032	·071	·051
133. Alexanders Kloof	1·87	7·19	·0034	·20	·045	·078	·061
134. Ganze Kraal	2·10	8·20	·014	·22	·058	·049	·061
135. "	1·37	4·39	·0049	·098	·030	·061	·041
136. Tygerhoek	·95	4·60	·0042	·13	·026	·042	·038
137. The Oaks	1·19	6·04	·0037	·16	·041	·045	·056
DIVISION—BREDASDORP *Field-Cornetcy: Napier*							
138. Klippe Drift	1·25	7·95	·0096	·18	·20	·062	·011
139. Leeuwen River	1·63	9·65	·019	·18	·15	·18	·026
140. Halfaampjes Kraal	1·39	6·94	·011	·15	·18	·19	·032
141. Quarrie	1·27	7·01	·029	·17	·16	·11	·026
142. Kilppe Drift	0·95	5·86	·021	·16	·37	·13	·028
143. "	0·91	4·23	·028	·17	·094	·089	·019
Field-Cornetcy: The Ruggens							
144. Rem Hoogte	1·32	6·91	·017	·15	·15	·19	·038
145. Koeranna	1·43	7·19	·043	·077	·15	·15	·030
146. Haasjes Drift	1·65	6·34	·0071	·15	·16	·12	·024
147. Nooitgedacht	0·71	3·96	·0064	·19	·094	·15	·022
148. Patrys Kraal	1·02	2·89	·017	·16	·20	·098	·010
DIVISION—SWELLENDAM *Field-Cornetcy: River Zonder End*							
149. Appels Kraal	0·09	0·77	·0056	·11	·084	·034	·0048
150. "	1·05	5·41	·025	·18	·060	·035	·011
151. "	0·57	3·36	·013	·16	·044	·049	·015
152. "	0·75	3·85	·0085	·14	·058	·10	·014
153. Stormsvlei	0·68	3·59	·093	·15	·14	·078	·016
154. Verdwaal Kloof	0·95	6·90	·018	·16	·25	·084	·013
155. Klipfontein	1·44	7·20	·028	·14	·16	·13	·012
Field-Cornetcy: Kluitjes Kraal							
156. Vryheid	·051	3·73	·011	·16	·080	·055	·017
157. Kluitjes Kraal	·080	4·78	·086	·15	·084	·14	·022

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Swellendam							
158. Appelsboch	1·50	4·64	·0028	·028	·096	·015	·036
159. Oude Post	1·58	5·91	·0025	·065	·15	·053	·041
160. Kinko	1·08	4·14	·019	·098	·33	·062	·023
Field-Cornetcy: Breede River							
161. Uitvlugt	1·76	5·65	·010	·098	1·18	·43	·009
162. Rhenosterfontein	·59	1·87	·0073	·056	·16	·099	·010
Field-Cornetcy: Heidelberg							
163. Klein Duine Rug	·84	2·98	·011	·042	·32	·018	·014
164. Wagen Drift	·91	4·25	·019	·056	·37	·087	·019
165. Asch Kraal	2·68	7·53	·086	·035	2·73	·29	·041
Field-Cornetcy: Karnemelk River							
166. Honig Klip	1·70	9·26	·015	·12	·40	·045	·0080
167. Karnemelk River	4·82	4·07	·048	·077	·37	·11	·031
Field-Cornetcy: Zuurbraak							
168. Melkhout Boom	2·86	9·07	·016	·084	·23	·060	·019
169. ,, ,,	2·07	4·67	·015	·084	·083	·099	·036
DIVISION—ROBERTSON *Field-Cornetcy: Middle Bosjesveld*							
170. Vrolykheid	·34	1·94	·023	·077	1·08	·070	·060
171. Riet Vallei	1·35	5·01	·014	·14	·13	·10	·021
172. Bosjesmans River	2·09	6·30	·0088	·16	·79	·32	·051
173. ,, ,,	1·48	4·96	·035	·056	·29	·22	·068
DIVISION—RIVERSDALE *Field-Cornetcy: Onder Duivenhoek's River*							
174. Oude Muragie	2·10	5·20	·014	·028	·013	·36	·090
175. Jan Pienaars Rivier	1·79	4·85	·017	·056	·11	·21	·58
Field-Cornetcy: Vette Rivier							
176. Brak Rivier	1·73	4·20	·010	·15	·12	·13	·058
177. ,, ,,	1·14	4·81	·012	·056	·12	·32	·081
178. Oude Bosch	1·66	3·78	·010	·056	·19	·14	·087
Field-Cornetcy: Riversdale							
179. Novo	2·05	4·01	·012	·15	·18	·24	·099
180. Klein Rivier	3·63	5·71	·013	·028	·13	·24	·15
Field-Cornetcy: Valsch Rivier							
181. Boschjesfontein	2·69	4·50	·062	·070	·14	·19	·069
182. Middelste Drift	4·05	4·87	·012	·11	·13	·34	·056
Field-Cornetcy: Buffels Kraal							
183. Zandfontein	2·58	2·85	·0062	·028	·11	·15	·044
184. Drooge Rug	0·96	2·13	·0053	·028	·14	·26	·069

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Kaffir Kuils River							
185. Hooge Kraal	2·38	4·68	·011	·029	·10	·29	·089
186. Tartouwa	1·61	4·32	·025	·027	·13	·24	·044
DIVISION—MOSSEL BAY *Field-Cornetcy: South Middelveld*							
187. Buffels Drift	2·52	6·29	·0062	·056	·43	·39	·13
188. Hartjesfontein	2·99	4·87	·037	·043	·23	·46	·070
189. ,,	6·95	10·24	·035	·17	·59	·87	·12
Field-Cornetcy: Mossel Bay							
190. Patrysfontein	·78	2·29	·026	·13	·10	·13	·033

Here again, as in the case of the clay slate soils, we may fairly compare the map with the diagram (Plate XIX.) showing the chemical composition of the individual samples, and again some salient features are noticeable at the first glance. The Caledon soils, for instance, are far the lowest in respect of the quantity of lime contained, the average percentage of lime in the 23 soils being only ·054, with a minimum of ·016 and a maximum of ·27; in fact, only two samples, Nos. 115 and 125, attain to more than ·1 per cent. This is a very much worse exhibition than anything afforded by the Malmesbury slates. Passing eastward into the Bredasdorp Division, a considerable improvement manifests itself. The lime rises to an average percentage of ·174 in the 11 soils of this division, an average percentage about five times as great as that in the Caledon soils. This percentage is maintained in the western part of the Swellendam Division represented by the Field-Cornetcies of River Zonder End, Kluitjes Kraal, and Swellendam, the average of 12 soils collected in this area being ·128. The diminution is due to the low lime contents of the four soils, Nos. 149, 150, 151, and 152, from the farm Appelskraal. Now these samples, it must be remarked, lie just on the verge of the mass of sandstone which forms the River Zonder End range, and are apparently influenced thereby. To this influence must also be ascribed the poverty in lime exhibited by the Caledon soils, lying, as they do, in a tract of country almost entirely hemmed in by sandstone. When we reach the Bredasdorp Division and the western part of the Swellendam District we emerge from this sphere of influence, and the lime becomes less deficient. I have included sample No. 160 from the farm Kinko in the western half of the

Swellendam Division ; but manifestly that is not its proper place, for it lies east of the Breede River and of the Witteberg beds which surround the village of Swellendam, and hence belongs to an area which, as we shall see, differs somewhat from the western part of the division. Compare in the diagram showing the composition of the various soils, this sample No. 160, with the others belonging to the western part of the district, namely, Nos. 153 to 159, and the difference becomes immediately apparent. The lime shows a definite preponderance over that of the other samples. It is the beginning of an increase which becomes much more noticeable as we go still further eastwards. This is clearly seen on the diagram in the case of all the samples from 161 up to 167 both inclusive. Nos. 168 and 169, which of course belong to this part of the division, are again poorer, but they are also within reach of the sandstone formation just to the north.

The potash, it will be noticed from the diagram, increases with the lime, though the ratio of increase is smaller. Strange to say, however, the amount of phosphoric oxide is apparently in inverse proportion to the amount of lime. The reason of this curious fact I have not been able to solve. These remarks apply only to the soils of the Caledon, Bredasdorp, and Swellendam Divisions. On coming to Riversdale we find, conjointly with an increase of phosphoric oxide, a fairly large increase of potash, while the lime is about the same as in the western portion of the Swellendam District. Still further east, in the division of Mossel Bay, three out of the four soils analysed showed an all-round improvement on the soils of the more westerly districts.

It is almost to be expected that soils derived essentially from a sandstone formation can scarcely claim to be otherwise than poor. Only six such soils were analysed, all lying on sandstone, in the Caledon Division. Their analytical results are as follows:—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—CALEDON							
Field-Cornetcy: Bot and Palmiet Rivers							
191. Dasjesfontein	1·27	6·43	·0034	·13	·098	·060	·12
Field-Cornetcy: Caledon							
192. Klipheuvel	2·05	8·30	·0031	·19	·080	·078	·077
193. Dunghye Park	1·49	5·81	·0021	·14	·038	·048	·072

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Uilen Kraal							
194. Paarde Berg	·88	3·37	·0049	·091	·054	·041	·046
195. ,,	1·57	5·21	·0055	·13	·029	·24	·032
Field-Cornetcy: Goudini							
196. Klein Wolvegat	1·38	6·57	·0097	·17	·025	·045	·036

Lime is lacking right through the series; but for one exception this would be true of potash as well; of the latter there is a satisfactory amount in No. 195. The last 3 soils are poor in phosphoric oxide; there is a fair amount in Nos. 192 and 193, and No. 191 is really good in this particular. No. 194, I would remark in passing, is found by Mr. de Villiers, the occupant of the farm, to be very poor, the ears of corn generally shrivelling up without coming to perfection, whereas No. 195, though really even poorer in lime and phosphoric oxide, was stated by him to be very rich, due no doubt to the amount of potash it contains.

The samples collected from above the Witteberg beds were 10 in number, and the results of their analyses are given in the following table:—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—CALEDON *Field-Cornetcy: Zwart River*							
197. Bok Kraal	1·06	3·85	·0061	·13	·034	·076	·038
DIVISION—ROBERTSON *Field-Cornetcy: Voor Cogmans Kloof*							
198. Riet Vallei	1·54	2·45	·0071	·077	2·65	·15	·017
199. ,,	1·26	3·64	·014	·11	·89	·070	·0037
Field-Cornetcy: Robertson							
200. Hex River	2·09	7·60	·095	·098	1·20	·12	·083
DIVISION—SWELLENDAM *Field-Cornetcy: Swellendam*							
201. Klippe River	·86	6·26	·018	·16	·29	·12	·040
202 Distelsfontein	·65	4·30	·0019	·042	·16	·074	·052
203. Bonteboks Kloof	1·81	6·76	·019	·098	·63	·23	·044

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Breede River							
204. Zwartklip........................	1·35	5·38	·0068	·077	·45	·23	·018
Field-Cornetcy: Klip River							
205. Boschjesmans Pad............	1·43	5·60	·015	·084	·46	·10	·010
DIVISION—RIVERSDALE							
Field-Cornetcy: Vette River							
206. Kweek Kraal	2·66	6·59	·040	·11	·16	·22	·13

Compared with the other soils examined, these Witteberg soils show remarkably high percentages of lime. Only one is deficient, namely No. 197, a Caledon soil, which in this respect conforms to the generality of soils in that division. No. 202, in appearance, general character, and composition, approaches nearest to the soils of the Caledon Division, but even here the percentage of lime is fair; this is also the case with sample No. 206; Nos. 201, 204, and 205 contain a satisfactory quantity of lime, 199 and 203 are really good in this respect, while 198 and 200 are decidedly rich. The soils of this series all yield a fair proportion of potash, but there are only two—namely, Nos. 200 and 202—that can be described as anything else than absolutely poor in phosphates, while No. 202 borders on poverty and No. 200 is slightly better off, though not satisfactory.

Coming to the soils overlying the more recent formations, 21 samples were taken from the Enon deposits, chiefly in the Riversdale and Mossel Bay Divisions; these yielded the following analytical results:—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—SWELLENDAM							
Field-Cornetcy: Heidelberg							
207. Duivenhoks River	·21	2·16	·0057	·063	·64	·033	·011
Field-Cornetcy: Karnemelk River							
208. Hooi Kraal	1·64	4·97	·053	·15	·51	·11	·015
DIVISION—RIVERSDALE							
Field-Cornetcy: Vette Rivier							
209. Vette Rivier........................	·91	1·66	·0088	·056	·093	·22	·13

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
Field-Cornetcy: Krombeks Rivier							
210. Spiegel Rivier	4·27	4·71	·020	·056	·075	·27	·065
211. ,, ,,	4·35	5·95	·019	·084	·025	·26	·099
Field-Cornetcy: Riversdale							
212. Novo	3·32	4·98	·012	·028	·15	·11	·078
213. Kruis Rivier	1·13	2·99	·013	·028	·13	·24	·11
214. Doorn Kraal	2·08	3·85	·054	·028	·18	·28	·061
Field-Cornetcy: Valsch Rivier							
215. Assegaai Bosch	1·88	3·57	·013	·030	·23	·082	·061
Field-Cornetcy: Buffels Kraal							
216. Zandfontein	4·27	5·45	·014	·14	·93	·29	·22
DIVISION—MOSSEL BAY *Field-Cornetcy: Upper Gouritz River*							
217. Hemelrood	1·58	3·54	·011	·028	·10	·39	·074
218. Heuning Bosch	2·52	4·98	·016	·042	.16	·20	·054
Field-Cornetcy: Before Attaquas Kloof							
219. Hagel Kraal	2·66	5·67	·011	·030	·15	·25	·11
220. ,, ,,	2·75	4·47	·040	·17	·13	·36	·059
221. Ruiter Bosch	1·97	4·17	·012	·044	·15	·080	·064
Field-Cornetcy: Brak River							
222. Great Brak River	2·73	5·01	·0079	·046	·39	·58	·056
223. ,, ,, ,,	1·97	6·29	·047	·044	·30	·34	·10
224. Klipheuvel	2·12	4·41	·044	·057	·31	·56	·092
225. ,,	1·05	2·13	·044	·029	·15	·26	·058
226. Geelbeks Vallei	2·21	5·71	·057	·056	·40	·76	·15
227. Hartenbosch	·46	·89	·021	·045	·11	·14	·046

Here for the first time we meet with some really good all-round soils. Many of the others have been found to be rich in one or two of the three essential inorganic plant-food constituents, but in all cases this has been counterbalanced by a lack of one, frequently of two constituents, and phosphoric oxide has generally been the one lacking. Now we come across a few samples which are in every respect satisfactory, and especially prominent are Nos. 216 and 226. The former of these two soils is typical of the Gouritz River basin; the richness of the latter is tempered by its being brack. In respect of the fertilising elements the samples from 212 to 226 inclusive constitute the most satisfactory group of the entire range of soils examined. Though it would be too much to say that addition of suitable fertilisers will not improve their quality, yet it is certain that none of them are in any respect what may be called poor soils.

From the surface deposits and sands along the Bredasdorp and Riversdale coast 5 samples were collected; these yielded the following results :—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—BREDASDORP							
Field-Cornetcy: *Bredasdorp*							
228. Nachtwacht	·54	2·83	·011	·15	·25	·076	·028
229. ,,	1·10	5·65	·018	·16	·40	·12	·015
230. Matjesfontein	·92	5·30	·011	·16	·31	·23	·0038
DIVISION—RIVERSDALE							
Field-Cornetcy: *Onder, Duwenhoeks River.*							
231. Honig Fontein	1·49	2·23	·004	·059	·44	·074	·098
232. Watergat	·82	2·47	·003	·030	·19	·25	·082

As their formation would lead one to expect, the amount of lime is not unsatisfactory in these soils; nor indeed is the potash, but the phosphates stand in need of augmentation, especially in the three Bredasdorp soils, which are decidedly poor.

One more sample completes our list; it was taken from the Dwyka formation north-west of Robertson, and its analytical results are as follows :—

Name of Farm and No. of Sample.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
DIVISION—ROBERTSON							
Field-Cornetcy: *Robertson*							
233. Hex River	·38	1·53	·0053	·13	·34	·066	·036

The amount of lime in this sample is normal; there is not much, but still a fair quantity of potash, but the almost generally prevalent poverty in phosphates is again noticeable. Of course, to draw any general conclusions from the analysis of a single sample is out of the question.

Rather interesting results were yielded by analyses of 6 soils from the Malmesbury District, which may be taken as supplementary to the main series of investigations. While travelling in the district mentioned my attention had been more than once drawn by the local farmers to numerous slight elevations, from 1 to 4 feet in height, and 20 or more yards in diameter; the soil of these hillocks was alleged to be extremely rich, and cereals of all kinds were said to grow on them with luxuriance, while on the lower ground, between the elevations, the soil would be poor and produce scanty crops. It was represented to me that if these lower portions could be worked up by artificial fertilisers so as to equal in fertility the soil of the hillocks, a great improvement in the average yield of the crops would be discernible. I was further told that it was not the practice ever to manure these hillocks, and that there were some lands on which wheat had been sown for nearly a century without the hillocks either getting any manure or becoming exhausted. Mr. J. P. Cloete, Alexanderfontein, states that for the last four years he has been urging farmers to use lime largely on the poor, cold soils, between the hillocks; but, he added, "I am sorry to say that though I have preached, they have not heeded—though I have quoted instances to them of a very poor land having yielded a heavy crop of wheat by the aid of a good dressing of lime."*

In order to ascertain more definitely by chemical analysis what difference, if any, existed between the high- and low-lying soils, samples were procured from some of the hillocks said to be so rich, and also from the adjoining grounds. Those from the hillocks are marked A, B, and C; those from the lower grounds A′, B′, and C′. In every case the soil was taken from ground that had been cultivated.

No.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
A	1·574	5·834	·0106	·175	·146	·121	·061
B	1·146	3·182	·0078	·189	·072	·075	·072
C	1·472	5·012	·0042	·126	·096	·095	·073
A′	1·010	4.332	·0261	·119	·014	·114	·049
B′	1·092	2.640	·0159	·112	·014	·045	·028
C′	1·278	4.296	·0078	·119	·014	·095	·055

The mechanical analysis of the soil, I may say, did not reveal anything very striking, there being little difference in fineness of grain between the soil taken from the hillocks and that below.

* The point had first been raised in connection with the two samples from Karnemelksfontein, Nos. 74 and 75, the former being from high- and the latter from low-lying ground. The retentive power for moisture appeared greater in the case of No. 74, which was also the richer in plant food materials.

Taking into consideration the composition of the fine earth, in which determinations of lime, potash, and phosphoric oxide were made, it may be said at once that in every case the soils taken from the low-lying ground were exceedingly poor in lime, and herein lies the great difference between the hillock soils and those below; even samples B and C are very deficient in this respect, although considerably superior to samples A′, B′, and C′. A contains lime in fair amount. The potash present in A, B, and C, is fair in quantity, but B′ is rather poor. A′ and C′ likewise show a moderate percentage of potash, though in each case poorer than the corresponding samples from the hillocks. As far as the phosphates are concerned, there is a fair percentage in the hillock soils, and also, though to a less extent, in sample C′, but A′ and B′ are decidedly poor. Clearly the chemical analysis tends to confirm the popular idea; and yet the difference all round is not as wide as some of the statements made might possibly have led one to expect. To this observation there is just the exception already noted—that of the lime.

Physically, as well as chemically, the hillock soils are slightly superior. In water retentive power their average stands higher than that of the soils around. To this fact I have already alluded. The organic matter in the hillock soils is also better than in the others, and the former are likewise the richer in nitrogen. The inferiority of the low-lying soils also comes out in the amounts of common salt they contain, as indicated by the percentage of chlorine; thus every single one of the seven sets of determinations made shows the soils from the hillocks to be better adapted for agriculture, they contain more of the six useful constituents and less of the one that is harmful.

Some soils were also collected in the Wellington District, where a somewhat similar configuration prevails, and on the farm "Groenberg" a sample of soil E′ from level ground was taken, as well as one E from a hillock. Analysis seemed here also to confirm the popular theory, as may be seen from the following table:—

No.	Water.	Organic Matter.	Chlorine.	Nitrogen.	Lime.	Potash.	Phosphoric Oxide.
E	·76	5·57	·0255	·006	·064	·171	·074
E′	·76	5·11	·006	·003	·037	·084	·077

Of course the characteristics of the Wellington District are not strictly comparable with those of Malmesbury, but it is noteworthy that there is a marked difference in both the lime and potash of these two soils; both are poor in lime, it is true, yet the lime in E is nearly double that in E′. The quantity of potash in E is also quite normal, though it is but moderate in amount in E′.

Under all the circumstances, to revert again to the Malmesbury soils, it seems quite feasible that the process of levelling down the hillocks—said to have been attended with success in one instance—may in some cases lead to an all-round increase in fertility, notably where the hillocks are numerous.

It appears reasonable to suppose, from what these results reveal that an addition of lime would lead to an improvement. In the Malmesbury District there are numerous outcrops of lime—for instance, on the farms Drooge Vlei, Geelbeksfontein, Springfontein, and Lang Riet Vlei. Even if levelling down does not achieve the desired result, there should be plenty of lime near at hand on which to draw for a supply.

It may be useful to compare the average percentage composition of the hillock soils with those from below. The results, calculated on the unsifted soils, are as follows:—

	Lime.	Potash.	Phosphoric Oxide.
Hillock ground	·078	·073	·051
Level ground	·010	·061	·032

Calculated in pounds per acre to a depth of 6 inches of soil, this would amount to:—

	Lime.	Potash.	Phosphoric Oxide.
Hillock ground	1,560	1,460	1,020
Level ground	200	1,220	640

Hence, generally speaking, to bring the latter soils up to the fertility of the former, they would require per acre over half a ton of lime, together with about 200 lbs. of potash and 400 lbs. of phosphoric oxide; in other words, the equivalent of a ton each of Kainit and Thomas' phosphate per acre. At the same time it would not do to rest content with these additions, for so we would only be levelling up the general fertility to that of the hillocks, which are themselves in want of improvement. In fact, the lime in the latter may safely be trebled and the potash and phosphoric oxide doubled.

Reviewing the entire area covered by these analytical investigations, it is difficult, if not impossible, to trace well-defined family resemblances between the members of a series of soils overlying the same geological formation; similarity between samples is geographical rather than geological. For instance, the Caledon soils all present certain distinguishing features, easily discernible on the diagrams, no matter, apparently, whether the underlying rock be Table Mountain sandstone or belong to the Bokkeveld or Witteberg beds; and again, though the Enon soils of the Riversdale and Mossel Bay Divisions are all round the richest, yet they do not differ very widely from the soils of the same districts overlying the Bokkeveld beds.

Without for the moment considering the geological relations of the soil, some interesting information may be afforded by making two cross-country cuts, one almost due east and west from the farm Rietfontein in the western part of the Caledon Division, terminating near the mouth of the Great Brak River; and the other beginning from the same farm, running in an east-south-easterly direction, and reaching the coast about midway between Struys Point and Cape Infanta; as we travel along these lines let us take the soils lying nearest to hand, on either side, for consideration. Taking, then, the south-easterly course first, we meet in succession the soils enumerated in the following list (compare Plate XX.):—

No.	Lime.	Potash.	Phosphoric Oxide.
118. Rietfontein	·093	·050	·058
119. The Vlei	·028	·056	·036
120. Lang Hoogte	·083	·073	·032
121. " "	·030	·038	·058
122. Avontuur	·026	·098	·049
124. Muurton	·018	·055	·038
123. "	·039	·036	·056
125. Klein Steenboks River	·150	·076	·056
126. Weltevreden	·024	·073	·056
127. Dunghye Park	·045	·087	·059
130. Goudini	·016	·072	·036
132. Jongens Klip	·032	·071	·051
131. Roode Vlei	·058	·068	·13
139. Leeuwen River	·15	·18	·026
140. Half Aampjes Kraal	·18	·19	·032
142. Klippe Drift	·37	·13	·028
143. " "	·094	·089	·019
141. Quarrie	·16	·11	·026
147. Nooitegedacht	·094	·15	·022
145. Koeranna	·15	·15	·030
144. Rem Hoogte	·15	·19	·038
146. Haasjes Drift	·16	·12	·024
148. Patrys Kraal	·20	·098	·010
230. Matjesfontein	·31	·23	·038
228. Nachtwacht	·25	·076	·028
229. "	·40	·12	·015

A somewhat zigzag course having been taken in passing from point to point, it is scarcely possible for this, as well as for other obvious reasons, to expect anything in the way of regular gradation in the composition of the soils collected along the line; but it is clear that there is a noticeable increase both in lime and potash as we move onwards, and a corresponding decrease in respect of phosphoric oxide. The first few soils of the series are poor in lime and not very satisfactory as to potash and phosphates; the last few are very poor in phosphates, but, with few exceptions, show normal amounts of lime and potash.

Now taking an easterly course from the same starting-point, the following samples come into consideration (compare Plate XXI.):—

No.	Lime.	Potash.	Phosphoric Oxide.
118. Rietfontein	·093	·050	·058
117. Zwart River	·018	·043	·038
116. " "	·034	·13	·059
137. The Oaks	·041	·045	·056
134. Ganze Kraal	·058	·049	·061
135. " "	·030	·061	·041
136. Tygerhoek	·026	·042	·038
151. Appels Kraal	·044	·049	·015
150. " "	·060	·035	·011
149. " "	·084	·034	·0048
152. " "	·058	·10	·014
156. Vryheid	·080	·055	·017
157. Kluitjes Kraal	·084	·14	·022
201. Klippe River	·29	·12	·040
202. Distelsfontein	·16	·074	·052
160. Kinko	·33	·062	·023
166. Honig Klip	·40	·045	·0080
167. Karnemelk River	·37	·11	·031
208. Hooi Kraal	·51	·11	·015
207. Duivenhoks River	·64	·033	·011
206. Kweek Kraal	·16	·22	·13
176. Brak River	·12	·13	·058
177. " "	·12	·32	·081
214. Doorn Kraal	·18	·28	·061
213. Kruis Rivier	·13	·24	·11
215. Assegaai Bosch	·23	·082	·061
181. Boschjesfontein	·14	·19	·069
182. Middelste Drift	·13	·34	·056
183. Zandfontein	·11	·15	·044
217. Hemelrood	·10	·39	·074
218. Heuningbosch	·16	·20	·054
219. Hagel Kraal	·15	·25	·11
220. " "	·13	·36	·059
38. Hartebeeste Kraal	·15	·63	·074
39. " "	·13	·18	·061
222. Great Brak River	·39	·58	·056
223. " " "	·30	·34	·10

Here we first of all notice a change of composition somewhat similar to that drawn attention to in connection with the last-mentioned series, an increase with regard to lime and potash, a decrease in phosphoric oxide. This change proceeds more or less regularly up to the village of Heidelberg, but after that the lime undergoes a sudden diminution from ·5 to between ·1 and ·2 per cent., and remains comparatively uniform along the rest of the line; the potash continues to increase more and more, and the phosphates also show a sudden augmentation and remain, like the lime, more or less uniform thereafter. In popular language we may say that the soils, starting the series with a fair amount of phosphoric oxide, though poor in lime and not much better in potash, on reaching the eastern part of the Swellendam Division, become poorer than ever in the first-named constituent, although they show a good amount of lime and a fair quantity of potash. Across the river the lime diminishes and the phosphoric oxide increases, but both still remain fair throughout, while the potash attains to a normal condition and afterwards becomes in parts really rich, notably in the neighbourhood of the granite formation north of Mossel Bay.

Only 45 soils out of the entire series of 212 examined show normal proportions of lime; the remaining 167 cannot be said to be more than fairly well supplied, and of these 86 are decidedly poor. With regard to phosphoric oxide the case is even worse; here no less than 124 out of the 212 soils must be classed as poor, and of the whole range of samples only 15—that is to say, less than 8 per cent.—reach the normal standard. As to potash, conditions are rather more satisfactory; 57 samples show normal amounts, and only 53 are actually poor. These results show that, as far as my investigations have gone, my surmise of ten years ago was fairly correct; the great want of most of our soils is phosphatic material, and, next to that, lime. And all the while, for years in succession, we have continued exporting bones by hundreds of tons, and bones consist mainly of phosphate of lime and thus supply the very essential most lacking in our soils. Until a few years ago judicious fertilising was all but absolutely unknown in this Colony; the principle on which manuring was carried on may be instanced by the following: In one of the districts traversed I found that the practice was to manipulate with farmyard manure the lands adjacent to the homestead, guano being reserved for those at greater distances or in less accessible situations—hillsides, for instance. Here there was no inquiry after the needs of the soil and the fitness of the fertiliser to supply those needs; it was all a question of which is the easier to employ. There is an immense amount of education to be done in this respect, and from its very nature and the country's circumstances it is an education that takes time. More rational inquiry is now being made after the proper fertilisers to apply to particular soils than was the case in years gone by. None the less there still is a very extraordinary rush on guano as the hoped-for saviour of the land from all its ills, and people will not recognise that on poor lands this method of treatment results in all the more speedy depletion of the soil, for guano, by virtue mainly of its nitrogen, is a stimulant, and the usual results of stimulants follow its use. What is known to agricultural chemists as the law of the minimum should be borne in mind. Briefly stated, it is this: The growth and development of plant material is regulated by the amount of that particular form of plant food which is present in smallest proportion. If one particular substance required by the plant is deficient in the soil, no excess, however great, of other varieties of plant food will cover the deficiency. The soil may contain abundance of nitrogen, lime, and potash, for instance, but if phosphates are absent, or present only in small amount, no crop can reach perfection; for one reason, because the quantities of the former taken up are proportionate to the quantity of the latter available; hence, if only *one* of the plant-food constituents is deficient, the crop suffers as much as if *all* were wanting.

Now to supply stimulating manures in such cases is worse than useless, as the reaction is sure to follow. Under the influence of the stimulant the plant makes, as it were, a special effort to get sufficient phosphates as an adjustment to the other nutritive constituents, and the result is a more rapid impoverishment than would otherwise have been the case, inevitably bringing on a collapse from which no amount of stimulants will be able to rouse the land again.

Moreover, the lack of one constituent is sometimes not only the indirect, but the immediate cause of others being deficient. Research has shown that nitrifying bacteria need phosphates for their development: hence lack of phosphates goes hand in hand with retarded nitrification. This latter process, besides, cannot go on except in a soil sufficiently alkaline, and it is therefore also retarded by a defective lime supply, for the lime neutralises acidity in the soil and renders it ready for the reception of the nitric acid formed in the process of nitrification. Thus we see that the supply of nitrogen is also dependent upon the presence of a sufficiency of lime and phosphates in the soil.

From a utilitarian point of view one cannot help regarding it as in the highest degree unfortunate that we should spend millions upon millions in fouling our rivers and other sources of water supply and in casting into the sea what nature meant to be restored to the earth whence it came. Every sewer we construct is in a sense an additional step towards the impoverishment of the land, and all the refuse we cast away instead of employing, tends further in that direction. The recent discoveries regarding the functions of bacteria with respect to the assimilation of nitrogen in the soil help to convince us that the soil is the laboratory where garbage is refined and rendered fit for use, and in our war with nature we are only fighting our own interests by depriving the soil slowly but surely of what is indispensable to it.

With regard to rust and similar diseases in cereal crops it must be remembered that a well-nourished and cared-for child is, other things being equal, better able to resist the attacks of disease than one living in a vitiated atmosphere, badly fed, and poorly clad. The statistics regarding tuberculosis, for instance, tell an unmistakable tale in this respect. As with human, so with plant life: when a soil becomes exhausted, and the crops are no longer able to draw from it adequate supplies of plant food, they fall an easy prey to the diseases which they resisted successfully while the soil was in better condition. We hear of grain districts where the ravages of rust become more calamitous and more widespread every year. The first, or one of the first, of the warnings given by the hungry land of its approaching exhaustion should not be despised, and the important matter for consideration is not to give the soil some fertiliser, no matter what, at haphazard, but to adjust the manure to the needs of the soil.

NOTES ON THE OCCURRENCE OF ALPINE TYPES IN THE VEGETATION OF THE HIGHER PEAKS OF THE SOUTH-WESTERN REGION OF THE CAPE.

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(Read April 27, 1899.)

(Plates XXII., XXIII., XXIV.)

In ascending the higher mountains of a country one notices a more or less gradual change in the vegetation, according to the different altitudes. Although the mountaineer may have no knowledge of botany, he recognises the great difference in the general habit of growth of the plants of the higher and lower regions.

Long-continued observation and cultivation of plants on high mountains and in the plains have shown that the characteristics of Alpine vegetation are principally due to the Alpine climate, and not to the peculiarities of the soil. As far as the climate is concerned, it is often thought that the principal factor in shaping the plants is the cold and frost, owing to which the plants are not able to reach greater dimensions. It is thought that the vegetation of high mountains, particularly of those above the snow line, is subject to similar conditions as that of the Arctic regions, and that consequently these two vegetations should be more or less identical.

But that is not so, and although in some respects such similarity exists, we find a great difference in others. Common to both climates are the low temperature and the excess of light, but in both respects there is a great difference of actual conditions. While the Arctic plants, even in summer, are exposed to an only moderate heat, those of the Alpine regions have to resist extreme heat and cold in rapid succession, owing to the powerful insolation and radiation in the rarefied air of the higher elevations.

More pronounced even is the difference in the amount of illumination which they receive, for while in the former case the light is weak but continuous, it acts only periodically but with great intensity in the latter, and while the risk due to the want of water is caused in the Alpine regions by the occasional extreme dryness of the air, this occurs in the Arctic zone through the coldness and the freezing of the soil.* It is consequently not surprising that comparatively few species only are common to the Arctic and Alpine regions, and that there is a great difference in the vegetation of both, not only as far as the species of plants are concerned, but specially also with regard to their general habit of growth and their external as well as internal structure.

If we examine the vegetation of Alpine regions we find that it is characterised by the absence of trees, tall shrubs, and high herbaceous plants. On the other hand, new forms and modes of growth appear or become more numerous. Many plants produce no central stem but a large number of very short stems, packed so closely together that they form an almost solid cushion—a mode of growth well known among mosses—while others develop only a rosette of leaves close to the ground; almost all possessing a very large system of roots. There are other special features in their appearance. Their leaves are mostly hairy or leathery, which peculiarities are not protections against the cold but against the heat; that is to say, they protect the plants against the loss of too much water during the hours or days when the surrounding air is hot and dry.

We here at the Cape are, of course, familiar with many plants which secure their existence during the dry and almost rainless summer in a similar way; the silver-tree, the everlastings, and many other plants being protected by a coat of fur, while the Proteas illustrate the leathery foliage. These and many other peculiarities of structure in our vegetation are principally due to the necessity of regulating the transpiration of the leaves; they are characteristic of xerophilous plants. Consequently, while in Northern and Central Europe the xerophilous characters form the principal distinction between the vegetation of the lower and higher regions, we cannot expect this to be the case here, for protection against excessive transpiration is wanted in the valleys as well as on the mountain-tops. In fact, the climate of the higher mountains is moister than that of the plains. This is due partly to the snow which remains on some of the higher peaks for months, and appears on the Hex River range even as late as Christmas. Much more important in this respect are, however, the clouds which cover the mountains during the south-east winds, for then considerable quantities of moisture are deposited, which gradually soaks into the ground and the fissures of the rocks, thus often feeding springs quite close to the top of a mountain.

This greater amount of moisture causes the existence of a much

* *Schimper*, Pflanzen-Geographie auf Physiologischer Grundlage, Jena, 1898.

more considerable vegetation. Every ledge, every corner, every crack is filled with it, and often one finds on the very top of the mountains thickets of shrublets covered with flowers, wherever there is a place sheltered by the boulders against the wind. Yet every one of the plants, with the exception of those which grow under rocks or in caves or in other sheltered places, shows unmistakably its xerophilous nature. Leathery leaves and coatings of felt and hairs are as numerous here as in the valley, for the insolation of the sun is intense and the rarefied air favours evaporation. [See Plate XXII.]

If one ascends one of the higher mountains, *e.g.*, the Great Winterhoek near Tulbagh, one passes the last arborescent shrubs at an elevation of about 4,000 feet, where in ravines and sheltered corners *Cunonia capensis*, *Olea verrucosa*, *Mimetes cucullata*, and a few others manage to find sufficient moisture even in summer. Higher up only low shrubs of heath, composites, Bruniaceæ, Rutaceæ, Thymelæaceæ, &c., cover the slopes, becoming smaller and more compact the further one ascends. [See Plate XXII.] There is, however, no perceptible change in the general appearance of the vegetation until one reaches an altitude of about 6,000 feet. Then only forms appear which remind one of the peculiarities of Alpine vegetation, and the higher one rises the more numerous become these types.

There are not many mountains in the South-Western part of the Colony which exceed that height, and about some of them, *e.g.*, the summits of the Zwartebergen range, nothing is known botanically. The Hex River range, which culminates in the Matroosberg, 7,430 feet, possesses several peaks which are between 6,000 and 7,000 feet above sea-level, but, with the exception of the Matroosberg itself, they have not as yet been explored. Besides these, there are only the Mostert's Hoek, 6,670 feet; the Du Toit's Peak, 6,580 feet; and the Great and Little Winterhoeks, near Tulbagh, 6, 840 and 6,400 feet respectively, which exceed a height of 6,000 feet.

It was on these five mountains that I gathered, above that level, the 72 plants mentioned in the following list. They do not, however, represent the whole flora, for I have visited some of these mountains only once, and others, *e.g.*, the Great Winterhoek, always at the same season, viz., in midsummer.

Anemone capensis L. var.

Heliophila nubigena Schlechter. Leaves hairy.

Drosera pauciflora Banks, var. *acaulis*. A very dwarf form, but the flower as large as a leaf.

Cerastium capense Sond.

Oscalis spec. ? Leathery leaves.

Pelargonium spec. non-descr. In fissures of rock with a thick woody root and small entire leaves, close together and tightly pressed against the rock.

Diosma teretifolia Link. The branches of this shrublet are spread out over rocks.

Barosma latifolia R. and I.

B. Marlothii Schlechter. Both species form small shrubs with a mass of upright branchlets. Between small boulders of stony slopes.

Agathosma alpina Schlechter. Similar in habit to the preceding species, but smaller.

Phylica chionophila Schlechter. Small compact shrub.

Aspalathus nivalis Schlechter. A miniature shrub with thick branches lying flat on the ground, somewhat like *Salix herbacea*. Plate XXIV., fig. 2.

Aspalathus ? spec. ?

Cyclopia Bowieana Harv. Leathery leaves.

Cœlidium humile Schlechter. Leaves very small, silvery white. Plate XXIV., fig. 1.

Amphithalea spec. ?

Cliffortia Dregeana Presl. Very hairy.

,, *juniperina* L. Hairy.

,, *pungens* Presl. Very hairy.

,, spec. ?

Crassula papillosa Schönland. Under rocks.

Crassula spec. ?

Tittmannia laxa Sond. Tiny shrublets.

Berardia velutina Schlechter. Velvety.

Mesembryanthemum spec. ?

Psammatropha quadrangularis Fenzl. Forms cushions up to six inches in diameter. Plate XXIV., fig. 3.

P. frigida Schlechter. Plate XXIII., fig. 2.

Hydrocotyle Centella Ch. & Schl. var. *coriacea* Harv. Similar to normal form but smaller.

Sarcocephalus ciliatus Schlechter.

Bryomorphe Zeyheri Harv. Leaves hairy, white.

Cineraria tomentosa Less. Leaves hairy, white.

Cenia spec. ? Hairy.

Felicia bellidioides Schlechter. Leaves villous. Plate XXIII., fig. 1

Gazania pinnata L. var. Very hairy.

Helipterum canescens DC. Covered with white felt.

Helichrysum spec. duæ. White felt.

Leontonyx spathulata L. var. White felt.
Relhania spec.? Hairy.
Senecio Marlothii Schlechter. White felt.
Stoebe spec.? White felt.
Ursinia macropoda N. E. Br. Hairy.
Prismatocarpus subulatus DC. var. *alpina.* Branchlets numerous, closely matted into each other.
Roella spec.?
Erica cristæflora Salisb.
,, *Junonia* Bolus.
,, *lutea* var. *rosea.*
,, *nubigena* Bolus.
,, *oresigena* Bolus. Leaves whitish.
,, *Sebana.* Short compact shrublets.
,, *tumida.* Straggling over stones and boulders.
,, species duæ ignotæ.
Nyctaginia ovata. In the shelter of rocks.
Zalusianskia dentata Bth. var. Similar spots.
Phyllopodium glutinosum Schlechter.
Selago spuria L.
Lachnæa buxifolia Lam.
,, *diosmoides* Meissn.
,, *eriocephala* L. var. *purpurea.*
,, *Marlothii* Schlechter.
Protea saxicola R. Br. A dwarf decumbent shrub, its branches spreading over stones or pressed against rocks.
P. scolopendrium R. Br. var. No stems, but many very short branches, the large flower-head almost flush with the ground.
Thesium microcephalum Schlechter. Depressed shrublet.
Nanolirion capense Hook. On the Little Winterhoek, Great Winterhoek, and Matroosberg. The specimens from the latter locality are much larger than those from the Little Winterhoek, upon which the genus was established.
Dipidax ciliata Bkr.
Gladiolus oreocharis Schlechter.
Romulea rosea Ecklon, var.
Ixia flexuosa L. var.
Aristea capitata Ker.
Restiaceæ form the bulk of the vegetation, growing socially in tufts or large patches. [See Plate XXII.]
Several Graminaceæ and Cyperaceæ.

These plants represent the following orders and genera

Ranunculaceæ 1; *Cruciferæ* 1; *Drosera* 1; *Caryophyllaceæ* 1; *Oxalis* 1; *Pelargonium* 1; *Rutaceæ* 4; *Phylica* 1; *Papilionaceæ* 6; *Cliffortia* 4; *Crassula* 2; *Bruniaceæ* 2; *Ficoideæ* 3; *Umbelliferæ* 1; *Rubiaceæ* 1; *Compositæ* 13; *Campanulaceæ* 2; *Erica* 9; *Scrofulariaceæ* 3; *Selago* 1; *Thymelæaceæ* 4; *Protea* 2; *Thesium* 1; *Liliaceæ* 2; *Iridaceæ* 4; *Restiaceæ* ?; *Graminaceæ* ?; *Cyperaceæ* ?.

From this list, although necessarily very incomplete as yet, it is evident that the general systematic composition of the flora is practically the same as that of the lower slopes and valleys. It includes a few species known from the plains below, a number of others known from the foot of the mountains, and some, *e.g.*, *Erica Sebana*, *Bryomorphe Zeyheri*, and *Anemone capensis*, which are also met with at or below the altitude of Table Mountain, 3,549 feet.

On the other hand, I must point out that in several cases the specimens from the high regions represent a distinct variety, which some botanists would probably distinguish as new species. A striking example of this kind is *Anemone capensis*. While in the ravines and on the slopes of the eastern side of Table Mountain this plant possesses mostly solitary stems one or two feet high, the variety on the Matroosberg * produces a large number of stemless shoots, growing in such close proximity to each other that the finely divided leaves form a flat cushion, a foot or more in diameter. From this compact mass of leaves rise the numerous peduncles 6 to 8 inches high, bearing flowers as large as those of the tall plants of Table Mountain, but much more hairy and more intensely coloured than those, being bright rose inside as well as outside. This Alpine form is a beautiful example of the influence of the intense light, of the furious winds, the occasional extreme dryness of the atmosphere, and, I think, of the merely mechanical pressure of the snow which falls at these altitudes sometimes as late as December. It was a most interesting sight to find one day in October hundreds of anemones projecting through a firm layer of freshly fallen snow on a slope of the Sneeuwkop, just as one can see the tiny *Soldanella* fringe the snowfields of the Alps.

Other plants of typical cushion-like growth are *Psammatropha quadrangularis* [Plate XXIV., fig. 3], which resembles in its growth a fair-sized patch of *Polytrichum commune* and *Bryomorphe Zeyheri*, of which the name indicates this habit, but which plant is also found at somewhat lower levels. *Prismatocarpus subulatus*, *Crassula papil-*

* This is not merely the form mentioned in the "Flora Capensis," vol. i., p. 3, as var. *tenuifolia*, for it differs from the type not only in its leaves but also in the flowers.

losa, and *Leontonyx spathulata* form similar pads, and *Pelargonium* [spec. non-descr.] bears shortly petiolate leaves of the size of a six-pence, on a woody root of the thickness of a finger hidden in the cracks of the rock, against whose surface the leaves are closely pressed, while *Psammatropha frigida* is just like some Alpine species of *Saxifraga* or *Androsace*, *e.g.*, *S. bryoides*. [Plate XXIII., fig. 2.]

The stunted but extremely social growth of Rhododendron in its smallest forms is well represented by *Cœlidium humile*, and two species of *Barosma*, and the thick, woody rooted, but stemless habit, by *Protea Scolopendrium*, while the decumbent shrublets, *Protea saxicola*, *Erica tumida*, and *Diosma teretifolia*, spread over rocks and boulders somewhat after the style of *Juniperus nana*. Even the typical form of growth of *Salix herbacea* is not wanting, for *Aspalathus nivalis* possesses horizontal stems a quarter of an inch in diameter, lying flat on the ground, while its numerous erect branchlets with leaves and flowers are hardly an eighth of an inch high. [Plate XXIV., fig. 2.] Plants with rosettes of leaves abound also at lower levels, but *Senecio Marlothii* and *Felicia bellidioides* exhibit this peculiarity in a most marked degree. [Plate XXIII., fig. 1.]

One general feature, however, is specially noteworthy, viz., that all the plants with permanent foliage are thickly coated with hairs, or are provided with leathery leaves and a thick epidermis. All the composites (14) are not only hairy, but more or less covered with white felt, showing that the plants of these altitudes are even more xerophilous than their nearest allies of the lower regions.

On the other hand, as the vegetation of these lower regions is also typically xerophilous, and as a few summits only of our mountains reach the altitude of permanent winter snow, it is evident that the conditions for an entirely Alpine flora, well distinguished from that of the valleys, are not present.

One point, however, must be borne in mind, and that is the incompleteness of the knowledge of this flora at our disposal. This is well illustrated by the fact that among the 72 species enumerated above there are 16 species described only recently, 14 of which were gathered by me in a single day. There is no doubt that a good many more species are awaiting discovery, and that a number of truly Alpine forms will be found among them.

PLATES XXII.-XXIV.

Plate XXII.

Part of the Hex River range, the photograph being taken in May, 1899, at an altitude of 4,500 ft. The vegetation consists of Restiaceæ, with shrublets of *Protea* and *Leucadendron.* The rock is Table Mountain sandstone.

Plate XXIII.

Fig. 1.—*Felicia bellidioides*, Schlechter.

The leaves are covered with white felt. This species occurs from 6,000 ft. upwards. The specimen figured was gathered near the summit.

Fig. 2.—*Psammatropha frigida*, Schlechter.

A very small plant, the specimen represented being the largest one found.

Plate XXIV.

Fig. 1.—*Cœlidium humile*, Schlechter.

The shrublet of which the figure represents about one-tenth was only six inches high.

Fig. 2.—*Aspalathus nivalis*, Schlechter.

This shrublet spreads on the surface of the ground. When not in flower it would look somewhat like a cushion of moss.

Fig. 3.—*Psammatropha quadrangularis*, Fenzl.

This plant forms thick cushions similar in structure to those of *Polytrichum commune.* The figure represents about a twentieth part of such a cushion.

Photograph by I. Meiring. West, Newman phototyp.

R. MARLOTH: ALPINE TYPES IN CAPE VEGETATION.

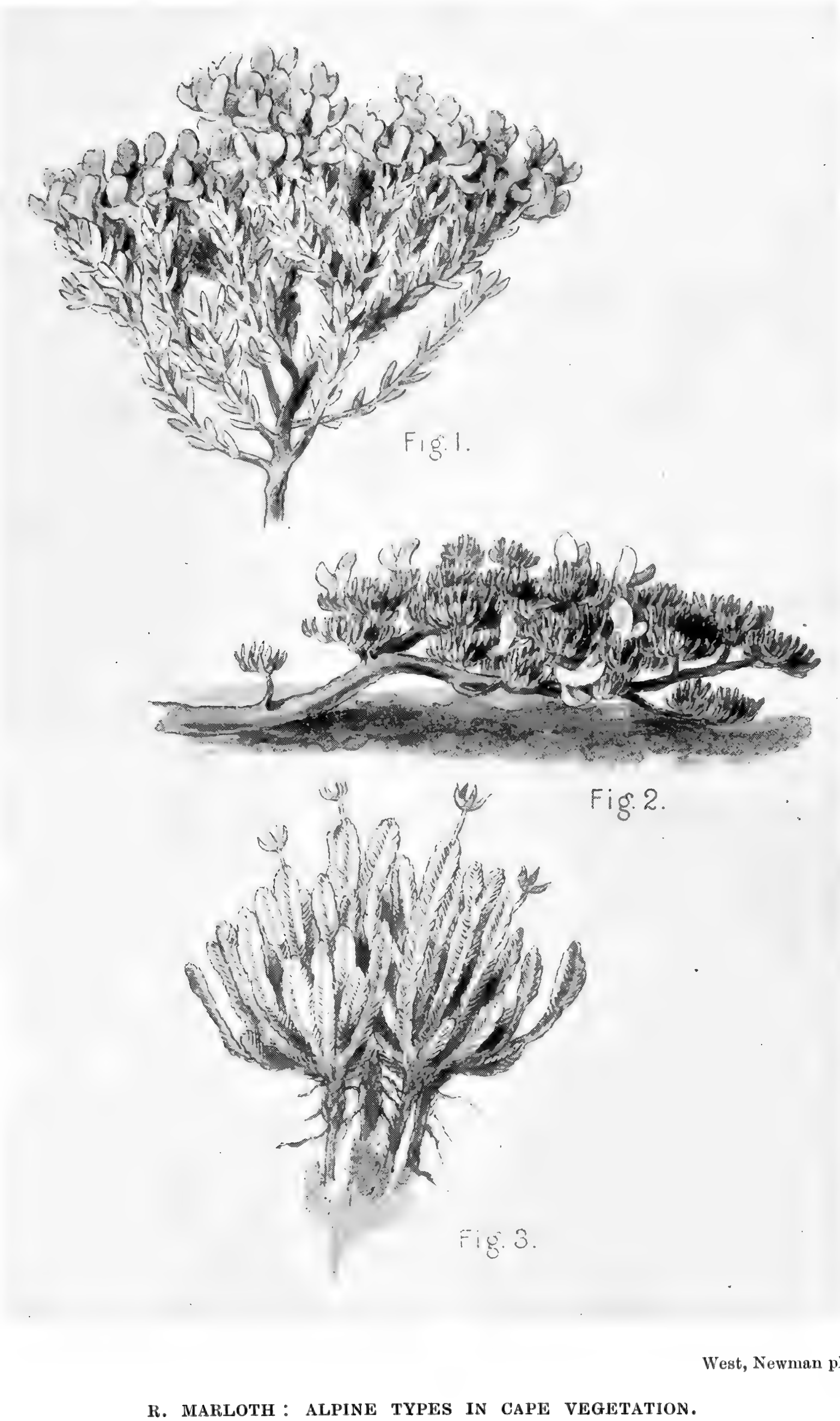
Fig. 1.

Fig. 2.

West, Newman phototyp.

R. MARLOTH: ALPINE TYPES IN CAPE VEGETATION.

1. *Felicia bellidioides*, Schlechter; nat. size.
2. *Psammatropha frigida*, Schlechter; nat. size.



West, Newman phototyp.

R. MARLOTH : ALPINE TYPES IN CAPE VEGETATION.

1. *Cœlidium humile*, Schlechter; nat. size.
2. *Aspalathus nivalis*, Schlechter; nat. size.
3. *Psammatropha quadrangularis*, Fenzl.; nat. size.

ON THE STRUCTURE OF THE PALATE IN *DICYNODON*, AND ITS ALLIES.

By R. Broom, M.D., B.Sc.

(Read August 29, 1900.)

(Plate XXV.)

Though various accounts have been given of the structure of the palate in Dicynodon and its allies, it must be admitted that as regards many details of structure very little is known, and even where there is general agreement as to the structures there is much discrepancy in the interpretation of the elements.

Owen,* in his "Reptiles of South Africa" and other papers, has shown the general arrangement of the bones in the roof of the mouth; but as regards the limits of the different bones he does not supply very definite information.

Huxley † made sections across the anterior part of an imperfect skull of Ptychosiagum Murrayi, and thereby revealed the presence of an extensive though delicate median osseous septum, which he regarded as an ethmo-vomerine septum. He gives fairly good figures of his sections, but his interpretation of the structure of the septum is altogether erroneous.

Lydekker, ‡ in the British Museum "Catalogue of Fossil Reptiles," gives a figure of the palate of Dicynodon with a determination of the elements.

The fullest account, however, of the Anomodont § palate is that given by Seeley || in 1889. He gives a figure of the palate of Dicynodon, and a description of the bones. Though Seeley's de-

* R. Owen, "Cat. Foss. Rept. South Africa," 1876.

† T. H. Huxley, Quart. Journ. Geol. Soc., vol. xv., p. 654, and plate xxii., figs. 3–6.

‡ R. Lydekker, "Cat. Foss. Rept. and Amphib. Brit. Mus.," part iv., 1890, p. 18.

§ The term Anomodontia or Anomodont used throughout the paper is employed as by Cope, Baur, and Zittel to denote the order or sub-order of which Dicynodon is the type, and not as it is employed by Lydekker and Seeley for the large sub-class of Reptiles with mammalian affinities.

|| H. G. Seeley, "On the Anomodont Reptilia and their Allies," Phil. Trans., 1889.

scription is fuller and more accurate than that of the earlier authors, we are still left in a state of much uncertainty on a number of points on which it is of great importance for the morphologist to have light.

While engaged in the study of the comparative anatomy of Jacobson's Organ I was led to the conclusion that the lacertilian so called "vomer" is not the homologue of the mammalian vomer, but of the "dumb-bell-shaped bone" in Ornithorhynchus and of the palatine process of the premaxillary in the higher mammals. For this element which is usually anchylosed with the premaxillary as its palatine process, but which remains distinct throughout life in Ornithorhynchus, and in the little cave bat, *Miniopterus schreibersii*, I proposed the name of Prevomer.* To find further evidence in support of my position I naturally turned to the Theromorous reptiles as showing affinities with both the lizards and mammals. The examination of the beautiful skulls of Gomphognathus discovered by Seeley revealed that not only is there a well-developed true vomer, but that anteriorly are a pair of prevomers, situated exactly as are the palatine processes in the higher mammals but apparently quite distinct from the premaxillary.†

In the Anomodont skull the great development of the premaxillary renders the examination of the vomerine region difficult, and I found it impossible to get very satisfactory results from the British Museum specimens, though it soon became quite manifest that the median ridge on the posterior part of the hard palate which has been regarded by all previous writers, so far as I am aware, as the vomer, could not be the true vomer which undoubtedly is situated in the angle between the two anterior branches of the pterygoids.

Since returning to South Africa I have come across a number of specimens, the examination of which has enabled me to settle definitely almost all the details of the anatomy of the palate.

In Dicynodon and its near ally Oudenodon there is a well-developed bony roof to at least the anterior half of the mouth. On the anterior part of this bony roof or hard palate are two parallel longitudinal ridges, and in the posterior part is a well-developed median ridge. The structure of this hard palate has been a matter of some difference of opinion, as in the majority of the British Museum specimens the sutures are very indistinct. But while opinions have varied as to the extent of the premaxillary and maxillary elements, there has been a general agreement in regarding the median ridge as the vomer.

* R. Broom, "On the Homology of the Palatine Process of the Mammalian Premaxillary," Proc. Linn. Soc. N.S.W., 1895, p. 555.

† R. Broom, "On the Occurrence of an apparently distinct Prevomer in Gomphognathus," Journ. Anat. and Phys., vol. xxxi., p. 277.

The examination of a beautifully weathered palate in the Port Elizabeth Museum, which I have elsewhere described as the type of *Oudenodon truncatus*,* shows that almost the whole of the palatal surface of the hard palate is formed by the premaxillary, and a transverse fracture through the median ridge reveals that the ridge is, if not morphologically a part of the premaxillary, at least an element completely anchylosed to the premaxillary. Figure 3, Pl. XXV., represents semi-diagrammatically a transverse section through the median ridge of Oudenodon. It is here seen that though the maxillary has large palatal plates they are to a great extent overlapped by the premaxillary plates. Above the palate is seen the median internasal plate of the premaxillary. This median plate extends from the anterior part of premaxillary backwards as far as the palatal portion, and is closely articulated posteriorly with the large median plate of the true vomer. In Dicynodon the structure of the premaxillary, so far as I have been able to observe, is quite similar.

In Ptychosiagum † the general arrangement of parts is similar to that in the more normal genera, though the proportions differ somewhat. Figure 1 represents the palate of Ptychosiagum. Here as in Dicynodon and Oudenodon the palatal plates of the premaxillary overlap the plates of the maxillary and form the larger portion of the bony palate. The median ridge is much more conspicuous than in the less specialised genera, projecting very considerably from the rest of the palate. It passes backwards a short distance beyond the limit of the lateral palatal plates and articulates with the anterior end of the vomer by an interdigitating suture. Only a small portion of the maxillary shows on the palate between the premaxillary and the anterior part of the palatine. It forms a distinct though imperfect secondary palate, its inner edge not quite meeting the median ridge. Immediately behind the median ridge is seen the well-developed vomer.

Figure 2, Pl. XXV., represents a median section of the snout of Ptychosiagum, and shows very clearly the structure of the internasal septum. The internasal ridge of the premaxillary is very greatly developed, its depth being about equal to the antero-posterior measurement of the premaxillary. Immediately behind the large

* R. Broom, "On Two New Species of Dicynodonts," Ann. South African Museum, vol. i., pt. 3, p. 455.

† As Owen's name *Ptychognathus* is preoccupied by Stimpson, 1858, for a Crustacean genus, I have adopted provisionally Lydekker's name *Ptychosiagum*, 1889. Cope had, however, described a species of this same genus in 1870 under the name of *Lystrosaurus frontosus*, and if Cope's name is not preoccupied it will take the place of Owen's name. When writing in the bush away from libraries it is impossible to decide on questions of nomenclature.

vertical plate of the premaxillary is situated the vomer, as an irregular triangular plate. It articulates with the premaxillary plate inferiorly by an interdigitating suture; but superiorly, the vomer divides into two delicate plates between which the premaxillary plate passes. Posteriorly the vomer articulates with the prespheroid clasping its anterior and inferior border. At its posterior and inferior angle the vomer divides to two small branches which pass outwards and backwards to meet the pterygoids. Above these branches the vomer for a short distance is quite separated from the prespheroid by an oval space.

Though both the premaxillary and the vomer form such large median plates, the plates are for the most part exceedingly thin, as is well shown by Huxley's sections. In figure 2 the letters AA, BB, and CC indicate approximately the positions of Huxley's three sections. His front section, AA, lies slightly above the palatal plate of the premaxillary, and shows the internasal plate of the premaxillary to be moderately thick in its anterior region. His next section, BB, passes through the palatine bone in its anterior and greatly developed region. The median plate is here formed of the premaxillary above and the vomer below, the premaxillary fitting into a deep cleft in the vomer. In the posterior of Huxley's sections the median plate is almost entirely formed by the vomer, only a very small portion of the premaxillary plate presenting above fitted into the cleft of the vomer. At its lower end the vomerine plate is seen to be cleft. Outside of the vomer the palatine and pterygoid are seen cut across—the lower being the pterygoid.

On each side of the vomer near its posterior border is developed a small lateral wing which articulates with the palatine and forms with it the posterior walls of the nasal passage. In figure 2 a dotted line indicates the position of the lateral wings.

The posterior part of the vomer is exceedingly well shown in more than one of the British Museum specimens, more especially in the imperfect skull which formed the type of Owen's *Ptychognathus boopis* (Spec. No. 36253) and in the skull which formed the type of *Cistecephalus chelydroides* (Spec. No. 47068), and it seems remarkable that there should have been any doubt as to its being the true vomer, more especially as in some mammals the posterior part of the vomer presents a strikingly similar appearance. Seeley,* in describing the skull of *Dicynodon copei* [= according to Lydekker, *Ptychosiagum Murrayi*, Huxley], suggests the possibility of this element being the vomer. He says: "In the constricted middle

* H. G. Seeley, "On Anomodont Reptilia and their Allies," Phil. Trans., 1889, p. 241.

plate of the pterygoid is a long median vacuity, lanceolate behind, and tapering in front to a slender point. It is defined laterally by very slender plates, which converge inward and forward to form a single median plate, reaching forward to the maxillary region : and this plate may probably be identified as the vomer." In the same paper, however, he describes the almost identically similar structure in Dicynodon (pardiceps ?) as part of the pterygoid, and figures the median ridge of the premaxillary as the vomer.

The palatines in Ptychosiagum are fairly well-developed bones which form to a large extent the posterior and outer walls of the nasal passages. Posteriorly each palatine articulates with the lateral wing of the vomer, and along its inferior third it meets on its outer side the anterior spur of the pterygoid. From its articulation with the vomer the palatine is developed both in a lateral direction and anteriorly. The lateral wing passes outwards and upwards to meet the jugal. The anterior development passes slightly outwards, and then forwards, meeting and resting on the inner side of the maxillary and of the pterygoid. In this region the maxillary sends a short plate backwards, which in part lies on the palatine, but is mainly separated from it by the anterior spur of the pterygoid. Inside of the pterygoid spur and the maxillary the palatine is well developed anteriorly, and forms an imperfect secondary palate, articulating with the palatine plate of the maxillary. It does not, however, meet the vomer or the median ridge of the premaxillary.

The pterygoid requires but little description; the posterior spur to the quadrate and the anterior development to the maxillary having been correctly described by Seeley. Though the median structure in front of the pterygoids is the vomer there are two small delicate plates which rise from the pterygoids and lie on the inner sides of the posterior branches of the vomer, forming in part the walls of the median vacuity. The bone with which the united pterygoids are articulated is evidently the basisphenoid, but the anterior continuation of the bone is possibly the presphenoid. I have been unable to detect a suture between the parts, but in Dicynodon there is a peculiarity in the arrangement of the fibres that suggests the probability of the two elements being present anchylosed together.

In Dicynodon and Oudenodon the structure of the palatines and pterygoids is very similar to that described in Ptychosiagum, the main differences being due to the fact that in Ptychosiagum, as in the Cetaceans, the nasal passages lie almost vertically, while in the less specialised types the passages pass as in land mammals in an antero-posterior direction.

In Cistecephalus the anterior part of the palate is unknown, but as the pterygoids, the vomer, and at least the posterior part of the palatines are constructed almost exactly as in Ptychosiagum, and as the rest of the skull, so far as known, is thoroughly Dicynodont in type, it is very unlikely that the anterior part of the palate differs appreciably from that in Ptychosiagum.

In Endothiodon, which forms the type of the other family of the Anomodontia, the palate, though closely agreeing with the Dicynodont type, presents a number of peculiarities. The main differences are due to the greater development of the maxillary, which bears a row of teeth, and the corresponding less development of the premaxillary. The premaxillary is, as in Dicynodon, edentulous. Its anterior palatal portion is moderately developed in *Cryptocynodon simus*, but is relatively smaller in *Endothiodon* (*Esoterodon*) *uniseries*. The median ridge of the premaxillary is much more distinct than in Dicynodon, and though in none of the known specimens is there conclusive evidence that it is distinct from the premaxillary, there is certainly a strong suggestion of its being a prevomer. The vomer is very distinctly seen in the three known specimens immediately behind the median ridge—exactly as in Dicynodont type. In Seeley's figure of Cryptocynodon * the division of the vomer from the anterior element is not very distinctly brought out, and from his description it is evident that he did not recognise the two elements as he speaks of the whole ridge, vomerine and premaxillary or prevomerine, as "presumably formed by the vomer." In the original specimen the anterior end of the true vomer is sharply defined from the premaxillary ridge, almost exactly as is the case in *Endothiodon bathystoma* and *E. uniseries*. The palatines are formed on a very similar plan to that of Dicynodon. They articulate with the vomerine wings or lateral ridges, and form the posterior and upper walls of the nasal passages behind. Anteriorly they form an imperfect secondary palate, though a larger one than in Dicynodon. The hinder part of the palate is unknown, but presumably similar to that in Dicynodon.

The Anomodont palate, it will be observed, does not show a marked affinity with that in my Reptilian order, except the Theriodontia and the Chelonia; while as regards the vomer and palatines there is a distinct affinity with the Mammalian type. In almost all the known Reptilian orders the palate is formed essentially on the Rhynchocephalian type. In the Chelonia and the Crocodilia there are specialisations which greatly mask the ancestral type, and this is likewise the case with the Theriodontia and the sub-order Anomodontia.

* H. G. Seeley, "On the Therosuchia," Phil. Trans., vol. 185, B., 1894.

In the Cotylosauria, as exemplified by the American genus Pariotichus, and by the European and South African genera of presumably the same order, Elginia, Pareiasaurus, and Procolophon, the palate is made up of a pair of large, usually tooth-bearing pterygoids, a pair of small palatines and transpalatines, and a pair of large prevomers. The posterior nares lie by the sides of the prevomers, and there is no secondary palate formed.

In the Pelycosauria, as exemplified by the genus Dimetrodon, the general arrangements of the palatal elements is very similar to that in the Cotylosauria, except that the transpalatine is either lost, or, as suggested by Baur and Case,* rudimentary. The posterior nares open by the sides of the prevomers and near the front of the palate.

Between the Pelycosauria and the Theriodontia, of which Galesaurus is the type, the gap is rather a wide one, and though a few possibly intermediate types are known, they are known so imperfectly that they are of comparatively little use in the tracing of the evolution of the palate. Though Ælurosaurus has always been regarded as a Theriodont and a close ally of Galesaurus, the palate, so far as known, is very dissimilar, and resembles considerably that of Dimetrodon. The posterior part of the skull is quite unknown. It may be noted, however, that the jugal or squamosal does not form a descending process, as shown in the figures of Owen, Lydekker, and Seeley, a calcareous incrustation having apparently been taken for bone. In the Theriodontia, as exemplified by Galesaurus and Gomphognathus, the posterior nares are carried far back by the formation of a secondary palate. In the Anomodontia we find the secondary palate in a rudimentary condition, the bony plates of the maxillaries and palatines not meeting but still forming a firm support for the soft, fibrous palate. It seems highly probable that true Theriodonts will be discovered with the palate in the same rudimentary condition as is found in the Anomodonts.

With the formation of a secondary palate a number of important changes have taken place. The element so important as a basal support of the skull in Labyrinthodonts and other Amphibians—the so-called "*parasphenoid*"—becomes in the large majority of Reptiles quite rudimentary. With the formation of a secondary palate, however, a new function is given to it, and it becomes developed as a median support for the palate. This median support is handed on through the Theriodontia to the Mammalia, and forms the mammalian Vomer. The large prevomers of the Cotylosauria and the Pelycosauria being, with the formation of a secondary palate, no

* G. Baur and E. C. Case, "On the Morphology of the Skull of the Pelycosauria, &c.," Anat. Anz., 1897, vol. xiii., p. 109.

longer required as supports for the palatal roof, become much reduced, and are retained only as supports for the cartilage of Jacobson's Organ.

The stages by which the Theriodont secondary palate has been formed from a simple palate of the Dimetrodon type are apparently analogous to the steps by which the Crocodilian palate has been evolved from the simple palate of its Phytosaurus-like ancestor.

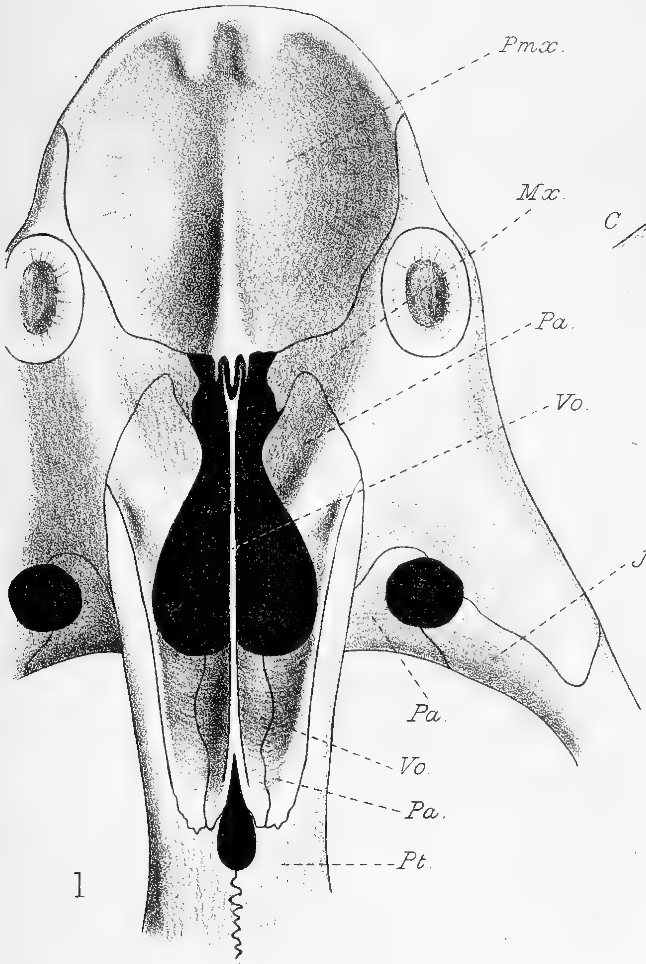
The Anomodont palate is probably a specialised modification of the primitive Theriodont type, where the Theriodont character is somewhat obscured by the great development of the premaxillary. Whether the prevomer is lost or anchylosed with the premaxillary present evidence does not show. Theoretically it seems not improbable that the prevomer is retained anchylosed with the premaxillary, and the condition in Endothiodon would seem to confirm this view. The direct evidence, however, is rather against this view, and it is quite likely that the prevomer is lost, as frequently happens in mammals, *e.g.*, Pteropus, Echidna, &c.

I can find no trace of a transpalatine element in any Anomodont skull, nor of an " infranasal " bone.

PLATE XXV.

AA, BB, CC, approximate planes of Huxley's sections of the snout of Ptychosiagum; Ju, Jugal; Mx, Maxillary; Pa, Palatine; Pmx, Premaxillary; P.S., Presphenoid; Pt, Pterygoid; P.Vo., Prevomer; Vo, Vomer.

FIG. 1. Palate of *Ptychosiagum*.
,, 2. Median section of snout of *Ptychosiagum*.
,, 3. Section across Premaxillary in region of median ridge of *Oudenodon*.
,, 4. Section near posterior part of Vomer in *Oudenodon*.
,, 5. Palate of *Endothiodon* (*Esoterodon*) *uniseries* — partly restored. (Reduced.



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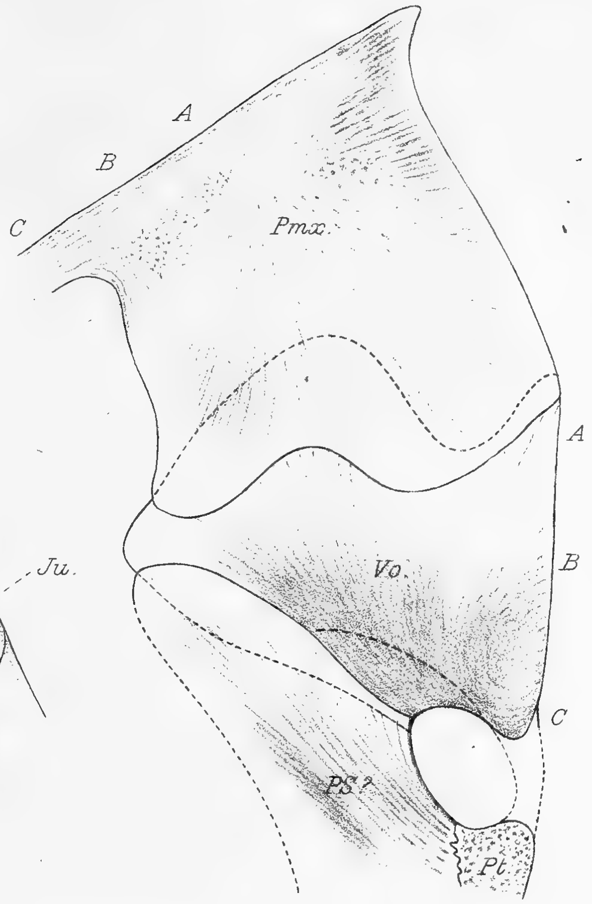

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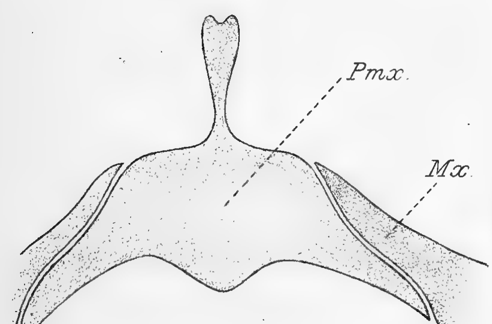

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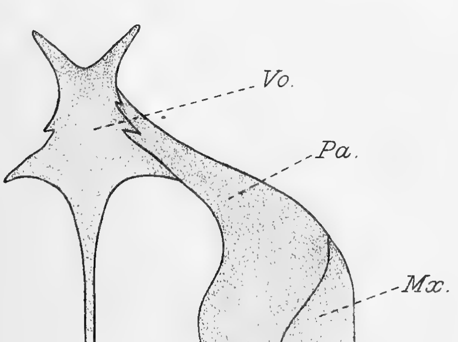

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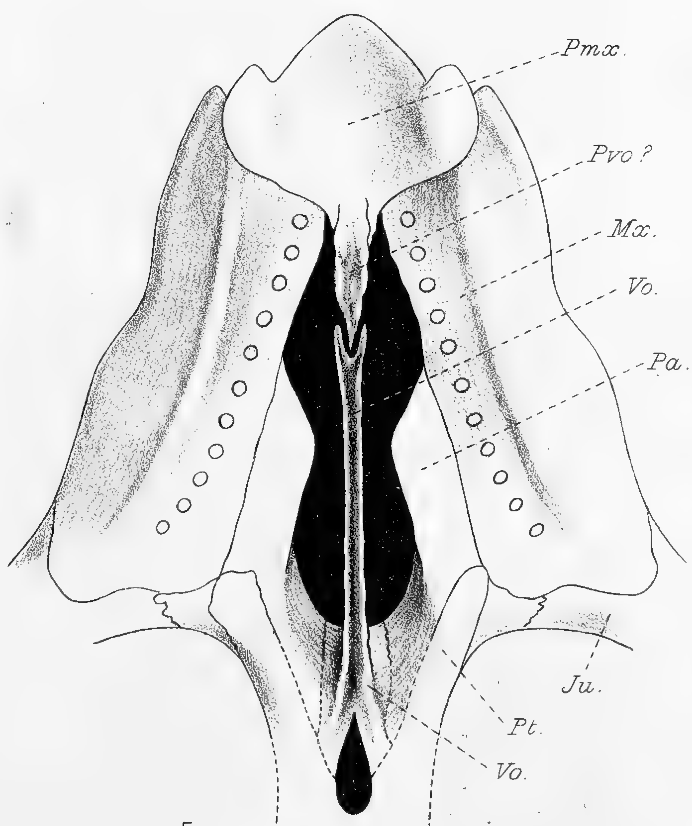

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R. Broom del.	West, Newman lith.

R. BROOM; STRUCTURE OF ANOMODONT PALATE.

ON *ICTIDOSUCHUS PRIMÆVUS.*

By R. Broom, M.D., B.Sc.

(Read October 31, 1900.)

(Plates XXVI., XXVII.)

Some months ago I was fortunate in discovering on the farm of Mr. J. Krüger, in the neighbourhood of Pearston, the remains of a very interesting Theriodont. The coracoid and precoracoid bones were seen exposed on the hard shale which formed the bed of a small creek. On digging into the rock I found within a space of less than a square foot a considerable number of other bones. Unfortunately the bones have been disconnected and confusedly huddled together, so that it has been a matter of considerable difficulty to expose one bone without badly injuring another which lies across it, and the difficulty has been rendered the greater by the hardness of the rock and the brittleness of the bones. Though much of the skeleton is missing, I have succeeded in discovering, besides the bones of the shoulder girdle, not only a humerus, a radius, a femur, a tibia and a fibula, but also a fairly complete lower jaw and the greater part of the skull.

The discovery is interesting, not only in making known a new type of Theriodont skull, but also in having the principal bones of the skeleton found in association with it.

For the new form I have proposed the name *Ictidosuchus primævus*.

Skull.

The skull is very imperfectly preserved, and had manifestly been broken at the time the remains were originally deposited, as the right maxillary region was found quite away from the greater part of the skull and no trace of the snout has been found except a small fragment. Fortunately sufficient of the skull has been found to give not only a good idea of the proportions, but also to show most of the external characters. The left side, with the exception of the snout, is fairly complete, and of the right side there is preserved in apposition the larger portion of the squamosal, and though the whole is slightly distorted it is not difficult to restore it to its original shape.

As is the case in many Theriodonts and most Anomodonts, the skull is large in proportion to the limb bones, but is characterised by the slightness of its build and the slenderness of the arches.

The frontal region is moderately developed and is somewhat concave both antero-posteriorly and transversely. The frontal bones articulate in front with the prefrontals and presumably with the nasals. Behind they articulate with the postfrontals and parietals. Only a comparatively small part of the supraorbital ridge is formed by the frontals.

The postfrontal bone is of a remarkable form. It is shaped much like the letter "L"—the longer limb forming the postorbital arch and the shorter resting on the parietal ridge. The inner half of the postorbital arch is unusually deep, and being markedly concave on the anterior side, forms not only the posterior wall of the orbit, but, as a continuation of the supraorbital ridge, forms to some extent a roof. The outer part of the postorbital arch is very slender. The shorter limb of the postfrontal lies quite at right angles to the larger limb.

The parietal crest is narrow and deep. About midway between the inner end of the postorbital arch and the top of the occiput is a fairly large parietal foramen. The parietals pass for a considerable distance outwards from the hinder part of the crest and meet the squamosals.

The squamosal is a much more slender bone than in the Anomodonts, but is very similar in structure. Articulating above and internally with the parietal, it passes outwards and downwards —no doubt in contact with the supraoccipital and exoccipital—and sends forward a slender bar to meet the jugal and form the temporal arch. The greater part of the bone, however, descends as a bony plate—convex posteriorly—and no doubt gives articulation to the quadrate. The greater part of the squamosal is fairly well preserved on the right side of the skull.

In the anterior region of the skull most of the sutures are unrecognisable. The prefrontal is, however, readily distinguishable from the frontal. It seems to be rather a narrow element, though, as the suture between it and the lachrymal cannot be made out, it is impossible to say whether it or the lachrymal forms the larger part of the facial surface. It forms the anterior part of the supraorbital ridge.

The maxillary bone is well developed, and though it bears some resemblance to the corresponding bone in previously known Theriodonts, it has a number of characters that are quite distinctive. The anterior dentigerous portion has a moderately flat surface and is even slightly concave at its lower border, but is remarkable by having numerous small irregular cuplike depressions, which give the bone a rough appearance at this part. The posterior non-dentigerous part, which is of moderate size, though showing very marked longitudinal striæ, has the surface of the bone smooth and even polished. The teeth comprise one large canine and a row of small simple molars. In the maxillary as preserved there are the remains of eight molars, and one is probably lost. Unfortunately the anterior three teeth are crushed backwards on the others, and of all the crowns are wanting. Fortunately in the detached right maxilla the crowns of three teeth are preserved, and show them to have been simple cones with the sides of the teeth ridged. The molars are all subequal in size. The canine is of relatively large size and directed mainly downwards. The fragment of maxilla which contains the root of the canine, though it cannot be fitted on to the larger portion of the maxilla, is figured in its exact relative position, the cast of the maxilla having fortunately been kept.

The jugal bone is a somewhat slender bone which probably forms the whole of the suborbital arch, and possibly a considerable portion of the temporal arch.

Of the palate it is impossible to speak with any degree of confidence. The little that remains in connection with the maxilla of each side is so crushed and imperfect that but a very unsatisfactory idea can be formed of the original condition. It may be regarded as moderately certain, however, that there is no distinct secondary palate such as is seen in Cynognathus. The maxillary only shows to a very small extent internal to the molar teeth, and joins what is apparently a forward extension of the palatine bone.

The lower jaw is fairly well preserved; almost the whole of the dentary element, with most of the teeth, having been found. It is characterised by the remarkable slenderness of the ramus and by the greatly developed coronoid process. In the large majority of Theriodonts hitherto discovered the lower jaw is a powerful bone with a deep symphysis. Tribolodon, however, agrees with Ictidosuchus in having a slender ramus, though the two genera are probably very dissimilar in most points of structure. In the jaw as preserved there are the remains of seven teeth, for the most part in good condition. They are all situated near the middle of the ramus, and, like the molar teeth above, are subequal in size. From the posterior third of the ramus teeth are undoubtedly absent, and from the anterior fifth they are either absent or lost. Probably there have been some small incisors and a small canine such as is seen in the long slender jaw of *Perameles nasuta,* but no distinct indications of them remain. The jaw has been loosely articulated with its neighbour by a rather long symphysis somewhat similar to that seen in many Marsupials. The coronoid process is remarkably well developed, and is not only of great length, but is unusually thick. It forms an angle with the axis of the ramus of about 120°. The splenial appears to be only a feeble splint closely applied to the dentary. The articular is lost. The anterior of the teeth of the lower jaw are simple sharp conical teeth, very similar to those of the upper jaw, and, like them, ridged. The posterior four teeth are also very simple in structure, but have more rounded apices and are more feebly ridged.

In only a few of the many described Theriodont genera is the skull at all satisfactorily known; and in those the skull differs very considerably from that found in Ictidosuchus. In some of the higher Theriodonts, *e.g.*, Gomphognathus, the frontal bones are excluded from the orbits by the meeting of the prefrontals and postfrontals. In Ictidosuchus, as in Dicynodon and most Anomodonts, the frontals form a part of the supraorbital ridge. In the higher Theriodonts the parietal foramen is absent or rudimentary, though in Galesaurus, and probably the majority of lower Theriodonts, there is, as in Ictidosuchus, a well-developed parietal foramen. In the structure of the squamosal the affinities of Ictidosuchus are apparently more with the Anomodonts than with the majority of the Theriodonts. As regards the structure of the postorbital and temporal arches the condition in Ictidosuchus differs considerably from that in Cynognathus and is essentially similar to that in most Anomodonts. It is probable, however, that in most of the lower Theriodonts the structure of the arches is very similar to that in the Anomodonts. The lower jaw, so far as known, is thoroughly Theriodont in structure.

Shoulder Girdle.

Of the shoulder girdle, the scapula, the coracoid, and the precoracoid of the left side are well preserved, and they present one or two characters in which they differ from those bones in the previously known South African forms. The scapula, though very broad at its base, is for the most part a long slender bone, with its axis so much curved that a tangent to the upper end of the bone would make with a tangent to the lower end an angle of about 100°. In the middle region the scapula is narrow and flattened, with a rounded posterior and a sharp anterior border. As it passes upwards it gradually widens, and becomes at its upper end almost quite flat. The lower end of the scapula is unusually broad, and, with the exception of the low ridge which passes up from the glenoid cavity, almost quite flat. The lower border of this large anterior flat expansion articulates with the precoracoid. The acromion process is quite rudimentary. The glenoid surface of the scapula is of moderate size.

The coracoid is very similar to the coracoid in the Anomodonts, but has a rather larger glenoid cavity, and the posterior part is rather more developed.

The precoracoid differs considerably from that of the Anomodonts. It is a larger element proportionally than in the Dicynodont girdle, being very considerably larger than the coracoid. In its upper and posterior quarter there is a large oval foramen, which is completely formed by the precoracoid.

On the whole the shoulder girdle, so far as known, seems to be of a more primitive type than that of either the Anomodont or the higher Theriodont. In Cynognathus the scapula is much specialised, having a well-developed spine and a distinct acromion which projects outwards considerably from the general surface, and the precoracoid foramen is almost, but probably not altogether, surrounded by the precoracoid bone. In the Dicynodont type there is likewise a well-developed acromion; while the precoracoid foramen is in the upper border of the precoracoid and partly walled by the scapula. In the Russian genus Rhopalodon the scapula is moderately flat, and the acromion rudimentary as in Ictidosuchus, while there is a further agreement in the large development of the precoracoid and in the foramen being entirely in the precoracoid bone.

Humerus.

The humerus is fairly well preserved, though unfortunately the distal extremity is missing. It is rather a slender, elongated bone, and is unlike the humerus of any form hitherto described except the imperfectly known humerus of Theriodesmus. Unfortunately in Theriodesmus the humerus is only known from a mould of the upper and lower ends, and so imperfect are the impressions that Seeley * was originally led to the conclusion that the remains were those of a mammal, though he † afterwards recognised them to belong to a

* H. G. Seeley, "On Parts of the Skeleton of a Mammal from Triassic Rocks, &c.," Phil. Trans., 1888, p. 141.

† H. G. Seeley, "The Reputed Mammals from the Karroo Formation of Cape Colony," Phil. Trans., 1895, p. 1019.

Theriodont. The humerus in Ictidosuchus, like that in Theriodesmus, in its general proportions seems more mammal-like than any other of the known Theriodont humeri. The upper part of the humerus bears some resemblance to that in Gomphognathus, but the radial crest passes less directly outward from the bone than in that genus, and forms a deeper concavity on its inner side. As in Gomphognathus, the radial crest arises rather abruptly near the middle of the bone, and is not continued down as in Cynodraco to strengthen the bridge over the entepicondylar foramen—the bone between the lower end of the radial crest and the upper end of the bridge being almost quite round. The entepicondylar foramen is fairly large, and is much more proximally situated than in Gomphognathus. Though the distal extremity is missing, from what remains it is manifest that there must have been a very small external condyle, though the internal condyle may have been moderately large.

Radius.

The radius is somewhat crushed, and the extremities not very perfect. In its general proportions it agrees fairly well with that in Theriodesmus. It is about 70 mm. in length.

Femur.

The femur is fairly well preserved, and is unlike any femur hitherto found. Unfortunately the head is lost; but though the lower part is somewhat fragmentary, the fragments can all be fitted in true apposition. In the middle region the femur is fairly round and small, but it becomes greatly expanded at each end. The upper end has a large trochanter major, immediately below which on the front of the femur is a large deep oval depression, about as wide as the femur is at its middle, and almost as deep as it is wide. The bottom of this concavity is rounded and smooth. I am not aware of a similar concavity having been found previously in the femur of any Theriodont, but a distinct though much less marked concavity is found in the corresponding part of the femur of Dicynodon; and among mammals a quite distinct depression below the trochanter major occurs in Ornithorhynchus and Echidna. So far as the femur is displayed no trochanter minor is to be seen. Near the junction of the upper $\frac{3}{5}$ with the lower $\frac{2}{5}$ the femur begins to expand out towards the distal end, and as it broadens out it becomes transversely concave. The axis of the lower part is also bent slightly backwards and inwards, so that the lower part of the femur looks slightly outwards. The condyles are apparently situated mainly below the outer part of the expanded lower end, so that the inner side of the concave lower end is really an anteriorly directed ridge, which stands prominently out from the femur.

Tibia and Fibula.

The tibia is fairly well preserved, but only a portion of the fibula remains. The tibia is a moderately long bone of fairly uniform thickness, considerably expanded at its upper end and slightly at its lower. It resembles the tibia in Marsupials in being flattened laterally. Near the union of the middle with lower third the axis of the bone is bent slightly backwards. The fibula near the middle is about half the thickness of the tibia, but at its lower end it becomes considerably expanded.

Vertebræ.

One or two vertebræ have been found, but not in a very satisfactory condition. The bodies of the vertebræ are biconcave, but not very deeply cupped, and the arches remain united with the bodies only by suture. The length of the body is one of the best preserved, and probably a dorsal vertebra is 15 mm.

Undetermined Elements.

Two moderately well-preserved bones I have thought it advisable to figure, though I cannot venture on an opinion as to what they are. The first is a somewhat triangular little bone, from one angle of which passes out a long, delicate, perfectly flat bony process. This process has evidently lain alongside of some element which fitted into a deep groove on the same side of the triangular bone as the process; and the element which has fitted into the groove has been held in position by an overlapping plate of the triangular element.

The other bone is moderately flat, and has passing out on one side also a long bony process, but a slightly twisted one.

As there is no evidence as to the relations of these bones, I think it inadvisable to speculate as to what they may be.

Conclusions.

From the examination of the various remains of Ictidosuchus it will be seen that, though the form is a Theriodont, it differs very considerably from most known Theriodonts, and in a number of points shows affinities with the Anomodonts, and it is not improbable that it may belong to that group of primitive Theriodonts from which Dicynodon and its allies appear to have sprung.

Ictidosuchus is probably allied to Theriodesmus, but the structure of the tibiæ shows the two genera to be quite distinct.

PLATES XXVI. AND XXVII.

ALL THE FIGURES ARE NATURAL SIZE.

PLATE XXVI.

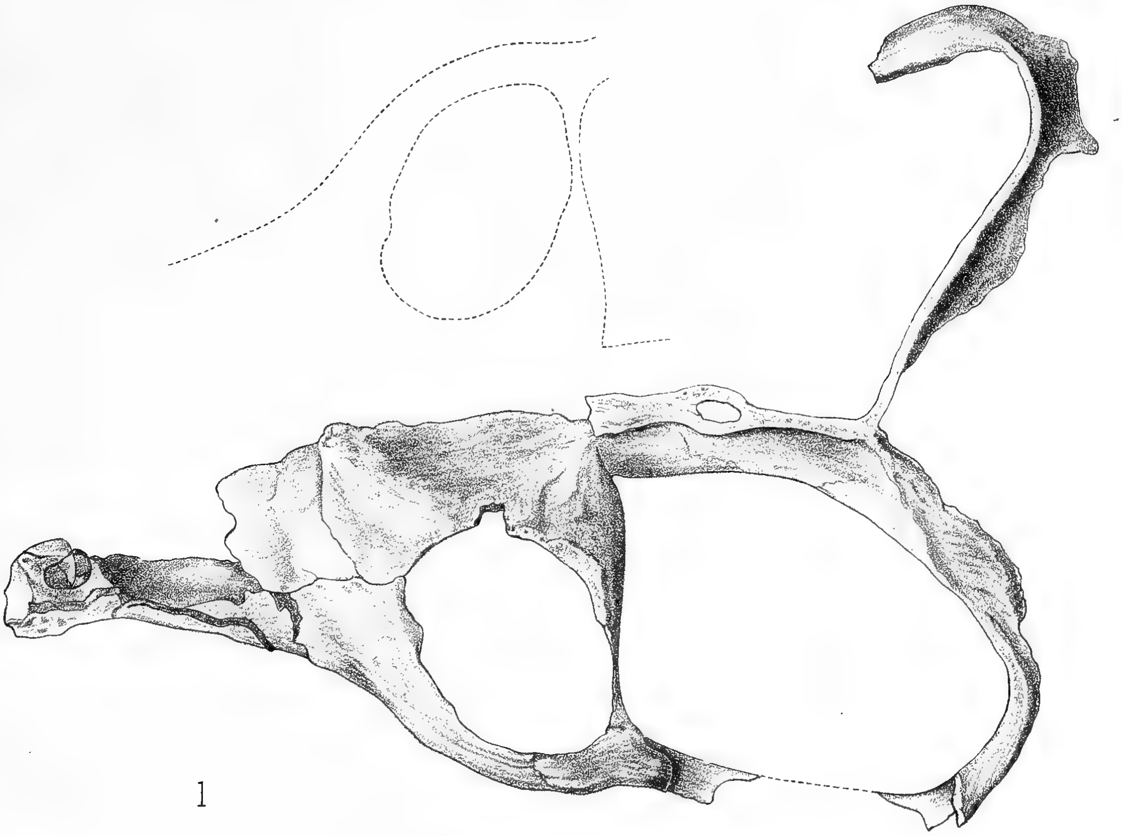
FIG.

1. Upper side of skull of *Ictidosuchus primævus.*
2. Side view of skull and lower jaw. The fragment of the maxilla with the canine tooth is in true apposition. The squamosal is restored from that of the right side. The upper molars are somewhat crushed together.

PLATE XXVII.

3. Side view of left shoulder girdle. The upper part of the scapula is much curved, and consequently fore-shortened in the drawing.
4. Front view of right humerus.
5. Inner view of right humerus.
6. Front view of left femur. The lower portion of the femur is figured in true position.
7. Outer view of left tibia. The tibia is practically complete, but as the lower part is in a different block and has its inner side displayed it is merely figured in outline.

8, 9. Undetermined elements.



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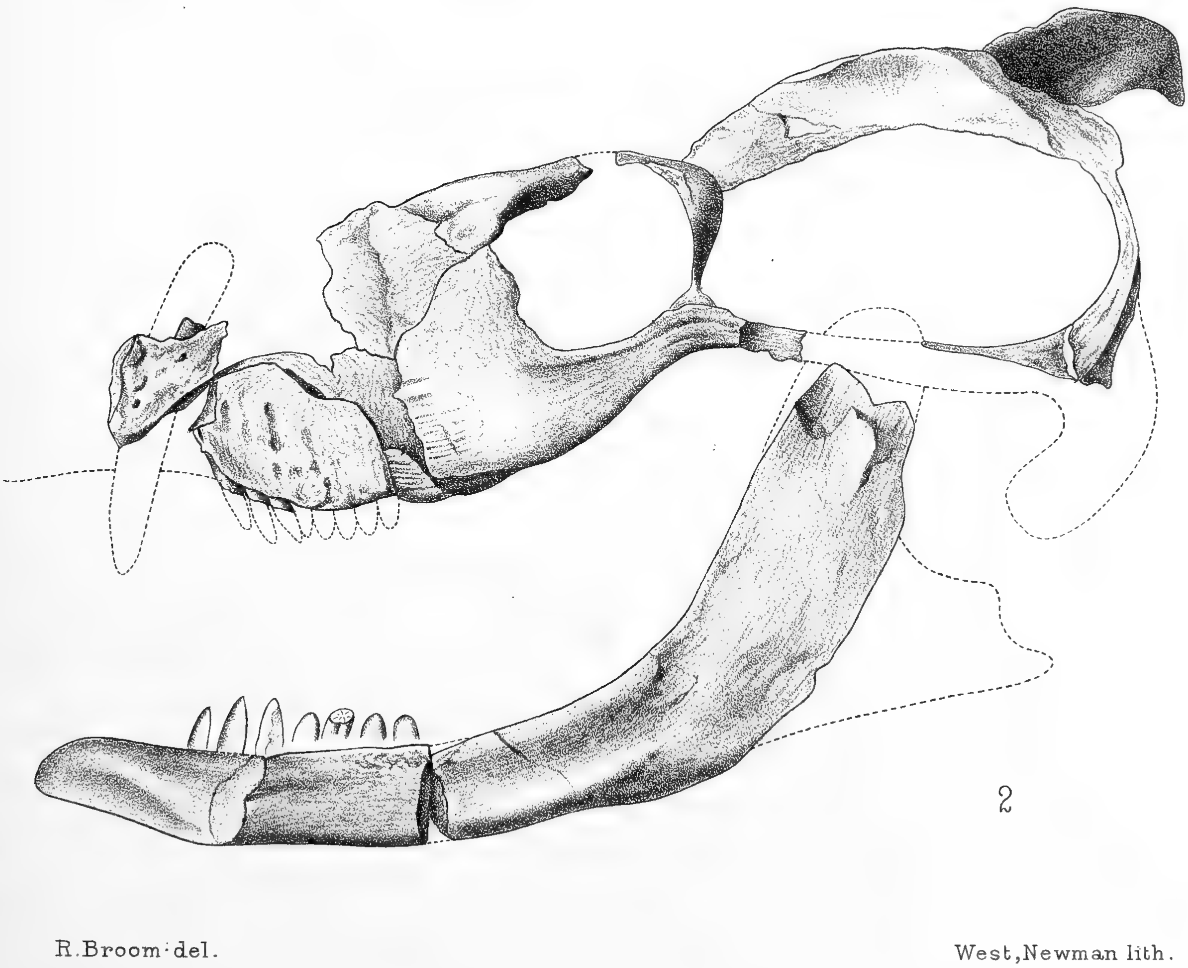

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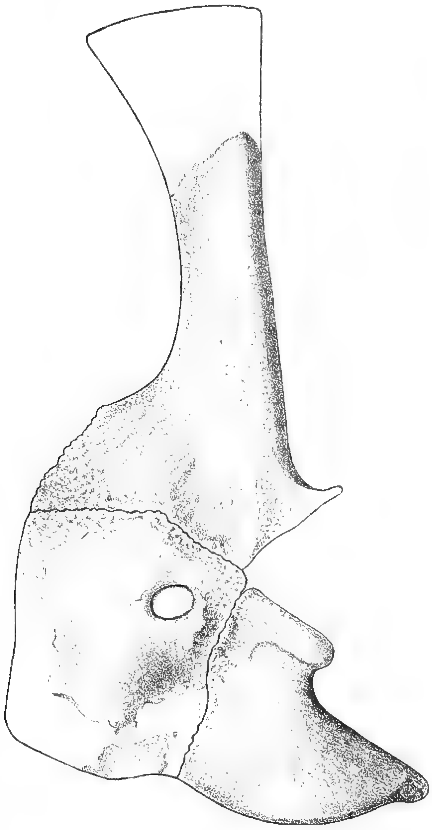
R. Broom del. West, Newman lith.

R. BROOM; ICTIDOSUCHUS PRIMÆVUS.



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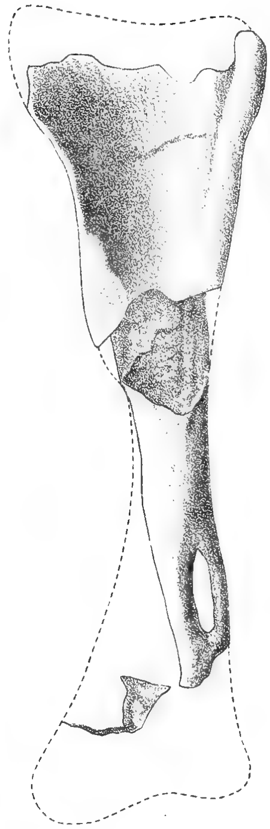

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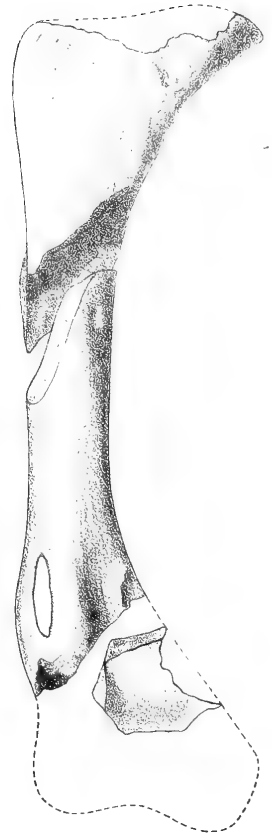

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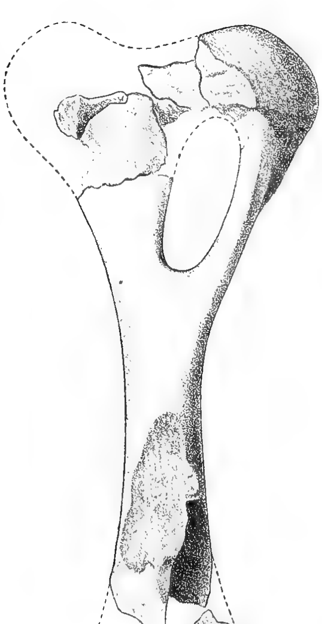

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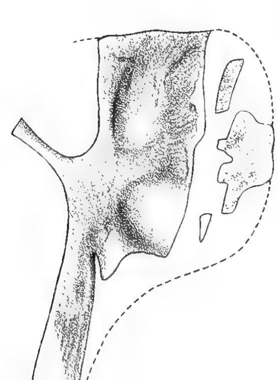

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R. Broom del.

West, Newman lith.

R. BROOM; ICTIDOSUCHUS PRIMÆVUS.

ON THE APPEARANCE AND DISAPPEARANCE OF A MUD ISLAND AT WALFISH BAY.

By F. W. Waldron, A.M.I.C.E.

(Read August 1, 1900.)

Plates XXVIII., XXIX., XXX., XXXI.

In submitting the facts in connection with the appearance and disappearance of a mud island in Walfish Bay, it will perhaps be advisable to give first a description of the locality in which the phenomena took place, together with the information which is furnished in the *South African Pilot*, No. 2 of 1884, pp. 208–210.

Walfish Bay.

"Pelican Point, the western point of Walfish Bay, lies south 69 miles from Cape Cross, the intervening coast, which bends to the eastward, is distinguished by white sandhills of moderate elevation falling suddenly to the sea. It is entirely free from any known danger excepting off the River Swakop, and there are depths of 4 to 6 fathoms at the distance of a quarter of a mile off shore. Pelican Point is in latitude 22° 52′ 30″ S., longitude 14° 27′ 15″ E.

"Walfish Bay was surveyed in 1825 by the officers of H.M.S. *Leven*, and the information resembles most of the other harbours on this coast as far north as St. Paul de Loando. Its westerly side is a sandy peninsula nearly four miles in length, terminating at its northern end in Pelican Point, where the breadth of the entrance is 3¾ miles.

"The Bay is spacious and safe, being protected on all sides excepting the north and north-west, whence winds are fortunately not of frequent occurrence. All the shore is of sand, and the soundings regular from 8 to 3 fathoms, but within the peninsula, along the western shore of the Bay, the water is shoal, and the coast at the bottom of the Bay low and marshy. . . .

"The River Kuisep runs into the depth of this Bay. It trends to the southward for a distance of about 35 miles, and then turns sharply to the eastward into the interior. . . .

"*Remarkable Soundings.*—The soundings on all this coast are dark muddy sand, the action of which upon metals turns them black, which effect was produced upon our leads and chain cables, making them appear as if painted."

Description of the Mud Island.

On the 1st of June, 1900, Miss Cleverley, the daughter of the Resident Magistrate of Walfish Bay territory, whilst scanning the horizon with a field-glass from the settlement at the head of the Bay saw a dark object resembling the hull of a vessel lying inside the Bay, just off Pelican Point, a distance of 6½ miles from the settlement. To ascertain what this object was, steam was immediately got up in the launch, and Mr. Cleverley, with a small party, proceeded to the spot. As Pelican Point was neared, it was found that a mud island had appeared on the inner side at about 100 yards from the shore. (See Chart, Plate XXVIII.)

Careful soundings taken close to and around the island gave depths of 7 to 8 fathoms. The dimensions were approximately 150 ft. long, 30 ft. wide, and the height 15 ft. above the surface of the sea; the sides under water appeared to be nearly vertical, but above water pieces had been washed off by the sea, giving the jagged appearance shown on the photograph (Plate XXXI.). Whilst we were there several large pieces fell off into the sea.

A very strong odour of sulphuretted hydrogen pervaded the spot, and steam appeared to issue from the northern end of the mass. I was afterwards told that the smell from the island was noticed at Swakopmund, a distance of 25 miles from Walfish Bay.

The next day (June 2nd) we visited the island to make a more minute examination. Soundings were taken again with similar results. Lieutenant Gutsche, of the Cape Garrison Artillery, swam off from a boat, it not being possible to land otherwise, and procured a specimen of the mud.

Since the previous day a large quantity of the material had fallen off into the sea. Steam was still seen issuing from the same spot.

We had no means of making temperature observations of the mass or of the water, but Lieutenant Gutsche said he felt no heat on the island, and the water was very cold.

The water around the island was dirty, and the surface covered with bubbles. A few dead fish were found upon Pelican Point.

On the 4th of June another visit was made. The size of the sland above water appeared somewhat diminished and levelled down to not more than half the height observed on the 1st, but under water was about the same. The soundings had not altered nor had the smell disappeared.

No further visits were made until the 7th of June, when it was found that the island had entirely disappeared. Careful soundings were again taken over the spot. The bottom had assumed its original depth, and no sign of the island was to be found. The water was dirty and covered with bubbles on the surface as before, and the smell of sulphuretted hydrogen was still perceptible in the air.

Nothing happened on the coast about the time of the upheaval of the island to indicate that anything unusual was taking place. A airly high tide occurred a night or two previous to the appearance of the island, and a report came from Swakopmund that a very heavy sea had swept away 30 metres of a breakwater in course of construction there by the German Government; but as similar heavy seas are frequent at this time of year on this coast, so exposed to the full force of the South Atlantic, no great importance can be attached to the occurrence.

From the first appearance of the island on the 1st of June a constant look-out was kept, but there was no reappearance of it up to the time of my departure from Walfish Bay on the 10th of July.

The following facts are interesting to consider in connection with the phenomena, viz.:—

The remarkable soundings mentioned in the *South African Pilot,* referred to above:

The existence of sulphur holes in various spots on the peninsula and at the head of the Bay:

The frequent evolution of sulphuretted hydrogen gas during the winter months; the dirty appearance of the water with the occurrence of bubbles on the surface similar to those seen over the spot where the island disappeared; also the fact of fishes becoming suffocated during these times and floating on the surface of the water.

As a probable cause of the presence of gases in the mud of Walfish Bay, large quantities of animal matter must from time to time be collected in the still water of the Bay from the myriads of seabirds there, and from the flamingoes, pelicans, and other birds that exist in the lagoons at the head of the Bay. The Bay also abounds with fish of various kinds, and remains of large numbers of whales are strewed along the coast for many miles.

As a matter pointing to submarine disturbance near the locality, there was a breakage in the telegraph cable to German territory, which reaches the shore at Walfish Bay. (See chart, Plate XXVIII.) This breakage took place a few weeks previous to the upheaval of the island, and I was informed by the manager of the Cable Company's office at Swakopmund that the break occurred about 10 miles from the shore, or 6 miles from the site of the island. The fracture was a most unusual one, the cable being cut clean through, not jagged or chafed, as is the case in most submarine cable fractures.

The following gentlemen were present at the several visits made to the island on the 1st, 2nd, 4th, and 7th of June: The Resident Magistrate, J. J. Cleverley, Esq., Captain C. Richardson, Lieutenants A. Borcherds and C. Gutsche, and Dr. Sterne, of the Cape Garrison Artillery, who were stationed at Walfish Bay; and the author of this notice, Frank W. Waldron, of the Public Works Department, Cape Town.

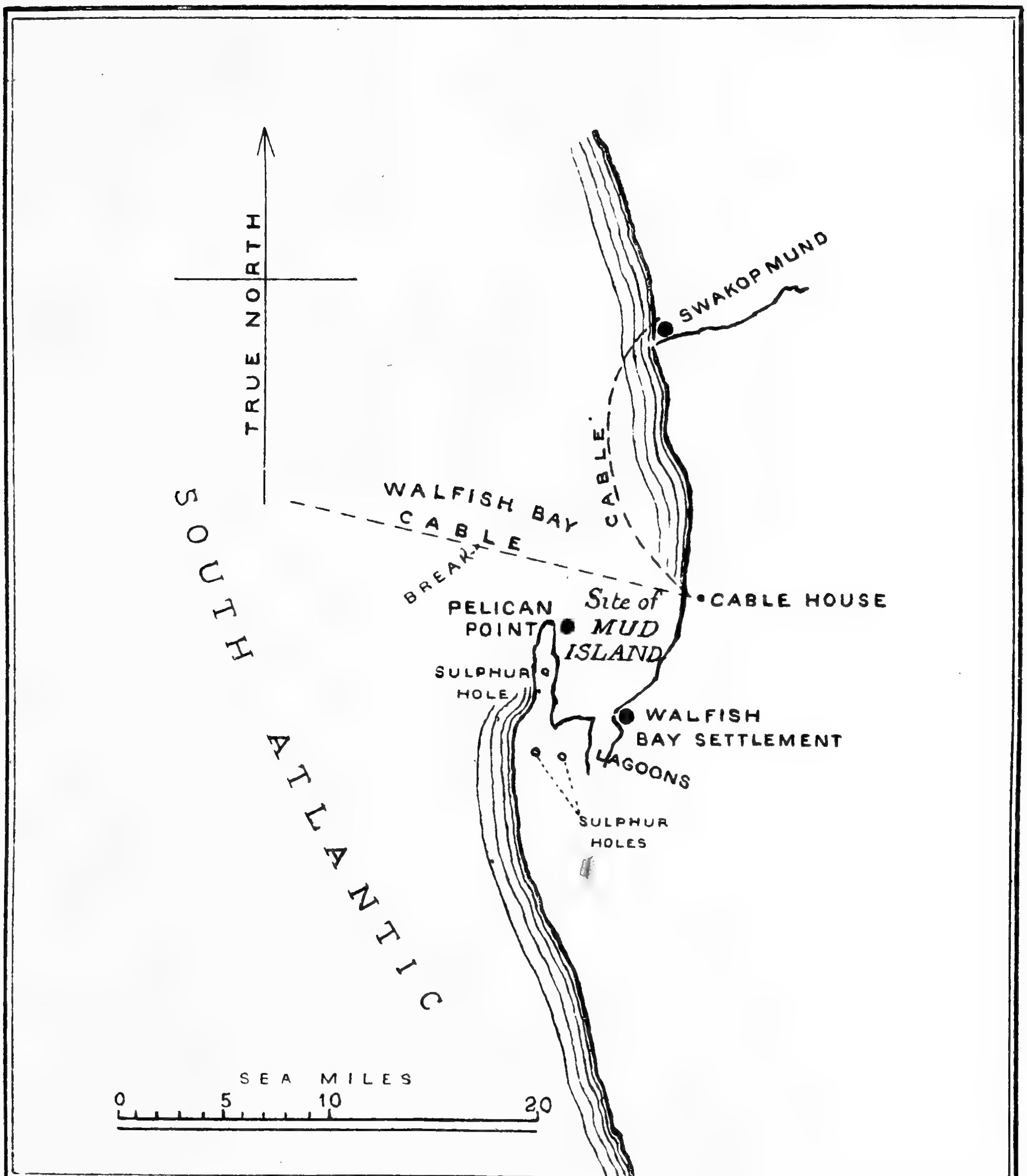
PLATES XXVIII–XXXI.

PLATE XXVIII. Chart of Walfish Bay, showing the site of the mud island which appeared off Pelican Point on June 1st, 1900.

,, XXIX. The island as seen from Pelican Point on June 1st.

,, XXX. The island as seen from Pelican Point on June 2nd.

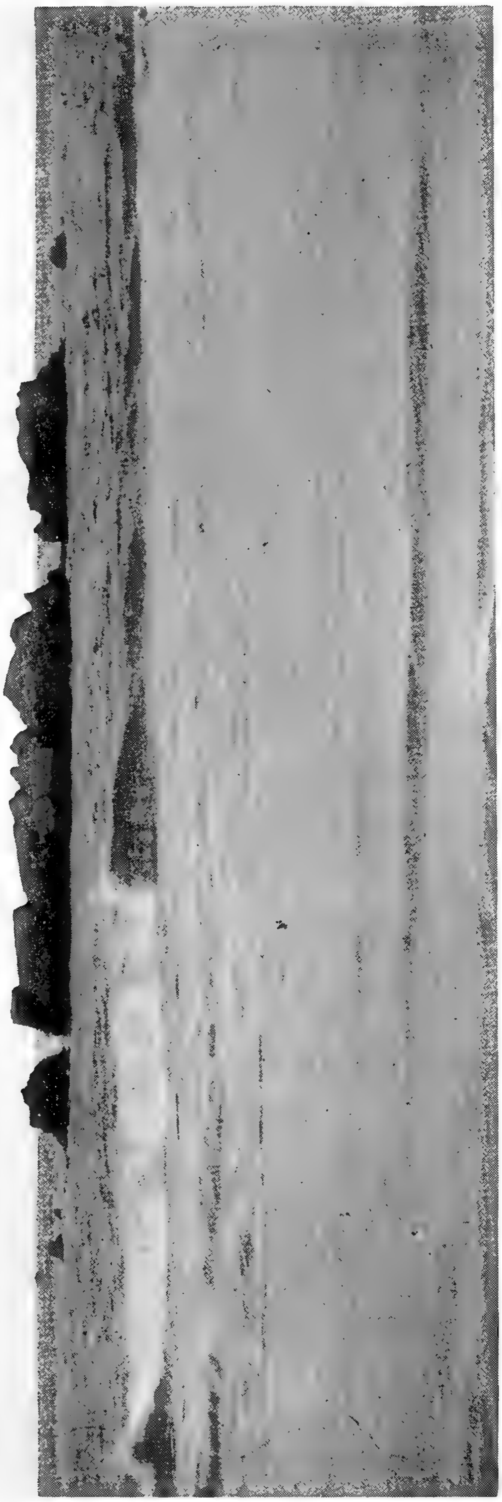
,, XXXI. View of a portion of the island as seen from a distance o 50 feet on June 2nd.



West, Newman phototyp.

F. W. WALDRON: MUD ISLAND IN WALFISH BAY.

CHART OF THE BAY.



West, Newman phototyp.

F. W. WALDRON ; MUD ISLAND ; AS SEEN FROM PELICAN POINT, JUNE 1, 1900.

West, Newman phototyp.

F. W. WALDRON: MUD ISLAND; AS SEEN FROM PELICAN POINT, JUNE 2, 1900.

West, Newman phototyp.

F. W. WALDRON: MUD ISLAND; PORTION OF ISLAND AS SEEN FROM A DISTANCE OF FIFTY FEET, ON JUNE 2, 1900.

NOTES ON THE SO-CALLED "POST OFFICE STONE" AND OTHER INSCRIBED STONES PRESERVED IN THE SOUTH AFRICAN MUSEUM AND ELSEWHERE.

By W. L. Sclater, M.A., Director of the South African Museum.

(Read June 27, 1900.)

A good deal of interest has been excited from time to time by the discovery of inscriptions cut on boulders or on the solid rock laid bare in digging out foundations for new buildings in Cape Town, and it seemed to me worth while to try to collect together all the information I could regarding these and other inscriptions bearing on the early history of South Africa.

There is no doubt that in early times not only the English, but also the Dutch and Portuguese, very usually when making any stay in a harbour for the watering and refreshing of their crews, left behind them some sort of inscription recording their visit, and that subsequently, especially in the case of Table Bay, when the visits of the regular fleets became annual, the outgoing ships left letters buried near or under the inscriptions for the return fleet to unearth and carry back to Europe.

After the discovery of the Cape by Bartholomew Dias in 1486–7, and the first Cape voyage to India by Vasco da Gama in 1497–9, the Portuguese had an actual monopoly of the Indian trade by the Cape for nearly a hundred years, and it was not till 1577 that Drake, the first English circumnavigator of the globe, set out, but neither he nor Thomas Cavendish, who followed him in 1586–8, landed on South African shores, though both passed by on their return homewards.

In 1591 the first English ships put into Table Bay. These were the *Penelope*, *Merchant Royal*, and *Edward Bonaventure*, under the command of "General" George Raymond. Of these, the *Merchant Royal* returned with sick from Table Bay direct, the *Penelope* was lost, and the *Edward Bonaventure* alone reached her destination (the Malay Peninsula), but on her way back to England was lost in the West Indies, and out of 198 men only 25 (including James Lancaster) reached England in safety.

In 1599 the English East India Company was formed in London, and in 1602 their first fleet of four ships, under the command of James Lancaster, who had successfully commanded the *Edward Bonaventure* in 1591, set sail, and called at Table Bay on their outward voyage. From that date onward English ships called nearly every year at the Cape.

The earliest Dutch expedition to India *viâ* the Cape was one under the command of Cornelius Houtman, which left the Texel in April, 1595. They called at Mossel Bay for refreshment, and though no less than fifteen Dutch expeditions sailed between 1595 and 1601, it was not till the latter year that Spilbergen anchored below the heights of Table Mountain, and gave its present name to Table Bay. Hitherto it had been known as Saldanha Bay, a name which he erroneously transferred to the present Saldanha Bay. The Dutch East India Company was formed in 1602, and after that the fleets called at Table Bay almost every year. It is therefore during the first half of the seventeenth century, from 1601 to 1652, when the first settlement under van Riebeck was made, that the inscriptions on rocks and boulders were made by the crews of passing ships.

In those early days a stream descended from Table Mountain and ran down more or less along the present line of Adderley Street, discharging its water into Table Bay near where the Railway Station now stands. This stream was known as the Fresh River in contradistinction to the Salt River, which, being tidal, was useless for watering purposes. It was therefore at about the bottom of Adderley Street that the crews of the ships landed to fill their water casks, and it was close by that the inscriptions were usually carved, and this explains how it is that all the stones hitherto disinterred have been found near this spot.

The earliest inscribed stone so far discovered is of considerably later date than the earliest arrival of the East India Company's ships, *i.e.*, 1619, but it is stated that Sir Thomas Roe, during his stay at the Cape while on his voyage to India in 1615, "set up a pillar with an inscription of his embassy." * Perhaps at some future time this may be found.

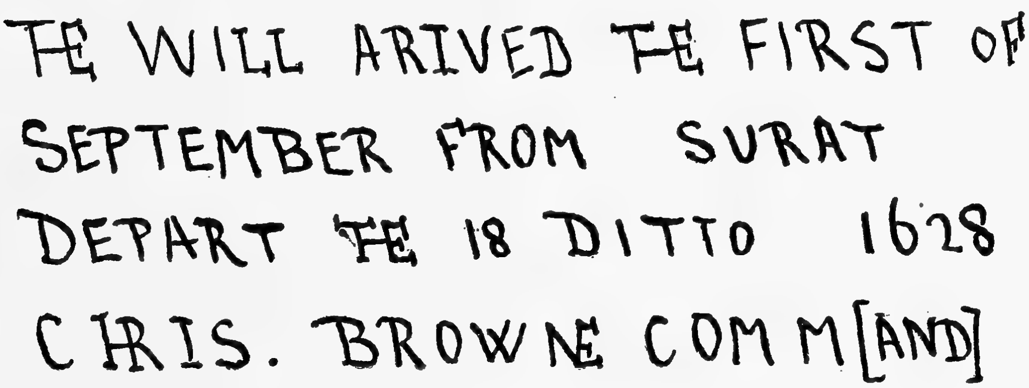
Before commencing the account of the various inscriptions, I must offer my warmest thanks to Mr. William Foster, of the India Office, and to Mr. Donald Ferguson, of Croydon, to whom I am indebted for most of the information conveyed in this paper. The former gentleman has most kindly looked through the India Office records

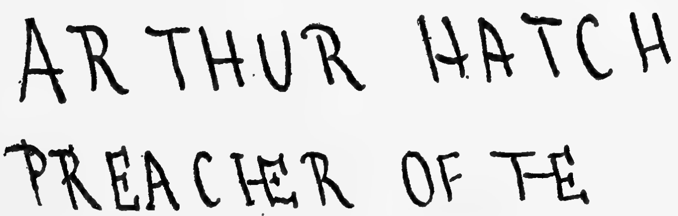
* Foster: Embassy of Sir Thomas Roe, vol. i., p. 11, Hakluyt Soc., 1899.

for the details of the voyages recorded on the Post Office stones, while the latter has undertaken the translation and transcription of the Plettenberg Bay Stone. I will now proceed to say a few words about each of the stones in order.

I.—The Dutch Orphanage Stone.

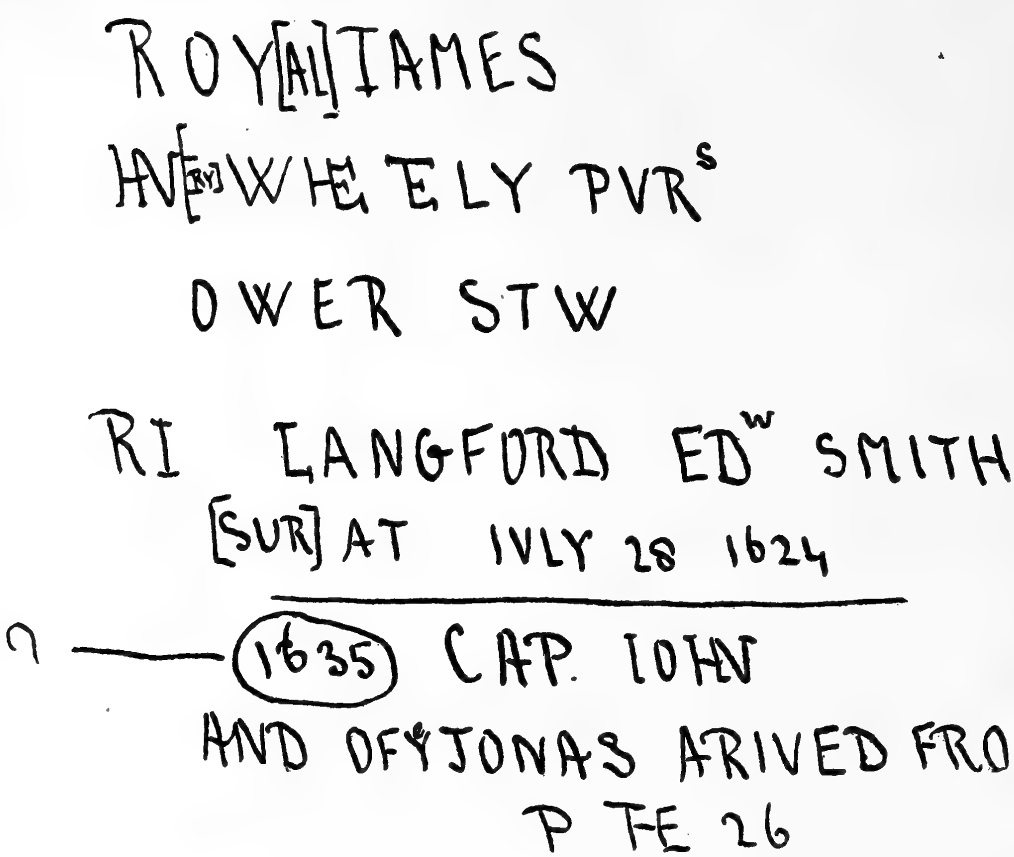
An old inscribed stone, which was no doubt found in Cape Town, but of which the exact history is unknown, was for a long time in the possession of the Trustees of the Dutch Orphanage in Long Street. It was presented to the South African Museum in 1896, and is now preserved in that institution. It is a large block of sandstone, and contains traces of two separate inscriptions. On the two larger faces these are as follows:—





The name of the ship is the *William*, which, as stated, arrived at Table Bay on the 1st, and sailed again on the 18th of September, 1628, reaching England in the following December (Journ. in I. O. Records Marine, No. xlv.). Christopher Browne was her commander, and Arthur Hatch was the preacher on board. The latter went out first in 1619, returning in 1623; then in the present voyage (1626–8), and a third time in the *Charles* in 1632. He wrote "a letter touching Japon," which is printed in "Purchas His Pilgrimes" (vol. ii., p. 1696). The letter was written from Wingham, in Kent, and is dated the 25th of November, 1623, and must have been prepared after his return from his first voyage.

On the other side of this stone the following somewhat imperfect inscription can be deciphered :—



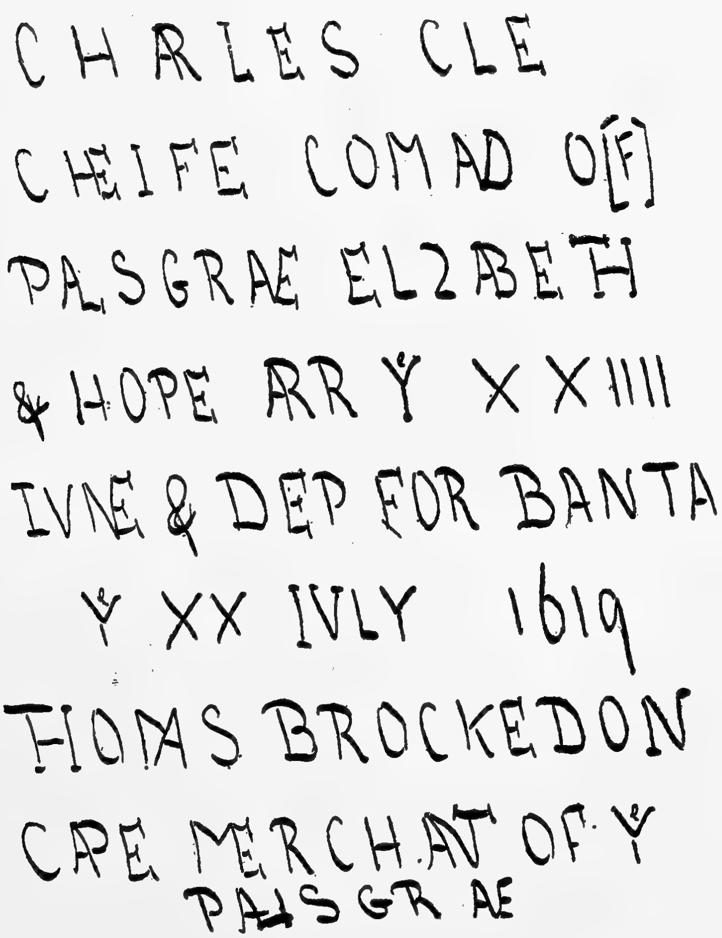
The *Royal James*, *Jonas*, *Eagle*, *Star*, *Spy*, and *Scout* sailed from the Thames about the end of January, 1624, and left the Downs on March 27th. They anchored at the Cape on the 19th of July, 1624, and left again on the 29th. John Weddel was captain, Richard Swanley, master ; Henry Wheteley, purser ; and Richard Langford a purser's mate ; all in the *Royal James*. Edward Smith was a purser's mate in the *Jonas*.

Thomas Kerridge, who was going out to resume his post of president at Surat, was on board the *Jonas*, and his account of his stay at the Cape, contained in a letter to the East India Company (written at Swally, near Surat, in Western India, November 15, 1624, I. O. Records, O. C., No. 1169), is worth quoting, as showing the practice in vogue of burying letters and making inscriptions on the rocks :—

"WEE anchored in Saldania Baie [*i.e.*, Table Bay] the 19th ditto [*i.e.*, July 1624]. Wee perceaued by inscriptions on stones that the *Dolphin* was departed thence homeward bound from Suratt the — Aprill past, but could not finde anie lettres though the inscriptions mentioned some to be there left which appeared plainely to be disinterred and taken thence by the Dutch or Danes, shipps of each having touched there since her departure. In this place wee found reasonable store of refreshing, as well flesh from the countrie people as fish taken plentifully in the River, whereby, togeather with the howlesomenes of the Ayre and hearbes et. ct. for bathes, our sick men for the most part (their sickness being the scurbeck) thanks be to god, recovered within 10 dayes in some reasonable measure to help themselves. The 29th July the whole fleete sett sayle togeather from the Cape."

II.—Museum Inscribed Stone No. 2.

When Messrs. Wilson, Miller, and Gilmore, of 40 and 42, Adderley Street, opposite the new Post Office, were rebuilding their premises, the following inscription was found graven on the solid rock lying a few feet below the surface. The block on which the inscription was written was carefully removed and deposited in the Museum by Messrs. O'Flaherty, Grant & Co., and is now preserved there.



The fleet in question sailed from the Thames in March, 1619. The *Hope* had made several previous voyages, but the *Palsgrave*

(1,083 tons) and *Elizabeth* (978 tons) were new ships, built by the Company in the previous year. The chief commander was Charles Clevenger (CLE of the inscription), who hoisted his flag on the *Palsgrave*.

At the Cape they seem to have met the *Lesser James*, homeward bound. Writing from Tiku, in Sumatra, which was reached on the 23rd of October, 1619, Clevenger, Brockendon, and a factor named Mills, say: "The 3rd of August before day wee sett sayle from the Cape, where we were 16 dayes wynde bound" (I. O. Records, O. C., No. 821). This conflicts with the inscription, but the two dates are not irreconcilable. No doubt it was intended to sail on the 20th of July, but after cutting the inscription and getting on board, the want of a suitable wind prevented them from making a start until the 3rd of August. The Thomas Brockedon mentioned in this inscription subsequently became the chief agent of the British East India Company at Batavia, in Java, and at the time of the great struggle for commercial supremacy in the trade of the East Indian Islands, which finally culminated in the well-known massacre of Amboyna, he wrote (August, 1622) to his directors in London asking leave to return home, as he could "live no longer under the insolence of the Dutch" (Hunter's "History of India," i., p. 385).

III.—The Inscribed Stone now in the General Post Office.

THE LONDON ARIVED THE 10 OF M
HERE FROM SVRAT BOVND FOR
ENGLAND AND DEPAR THE 20 DICTO
RICHARD BLYTH CAPTANE 1622
HEARE VNDER LOOKE
FOR LETTERS
1629
IAN. REY^{R} CLOCK
GASH. V. BERIVECI

The preceding is a copy of the inscription on this stone which was found in 1897, when an excavation was being made in the ground immediately in front of the then recently completed offices of the Castle Company. The stone is now mounted for exhibition in the vestibule of the General Post Office.

The *London* (Captain Richard Blyth), *Jonas*, and *Lion* sailed from Surat December 18, 1622, anchored in Saldania (*i.e.*, Table, not Saldahna) Bay, March 10, 1622–3; left again March 23rd (not 20th, as inscribed), reaching the Downs July 18, 1623. The rest of the inscription appears to refer to some other voyage.

IV.—Gravestone in the South African Museum.

Recently, on the removal of an old house in Strand Street opposite the Grand Hotel, there was found, about four or five feet below the surface of the ground, a block of sandstone with one face only smoothed, on which was the following inscription :—

HIER·LEIT·BEGRAVEN
IAN GERRIT SEN VAN·
AMSTERDAM OPPER
STVIRMAN OP HET
SCHIP HOLLAND
STARE DEN 24
APRIL A° 1624

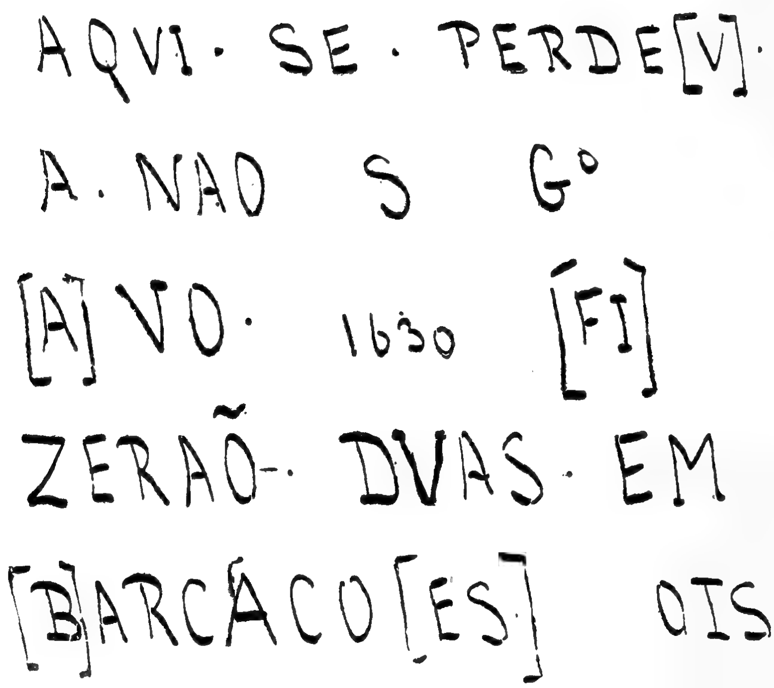
The "Opper Stuirmàn" was probably the navigating officer of the ship and a person of considerable importance. The block was presented to the South African Museum by Mr. John Parker, and is on exhibition with the other inscribed stones of a similar nature.

V.—The Plettenberg Bay Stone.

This is an inscribed stone preserved in the South African Museum, where it has been for many years. From information derived from old residents, for which I am indebted to Mr. W. Groom, I believe that it was removed from Plettenberg Bay to Cape Town about the year 1860 at the request of Sir George Grey, and it is further stated that the monument or stone originally stood on a sandhill about 3 miles south of the present village of Plettenberg.

The stone now in the Museum bears a Portuguese inscription, which has recently been deciphered and translated by Mr. Donald Ferguson as follows :—

Inscription.



Translation.

Here was lost
The Ship San Gonzales
Year 1630
They made two
Boats.

The inscription is cut on the face of a rudely cubical block of sandstone, which has been broken across, and on the fractured surface at right angles to the inscribed face is a peculiarly shaped cross.

The block measures about 19 × 12 × 12 inches.

The inscription obviously refers to a Portuguese ship, the *Saõ Gonçalo*, which was wrecked, on its way home from India in 1630, in Bahia Fermoza, now known as Plettenberg Bay, and doubtless the stone marked the spot.

Mr. Donald Ferguson informs me that there is a Portuguese manuscript in the British Museum (B. M. Addit. MS., 20, 902) in which is an account of the disaster. The title of the MS. is as follows :—

"Relaçao dos Nâos, e Armadas da India com os successos dellas q̃ se perdéram saber, para noticia, e instrucçaõ dos curiozos, e amantes da Historia da India." (B. M. Addit. MS. 20, 901.) fol. 267.

The following is a translation of the title and the extract relating to the disaster in question :—

"Account of the India Ships and Fleets with their successes as far as can be ascertained, for the information and instruction of the curious and lovers of the history of India.

"Dom Miguel de Noronha Conde de Linhares, viceroy ; succeeded the Governors as will be seen on the following page.

"Anno 1629.

First fleet that the Company prepared.

Left on the 3rd of April, Tuesday.

The successes that the Conde de Linhares had in returning to this Kingdom can be seen on f. 287.

"There left on the third of April with three ships and six galleons the viceroy the Conde de Linhares in the ship *Santissimo Sacramento.* It reached India on the 21st of October 1629 ; left for the Kingdom [*i.e.*, Portugal] on the 4th of March 1630 ; and arrived at the Kingdom on the 27th of September 1630. There came as Captain of the ship Sancho de Faria da Silva.

Successes.

"*Nossa Senhora de Bom Despacho,* captain-major Francisco de Mello de Castro, reached India on the 15th of October ; left for the Kingdom on the 4th of March 1630 ; reached Angola on the 3rd of August ; left on the 5th of April ; arrived at Lisbon on the 3rd of July 1631.

"*Saõ Gonçalo,* captain Antonio Pinheiro de Sampaio, reached India on the 24th of September ; left for the Kingdom on the 4th of March. This Antonio Pinheiro de Sampaio, captain of the ship *S. Gonçalo,* died in India and there came in his place Fernaõ Lobo de Menezes, which ship on the return voyage put in to the Bahia Fermoza ; * where being anchored, it foundered in a gale, which

* See map at p. 306 of Theal's "Records of S.E. Africa," vol. i.

came upon it while at anchor, and was lost, 133 persons perishing. In this Bay were made two pataxos,* one of which left for Mozambique where it arrived; and the other at the Cape of Good Hope caught sight of the ship *S. Ignacio de Loyola* of the fleet of the year 1630 and arrived alongside of it, where they took in the people, and abandoned the pataxo; and the captain Fernaõ Lobo de Menezes, who came in the said pataxo died in the said ship *S. Ignacio.*"

Another account of the shipwreck of the *San Gonzales* is to be found in the Asia Portuguesa of Manuel de Faria e Sousa, a work published in Spanish at Lisbon in three folio volumes in 1666 and 1674. An English translation by Captain John Stevens was published in London in 1695, entitled, "The Portuguese Asia; or, the History of the Discovery and Conquest of India by the Portuguese." Extracts from this translation are included in Mr. G. McC. Theal's "Records of South-Eastern Africa," recently published, and the one dealing with the wreck of the *San Gonzales* is to be found on page 44. As this translation is stated by Mr. Ferguson not to be a very accurate one, I have had the account of the wreck copied out of the original Spanish work now in the British Museum, and append a translation, for which I am indebted to Mr. and Mrs. Péringuey, to whom I return my best thanks.

Translation of an Extract from the 8th Chapter of the 3rd volume of the Asia Portuguesa of Manuel de Faria e Sousa, published in 3 folio volumes at Lisbon, 1666–1674.

12. And in order to prove that he who is fated to die finds death in the very thing which is intended to save, we shall narrate here the loss of the ship *S. Gonzalo*, which served as a refuge to some who thereby lost their life.

In the early days of March there sailed from Goa three vessels, the commander-in-chief of which was Francisco de Mello, and the other two captains were Sancho de Faria and Fernando Lobo de Meneses. It is the wreck of the last which is of interest (to demonstrate what has been adduced). After having undergone the terrible expectation caused by the fear of the sinking of such a large vessel, the sailors fearing death owing to the vessel having sprung a leak and being compelled on that score to make for the land, they came to the bay called Fermosa (the beautiful), owing to its capacity, being three leagues wide at the mouth and five leagues in circum-

* Pinnaces.

ference, and only exposed to east, north-east, and south-east winds. It is on the confines of the Cape of Good Hope.

13. Our vessel having cast anchor in this place towards the middle of June, instead of taking advantage of the weather to land without loss of life, and rescue the goods that had been jettisoned to lighten the ship, the misguided officers would persist that they could navigate the vessel after pumping her dry (strange indeed that the direction should be entrusted to people incapable of thinking reasonably). For that purpose a man was sent down to clean the pump, and as he was slow in returning, another one went down, and then another was sent after him. None of the three coming back, another man was lowered with a rope. He found the other three already dead, and came up himself almost at his last gasp. He would have died like the other three had he not been promptly hauled to the air, because the pungent aroma of the damp pepper had choked them.

14. They then endeavoured to put the ship straight, and a hundred sailors having jumped on the shore, there remained on board 150 people, who at the end of about fifty days met with a sudden death owing to a violent tempest which shook the vessel and broke it into pieces on the shore. Having faced this terrible sight, the hundred people that were on the shore set to building huts, realising that it would be long before they could build two vessels from the wreck and the trees growing on the mountains, and set to sea again. The Captain, who was old and ailing, finding that he could no longer retain the command, allowed the people to choose another in his stead, and they chose Roque Borges, who knew his profession well, but a Sinão de Figueyredo, who was coveting this post, opposed the choice. Covetous people are found even in misfortunes. One evening he attacked him with the intention of putting him to death, and although he did not succeed in his design, he left Borges seriously wounded. The latter dissembled much, but eventually killed him with a dagger as a punishment for such an audacity, and every one was quiet (hereafter).

15. They sowed some seeds and reaped the fruit, such as gourds, melons, cucumbers, et. ct., which grew while the two small vessels were being built. They lived upon rice which they had saved, and upon other things, such as fish and roots, which they dug, and also oxen and sheep, which they exchanged for iron with the natives (Barbars). The latter spoke in such a manner that they could not understand them, and they used signs to make them understand. These natives are not quite black; they go naked, but cover their (immodest) private parts with a small (piece of) skin;

in winter they wear a kind of mantle (cloak of skin); on the arms they have rings of copper, and round the neck twisted ox sinews; with the excrements of the latter they (anoint) besmear their whole body and thus make themselves hideous; they make a (clicking) clapping noise with the tongue and the lips in their speech, and they carry in their hand fox tails to signal with; they do not form a stationary population but wander in groups with their flocks like the Arabs, using (but not all) portable tents made of sticks and mats; they do not cultivate the soil; they offered our people a cake looking as if it were flour of roots kneaded with ox dung; the flesh of the latter they eat nearly raw, hardly warming it at the fire, which they make by rubbing sticks one against the other; the guts are to them the nicest part without any other preparation than squeezing out of the filth; for arms they have spears (assagaies) and bows; no sign of worship was noticed, but a remarkable thing happened in the morning of St. John's (the Baptist) day, they appeared with crowns of various (grasses) green plants.

16. The soil is very fertile, free from stones, and there are a few hills. These hills, and also the valleys, contain much grass and plants like rush, red mace, thistle, rosemary, lavender, and other varieties of odoriferous flowers. The large and numerous copses (? forests) are watered by rapid rivers and by fine and copious springs. Spring begins in November. And as we speak sometimes of the variableness of the seasons of the year in these climes, we must clearly state that summer and winter in these climes, and also in India, are not caused by the sun coming near or going from the zenith, as happens in Europe, but by the winds (*litt.* by the winds that blow). The rainy season is in winter. It is winter when it rains, the sun being then at its highest point, and at its lowest when there is no rain, in which case it is summer. Winter begins at the end of May at the same time as the westerly winds, which bring many clouds and much rain, and lasts until September, during which time all navigation stops. From September to March blows the north-east wind, which keeps the sky constantly cloudless; it is then summer, and every one puts to sea. I return to the description of this country.

17. Numberless and of extraordinary size are the wild beasts, such as deers, wolves, hippopotami (sea-horses), buffaloes, wild boars, monkeys; there are also tigers and elephants, rabbits resembling ferrets; birds, peacocks, all forest-inhabiting; geese, pigeons, doves, partridges, small birds resembling those of our country are found in wonderful numbers, but the latter differ in not making their nest on he ground or on the branches of the trees, but they suspend them

from the branches of trees with an admirable skill. Such is the population and the land of the Cape of Good Hope and surrounding country. It is there that the shipwrecked crew lived. They erected a sort of church where holy mass was said (the very sacred Sacrament of the altar was performed); sermons to deliver them from vice and to cheer up their mind they did not lack, because among them were the following priests and friars: Francisco de los Santos, custodian of the Province of the Mother of God of the Capucins in India, who has written a diary of this journey; Joseph de Mendoca, Francisco de Gouvea, Juan Capistrano, and also the Chaplain of the vessel.

18. The first mass was said on St. Lawrence day. As soon as it was over a swarm of bees entered through the door and settled on the canopy of the altar. They were captured and set in a cask alongside of the holy table (communion table). They were pleased with their new abode, and set to build their sweet combs, so much in the service of the Holy Ghost that they never stung the officiating priest, over whose head they flew during the eight months that they were there. Thus they taught that some animals are more grateful towards the Creator than many men, because those who see the Sovereign Host do not acknowledge him, while these bees having felt his presence, flew at once to acknowledge him and serve him.

The building of the ships being completed, they used instead of tar the fragrant (benjamin), and also much frankincense, which had been part of the cargo of the ship. There was no oil to melt this material with, but they found a remedy, because, remembering that this material could be replaced by the fat of seals, which were found in quantity on a small island opposite, they killed with clubs such a quantity of them that they had a sufficient provision for their purpose.

When ready for departure they placed a cross upon the top of a mountain with an inscription relating their misfortune.

They launched the two boats, and shipped the goods and the men in two parties, one wishing to return to India, the other to sail for the Kingdom.

This latter, not sufficiently acquainted with nautical knowledge, found themselves after some days in the same place from which they had set out, when they sighted the vessel of Antonio de Sousa y Carvallo, who took them up, which fared as was said before, *i.e.*, afterwards perished upon the bar of Lisbon.

VI.—The Mossel Bay Stone.

In one of the earliest reports of the South African Museum, dated August 2, 1855, the following entry occurs among the list of donations :—

"Municipality of Mossel Bay.—Two curiously carved stones, found in a ruin, supposed to have been carved in the year 1500 or 1501. (See a pamphlet published by the Rev. J. van der Riet, minister of the Dutch Reformed Church of Mossel Bay.)

For some time I searched in vain for traces of the pamphlet. Recently, however, through the kindness of Mrs. W. Thomson, a niece of the late Mr. van der Riet, I obtained a loan of a copy of the work in question, of which the following is the title :—

"Leerrede gehouden aan de Mosselbaai op Dingstag den 6 April 1852 door J. J. van der Riet VDM.

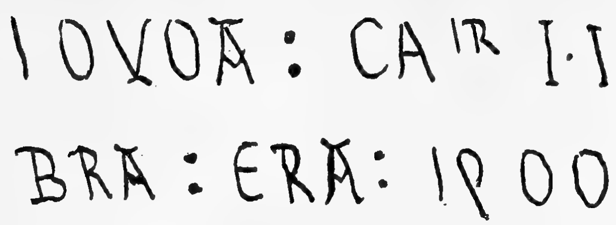
"Kaapstad Van de Sandt de Villiers en Tier 1852."

The sermon, therein contained, was preached to commemorate the bicentenary of the foundation of the Colony, and contains several allusions to history. In a note at the end of the sermon is an account of the finding of the stones, one of which is in the South African Museum, together with a woodcut, which shows beyond a doubt that the stone in the Museum is rightly identified.

The following is a transcription of the note, reproduced here, as the copy of the sermon lent me by Mr. Horak, the late Minister of the Dutch Reformed Church at Mossel Bay, appears to be unique :—

"Zie de belangrijke bijdragen tot de Geschiedenis dezer Volkplanting welke in de *Observer* verschenen zijn, en wel die van Julij 23, 1850, waar men vinden zal dat de Portugeezen bij die gelegenheid eene menigte van Solitarios en Zeewolven in de Mossel baai vingen. En, in een volgend nommer, bladzijde 525, wordt gemeld dat eene Portugeesche vloot, bestaande uit drie schepen en eene sloep, onder bevel van De Nuere, ten jare 1501 de Mosselbaai aandeed, en alhier eenen brief, in eenen ouden schoen verstoken aantrof welke alhier was achtergelaten door een der schepen onder Cabral, die in het vorige jaar Portugal verlaten had.

"Het zal, hoop ik, den lezer niet onbelangrijk zijn te vernemen, dat er voor eenigen tijd alhier, bij het afbreken van het oude Gouvernements Huis, twee steenen zijn gevonden, op een van welken een kanon en op den anderen eenige Portugeesche woorden zijn uitgehouwen waar van sommige letters afgebroken, andere onduidelijk zijn, doch die ongetwijfeld de namen uitmaken van zeker schip en deszelfs kapitein, alsmede het tijdstip van deszelfs aankomst alhier, zijnde het jaar 1500 of 1501."



The above is the inscription as far as I have been able to transcribe it. As the stone is broken off on the left-hand side, it is imperfect, but the first word appears to be Nova and the last a date—1500.

The facts mentioned by Mr. van der Riet are corroborated by G. Danvers in his "Portuguese in India," published in 1894. He states that João de Nova left Portugal in April, 1501, and after discovering the island of Ascension, anchored on 7th July in the Bay of San Bras (*i.e.*, Mossel Bay); there he found a letter in an old shoe left by Pero de Ataide the year before. This latter was one of the Captains of the fleet of Cabral, which left Portugal in March, 1500, and after discovering Brazil encountered a storm in the Atlantic. Out of the eleven ships composing the fleet, only six reached Calicut in India, the other five were dispersed and most of them lost. That of Pero de Ataide, however, apparently weathered the storm, reached Mossel Bay, left the above-mentioned letter there, and got back to Lisbon shortly after Cabral.

I think it quite possible that the "Mossel Bay Stone" refers to Nova's visit.

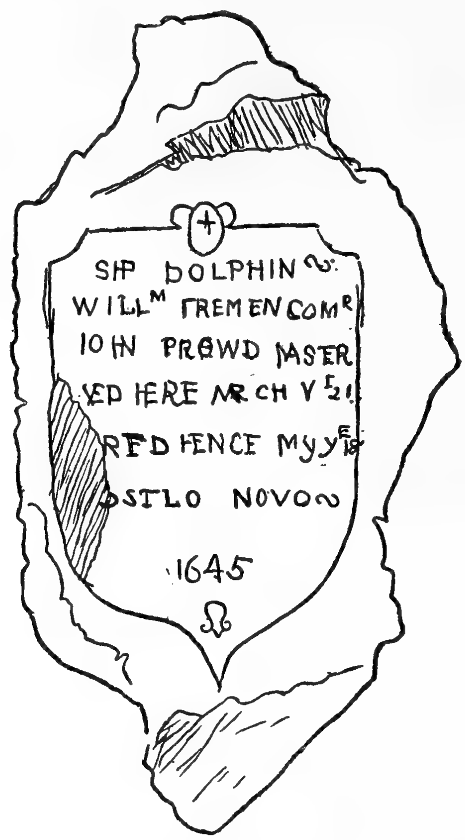
I must add that Mr. Ferguson, to whom I have sent rubbings and copies of the inscription, does not appear to be of my opinion.

Although I have endeavoured to do so, I have been unable to find a copy of the newspaper *The Observer*, which was referred to in Mr. van der Riet's note, so that I cannot trace where the story of the old shoe originated.

VII.—The St. Helena Stone.

An inscribed stone is still preserved in St. Helena to which allusion was made in a letter by Mr. G. B. Bennett to the *Cape Monitor* of August 22, 1855, and which is described and figured in Melliss's "St. Helena," p. 6.

"This stone was built into the base of a cairn which supports the tomb of the wife of Governor Pike (about 1716), and is still to be seen in a good state of preservation in the lower cemetery at Jamestown."



ST. HELENA STONE, COPIED FROM MELLISS.

"Ship *Dolphin*, William Fremen Commander, John Prowd Master, arrived here March 21st, departed hence May 18th, stylo novo 1845."

It is curious the new style should be here quoted, as it was not adopted in England till the year 1752, though used in other European Catholic countries a good deal earlier, in 1582.

Mr. Sterndale, the present Governor of the island, assures me that this stone is still in the same position as described by Melliss and in excellent preservation.

VIII.—Missing Dutch Inscription.

Finally I will mention a missing inscribed stone in the hope that it may some day be traced. In the *Cape Monitor* for September 1, 1855, a correspondent, signing himself "G. T.," writes in answer to a previous correspondent signing himself "Q.," as follows:—

"Sir,—For the information of your correspondent, 'Q,' I beg to state that the stone he refers to is in my possession, and ready for presentation to the Cape Museum on a niche being prepared for its reception. On the demolition of the wall of the canal,* your correspondent, who evidently appreciates the value of such relics, will doubtless be glad to find that the writer rescued the stone from the *débris;* but, he regrets to say, not until the Anno Domini had been carelessly effaced. The inscription runs as follows :—

HANDEL. RAE. VAN. INDIEN
'D. MARTINVS. SONCK. FISCVS."
JACOB. LODESTEYN. SCHIPPER
GEARRIVEERT MET SCHIP
VAN. AMSTERDAM. DEN. 20 MEY
VERTROCKEN. NAE. BATAVIA.
DEN. 4. JVNY

" Some few years back, on removing the earth in the street fronting Messrs. Dean and Johnson's stores for a water leading, a rock was laid bare showing the following inscription .—

(*The inscription appears on next page.*)

" The latter name was not very perceptible.

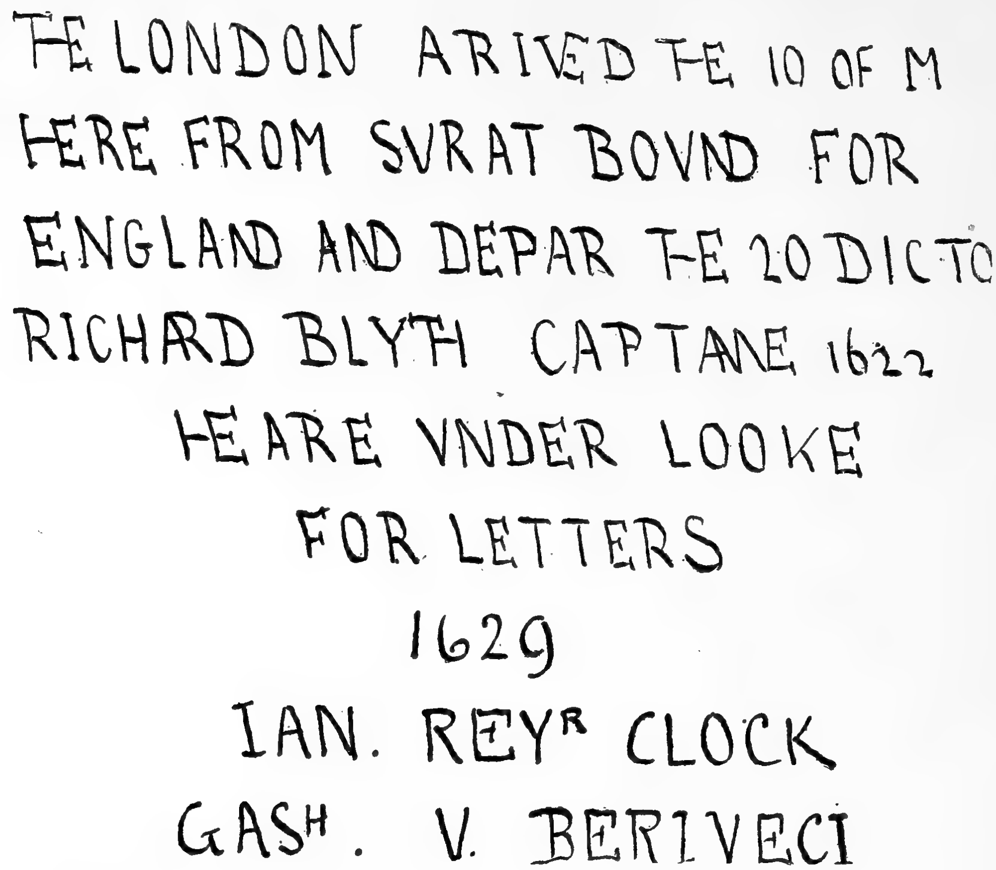
" In the same neighbourhood many such records exist, the place being contiguous to the ancient watering fountain frequented by seafaring people, who thus reported their progress, east or west. Something similar exists at the present day on a small island in Torres Straits, with the addition of provisions for the shipwrecked.

" You are welcome to these lines if you deem them worthy of publication.

" G. T."

The first of these is interesting as being the only complete Dutch inscription which I have hitherto come across, and it would be very desirable to find out who " G. T." was, and what became of the stone which he was so carefully preserving, as it never, so far as I am aware, reached the Museum.

* Which at that time ran down the centre of the Heerengracht, now Adderley Street.



Through Mr. William Foster I am indebted to Dr. W. R. Bisschop for some information regarding Martinus Sonck. He was "Advocaat-fiskaal" (Public Prosecutor) and Extraordinary Member of the Council of India. He arrived in Java probably in 1619, for he signs a letter as a Member of Council, dated July 31, 1620. Subsequently he was appointed Governor of Banda on April 10, 1621, and thence went to Amboyna in 1623 with the Governor, H. v. Speult. Finally he returned to Batavia, when he again took his seat at the Council during the end of 1623 and the beginning of 1624, after which we hear of him no more. This information is all extracted from a work on the early voyages of the Dutch by de Jonge, "De Opkomst van het Nederlansche Gezag in Oost Indie, et. ct.," published at the Hague and at Amsterdam between 1862 and 1880.

The other inscription mentioned by "G. T." is the one now preserved in the General Post Office, and must have been again buried until finally unearthed in 1897.

HISTORY OF THE LOCAL NAMES OF CAPE FISH.

By J. D. F. Gilchrist, M.A., B.Sc., Ph.D.,

Government Biologist.

(Read November 28, 1900.)

One of the most important factors to be taken into account in any scientific inquiry into the physical and biological conditions to be met with in South Africa, is the existence of two great ocean currents which encounter each other in this region, the one originating in the heated Indian Ocean, and bringing with it the climatic condition and abundance of forms of animal and vegetable life characteristic of more tropical regions, the other coming from the colder Antarctic regions and producing a very different effect on the coasts on which it impinges.

We are familiar with the results of investigation into the meteorological and biological characteristics associated with the land regions under the influence of these currents, but little or no attention has as yet been directed to marine life, which there is reason to believe is even more interesting in this respect.

The various kinds of fish that are found at different localities on the coast is one of the most striking instances of this, and it was while endeavouring to obtain information as to their occurrence, variety, and relative abundance at these places that my attention was directed to the subject we are about to consider.

An unexpected difficulty arose as to the names used at different places by those who supplied the required information, but who quite unwittingly often employed different names to signify the same fish, and as often the same names to signify different fish.

After some personal inquiry and correspondence the various names have been in a measure reduced to order, but the treatment of the subject is by no means exhaustive, and it was only when it proved to be expanding to undue dimensions that it seemed better to give a summary of results which might be a nucleus for further research.

Apart from the utility of the subject as a means to an end, it may also prove not uninteresting from a philological point of view, if only as in some measure indicating the rich field of investigation open to the philologist in South Africa.

That it will prove interesting and useful to many amateur naturalists and enthusiastic fishers in South Africa, who have supplied much of the information, I do not doubt.

Before entering into the question of the origin and history of individual names I shall give a list of those which have been procured. They are arranged alphabetically for convenience of reference, but different names for the same fish are grouped together under one of these names (the oldest as in zoological nomenclature) and are followed by the scientific name so far as it can be ascertained. Where the various synonyms occur again in their alphabetic place a reference is merely made to the oldest name. The list is thus not merely a catalogue, but an attempt to identify the various fish to which the names are applied. This has not been an easy matter, and I cannot hope that the result is at all free from possible error.

In many cases I have added in brackets after the name the locality in which it is used, and in others the authority by whom used. Where the name has only been heard and not found in written form, I have spelt it phonetically and added the word *voce*. These additions, however, are only given in cases where they seem of particular interest.

[For list see end of this paper where it is also used as an index.]

The most striking feature of this list is the mixture of Dutch and English names, the former being predominant. Of the Dutch names there are several for which no English synonym has been found; nor are these confined to the rarer fish which might be known only in Dutch communities, but include such well-known forms as the Snoek. A very few names—only one or two—occur which are apparently neither of Dutch or English origin, but are for this reason all the more interesting as probable relics of the past, for in nomenclature there is as truly a natural selection or the survival of the fittest, as in the arena of animal life. I hope, indeed, to be able to point out some instances in which the process is now going on.

It is well known to the philologist that names form an unwritten history of the vicissitudes through which a country has passed, as well as reflect the character of the people who originate and use them—in short, that the human struggle for existence is—dimly it may be, but faithfully—reflected in nomenclature, and it will be found instructive to keep this in view in endeavouring to trace the origin of the individual names.

In glancing over the list it will be seen that they can be readily arranged in the following groups :—

(A) Borrowed names, including :
  1. Names borrowed from known fish more or less resembling the South African forms.
  2. Names borrowed from persons, animals, or things resembling in some respects the fish requiring names.

(B) New names, including :
  3. Names derived from some striking peculiarity of colour, shape, &c.
  4. Names derived from habitat.

1. *Names borrowed from known fish more or less resembling the South African forms.*

This is the most obvious origin of the majority of the names, and fortunately the detailed records kept by the early settlers, now made accessible by the labours of Mr. Leibrandt, are available for use in this inquiry.

When, in 1652, the Dutch East Indian Company decided to make the Cape a calling station for ships passing to and from their possessions in the East, they naturally began to turn their attention to the resources of the country. That the fishing industry was not regarded as one of these is apparent from Van Riebeek's complaint that the early settlers "paid more attention to fishing than to the development of the resources of the country." He even took active steps to discourage any development in this direction, doubtless, however, as he feared that other industries, of more immediate importance to his Company, might suffer thereby, for more than once he mentions the abundance of fish almost as if it were a particular grievance.

But Dutchmen are born fishers, and in an early entry in his Journal (April 6, 1652) we are informed that on his arrival at the Cape, to form a permanent settlement, one of the first things he did was to order "Skipper David Coninck to proceed to shore to search for letters, obtain vegetables, and draw the net for some fish." Four days after this, when the erection of the fort was begun, the same skipper set out on a fishing expedition to the Salt River, not without good results, for he returned with "750 beautiful Steenbraesems, and four other delicate fish of more delicate flavour than any fish in the Fatherland, one looking like a haddock (Shelvisch) and as good and fat."

The name "Steenbraesem" thus promptly given was undoubtedly adopted on account of a resemblance to the "Brasem" (*Cyprinus brama*) of Holland, though generically and specifically a different fish. The name has survived to this day under the somewhat modified form of "Steenbras," one of the most familiar names at the Cape. It is called Steenbras, White Steenbras, Kaapsche Blaauwe Steenbras. This last name, which I give on the authority of Pappe, does not seem to be now in popular use. Curiously enough the same fish seems to be known at Mossel Bay and Knysna as Vorkbek, or Varkebek, evidently corruptions of Vark-bek, literally Pig-nose. It may be that the Dutch who had spread to these places, not being of the seafaring class, or having lost their recollection of the fish of the fatherland, had invented this new name on account of the resemblance of the snout of this fish to that of a pig, and probably also on account of its habit of grubbing in the mud. If this is so the name throws an interesting side-light on the progress of early colonisation.

As regards the fish that looked like a Haddock, I am at a loss to know to what this could refer, and it is interesting to note that the name has not survived. It may have been a small Geelbek or Kabeljauw.

Van Riebeek's enthusiasm as to the superiority of the flavour of Cape fish has also not survived. Perhaps it is to be regarded as a tinge of the exaggeration and romance of those early voyagers to whom the world was then only becoming known.

The following entry is found at a later date (July 24th): "Stock fish supply exhausted—resolved to catch fresh fish to be supplied 3 times a day as long as the heavy work lasts. Went out fishing yesterday; caught 400 Steenbraesem and about 2,000 Harders, which we salted. Would that fresh meat were so abundant!" Harders are here mentioned for the first time, and the name applied to a South African fish which closely resembles the Dutch "Harder" (*Mugil chelo*) or English "Grey Mullet" (*Mugil capito*). The Dutch name Harder has survived in the Colony, and I know of no locality where the English name is used.

The mention of Stock fish is of interest. It occurs again in an entry in the Journal of October 21, 1655, and the context clearly shows that reference is made to the preserved fish brought out from Holland and not to the fish now known as Stok-visch at the Cape. The term is used in Holland with two different significations: (1) As dried Cod, called in Holland Kabeljaauw (*Gadus morrhua*) in opposition to salted Cod called "Laberdaan"; (2) as the popular name for *Merlucius vulgaris* known as "Hake" in England, and now known in South Africa, where the same fish occurs, as the Stok-visch, or Stock-fish.

In no instance can I discover that Van Riebeek refers to the South African fish under this name, and in this I am confirmed by Mr. Leibrandt, who is of opinion that this may be explained by the absence of the fish itself from South African waters in those days.

It is not mentioned by Kolbe, 1731, nor by Barrow, 1806, but appears in Pappe's list, 1853, with the following note : "It is remarkable that this fish, a notorious denizen of European Seas, was utterly unknown at the Cape of Good Hope before the earthquake of 1809 (December 4th). At first it was scarce and sold at exorbitant prices (4s. 6d.). Since that period it has yearly increased in numbers, and is now a standard fish on the market, being caught in great abundance."

This, however, may be received with a certain amount of reservation till more evidence is forthcoming.

We may note here the derivation of a word used in the Colony having the same double meaning as Stok-visch. It is "Bokkum," signifying in the Colony a small Harder, or Mullet, but also any small fish preserved whole. It is without doubt a corruption of the word "bokking" used in Holland, to signify smoked Herring—the small kind caught late in the year in the Zuider Zee being used for this purpose.

Gadus morrhua (called in Holland the Kabeljaauw, in England the Cod) does not occur in South Africa, but the names have been taken over to designate another fish which occurs in Europe, and is known in Holland as the Omber-visch, in England as the Meagre. This may be made clear by the following table :—

		Merlucius vulgaris.	*Gadus morrhua.*	*Sciæna aquila.*
Europe ……	(Holland)	Stok-visch*	Kabeljaauw	Omber-visch
	(England)	Hake	Cod	Meagre
South Africa …………		Stok-visch or Hake	Absent	Kabeljaauw or Cape Cod

It will be seen from this that the identity of *Merlucius vulgaris* with the northern form was recognised by both the Dutch and English, but not that of *Sciæna aquila*, which received the popular name given to *Gadus morrhua* in Europe (Kabeljaauw), the reason no doubt being that it is a somewhat rare fish in Holland and England though abundant in South Africa, and, curiously enough, common in the Mediterranean.

This fish was most probably the Cape Cod, well known to English seamen of early days as affording a welcome change of food on the long journey by the Cape to India. In the repertoire of wonderful stories of many an old sea captain is a more or less exaggerated account of the abundance of "Cape Cod" on the Agulhas Bank.

* Dried Kabeljauw and dried Stok-visch also called in Holland Stok-visch.

It was one of their many superstitions—in this case a very rational one—that it was unlucky to proceed with the voyage without stopping for a time in this locality.

The name Cape Cod is not used in the Colony, where the fish is universally known as Kabeljaauw.

Coming back again to earlier history we find the first mention of the now well-known Snoek in the account of an expedition to Saldanha Bay towards the end of the first year of the settlement at the Cape. The expedition was chiefly in search of seals, but numerous "Harders" and "Steenbraesem" were caught, and "some small sea Snoek." The name thus given has been retained ever since, and is one of the few for which there are no Dutch or English synonyms.

The name "Snoek" in Holland is applied to a fresh-water fish (*Esox lucius*, the English "Pike"), while the African fish (*Thyrsites atun*) is essentially a marine form though somewhat resembling the former.

The early settlers seem to have had some hesitation, therefore, in identifying the two fish, for it is called a "*sea* Snoek." Later generations have been less scrupulous, and it is now known simply as Snoek. The English word Pike does not seem to have been used at all to designate this fish.

It is of interest to note that *Thyrsites atun* occurs also in New Zealand and South Australia, where it is called the Barracouda, a name which also rightly belongs to another fish (*Sphyræna*).

The anglicised form Snook is frequently used in the Colony, and it occurs elsewhere (*e.g.*, in Jamaica) as the name of an entirely different fish.

On this same voyage to Saldanha Bay we find the first mention of Soles, called in Holland Tongen. They were named Tong, and the name is commonly used amongst the Colonial fishermen of the present day, though it seems to be in the process of being replaced by the English "Sole."

A characteristic of the early Dutch settlers comes out strongly in the naming of the animals and things they found in the new country. They were men of action with little time or inclination for reflection or scientific interest in things in themselves. For utilitarian purposes if a Dutch name could be got for a fish having some resemblance, however remote, to those already known they promptly applied the European name. When they came across fish totally unlike any known forms they were content to call them strange fish, or they might, by way of more definite specification, add some statement as to their taste when cooked. Thus in an account of an expedition to St. Helena Bay the entry occurs in the Journal: "Boat caught about 100 strange fish—not nice;" and again on another occasion they "caught some sweetly tasting fish," and "caught some fish (name unknown)."

But even the most stolid anti-scientific Philistine will on occasion become enthusiastic over the wonders of nature. At St. Helena Bay we are told some specimens of a remarkable fish were caught, which had "an antiquated head, a sharp spear on the back, and a tail like a shark; some had small legs, which they could draw up under the stomach, very strange—as may be seen from the accompanying sketch." This was apparently "*Callorynchus antarcticus*," the "small legs" being the "claspers" of the male. The investigations of the Dutch skipper have been followed up, and the fish has proved even more wonderful than he imagined. No name was given then to the fish, but it is now known as "Joseph, or Josup," a name the origin of which is as puzzling as the fish itself. I have not seen the name printed or written, and so far can suggest no plausible derivation. It may be a corruption of "Jood's visch" or "Jew's fish."

It is somewhat striking that the early Dutch seamen seem to have found many fish which are not now known to occur in the Colony, and of which the names have not survived. Thus we are informed that "Soles (Tongen), Plaice (Schol) Flounders (Bot), and other flat fish as well as Haddock (Shelvis)" were found at Saldanha Bay. Of these the present Dutch fishermen at that place know only the Sole.

A similar instance of the occurrence of varieties of fish not now known we meet with in a later entry. In an expedition to the interior, led by Surgeon Pieter van Meerhoff, we are told by him that in the space of 1½ hours they caught "beautiful Carp (Kerper)," as much as they could carry away. This is undoubtedly the fish (*Spirobranchus capensis*) still called Karper in the Colony by the Dutch (in Holland Karper = *Cyprinus carpio*). When, however, he proceeds to inform us that he also found in the same river "a living monster with three heads like three cats' heads" and provided with "three long tails showing above the water," we come to another instance of an extinct fish which has not left even a name behind.

There appears, therefore, to have been extensive changes in the fauna of our seas and rivers. Even as late as 1731 Kolbe informs us that there was "great plenty and variety of fish in the rivers," where now, alas! they are conspicuous by their absence. He also saw a sea monster, described it in detail, and gave it a name—"Sea Lion." That this is not another name for what is now known as the Robbe, or Seal, is apparent from his description, which is as follows:—

"I never saw a Sea Lion but once, and that was at the Cape in the year 1707. A Sea Lion that year came into Table Bay, and having sported for some time in the Bay got upon a cliff and lay there basking in the sun just on the edge of the water. The Cape Europeans had their eyes upon him immediately, and the Governor was quickly informed of this visitor. It was then ebb water. But it was not thought proper to attack him till the water should be fallen a good way from him. When the water had left him some considerable way the Governor ordered out the schallop with three men and as many firearms loaded with bullets to kill this creature. And the schallop coming pretty near him before he stirred, the men fired and despatched him. He was about 15 feet long and as many in circumference. His head was pretty much like that of a lion, save that he had no hair upon it. The tongue was all fat in a manner, and weighed 50 lbs. weight. There was neither hair nor scale upon any part of him. The colour of the skin was yellowish. He had forward two short legs ending with feet like those of a goose. These, I suppose, were of great advantage to him in swimming. In the place of hind legs he had two broad thick fins, each 18 inches long. His body tapered to the tail, which ended in the shape of a half-moon."

It is difficult to account for these lost names, and we cannot but reflect on the proverbial veracity of early travellers in general and of fishers of all times in particular.

It cannot, however, be inferred that they were more lacking in knowledge or observation than their present-day successors, and we may quote an instance to show this. In an expedition, October 20, 1657, "on the upper side of the Diamond and Paarl Mountain, following the course of the river" (evidently the Berg River), the explorers "caught some fish called Barmer and of pleasant flavour, rather full of bones though, like the Dutch Pike." The word Barm, or Barbeel, was evidently brought from Holland, where Barbeel or Berm is used for *Barbus vulgaris*, also called in Britain the Barbel. The fish found in the Berg River was doubtless also a Barbel, viz., *Barbus capensis*, which is known to occur there at the present day. It is now, however, called by the Dutch "Moggel"—a word which, as has been suggested (Mr. Tooke), may be a corruption of the Latin *Mugil*, a generic name which has been applied to this fish, or it may refer to the general appearance and shape of this fish, "moggel" in Dutch signifying a clumsy child. Quite recently inquiries were made as to whether this fish was a trout, and it was suggested that it might be a cross between a springer and a trout, as it had not been observed till recently.

Again as to their powers of observation, we find mention made in 1649 of the occurrence of Herring in the waters of the Colony. More than two hundred years later no little excitement was caused in the Colony by the discovery of "true Herring" at Port Alfred.

These fish are properly called Herring, and are a species peculiar to the Cape (*Clupea ocellata*), differing little from the European Herring (*Clupea harengus*). As evidence of the slow progress or even retrogression of popular scientific knowledge we may note that they are now generally known as "Sardyn," and if further evidence is wanted we find that the Harder, or Mullet, is now not unfrequently called the Cape Herring.

They are mentioned by Kolbe (1731) who tells us that "in the Cape seas there are shoals of Herring agreeing in every particular with the European Herring, and there is likewise about the Cape a sort of Herring the Cape Europeans call Harters." This is inaccurate, but not so inaccurate as the present-day popular nomenclature.

A few other names, obviously borrowed from European fish—though I have not been able to find any historical references—are the Elf (*Temnodon saltator*), which somewhat resembles the Elft (*Clupea alosa*) of Holland, though the two are by no means scientifically related; the Gurnard, or Knorhaan (*Trigla peronii*), not unlike its European representative (*Trigla gurnardus*); the Maasbanker, which is identical with the Maasbanker (*Caranx trachurus*) of Holland, and indeed is to be found almost everywhere within the temperate and tropical zones of both hemispheres. The English name for this fish (Horse Mackerel) is seldom heard in the Colony. Like the emphatic word "Snoek" it has retained its place, and, like it, is also represented in the New World by a modified form, "Mossbonker." It is otherwise with its kinsman the "Makreel," which seems to be giving place to the English form "Mackerel." The Cape Mackerel (*Scomber grex*) is closely allied to the northern form (*Scomber scomber*), both belonging to a family of very wide distribution. Another name obviously borrowed is that of the Cape Pijl Staart (*Myliobatis aquila* and *Trygon pastinaca*) from the fish of that name in Holland (*Trygon pastinaca*). The word Spiering, used in Holland as the popular name for *Salmo eperlanus* (the English Smelt) is also found in the Colony, and is applied to a fish somewhat resembling it (*Atherina breviceps*), but quite different scientifically. It is also called Spieringtje at Hout Bay and

Somerset Strand, and Castelnau says Cape fishermen also call it Assance. The Rog, or Roch, of Holland, Skate of England, is closely related to the Cape form (*Raja maculata*), and the word Vleet, used in Saldanha Bay, is most probably the name of a fish resembling the Vleet (*Raja batis*) of Holland, though it has not been described nor have I seen it.

We have commenced this section of names borrowed from Europe with Dutch names, we may fittingly close it by considering a pre-eminently English name.

If the tiger of the sluggish rivers of Holland, the Snoek, or Pike, was prominently in the minds of the Dutch when naming the fish of the new land, it might be expected that the lordly Salmon would be readily suggested to the British by any form at all resembling it. I have been informed (Mr. Thompson) that the name Cape Salmon has been applied to the commonplace Kabeljauw, and even to the culinary-looking Stock-fish, but it is now appropriated almost exclusively by the Geelbek, a fish which, seen fresh from its native element, certainly does call to mind the brilliance and majestic proportions of its European namesake.

Unlike the name Snoek, however, "Cape Salmon" had a rival already in possession—"Geelbek," and, moreover, its patrons were not undivided. Another fish was found on the East Coast at Port Elizabeth, which presented additional claims to the name, resembling the Salmon not only in shape and colour, but in sporting qualities, and showing almost as much game and fight on the rod as the monarch of mountain streams. It may be true that according to scientists it is only a large kind of Herring (*Elops saurus*), and it is even indifferent eating, but the towns of the Eastern Province stick to the name, and no little confusion is caused thereby. Thus one of my correspondents at Knysna informed me that the Cape Salmon there was very rare, another that it was very abundant; the explanation being that they were each referring to different claimants to the name.

We can leave the litigants to future generations, who will probably decide in favour of the Herring with the sporting qualities, which has besides no other name of its own. The Stock-fish and Kabeljaauw may retire from the contest, though we need not grudge the little glory which the latter still retains in the remote little village of Paternoster on the West Coast (see List).

We have now exhausted the list of names borrowed from Dutch or English fish, and have to mention two which have been adopted from the vocabulary of the cosmopolitan sailor. These are the Bonito (*Thynnus pelamys*), probably the Barneta of Britannia

Bay, and the Albacore—a name applied by seafaring men to other species of this genus, but which has been appropriated in South Africa by quite a different member of the Mackerel tribe, viz., *Seriola lalandii.* This seems quite unnecessary, as it is already provided with a well-known name, "Yellow tail"—Dutch "Geelstaart." As if this were not enough, it has also an extraordinary number of corruptions or variations of the name, viz., Albukure (Valentyn), Alfakoor (Cape Town), Albert-Koord (Hoetje's Bay), and Halfcord (Pappe). After this we are not surprised to find the same fish reported from Australia under the *alias* of "King Fish."

Two other names remain to be mentioned in this category if I am right in their derivations. These are the Leer-visch and the Panga.

As to the former the word Leer is evidently the Dutch leer or leder (English leather). I cannot find that any fish bears this name in Holland, but a passage in Valentyn's account of the Fishes of the East Indies (1726) seems to throw some light on the subject. He describes (p. 339) a fish resembling our Leer-fish (*Lichia amia*) and which he calls by this name on account of its "thick brown skin, almost like leather." Probably the Cape Leer-fish was so named by the early Dutch sailors, who brought the name from the East Indies, and were struck with the similarity in the leathery skin of each.

So far as I can ascertain there is not a single name which the Dutch have taken over from the natives of this country. The "Strand Loopers" whom the early settlers found eking out a precarious living by fishing and gathering shell-fish on the shore, and who must have had names for the various marine animals in which they were particularly interested from a practical point of view, have left no historical trace in fish nomenclature, nor have the various tribes of Hottentots, Kaffirs, &c. However closely the early settlers may have come in contact with the aborigines in commercial relations, there is evidence that in this respect they showed very little assimilative tendency, and we look in vain here for any trace of the presence of the lowly people, whom the Dutch found in possession of the land. It might have been expected that the Malay slaves whom the Dutch brought from their possessions in the East would have retained some of their native names, more especially as they soon became pre-eminently the fishing section of the community. I have found, however, only one name which can with any probability be traced to such an origin. This is the name "Panga" (*Pagrus laniarius*). The fish to which this name is applied bears a strong resemblance to the common Silver-fish, and at many places in the Colony does not seem to be distinguished from it by any specific name. It differs, however, from this fish in having a slightly different shape and in having two of the front teeth somewhat protruding from the mouth. As the name is chiefly used by the Malay fishermen, and no other derivation has been suggested, it seems probable that it may have been originally a Malay name; and there is some confirmation of this. Valentyn in his "Old and New East Indies" mentions a fish which the natives called Ikan Pangerang or Pangarang (literally, prince) which seems to bear some resemblance to the Cape Panga, more especially in its having the protruding teeth. I have some confidence, therefore, in offering this explanation of the name.

An interesting analogous derivation is to be found in the name "Snapper," applied in East London to the Red Stumpnose. This name is applied in Australia to a fish not unlike it, and the origin of the word is doubtless to be found in the English Colonies, just as Panga is to be traced to the early Dutch East Indies.

There seems to be no trace of the early French settlers, except perhaps the name "Carpelle," which I am informed by Mr. Péringuey is sometimes used in Stellenbosch district for the Dutch "Karper" (*Spirobranchus capensis*).

Summing up, therefore, the names in this section borrowed from known fish we have 23 Dutch, 15 English, 2 Cosmopolitan, 1 Indian, 1 French, and 1 Australian, representing 27 different species. Of these only two are identical with the forms after which they were named. These are the Dutch Stock-fish, (English Hake) and the Dutch Maasbanker (English Horse Mackerel). Another fish, the Dutch Omber-visch (English Maigre), occurred in South Africa, but was not recognised, and the name of another European fish (Kabeljaauw) given to it. The other names were given on account of more or less resemblance to their namesakes.

2. *Names derived from resemblance to persons, animals, or things.*

Wherever the Dutch settlers could find any resemblance, even a remote one, to the fishes of the Fatherland they did not hesitate to apply the known name rather than invent a new one or accept the one already in existence.

It is difficult, however, to discover many such resemblances, and other names had to be found. It is noteworthy that here again the tendency to think of and describe the unfamiliar by the familiar is forcibly illustrated, for the majority of the remaining names are derived from known persons, animals, or things, rather than from any outstanding features of the fish themselves.

Thus a certain fish characterised by a large head with striking frontal development, instead of being called Groot Kop, or some such name, is called Bisschop, though Groot Kop would not express that air of ecclesiastical gravity and profundity characteristic of the features of this fish and supposed to be found in a bishop. We may admit that the popular name has, therefore, in this case some claims as against a more strictly scientific designation. But what can one say of the "Fransch Madam"? The fish so called (*Chrysophrys holubi*) is of a swarthy colour, like the Hottentot Fish, somewhat plump in form and with large black eyes. I do not know if this description applies in any way to a French lady, but probably the inventor of the name detected some points of similitude.

There can, however, be little doubt as to the origin of the name Hottentot, and it requires no great stretch of imagination to see in the fish so called some resemblance to the black, stunted natives whom the Dutch found in possession of the land. Kolbe, however, suggests that the fish was so named because the Dutch were in the habit of purchasing it from the natives, and Nieuhof, because "the Hottentots caught it with a hook." This name is the only one which can be said to be of native origin—and that only very indirectly.

The Fishing-Frog, or Angler of the European seas, is represented in South African waters by a closely allied form (*Lophius upsicephalus*), and is known in several places in the Colony as the Paddy, and in others as the Devil Fish. In Holland it is known as Kikvorsch Zee-duivel, Hozen-mond or Hozen-bek.

[*Note.*—Miss Wilman, at the meeting of the Society at which this paper was read, suggested that Paddy might be a corruption of Padda, the Dutch for frog. This seems very probable.]

There is at Mossel Bay a somewhat rare fish called the Scotchman, but I have only heard the name, and am unable to say to what species it belongs, or what national characteristic it possesses to justify the designation. It is said to have a very long head.

The Boer Kabeljaauw is a name applied to large Kabeljaauw, a fish which sometimes grows to enormous proportions. Fishermen inform me that it is so called as it is eagerly bought by Dutch farmers who prefer quantity to quality.

The name Mooi Nooije (literally, pretty girl) is not inappropriate to a modest little fish with bright golden stripes which harmonise well with the dark grey and yellow of the sea Bamboo, amongst which it lives. It is for this reason also called the Bamboes-visch.

The name may be compared with the local name in Holland for young Kabeljaauw, viz., Mooi Meisje, and it is of interest to note that the word "noi" or "nooi" is exclusively a Cape word, probably derived, as Mansvelt suggests, from the Portuguese "noina," meaning a bride.

An allied name is the Kaapsche-Nooije, for which I am unable to suggest any origin.

These names derived from persons have all had a general reference, but there are two which have been named after individuals. The first, commonly called the Seventy-four (*Dentex rupestris*, Castn.), is also known in some localities as Peter's Fish, on account of its having a black mark on each side of its body such as might have been caused by its being violently seized by some one between the finger and thumb. I have been assured by Dutch fishermen that this is to be connected with the historic incident in which the Apostle Peter so miraculously found the tax-money.

The other case is that of an obscure sailor who has been immortalised in the name Jacopever. Francisci gives a most circumstantial account of the derivation of the name. The Dutch sailor, Jacob Evertsen, was possessed of a peculiar rosy complexion which the historian charitably supposes to have been a congenital not an acquired characteristic. While out fishing one day a remarkable, somewhat comical-looking little fish of a reddish blotched colour and with prominent eyes, was pulled up, and so struck were his mates with the resemblance to their companion that they forthwith christened it "Jacob Evertsen"—a name which it has retained to the present day under the somewhat modified form Jacopever.

As might have been expected, the peculiar fauna of South Africa has furnished some striking names, such as the Zebra, the Dasje, the Elephant, the Porcupine, and the Parrot. The name Zebra-fish, or Wildepaard, is applied to a fish with several well-marked stripes running across the body. The Dasje might also with a little stretch of the imagination be likened to the rabbit or dassie, from its general shape, and this is the name by which it is known in Cape Town, Hout Bay, and Kalk Bay.

The name Zee-vark (literally, sea-pig) presents some little difficulty, as the fish in no way resembles a pig. The derivation, however, becomes very apparent when we think of the Isser-vark, or Porcupine, and bear in mind that the fish is also called the Porcupine-fish. In the matter of bristles it is even better provided than the Porcupine, and resembles more a hedgehog in its most offensive attitude. The bristles are comparatively long and very sharp, so that the living fish must be handled with care.

This is the only case of what might be called indirect derivation of a name that I have come across.

Two other names may be compared with it—derived *directly* from the animal from which they have borrowed the name. These are the Vark-bek, so called on account of its pig-like snout, and the Varkje, so called on account of the grunting noise it makes.

The mane-like dorsal fin of the Paarde-visch, and the horse-like profile of the head, sufficiently accounts for its name, while the hard beak of the Papegaai-visch, or Parrot-fish, called also the Kraai-bek, or Crow-beak, is surprisingly like that of a parrot.

The name Tiger-shark is a libel on the monarch of the jungle. It is applied to a small dog-fish with yellow markings remotely resembling those of a tiger. So far from possessing the proverbial ferocity of his great namesake, this little creature is so shy that when taken out of the water he turns his head away from the onlooker quite abashed—at least, so the Dutch fishermen imagine who have given him for this reason the additional name of Schaam-oog.

The name Bontrok, applied to a species of Dentex at Mossel Bay, appears to refer to its variegated colouring (*bonte*, variegated, and *rok*, coat), or is perhaps derived from some supposed resemblance to the Bontrokje, a species of stone-chat.

Coming now to the names derived from inanimate things, we find a most extraordinary miscellany of objects from a man-of-war to a needle.

An anonymous writer in the *Cape Monthly Magazine* (vol. iv., p. 354) informs us that there was then a tradition that the name of the fish called Seventy-four arose "from its having been caught from a ship of the line of that number of guns on dropping anchor in Simons Bay." Similarly the name Gelleon, applied to a fish in the Dutch East Indies, is stated by Valentyn ("Old and New East Indies," vol. iii.) to have been so called because it followed the ships and was often found about the Galleons ("de Galleonen"). The Cape fish Galleon, or Galjoen, probably got its name in this way though it seems to be different from the East Indian form.

These derivations may be correct, but another naturally suggests itself to those familiar with the appearance of these fish. The Seventy-four is characterised by several very distinct bright blue bands running along the body, not unlike the rows of guns of an ancient man-of-war, one carrying seventy-four guns being considered a well-equipped vessel in those days. The Galjoen also can readily be supposed to have derived its name from its resemblance in shape to the high built three-decker of the fifteenth and sixteenth century called by the Spanish, "Galeon" (Latin, *Galea*), and by the Dutch "Galjoen" or "Galleon."

Additional evidence that the Seventy-four derived its name from a Simons Bay warship, is afforded by the fact that on the East Coast (Port Elizabeth and East London) the fish is not so named but is called the Silver-fish.

The Naald-visch, or Needle-fish, is the possessor of a long, slender beak, about half the length of its body—a prolongation of the lower jaw. The name Zee-naald is used in Holland to designate other fish, viz., the Garfish and a species of Syngnathus, but not with the same fitness as in the case of the South African form, and I am inclined to think that the name was not applied here on account of any resemblance to the European fish. This is borne out by the fact that a species of Syngnathus differing very little from that found in Holland occurs in the Colony.

The Melk-visch is said to derive its name from the colour of the flesh when cooked. It may, however, also be from the milk-white colour of the upper part of its mouth.

The Pampelmoes probably derives its name from its resemblance to the fruit so called, a species of bitter lemon. Pappe and Castelnau seem to be wrong in using the name "Pompelmoesje," as a synonym for Steen-klip-visch (*Chilodactylus fasciatus*).

The Vioel-visch, or Fiddle-fish, is a species of shark with no claim to musical talent, but having a flat body and long tail not unlike the body and neck of a violin.

Windtoy is a name the derivation of which is not very obvious. The spelling "Windtoy" is given by Pappe, Castelnau, and Bleeker, but as pronounced by Malay fishermen sounds more like Wind-ei, which would mean in Dutch a wind-egg, the colour of which is somewhat similar to that of this fish. This derivation I, however, suggest with some hesitation.

Some little difficulty was found in tracing the origin of the word Dageraad, owing to the various corruptions, verbal and written, under which it appears (see List).

I have little hesitation, however, in suggesting that it is the Dutch word Dageraad, meaning dawn of day, or sunrise, and certainly the gorgeous hues of this magnificent fish fully justify the name. The Dutch fisherman who first named the fish must have possessed a poetic imagination of no mean order. The name comes somewhat as a surprise. Rooije, Rooi-man, Rooi-stumpneus we expect, but not Dageraad (day-dawn). Perhaps it may have been a stray flash of oriental fancy not quite extinguished in the humble folks whom the countrymen of Van Riebek brought as slaves from the East.

The name Roman is of special interest. It is maintained by some that the fish takes its name from the Roman Rock in Simons Bay, where it is frequently found; by others that the Rock takes its name from the fish. This latter seems to be the most probable derivation, Roman being simply a corruption of Rooi-man. This is apparently lost sight of in the redundancy Red-Roman sometimes heard.

The fish now called Silver-fish is a strikingly red fish, though exhibiting a silvery sheen when fresh. It is so called in Table Bay and False Bay, while in Algoa Bay the name is applied (quite appropriately) to the Seventy-four. The "Gold-fish" described by Kolbe in 1738 seems to be the Cape Town Silver-fish, while his "Silver-fish" corresponds well with the present "Zee-basje" of Cape Town. At Port Elizabeth it is not called Silver-fish, but Kapenaar.

Other names derived from colours are the Blue-fish, the Gold-stripe-fish, the Keelbek (yellow mouth), the Geel-haai, the Geel-staart already noticed, the Geeloogie (yellow eye), and the Streep-visch.

The John Brown and Jacob Swart stand in a category by themselves. There is no reason to believe that the former is in any way connected with the hero of the American song, or that the latter has any individual reference. The names appear to refer simply to the colour of these fish.

3. *Names derived from striking peculiarities of colour, shape,* &c.

We come now to a different class of names. European fish and land animals have been drawn upon for names, but as there is only a limited number of either of these at all resembling South African fish the borrowing process was necessarily a limited one, and new names had to be invented.

Cape fish are, however, particularly adapted to this process. A European, accustomed to the sombre hues of northern forms, is at once struck by the number of fish with bright colours, red being prominent. This is reflected in the names Red Stumpneus, Red Steenbras, Roman (= Roi-man), Rooi-Knorhaan, Roije. The Silver-fish, Panga, and Jacopever, are also strikingly red fish, though they have got their names otherwise.

Other names have been derived from various peculiarities, and have only to be mentioned to show their origin. Such are Dik-kopje, Dik-bekje, Stompneus, Baardman (from a barbel or feeler under the lower jaw), Haarde-staart, Grunter, Klip Zuiger (from its habit of adhering to rocks), Stink-fish, Springer.

The name Drill-visch is apparently from the Dutch "trillen," to tremble. It is also called the Electric-fish. Both names refer to the unique method of defence or offence possessed by this fish.

One name in this section is of peculiar interest, as it illustrates a very primitive method of naming—perhaps the most primitive method of all naming. It is the name Chor-chor, given to a fish which, when caught, makes a grunting noise, apparently imitated in the name. Though not a fish the "Tschokka" may be mentioned as another example of this. It is applied to the Cuttle-fish, or Squid, on account of the peculiar noise it makes when landed.

4. *Names derived from habitat.*

Several names, or parts of names, are derived from the localities in which the fish are found. Thus we have Cape Salmon, Kaapsche Roode Stompneus, Baaische Roode Stumpneus (Pappe) Steenje, Klip Visch, Steen Klip Visch (a peculiar redundancy), Riet Bull, Sand-fish, Sand-Kruiper, and Sand-steenbras.

The name Kaapenaar evidently means Cape Fish. Hangberger is supposed (*vide* Pappe's Synopsis) to derive its name from Hangberg, a mountain at Hout Bay where the fish occurs, by others from the fact that it frequents overhanging ledges of rock, while I have been informed by a fisherman that it is so called because it is found in deep water off Cape Town at a place which is reached when Hangberg Mountain appears in sight.

We have hitherto considered names for which derivations can be suggested, some with a degree of probability, practically amounting to certainty, others with lesser claim to certainty, and others of very doubtful origin. There are a few, however, for which no plausible derivation can be discovered. These are Bafaro, Assous, Zeverrim, Katonkel, Joseph and its variations, Oortje, Forfarin, Sanchord. The first four have been heard only, and are written down here phonetically, the two following have been obtained from correspondents, and the last appears in Pappe's Synopsis.

The derivations are probably obscured by corruptions of the original words, and I am not without hope that they may be cleared up.

To illustrate how many extraordinary contortions the names may undergo, I give here a list of the corruptions which have been traced to their original forms :—

Albacore	corrupted	into	Albert-Koord (written), Alfacor (heard), Half-cord (written).
Ansjovi	,,	,,	Ansjous (written).
Biscop	,,	,,	Poeskop (written), Proenskop (written), Poenskop (heard), Koenskop (heard), Koeskop (heard).

Dageraad corrupted into Dagara (written), Davaraad (written), Dagerhart (written), Daaga - raad (written).
Jacob Evertsen ,, Jacopever (heard).
Riet Bull ,, ,, Red Bull (written).
John Brown ,, ,, Tambrijn (heard).

Having now finished the consideration of the individual names and their derivations, though the subject has been by no means exhausted, we may in conclusion direct attention to a few generalisations which have been forced upon our notice in the course of the inquiry.

It must have been observed that in these names there is a dim shadow of the history of the Colony. The word Hottentot is the only trace of the presence of an aboriginal race, while Panga suggests an East Indian element, and Nooije a Portuguese. The abundance of Dutch words indicates the presence of a more vigorous European people, while the English names, very evidently superimposed upon the Dutch, indicate the arrival of another people.

The old word "Galleon," together with the later "Seventy-four," are suggestive historic remnants, while the much later "Snapper," of Australian origin, brings us up to more recent developments.

An interesting sidelight seems also to be thrown upon the character of these various races. The only aboriginal name, Hottentot, was not taken over by the Dutch as the native name for this fish, but probably, as we have seen, on account of its having a resemblance to, or being in some other way associated with them. I believe there is even some doubt as to this being a native word at all. Similarly another humble people who came in contact with the more vigorous race have left only one single word to suggest their existence.

It is to be noted also that the early French settlers have left no trace of their nationality in these names, unless indeed the "Fransch Madam" and "Carpelle" be regarded as such. The Dutch have, on the other hand, left the impress of their individuality strongly on the nomenclature of the land. We cannot venture, however, to draw any general conclusions in this respect from the limited material we are now utilising, and it is properly a subject for a much wider philological investigation of South African names.

We are on surer ground when we consider names as they are at present distributed in the Colony. The outstanding feature is that those used on the West Coast are mostly Dutch, those on the East Coast English. In fact, there is a striking though accidental parallel between the distribution of the various names and that of the fishes themselves.

It has been one of the chief objects of this paper to homologise these names and thus help to eliminate the confusion caused by the application of different names at different places to the same fish, and if this has in a measure been attained we shall be in a better position to secure further information as to the varieties, occurrence, and habits of the fish inhabiting our seas.

This brings us back to the problem with which we started, viz., the distribution of marine forms of animal life and the peculiar conditions in South Africa which bring this about, and I cannot but hope that a little clearing up of the confusion of names will help in this investigation, and may induce some who have the opportunity to take an active interest in the subject, and add to our too scanty knowledge of the marine life of South Africa.

LIST OF THE LOCAL NAMES OF CAPE FISH.

		PAGE.
AAL, Paling, Eel	*Anguilla delalandii.*	
Albacore, Albicore, Albukur (Valentyn), Half-cord (Pappe), Alfakoor, *voce* (Cape Town), Albert-Koord (Hoetje's Bay), Yellow-tail, Geel-staart (Struis Bay and Jeffrey's Bay)	*Seriola lalandii*	217
Angler. *Vide* Fishing-Frog.		
Ansjovi, Ansjous (Hoetje's Bay), Anchovy, White Bait (Knysna)?	*Engraulis holodon.*	
Assance. *Vide* Spiering.		
Assous. *Vide* Spiering.		
BAAR. *Vide* Barbeel.		
Baardman, Baardmannetje (Pappe), Bellman (Riversdale)	*Umbrina capensis*	223
Bafaro, *voce* (Cape Town)	*Polyprion prognathus*	224
Bamboo-fish. *Vide* Bamboes-visch.		
Bamboes-visch, Bamboo-fish, Stink-fish, Gold-stripe-fish (Hoetje's Bay), Streepje (Knysna), Mooi-nooitje (Hermanuspetrusfontein and Struis Bay)	*Box salpa*	219
Bank Steenbras (Cape Town). *Vide* Rooi Steenbras.		
Barbeel. *Vide* Moggel.		
Barger (Steenberg's Cove), Baager (Britannia Bay), Baar (Paternoster)	*Galeichthys feliceps.*	

THE LEG AND TOE BONES OF *PTYCHOSIAGUM.*

By R. Broom, M.D., B.Sc.

(Read November 28, 1900.)

(Plate XXXII.)

Among a series of geological specimens recently presented by Mr. Leslie, of Port Elizabeth, to the Eastern Province Naturalists' Society was a piece of stone on which were displayed a small tibia and fibula. The specimen had been sent from Colesberg and had been found in association with a fine skull of *Ptychosiagum Murrayi*, now in Mr. Leslie's possession. As the matrix of the specimen is quite similar to that of the skull, and as the peculiarities of the leg bones are such as might be expected from what is known of the other limb bones of *Ptychosiagum*, there does not seem to be any reasonable doubt in referring the bones to the same genus.

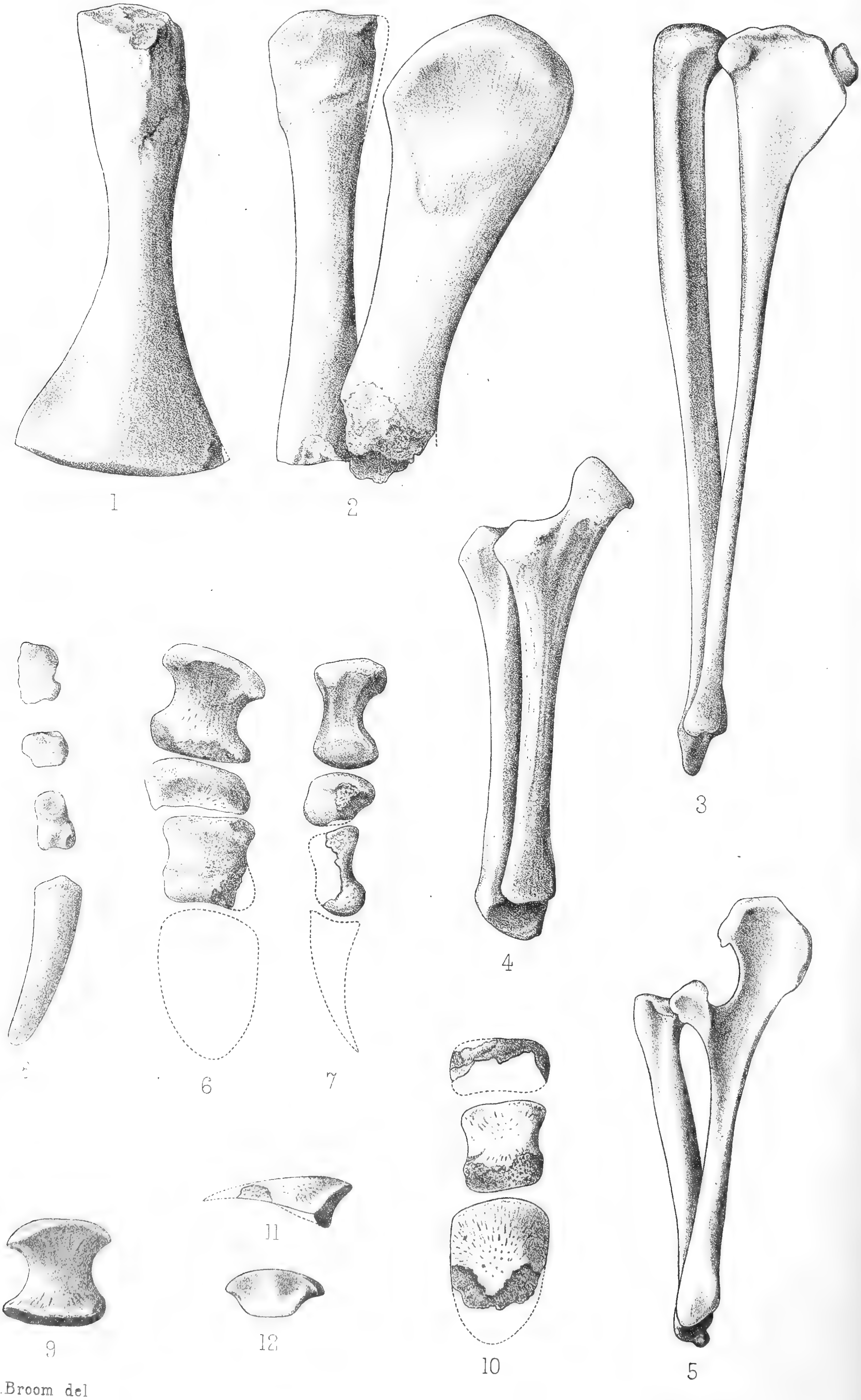
In clearing away the matrix from the bones I was fortunate in discovering the greater part of two toes with the bones in apposition, and a couple of carpal bones.

The tibia is almost quite perfect. It is narrow and rounded in the middle, slightly expanded at the proximal end, and greatly expanded at the lower end. Down the front of the upper third of the bone there is a fairly well-marked crest, on the inner side of which the bone is slightly hollowed for the attachment of the tibialis anticus muscle. On the outer side of the upper part of the crest is a small depression, doubtless corresponding to that seen in a similar situation in the tibia of *Ornithorhynchus*. The lower end of the tibia is so greatly expanded that its transverse measurement is quite three times that of the middle of the bone. The tibia has had a large cartilaginous pad on its lower end, so that instead of its showing an articular surface for the astragalus it presents an almost smooth surface to which the cartilaginous pad has been attached. This peculiarity has not been hitherto met with in any of the allied South African forms, and so far as I am aware only occurs in aquatic forms. Among Reptiles a somewhat similar condition is seen in the Pythonomorpha and in Plesiosaurians.

The fibula is unfortunately broken at its lower end, but otherwise is perfect. It is a moderately stout bone, with the lower end apparently only slightly enlarged, but with the upper end much flattened and very greatly expanded. The upper end has articulated with the tibia and probably also with the femur by its inner angle, while the outer part of the upper expanded portion extends considerably above the articular surface. In the large majority of mammals and reptiles the upper end of the fibula is comparatively small, and in the higher mammals it only articulates with the tibia. In the Marsupials and the Monotremes the fibula usually has an expanded head and articulates with the femur as well as with the tibia. In *Dasyurus* the fibula is but little expanded at its upper end, but in the nearly allied *Didelphys* the expansion is considerable, and in some Marsupials the expansion is very great. The greatest degree of expansion I have observed is in the large flying Phalanger (*Petauroides volans*) (Fig. 3). In both the Monotremes the expansion is well marked, and in *Ornithorhynchus* is very peculiarly developed. In *Oudenodon* and *Dicynodon* there is some degree of expansion of the upper end of the fibula, but it is less marked than in *Ptychosiagum.*

The two toes were found lying side by side and one has been cleared so as to show the under surface, the other the upper. Of the one the metatarsal and two phalanges were found; of the other the three phalanges. Fig. 10 Pl. xxxii. represents the upper surface of what is probably the third toe of the left foot. Fig. 6 shows the under surface of what is probably the fourth toe of the same foot.

The metatarsal bone is an irregular rhomboidal bone almost as broad as it is long. Each side and the under surface are considerably hollowed out, while the upper surface is only slightly concave. The articular surfaces, like that of the lower end of the tibia, have been padded with cartilage. The first phalanx in both the third and fourth toes is a very short but broad bone, being about twice as broad as it is long. It apparently to a slight extent overlaps the second phalanx. The second phalanx is about as long as it is broad. Its distal end has a well-marked articular head for the ungual phalanx. The ungual phalanx is well preserved in the third toe. It is a broad, flattened bone, which is only slightly curved. It must have supported a large and powerful claw, though a moderately flat one. The general proportions of the bones of the toes are closely paralleled by those in some of the toes of *Echidna.* Fig. 8 represents the second toe of the right foot of *Echidna* and shows a similar shortening of the first phalanx



R. Broom del

West, Newman lith.

and a very marked resemblance in the structure of the claw. Among the Edentates the first phalanx is similarly shortened in certain toes of the Armadillo and the Sloth. In *Oudenodon* and *Dicynodon*, so far as is known, the phalanges are all well developed. In those toes of *Cynodraco* which I have recently discovered the phalanges are likewise all well developed.

From the position of the nostrils in *Ptychosiagum* one would naturally conclude that it had been an aquatic form, and the structure of the leg and toes confirms this view.

EXPLANATION OF PLATE XXXII.

FIG.

1. Front view of tibia of *Ptychosiagum Murrayi*.
2. Outer view of tibia and fibula of *Ptychosiagum Murrayi*.
3. ,, ,, ,, *Petauroides volans*.
4. ,, ,, ,, *Echidna aculeata*.
5. ,, ,, ,, *Ornithorhynchus anatinus*.
6. Under surface of fourth (? third) toe of *Ptychosiagum Murrayi*.
7. Side view ,, ,, ,, ,, ,,
8. Upper surface of second toe of right foot of *Echidna aculeata*.
9. Upper surface of fourth (? third) metatarsal of *Ptychosiagum Murrayi*.
10. Upper surface of third (? second) toe of *Ptychosiagum Murrayi*.
11. Side view of ungual phalanx of third (? second) toe of *P. Murrayi*.
12. Articular surface of ungual phalanx of ,, ,,

ON A GLACIAL CONGLOMERATE IN THE TABLE MOUNTAIN SANDSTONE.

By Arthur W. Rogers, M.A., F.G.S.

(Read February 6, 1901.)

During the progress of the Geological Survey in the Clanwilliam Division last year a remarkable conglomerate was found, apparently lying in the Table Mountain Sandstone. The conglomerate is peculiar in containing flattened and striated pebbles scattered through a muddy matrix.

The observations were made on the Pakhuis Pass, over which runs the road from Clanwilliam to Calvinia. The accompanying map and section illustrate the geological features of the locality, and show the position of the outcrops to which reference will be made in the following description.

The conglomerate occurs on a horizon known as "the shale band," on account of its being the thickest and most constant band of argillaceous material in the great arenaceous deposit called the Table Mountain Sandstone. The shale band has been followed more or less continuously from the Hex River Mountains, round the south and west of the Warm Bokkeveld, through the Scurftebergen, Cold Bokkeveld Mountains, and Cederbergen.* The position of the shale band is usually marked by a steep slope at the foot of an escarpment formed by the overlying sandstone, and covered with fragments fallen from it. This feature may be well seen at several places on the west side of the Hex River Valley, and in Mitchell's Pass. The rock itself is very rarely exposed on the slopes or where a gorge or ravine crosses the outcrop, but only in artificial road cuttings. In Mitchell's Pass the part of the shale band exposed on the roadside is a sandy shale, red in colour owing to weathering.

* The shale band was first recognised by Mr. Schwarz in the Hex River and Warm Bokkeveld Mountains. In the 1st Ann. Rep. Geol. Comm. C. G. H. for 1896, p. 27, he describes two shale bands, one near the top of the Table Mountain Sandstone, and the other near the bottom : the upper of these two is the one referred to above. The course of this band between the Schurftebergen and Pakhuis is described in the 5th Ann. Rep. for 1900.

On a farm called Bailie's Gat in the southern part of the Cederbergen (in the field-cornetcy Scotland, of the Ceres Division) a bridle-path has been cut across a steep slope made of the shale band; the rock is exposed for some twenty yards along the path, and is a grey or brown shale with red and yellow stains very similar to some of the beds belonging to the Bokkeveld formation. North of the farm Pakhuis a similar rock is seen in a road cutting, and also in a cutting on the main road between Piquetberg Road and Clanwilliam, in the Olifants River Valley. At Bailie's Gat the shale band lies about 1,000 feet below the top of the Table Mountain Sandstone, but further south there seems to be less sandstone above it, although the thickness is difficult to estimate closely, both on account of the varying dip of the beds and the rugged nature of the country. The thickness of the shale band itself is also difficult to estimate, as the exact top and bottom of it are never seen, but it probably varies from 200 to 500 feet.

West of Clanwillian the Table Mountain Sandstone forms a broad anticline trending north-west, and sinking in the same direction, so that the beds dip some few degrees north of north-east, and west of south-west, on the two sides of the axis. Near the village the sandstone is faulted against the Bokkeveld Beds, which form the so-called Karroo hill, but further up the Olifants River it dips normally under an outlier of those beds. Similarly on the north-east side of the anticline, the Bokkeveld Beds have been let down against the sandstone between the farms Hoender Fontein and Welbedacht, while both to the north and south the usual conformable passage between the two formations is met with.

The road from Clanwilliam goes through the farms Klein Kliphuis, Rheebok's Valley, round the south end of Botha's Berg on to the farm Pakhuis. Between the houses on Rheebok's Valley and Pakhuis the road is carried along the curved outcrop of the shale band, and the rock is exposed at intervals through a distance of about three miles and a half. To the north-west of Rheebok's Valley the shale band is marked by a bushy, débris-covered slope, which lies on the north-east side of the Kliphuis River; above the slope is a continuous cliff, which terminates southwards in Botha's Berg. To the north-east of Botha's Berg the shale band sinks into the Pakhuis Valley, where it forms the flat ground on which the farm stands. From Pakhuis the band trends south-east towards Krakadouw, up the Pakhuis River.

The road between Rheebok's Valley and Pakhuis lies on the lower part of the shale band, for outcrops of the underlying sandstone are seen on the hillside immediately below the road near

Rheebok's Valley, at the summit of the Pass, and on the eastern side of the summit.

About two hundred yards above Rheebok's Valley house the conglomerate is seen in the ditch by the roadside, and also in shallow pits from which road-mending material is dug. The rock is a greenish-brown, sandy, unbedded mud-stone, with abundant well-rounded grains of quartz and a little felspar; pebbles up to five inches in length are contained in it. The pebbles are not arranged in layers, but are scattered through the rock at intervals of several inches or feet, and as the exposures are rather small only a few pebbles of the largest size were found. Since the amount of material removed to make the shelf for the road is not very great, and at the same time consists mostly of surface soil and fallen débris, only a small portion of the underlying conglomerate has been disturbed, so that there are no artificial débris heaps from which specimens of the pebbles can be collected. All the specimens obtained were picked out from the rock *in situ*, and some of these were only discovered on breaking down large lumps of the mud-stone.

Between Rheebok's Vlei and the top of the Pass there are no more good exposures, but the conglomerate is seen in the ditch by the roadside. Beyond the highest point there are numerous but small excavations along the road, forming a nearly continuous section perhaps two miles long. The bulk of the rock is an unbedded mud-stone with scattered pebbles, similar to that in Rheebok's Vlei; but two important varieties occur, in one of which an approach is made to the usual type of the Table Mountain Sandstone by the great increase of the proportion of quartz grains, and the other furnishes a transition series between the conglomerate and a shale, such as is seen by the roadside north of Pakhuis and in Bailie's Gat. The shaly variety of the conglomerate is seen about half a mile from the top of the road. In composition and colour it is similar to the unbedded rock, from which it differs by the presence of planes of lamination. Parts of this rock contain fewer grains of quartz than others, and thus assume the character of shale, and become red and yellow when weathered. The dip of the gritty shale is about 10° towards N., 35° E., agreeing with that of the quartzite outcrops below the road, and with that of the quartzites in the mountains above. It is only in the shaly portion of the conglomerate that dip can be observed, for in the other sections, none of which is more than 10 feet high, the conglomerate shows no sign of bedding.

The pebbles found in the conglomerate are of quartz, quartzite, dark hard grits, felsites, and granite. Many of them, especially the smaller ones, are well rounded; the small, often almost spherical, white quartz pebbles up to an inch in diameter, like those commonly found scattered through every part of the Table Mountain Sandstone, are particularly noticeable, and more abundant than any other sort. Nine pebbles showing signs of glaciation were collected. The largest is 3½ inches in length, 2 in width, and about 1 inch thick. It is composed of a hard, gritty slate. One surface is almost flat and covered with scratches, which are chiefly in two series, crossing each other at an angle of about 3°; a few other scratches cut across both these sets; the opposite surface is also fairly well striated, but it has been worn down to a smaller extent. One of the edges of the stone is also scratched. This specimen is indeed a typical glaciated pebble. Five of the other pebbles are also characteristic specimens, but smaller in size, the smallest being only 1½ inches in length. The remaining three only show scratches on a portion of one surface.

The evidence for a glacial origin of the conglomerate, *i.e.*, that ice played an important part in the locality during its formation, rests upon two facts:—

(1) The peculiar character of much of the rock itself, viz., the distribution of large pebbles at intervals through a fine-grained sandy mudstone.

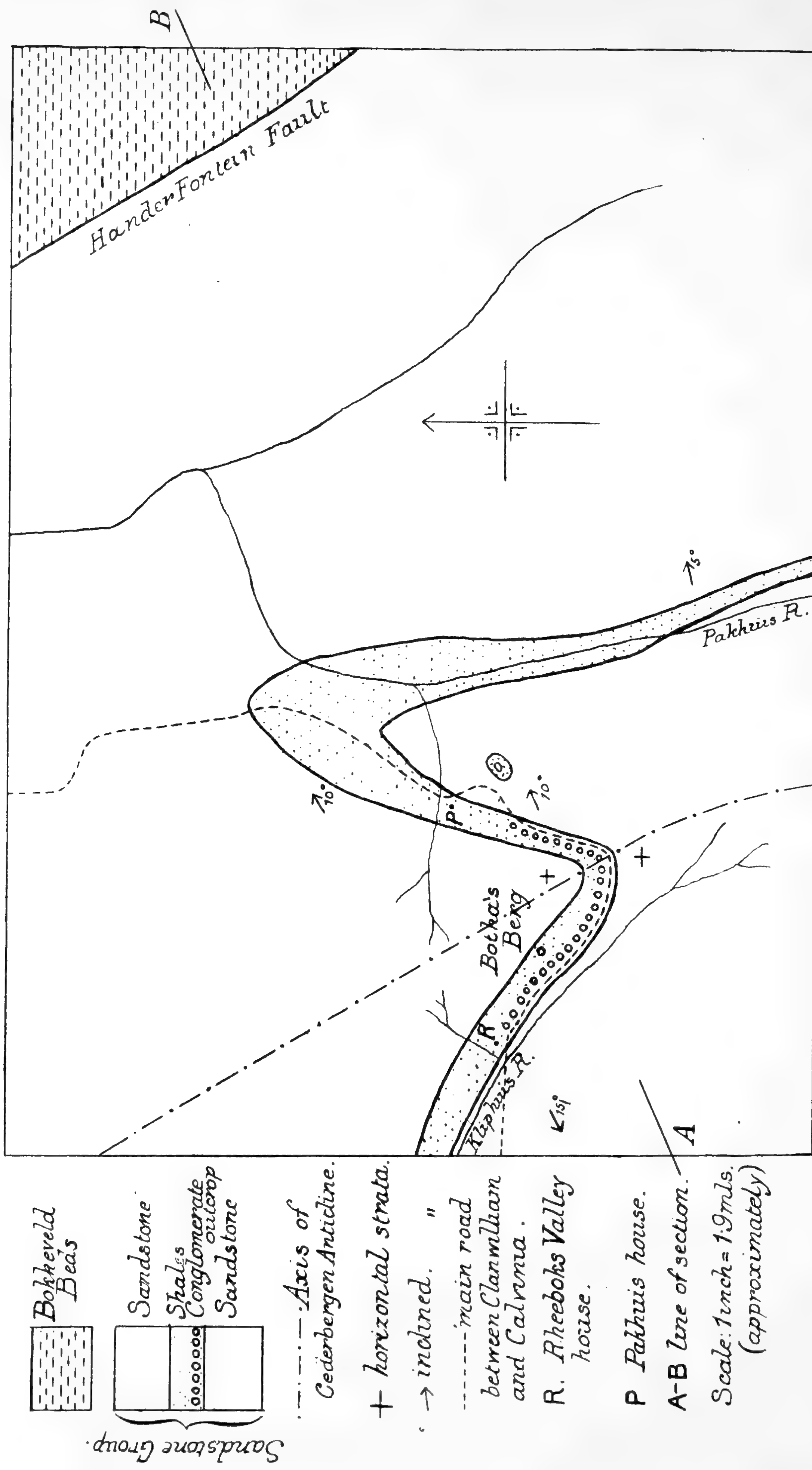
(2) The flattened and facetted form of the pebbles, and their striated surfaces.

In ordinary conglomerates the pebbles are very much more numerous in proportion to the matrix than in the Pakhuis beds, and at the same time they are arranged in layers; generally, too, there is a rough assortment of the stones, so that pebbles of about the same size are found together. The Pakhuis rock is best compared to glacial deposits, such as the Dwyka conglomerate of this country or some of the tills of the northern hemisphere.

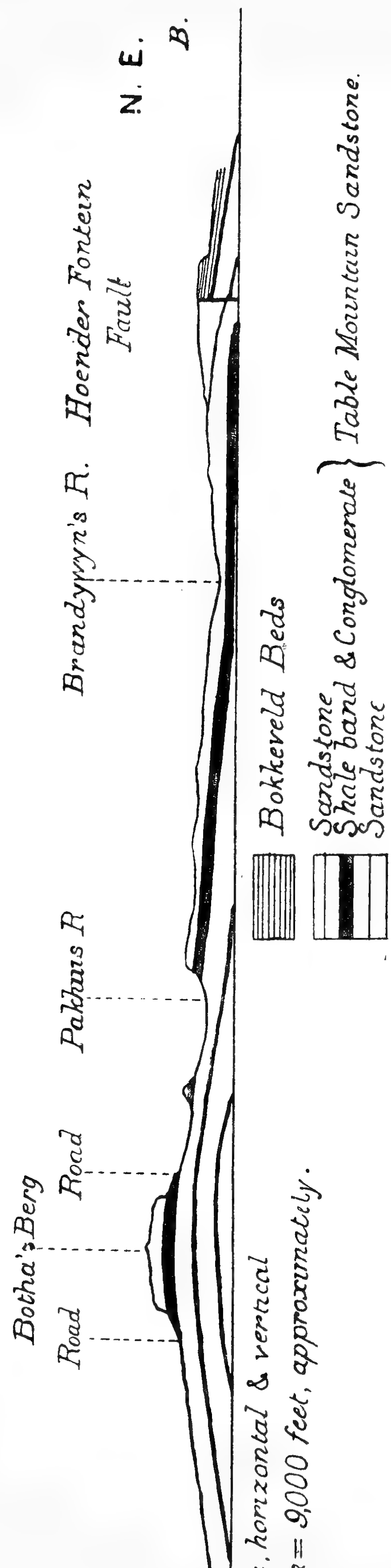
In the absence of any observed unconformity at the base or top of the Pakhuis beds they may have been deposited in water, like the sandstones above and below; the shaley portions certainly were, and as unstratified sandy clays with ice-born fragments are admitted to have been formed under water in recent times, there is no sufficient reason to assume terrestrial conditions in the locality during the formation of the unbedded part of the Pakhuis conglomerate.*

When the conglomerate was first observed its points of resemblance to the Dwyka conglomerate immediately attracted attention. The similarity consists in the scattered striated pebbles being embedded

* Feilden, "Glacial Geology of Arctic Europe," &c., Q.J.G.S., vol. l., 1896, p. 739.



GEOLOGICAL SKETCH-MAP OF THE COUNTRY NEAR THE PAKHUIS PASS.



SECTION AT RIGHT-ANGLES TO THE CEDERBERG ANTICLINE TO SHOW THE POSITION OF THE SHALE-BAND ON PAKHUIS PASS.

in a fine-grained matrix. The Dwyka found in the Karroo, some twenty-five miles east of Pakhuis, is blue in colour, harder than the Pakhuis rock, and contains a much greater variety of rocks in the form of boulders or pebbles. The chief classes of rocks which are present in the Dwyka and absent from the Pakhuis conglomerate are the amygdaloidal and other diabases, and amygdaloidal rocks of more acid composition. The small rounded quartz pebbles, mentioned above as being so abundant in the Pakhuis conglomerate and Table Mountain Sandstone, are not found in the Dwyka. There is, however, no essential distinction at present known between the lithological characters of the two conglomerates; therefore the determination of the stratigraphical position of the Pakhuis conglomerate is of great importance. The description of the occurrence of the conglomerate given above, together with the position of the outcrop laid down in the accompanying map and section, contains all that can be said on this point at present. The parallelism of the conglomerate outcrop with those of the sandstones above and below, and the agreement in dip, where dip can be observed in the conglomerate, lead to the conclusion that the conglomerate is actually interbedded with the sandstone, but a clear section showing the conglomerate overlain by the shale and sandstone will be very welcome.

I have been over a considerable part of the country between the Karroo and the Olifants River valley both north and south of Pakhuis, but no outlier of the Dwyka conglomerate has been found there; and as on the east side of that country the Bokkeveld and Witteberg Beds, or the former alone, lie between the Table Mountain Sandstone and the Dwyka, one would not expect the Dwyka to lie directly upon the Table Mountain Sandstone in the Cederbergen.

SOME PRESSURE AND TEMPERATURE RESULTS FOR THE GREAT PLATEAU OF SOUTH AFRICA.

By J. R. Sutton, M.A. (Cantab.).

(Communicated April 24, 1901.)

The accompanying notes were begun during 1897. The intention was to make them serve as an introduction to an inquiry of a physical rather than a climatological character. But their aggregate magnitude has increased step by step along a divergent direction, until it seemed better to present them as a separate paper, leaving the other matter for a future communication.

In its present form the paper contains the preliminaries of an attempt to make a systematic comparison between the temperatures and pressures of the air over a plateau and corresponding coast station (on much the same lines as the comparisons which are made between the summit and base of a mountain), at two of the most favourable geographical positions it is possible to combine, and with what are perhaps the best materials ever used for the purpose in South Africa. Plateau meteorology has a special interest all its own. Observations taken upon the summit of an elevated peak are important, because they tell us roughly something of the conditions prevailing in the free air at the same altitude, albeit balloons and kites give results which are superior in every way, excepting that continuity and regularity are not yet possible. Balloons or mountains, however, tell us only of the air: this great South African plateau gives us something more than a rough notion of what the climate of a great portion of the earth's surface will be like in ages to come, when the cooling earth has absorbed a considerable volume of its liquid envelope.

The stations referred to are Kimberley and Durban. The Kimberley results, given in Tables 13–24, are from the observations taken by the late Mr. G. J. Lee, F.R.Met.S., at his own second order station, with instruments that were very good of their kind, and nearly all properly certified at Kew. These instruments are now deposited at Kenilworth (Kimberley), and, with the exception of the wet bulb, compare excellently with the observatory standards there. Few gaps appear in the Lee register: scarcely any in earlier years, and not many in later years when the observer's advancing age might have excused them. Necessary interpolations have been made whenever possible from the Kenilworth records. The site of the station was not good, nor was the exposure of the thermometers all that could be desired. The thermometers were mounted on a modified Glaisher stand, and consequently the maximum shade temperatures, particularly in the summer, were somewhat too high; the minimum shade temperatures, particularly in the winter, being correspondingly too low. The wet bulb being found erroneous has, unfortunately, prevented the inclusion of a moisture comparison between the two places. The barometer—a Fortin, with adjustable cistern, by Negretti and Zambra—was kept in good order and hung in a good place. It may be fairly claimed that until the establishment of the first-class meteorological station at Kenilworth, some three miles from Kimberley, no better series of observations of temperature and pressure, probably none nearly so good, has ever been made in Cape Colony north of the Hex River.

The Durban observations, summarised in Tables 1–12, are taken from the Annual Reports of the Astronomer to the Government of Natal. Their quality appears to be exceptionally good. One observation only has been missed throughout the period considered. The instruments, and method of using them, will be found fully described in the same publications.

The order in which the results appear is as follows:—

Tables 1–12 give the daily mean temperatures and pressures of the air at Durban for the ten years 1888 to 1897 arranged in the following way:—

Opposite each date in the first column will be found values of—

M, the mean maximum temperature of the day;

m, the mean minimum temperature of the day;

$M - m$, the mean range of temperature;

$\frac{M + m}{2}$, the mean of the readings of the maximum and minimum thermometers equal roughly to the mean temperature of the day;

M', the highest temperature observed in the ten years upon the date of the same line;

m', the lowest temperature observed in the ten years;

(M +), the number of times the maximum temperature has exceeded the mean maximum temperature of the day;

(M =), the number of times the maximum temperature has equalled the mean maximum temperature of the day;

(M −), the number of times the maximum temperature has fallen short of the mean maximum temperature of the day;

(M +), (m =), (m −), the number of times respectively upon which the minimum temperature has exceeded, equalled, or fallen short of the mean minimum temperature of the day;

In the next six columns M_3 and m_3 give values of M and m in trihemera, the values entered opposite January 3rd, for example, being the mean values for January 1, 2, 3;

P, the mean barometric pressure of the day, reduced to mean low-water sea-level, from readings taken at IX. and XV. o'clock N.M.T.;

MP, the highest pressure observed upon the date in ten years;

mP, the lowest pressure observed;

P_3, MP_3, mP_3, trihemerial values of P;

(P +), (P =), and (P −), the number of times upon which the pressure was respectively above, equal to, or less than the mean pressure of the day.

Tables 13–24 give the corresponding **Kimberley** temperatures for the same period; but the Kimberley barometric pressures are available for eight years only, commencing in 1890. These are for the hours VIII. and XX. C.M.T.

Monthly and yearly summaries of Tables 1–24 are given in Table 25.

The successive values of M'_3, M_3, $\frac{M_3 + m_3}{2}$ m_3, and m' are depicted in Fig. 1, for both Durban and Kimberley; and of MP_3, P_3, and mP_3 for Durban in Fig. 2. In Fig. 2 also the curve P_3, only, for Kimberley is drawn below that for Durban and to the same scale, but *plus* 3·9 inches.

The mean pressure curves of the two places are practically identical in shape, the mean daily differences being something over 4 inches throughout the year with certain minor periods of approach and recession to be more fully referred to later on. The variations from the mean curve are, however, much greater at Durban, the extreme range in the eight years, 1890–97, being from 29·518 inches to 30·801 inches, *i.e.*, 1·283 inches, as compared with an extreme range at Kimberley from 25·665 inches to 26·508 inches, *i.e.*, 0·843 inch. The Durban readings, however, are timed to give almost the greatest range possible. Readings taken at Kimberley at IX. and XV. would give a mean daily range of about 0·04 inch more than those taken at VIII. and XX., and most likely an extreme range considerably greater.

The principal general differences between the temperature curves of the two places are just such as would be expected from the contrast of continental and coast stations: the mean daily temperature ranging from 44°·6 (July 17th) to 80°·2 (Dec. 28th) at Kimberley; and from 62°·0 (July 17th) to 79°·2 (Jan. 27th) at Durban—or rather less than one-half the other. The respective ranges from the lowest mean daily minimum to the highest mean daily maximum are—

At Kimberley from 32°·1 (July 17th) to 98°·4 (Dec. 28th),
At Durban from 51°·7 (July 18th) to 90°·4 (Jan. 27th).

For the extreme range of temperature observed in the whole ten years, we have: at Kimberley 20°·0 to 108°·5—the latter occurring in the midst of what would appear to be an annual wave of high maximum temperature at the end of January—and at Durban 42°·3 to 110°·6, the latter in a hot wind of the spring months.

By suitably choosing the scales on the paper it will be easily seen that the maximum temperature curve for Kimberley is almost identically the same as the mean pressure curves, inverted, for both Kimberley and Durban, either, as it happens, following closely upon the sun's changes of declination. An approximate formula for the relationship in inches and degrees Fahr., is—

$$100p + t = 0$$

where p is the total increase of pressure and t the total increase of temperature reckoned from any epoch.

The Durban temperatures lag very considerably behind those of Kimberley, in the summer months at any rate, and have no simple relationship to the collateral pressures. This is doubtless brought about by the vicinity of the ocean, and to a smaller extent by the greater quantity of vegetation, the moisture of the air along the Natal coast, and by the greater cloudiness of the sky. Clouds, generally speaking, prevent loss of temperature during the night in proportion to the area of blue sky hidden, and up to a certain limit—which does not, apparently, differ greatly at Kimberley from 50 per cent. of sky obscured—assist the rise of temperature during the day. Below this limit they admit more direct heat from the sun than they allow to radiate from the earth, but in a less and less degree as the sky is less cloudy; above it the quantity of heat admitted bears a less and less proportion to the amount checked in its radiation. Moreover, apart from the influence of the clouds, *i.e.*, the humidity of the upper air, the influence due to the amount of moisture, or rather the humidity, of the lower air is greater than one would expect at first, although Tyndall's "fairy tales," as Prof. Callendar calls them, would not altogether carry conviction, so far as can be seen at present, to the child of science who had seen meteorology at Kimberley.

It is to be regretted that the very important question of the moisture, or humidity, of the atmosphere of the two places does not admit of comparison, for its importance is not second to that of temperature and pressure. In Table 25, however, additional columns are inserted giving the amount of cloud month by month at Durban and Kimberley from one observation per diem at both places; also the moisture at Durban from observation at IX. and XV., and the humidity at Kimberley from observations at VIII. The Kimberley results for cloud and humidity are extracted from the annual reports of the Meteorological Commission, monthly numbers only being available: they must be regarded as very rough, although the deduced hygrometric state of the air is nearer to the truth than that obtained by the Lee wet bulb. The Natal reports give the temperatures at IX. and XV., and the mean moisture of the same two hours expressed in grains per cubic foot; but the wet bulb, dew-point, and humidity are omitted: the want of the first making the exact determination of the two latter a task of extreme difficulty and labour—almost an impossibility. It will be seen that the greatest cloudiness of the sky at Durban occurs during the five months Oct.–Feb., jumping at once to its maximum in October, and gradually falling off through the season, whereas the moisture of the lower air attains its maximum in the four months, Dec.–March. It is during these last months, it will be remembered, that N.E. winds prevail over Kimberley.* At Kimberley, on the other hand, there is an abortive increase in the cloudiness of the sky in October, the maximum not definitely establishing itself until the first quarter of the year. Some consequences of these changes will be seen when we come to the variations in the range of temperature later on.

The shape of the temperature curves in Fig. 1 obviously suggests that their irregularities may be best smoothed out by means of some simple sine curves. As a first approximation the equation—

$$y = \frac{R}{2} \sin x + T \dagger$$

* See "The Winds of Kimberley" (*Trans. of the Phil. Soc. of S. Africa*, vol. xi. pp. 75–112).

† "Playfair, following the steps of Kirwan, . . . endeavoured to create a formula which should enable him to approximate to the mean temperature of any day. This formula is the following;—

$$y = T + F \sin (\lambda - 30)$$

in which T denotes the mean temperature of the given place, F a constant coefficient will be found of service to the curves of either maximum, mean, or minimum,

y being the temperature of any day required;
R the mean range of the curve;
T the mean value of the curve; and
x the angular distance reckoned from the day whose mean temperature (maximum, mean, or minimum) is also the mean of the year.

For Durban, we have :—

$$y = M = (4{\cdot}8) \sin x + 80{\cdot}6$$

$$y = \frac{M + m}{2} = 6 \sin x + 71{\cdot}2$$

$$y = m = (7{\cdot}3) \sin x + 61{\cdot}8$$

the angles x being reckoned from near Oct. 31st, Oct. 24th, and Oct. 16th, respectively.

For Kimberley we have :—

$$y = M = (14{\cdot}7) \sin x + 79{\cdot}3$$

$$y = \frac{M + m}{2} = 13 \sin x + 64{\cdot}5$$

$$y = m = (12{\cdot}1) \sin x + 49{\cdot}8$$

the angles x being reckoned from near Sept. 20th, Sept. 28th, and Oct. 4th, respectively.

The smooth curves derived from these formulæ are plotted on Fig. 1, from the calculated values of y found in Table 26. The retardation of the minimum curve for Durban is easily seen, and even more so the retardation of all the three curves for Kimberley. It is significant, and may indicate some interaction of climatic conditions between the coast and interior that the maximum temperature at Durban lags as much behind the minimum as the minimum temperature at Kimberley lags behind the maximum. Taking the numbers from Table 26 for example, the greatest value of M at Durban is 85°·4 on Jan. 31st, the greatest value of m being 69°·1 on Jan. 16th. But at Kimberley the greatest value of M is 94°·0 on Dec. 20th, the greatest value of m being 61°·9 on Jan. 4th. Again,

determined by observation, λ the mean longitude of the sun computed from the first of Aries, for any day of the year, the mean temperature of which is y" (Harvey, Art. "Meteorology," *Ency. Metr.*, 1845). The formula, however, was not very successful, the errors in some places approaching 4° F. as compared with the mean daily temperatures of Stockholm derived from fifty years' observations.

and still more curiously, the mean date of the greatest maximum for Durban and Kimberley together is Jan. 10th—*i.e.*, half-way between Dec. 20th and Jan. 31st—which is also, as it happens, the very mean date of greatest minimum—*i.e.*, half-way between Jan. 4th and Jan. 16th. And here it is only fair to state that this neat result was only detected after Table 26 was fully complete, so that the dates were not "cooked" to bring it about.

But perhaps the most useful application of the sine formula will be to the differences of mean minimum temperature, Durban *minus* Kimberley. Here it takes the shape—

$$y = -(5\cdot4)\sin x + 12,$$

the angles being reckoned from near the end of September; nor does it differ anywhere by more than a few tenths of a degree from the observed differences. The value of so simple a connecting link, if only as an aid to memory, between the meteorological elements of the two places will be readily recognised. The calculated values, reckoned from just after the equinox, are given in Table 27. The corresponding calculated differences of mean and maximum temperature having no special exactitude are not thought worth insertion.

Lambert's formula is commonly used when it is required to smooth out the irregularities of temperature or other meteorological curves to any great degree of exactitude. It is—

$$a = p + p_1\cos\frac{\pi}{n} + q_1\sin\frac{\pi}{n} + p_2\cos\frac{2\pi}{n}$$
$$+ q_2\sin\frac{2\pi}{n} + p_3\cos\frac{3\pi}{n} + q_3\sin\frac{3\pi}{n} + \dots$$

in which a is the required temperature, or whatever it may be, and $p, p_1, p_2, \dots q_1, q_2, q_3, \dots$ constants to be determined. When a is the maximum, minimum, or mean temperature of any month, p is the mean yearly value, and p_1 approximately one-half the yearly range — corresponding, that is, to the T and $\frac{R}{2}$ used in the simple sine curve above.

Putting $n = 12$ and solving Lambert's equation by the method of least squares, we get the coefficients as in Table 28. The pressure numbers have also been added. But if

$$p_1 = u_1 \sin V_1$$
$$q_1 = u_1 \cos V_1, \text{ \&c.},$$

we get Bessel's formula—

$$a = p + u_1 \sin\left(V_1 + \frac{\pi}{n}\right) + u_2 \sin\left(V_1 + \frac{2\pi}{n}\right)$$
$$+ u_3 \sin\left(V_3 + \frac{3\pi}{n}\right) + \ldots$$

which is sometimes thought to be more advantageous than the formula of Lambert.* For the different elements it becomes:—

1. For the monthly maximum temperature at Durban—

$$\begin{aligned} a = 80^\circ{\cdot}6 &+ 5{\cdot}056 \sin(77^\circ\ 12{\cdot}8' + t) \\ &+ 0{\cdot}4916 \sin(48^\circ\ 14{\cdot}3' + 2t) \\ &- 0{\cdot}3934 \sin(36^\circ\ 22{\cdot}6' + 3t) \\ &+ 0{\cdot}1833 \sin(270^\circ + 4t) + \ldots \end{aligned}$$

2. For the monthly mean temperature at Durban—

$$\begin{aligned} a = 71^\circ{\cdot}2 &+ 6{\cdot}144 \sin(80^\circ\ 50{\cdot}2' + t) \\ &+ 0{\cdot}769 \sin(2^\circ\ 29' + 2t) \\ &- 0{\cdot}267 \sin(360^\circ + 3t) \\ &+ 0{\cdot}087 \sin(360^\circ + 4t) + \ldots \end{aligned}$$

3. For the monthly minimum temperature at Durban—

$$\begin{aligned} a = 61^\circ{\cdot}8 &+ 6{\cdot}964 \sin(84^\circ\ 4{\cdot}6' + t) \\ &+ 1{\cdot}289 \sin(324^\circ\ 51{\cdot}5' + 2t) \\ &- 0{\cdot}240 \sin(33^\circ\ 41' + 3t) \\ &+ 0{\cdot}242 \sin(333^\circ\ 25' + 4t) + \ldots \end{aligned}$$

4. For the monthly mean pressure at Durban—

$$\begin{aligned} a = 30{\cdot}105 \text{ inches} &+ 0{\cdot}1174 \sin(273^\circ\ 7{\cdot}7' + t) \\ &+ 0{\cdot}0097 \sin(62^\circ\ 27{\cdot}7' + 2t) \\ &+ 0{\cdot}0065 \sin(309^\circ\ 48' + 3t) \\ &- 0{\cdot}0107 \sin(315^\circ\ 34' + 4t) + \ldots \end{aligned}$$

5. For the monthly maximum temperature at Kimberley—

$$\begin{aligned} a = 79^\circ{\cdot}3 &- 14{\cdot}775 \sin(290^\circ\ 12 + t) \\ &+ 1{\cdot}604 \sin(319^\circ\ 6{\cdot}4' + 2t) \\ &- 0{\cdot}232 \sin(21^\circ\ 1{\cdot}6' + 3t) \\ &- 0{\cdot}259 \sin(26^\circ\ 48{\cdot}7' + 4t) + \ldots \end{aligned}$$

* Kaemtz, "On the deduction of mean results from meteorological observations" (*Quarterly Journal of the R. Met. Soc.*, vol. iii. p. 120; also E. E. Schmid, *Lehrbuch der Met.*, p. 8).

6. For the monthly mean temperature at Kimberley—

$$\begin{aligned} a = 64^\circ{\cdot}5 &- 13{\cdot}365 \sin (283^\circ\ 15' + t) \\ &+ \ 1{\cdot}626 \sin (318^\circ\ 13' + 2t) \\ &- \ 0{\cdot}271 \sin (42^\circ\ 30' + 3t) \\ &- \ 0{\cdot}159 \sin (24^\circ\ 48' + 4t) + \ldots \end{aligned}$$

7. For the monthly minimum temperature at Kimberley—

$$\begin{aligned} a = 49^\circ{\cdot}8 &- 12{\cdot}162 \sin (272^\circ\ 6' + t) \\ &+ \ 1{\cdot}724 \sin (318^\circ\ 54' + 2t) \\ &- \ 0{\cdot}247 \sin (61^\circ\ 14{\cdot}6' + 3t) \\ &- \ 0{\cdot}148 \sin (347^\circ\ 0{\cdot}3' + 4t) + \ldots \end{aligned}$$

8. For the monthly mean pressure at Kimberley—

$$\begin{aligned} a = 26{\cdot}055 \text{ inches } &+ 0{\cdot}1132 \sin (285^\circ\ 26{\cdot}5' + t) \\ &- 0{\cdot}0070 \sin (330^\circ + 2t) \\ &+ 0{\cdot}0087 \sin (275^\circ\ 29{\cdot}4' + 3t) \\ &- 0{\cdot}0052 \sin (343^\circ\ 18' + 4t) + \ldots \end{aligned}$$

Although Lambert's and Bessel's formulæ represent the facts of observation with remarkable accuracy, the simple sine curve, because it is less cumbersome, is advantageous when, searching for analogies, we wish to roughly compare different curves together, say, for example, the temperatures of Durban with those of Kimberley. Neither, however, has any actual physical basis, or involves the effecting agencies any more than p, q, and a, in Lambert's equation, applied to the path described by an inebriate would have anything to do with pints and quarts or the price of alcohol. The variable in each case, x, or π/n, or t, depends upon the sun's Right Ascension. The seasons depend almost entirely upon the sun's Declination. Right Ascension and Declination, it is true, vary together, but in such a totally different manner that the changes of temperature have no proportion to the sun's angular velocity. In fact, of the two only the Declination needs to appear in any physical formula dealing with the supply of heat received from the sun. This, manifestly, does not imply that such a formula is easy to discover. Indeed it is not; the diversity of condition prevailing over the earth's surface: land and water, garden and desert, acting and reacting upon the heat received; weather not being made where it is used; and so forth—all help to order it otherwise. Thus we are, in general, content to accept the purely mathematical equation to a curve drawn on paper in the place of a formula based upon natural phenomena.

The rise of temperature during the day depends mainly upon radiation from the sun; the fall during the night depends mainly upon radiation from the earth. Leaving the latter for future discussion, let us consider the course of the former as given in the daily and monthly averages. At the outset we detect the fact, differentiating Kimberley from most places in other countries, that the greatest and least values of the maximum temperature curve for Kimberley are nearly synchronous with the solstices. This suggests some possible simplification of the difficulties that otherwise might reasonably have been expected in the framing of a formula involving some direct function of the Declination. It is a legitimate argument, *à priori* that

$$y = A \cos Z + B;$$

where y is the required daily average maximum temperature;
A a constant defining the amplitude of the curve;
B the distance from the base line of reference;
Z the sun's zenith distance.

Applying the equation, as a test, to the Kimberley maximum values, we find—

$$y = 79 \cos Z + 14$$

a very good approximation to the observed facts—much better in every way than the simple sine curve.

The philosophy of this formula is evidently based upon the law that the quantity of heat falling upon any given surface for a given time will vary as the cosine of the inclination of the incident rays to the normal. But there is a factor, not to be neglected, arising out of the eccentricity of the earth's orbit. The sun's distance changes, being greatest early in July and least in January, and the amount of solar heat intercepted by the earth's full disk is less or greater accordingly. The sun's apparent area varies inversely as the square of its distance; the solar heat and light received also vary inversely as the square of the same distance; the quantity of heat received, then, at any time will be in proportion to the sun's apparent area. This last, multiplied by some suitable constant, we shall for the present call the heat coefficient, and denote by S^2. The formula therefore takes the amended form—

$$y = AS^2 \cos Z + B,^*$$

* Compare L. W. Meech, "On the relative intensity of the Heat and Light of the Sun upon different latitudes of the earth" (*Smithsonian Contributions to Knowledge*). He argues thus:—

in which y, A, B have the same meaning as before, though in general different values. Approximate values of A and B are 73°·4 and 22°·8 respectively.

In Table 29 will be found the successive steps of the computation for the average maximum temperatures of Kimberley on or about the middle day of each month, the sun's Declination and semi-diameter being taken from the *Nautical Almanac*. The values of y thus determined are marked in ring dots (thus ⊙) on Fig. 1. They evidently average a little higher in the spring months than the observed temperatures, for which, in all probability, the retardation of the minimum, on account of the cold wave of July, is responsible. The last column of Table 29 gives the numerical differences between the values of y for the middle day of each month and the mean monthly maximum temperatures, calculated *minus* observed, assuming—not quite accurately—that the latter is the same as the average maximum temperature of the middle day of the month.

In Table 30 is given some comparison values for Bloemfontein and Aliwal North, the respective conditions being:—

1. Bloemfontein—

S. Lat. 29° 7′

$$y = 55°{\cdot}8\ S^2 \cos Z + 33°{\cdot}5.$$

2. Aliwal North—

S. Lat. 30° 41′

$$y = 53°\ S^2 \cos Z + 33°{\cdot}6.$$

The temperature numbers for both the stations are averaged from

Let L = the "apparent" latitude of the place,
D = the sun's meridian declination,
Δ = the sun's semi-diameter,
A = the sun's altitude, and
H = the hour-angle from noon.

Then, generally, $\Delta^2 \sin A$ expresses the sun's intensity at any given instant during the day; and we have—

$$\Delta^2 \sin A = \Delta^2 (\sin L \sin D + \cos L \cos D \cos H).$$

Meech observes upon this result that it is "strictly true only at the exterior of the atmospheric envelope which encompasses the globe, or at the outer limit where matter exerts its initial change upon the incident rays." But there is every reason to suppose that the formula is more nearly true than would have been admitted at the time when this opinion was written (1855), or else that the table-land of South Africa is near the "outer limit." Writers generally have mistakenly applied formulæ involving the heating power of the sun to the determination of mean temperatures. Logically they can only be used for maxima.

the monthly results published by the Meteorological Commission in Cape Town.

Theory and practice are contrasted in Table 31, by comparing the calculated monthly changes of temperature with those observed for Kimberley, Bloemfontein, and Aliwal, separately and together. The chief deviations occur Nov.–Dec., and June–July, the observed variation being in the one case $1^{\circ}\cdot 9$ greater, and in the other $1^{\circ}\cdot 7$ less. The other deviations are not important, and the gradients are remarkably similar. Annual hot and cold periods seem to account in the main for such differences as do occur.

We gather from the close agreement between theory and observation how quickly the table-land of South Africa becomes heated by the sun's rays and how few of the rays it stores up. There is little resistance to or accumulation of heat at any time. Accepting for the present this responsiveness of the air to the action of the sun, we have now to face the curious and, at first sight, contradictory fact that the diurnal range of temperature at Kimberley is pretty well as great in winter as in summer, whereas, during the day at any rate, we should expect the winter range to be much less. For at the end of December and beginning of January the sun increases its altitude between VII. and Noon by fully 61 degrees of arc, but only by 37 degrees between the same hours at the beginning of July. Now taking the mean daylight temperatures during December and January to be the mean daylight temperature of December 31st or January 1st, we should, if the cosine formula applies to this special case, expect a rise of temperature between VII. and Noon of some 42°. The actual rise from VII. to the maximum (which occurs about 1h. 20m. p.m.) is on the contrary only 19°. Again about July 1st the calculated rise would be 39°, whereas the rise to maximum (which occurs about 2h. 35m. p.m.) is 27°—assuming, of course, that the initial temperature at sunrise is independent of any previous solar heat. If we calculate new values of A and B in the cosine formula, by considering only the rise of temperature to Noon, we shall get for the hourly rate of change—

$$\text{Winter} \quad y = 45^{\circ}\cdot 5\ S^2 \cos Z + 36^{\circ}\cdot 1$$
$$\text{Summer} \quad y = 31^{\circ}\cdot 4\ S^2 \cos Z + 55^{\circ}\cdot 8;$$

or by considering the rise of temperature to maximum :—

$$\text{Winter} \quad y = 51^{\circ}\cdot 3\ S^2 \cos Z + 36^{\circ}\cdot 0$$
$$\text{Summer} \quad y = 33^{\circ}\cdot 6\ S^2 \cos Z + 55^{\circ}\cdot 0.$$

In Table 32 will be found the result of the computation using the first of the two sets of coefficients :—

Col. 1 gives the hours ;

Col. 2 the corresponding values of Z, the sun's zenith distance, obtained from the spherical equation—

$$\cos c = \cos a \cos b + \sin a \sin b \cos C\ ;$$

Col. 3 the values of y for the respective winter and summer values of the coefficients for daily range of temperature ;

Col. 4 the values of y when A and B have their annual values ;

Col. 5 the temperatures hour by hour from the Kenilworth (Kimberley) records. These, it must be remembered, are not for the same years as the Kimberley temperature numbers used generally throughout this paper ; nor if the years were the same would they be quite the same as the Kimberley hourly temperatures. They must serve, nevertheless, because no hourly temperatures had ever been taken in Kimberley.

According to this Table the hourly differences between the observed and calculated temperatures are appreciably the same at the same hours in both summer and winter. In other words, the average hourly increase of temperature to noon in summer is to that in winter in the approximate ratio of 314 to 455. This greater winter rate of increase, together with the previous results elicited, may prove that the power of the sun to warm the air is limited, and that if it were to stand in the midst of heaven for any length of time the temperature over the table-land would not necessarily reach any very high degree. We see, for example, that when its zenith distance decreases from 66° 37′ to 53° 44′ (arc) it can raise the temperature from 67°·7 by 4°·6 ; but when its zenith distance decreases from 67° 31′ to 53° 45′ it can raise the temperature from 49°·4 by 9°·5. Also at the equinoxes a decrease of zenith distance from 64° 0′ to 51° 32′ will accompany a rise in the temperature of 5°·2 from 62°·2. Otherwise by taking averages we have a mean rise of temperature per 12 degrees decrease of zenith distance as follows :—

Summer..................	4°·3 from	67°·7
Equinox..................	5°·0 ,,	62°·2
Winter	8°·0 ,,	49°·4.

By measuring initial temperatures horizontally to the right, and average increase per 12 degrees of zenith distance vertically upwards (*i.e.*, using rectangular axes) we get three points on some plane curve. Also the three equations—

$$4{\cdot}3\,(67{\cdot}7 - x) = Q$$
$$5{\cdot}0\,(62{\cdot}2 - x) = Q$$
$$8{\cdot}0\,(49{\cdot}4 - x) = Q$$

are all nearly satisfied when $x = 28{\cdot}1$. Whence it follows that the three points lie upon a rectangular hyperbola,* one of whose asymptotes is the line of initial temperatures, and the other the line $x = 28{\cdot}1$: That is upon the rectangular hyperbola—

$$t(\mathrm{T} - 28{\cdot}1) = 170{\cdot}4,$$

where T is the initial temperature, and t the rise of temperature. It is curious that the numerical value of the equation is just about the highest temperature likely to be registered at Kimberley by a black bulb *in vacuo* on a fairly clear day at the end of December.

So far as can be ascertained from the as yet limited materials, the corresponding values for other months, lying between the solstices and equinoxes, are points upon the same hyperbola. Yet it would be exaggerating the evidence to consider the asymptotic nature of our temperature changes demonstrated; because, for one thing, the Kenilworth hourly temperatures are read only at the whole hours, and thus it is not easy always to select periods in which an average rise of temperature can be estimated, for a decrease of zenith distance by 12 degrees, from somewhere near 65 degrees.

Again, the equation is not generally true for temperatures falling outside the Kimberley limits. For imagine a still more elevated table-land whereon we might happen upon an initial temperature $\mathrm{T} = 28^\circ{\cdot}1$ for a solar zenith distance of about 65 degrees. This would clearly make t infinite, which is as clearly impossible. Moreover, the equation would give a value of t—small it is true—for the largest assigned value of T short of infinity, which is as clearly unthinkable. Perhaps the explanation is that a similar formula, but with different constants, would apply elsewhere, within the observed limits of temperature, to furnish—if no more—a very useful mnemonical aid.

At Cordoba, for example, which lies in S. Lat. 31° 24′, and very nearly on the central meridian of South America, but otherwise having no great advantages of geographical position, we get the following increases of temperature for decreases of zenith distance by 12 degrees from somewhere near 65 degrees:

March	2°·25 C.	from	18°·69 C.
June	4·36	,,	9·18
December	2·13	,,	19·79

Forming the equations as before, and solving by the method of least squares, we deduce the very accurate equation, in Centigrade degrees—

$$t(\mathrm{T} + 0{\cdot}943) = 44{\cdot}154,$$

* C. Smith, *Conic Sections*, Art. 151. Casey, *Treatise on the Analytical Geometry of the Point, Line, Circle, and Conic Sections*, Sec. Ed., p. 269.

the smallest value of the equation being 44°·136 C., and the greatest 44°·174 C., as compared with an extreme error of 0°·1 F. at Kimberley.

The only other hourly temperatures that have been tested in this way are for three (all that are available) incomplete years from Hong Kong in N. Lat. 22° 16′. They surrender to the same treatment the equation, in Fahrenheit degrees,

$$t(T - 34{\cdot}1) = 36{\cdot}3,$$

but the errors amount to fully three-quarters of a degree—which might be accounted large for a place with such a small daily range of temperature, did the available observations cover a longer period.

At the least, whether the changes of temperature be exactly or only approximately asymptotic, we conclude that the air of the table-land responds to the solar energy the more vigorously the more it happens at any time to be found below its theoretical temperature for that concomitant altitude of the sun; and that the time it requires to attain to its highest temperature is a question rather of hours than of days. The great lagging at Durban of more than a month must be regarded as pre-eminently due to the adjacent ocean *per se*. As to the atmospheric moisture rising from the water, its effect is probably infinitesimal by comparison, whether it be condensed into clouds or not. Nor does the ocean domain, meteorologically speaking, end with the shore, as is attested by Tables 33 and 34, in which the monthly means of maximum and minimum air-temperature, extracted from the annual reports of the Cape Meteorological Commission, are given not in districts but in sets according to distance from the sea; and by Tables 35 and 36 giving the monthly means of temperature, and of range of temperature, deduced from 33 and 34. The periods of observation vary from ten to seventeen years. The respective latitudes, altitudes, and distances from the sea are given more or less accurately below:—

1. Coast Stations:—

	S. Latitude.	Altitude.	Distance from sea.
Durban	29° 51′	260 feet	2½ miles
East London......	33 2	33 ,,	0 ,,
Port Elizabeth ...	33 58	181 ,,	0 ,,
Mossel Bay	34 11	105 ,,	0 ,,
Cape L'Agulhas	34 50	55 ,,	0 ,,
Simonstown	34 12	12 ,,	0 ,,
Average	34° 2′	64 feet	

2. Middle Stations :—

	S. Latitude.	Altitude.	Distance from sea.
Umtata............	31° 35′	2,400 feet	35 miles
Queenstown ...	31 54	3,500 ,,	100 ,,
Somerset East...	32 44	2,400 ,,	70 ,,
Graaff-Reinet ...	32 16	2,500 ,,	123 ,,
Prince Albert ...	33 14	2,120 ,,	60 ,,
Worcester	33 40	771 ,,	50 ,,
Average	32° 34′	2,300 feet	73 miles

3. Table-Land Stations :—

	S. Latitude.	Altitude.	Distance from sea.
Kimberley	28° 43′	4,042 feet	340 miles
Bloemfontein ...	29 7	4,518 ,,	290 ,,
Aliwal North ...	30 41	4,330 ,,	180 ,,
Philippolis	30 13	4,700 ,,	235 ,,
Average......	29° 41′	4,400 feet	261 miles

In the above list Durban should not properly be called a coast station, the observatory being two and a half miles from the sea—a distance which is pretty often quite enough to alter the type of temperature very sensibly. But it seemed better not to omit it, especially as its annual curves do not differ in character from those of the true coast stations.

In some respects Philippolis occupies a unique position : the lateness of the epoch of both its highest monthly maximum and minimum temperatures giving it Middle characteristics, yet showing full title to its position in the Table-Land set by reason of its early lowest maximum and minimum. But it has been included, although its meteorological history only runs back for nine years, chiefly because of the good quality of the observing, and next because of the lack of other material. Quite a half of Cape Colony is on the table-land, and as yet, unfortunately, the labours of the Meteorological Commission have only brought forth one complete register extending over a period exceeding ten years for a high level station. That being so, it is a distinct comfort to be able to cordially admit that the one register—for Aliwal North—is a good one.

Prince Albert belongs by reason of its altitude and distance from the sea to the Middle stations, but its meteorological elements seem to place it in a class intermediate between those and the Table-Land stations.

The numbers in 33–36 want little explanation. Their salient features only require a cursory inspection. We see that the highest mean maxima occur towards the end of December on the table-land; from a fortnight to three weeks later on the lower land; not appearing on the coast until the end of January. Again, on the table-land June is a little colder in the daytime than July; on the lower land July is a little colder than June; while on the coast July and August are both a good deal colder than June. In all the three sets of stations the difference of time between the highest and lowest maximum is just about six months. The average ranges of mean monthly maximum are—

Table-Land Stations	....	24°·3
Middle ,,	....	18°·4
Coast ,,	....	10°·9

In each set the highest and lowest monthly minima are reached a little later than the corresponding maxima, and are sufficiently pronounced to place the general highest mean temperature (*i.e.*, $\frac{1}{2}[M + m]$) of the whole country between the middle and end of January, and the lowest averages in July. But on the table-land July is very little colder at night than June, though much colder than August; in the middle stations August is somewhat warmer than June; while on the coast June is warmer than August. The average ranges of mean monthly minimum are—

Table-Land Stations	....	26°·4
Middle ,,	....	20°·6
Coast ,,	....	14°·2

The average annual ranges of monthly mean temperatures are—

Table-Land Stations	....	25°·0
Middle ,,	....	19°·4
Coast ,,	....	12°·5 *

The unlike influence of ocean and land upon the insolation and radiation to which the air is at any time subjected, is strikingly illustrated by the mean monthly range of temperature. Upon the table-land the curve is a simple one, having only a single maximum and minimum. The former comes in September, the latter in March. Bloemfontein and Aliwal North are almost identical, but Kimberley and Philippolis differ somewhat from them and from each other.

* The average temperature ranges of the middle stations are almost the same as the means of the averages of the coast and table-land.

The middle stations have also a minimum in March and also a second, much less pronounced, in the spring. The separate stations exhibit considerable variation among themselves, Worcester having the greatest range in the summer, while the others, on the whole, have theirs in the winter. The coast stations have a decided minimum range in February, and a smaller and, in some cases, abortive minimum in October. They are all alike in having the greatest range in winter, Simonstown excepted. At this station there is a third minimum, which also happens to be the greatest, and runs concurrently with that at Worcester, in the winter. Now Worcester and Simonstown are both in the Western Province, and their minimum winter range is no doubt a consequence of the greater rainfall, cloudiness, and humidity there at that season. The average annual ranges of monthly mean ranges of temperature are—

Table-Land Stations	7°·0
Middle ,,	3°·7
Coast ,,	3°·8

The results of the four Tables (33–36) seem to indicate that in the same way as the power of the sun to heat the air is limited by radiation, so is that same radiation limited (at night mainly) by the air's hygrometric condition. The curves of Fig. 3 suggest the conclusion perhaps better than the tabular numbers.

The influence of local surroundings is very clearly shown when we compare the temperatures of the different places with what some theory should indicate. The coast stations do not, for example, follow any simple cosine law in either their maxima, minima, or means of temperature. Neither do the various stations, when allowances have been made for latitude, conform to any law of decrease with altitude. Supposing the average in free air to hold good over South Africa, Prince Albert should have, approximately, a mean temperature $6\frac{1}{2}°$ less than that of East London, instead of $4\frac{1}{2}°$; Worcester nearly 2° less than Port Elizabeth, instead of 1°; Bloemfontein about 13° less than Durban, instead of $9\frac{3}{4}°$; and the Table-Land stations generally quite 5° less than that of the middle stations. The common reduction of temperature to sea-level, made with more or less (usually less) success in other countries, is therefore quite illusory here. We may conclude that the effect of the table-land is to reduce the fall by about one-third of its amount in free air, bringing it to, say, 1° in 440 feet. This is rather less than the rate (1° in 410 feet) connecting the temperatures of Mount Abu and Karachi, India, both near 25° N. Lat., at the respective altitudes of 3,945 feet and 49 feet, and in a climate not differing greatly, excepting at midsummer, from that of the dry regions of South Africa. Between Kimberley and Durban, making every allowance for the difference of latitude, the fall is not quite a degree in 500 feet. The monthly comparison numbers for Mount Abu and Karachi are given below in Table 37.* Considered side by side with the comparison of Table 25 they are most instructive, Abu being a fairly typical isolated mountain, and its observatory standing at about the same elevation above Karachi as Kimberley, on its typical table-land, is above Durban.

We come now to the remarkable numbers tabulated in columns 8–13 of Tables 1–25. Their meaning has been explained near the beginning of this paper. They show that the curve of daily maximum, and the curve of daily minimum temperature for the year have almost the same characters at both Durban and Kimberley, the respective positive and negative excursions occupying the same intervals of time at both places. Fifty-four per cent. of the registered maxima are above the mean maximum, and 52 per cent. of the registered minima are above the mean minimum. We infer from the given ratios that when the maximum falls below its mean amount it does so deeply and sharply, but its rises are more leisurely and more prolonged: that is to say, the general aspect of the graph is that of a prolate cycloid on the positive side of its base. The minima follow much the same course, although the cycloid shows a disposition in the winter months to shift to the negative side of the base.

Compare these temperature numbers with those for the pressures given in the concluding columns of Tables 1–24, and in columns 17, 18, 19, of the monthly summaries. Here the position is that the barometer at both Durban and Kimberley is as many times above the mean as it is below; *i.e.*, the average shape of the negative parts of the curve of departure from the mean daily pressure is an exact reflection of the average shape of the positive parts. In other words the curve displays the same peculiarities of detail either way up. Such being the case at both Durban and Kimberley, we must conclude that the mean pulsation is essentially undulatory. The idea is to some extent justified by an analysis of the pressures year by year deduced from hourly observations at Kenilworth. It is found that the annual mean pressure is practically constant, although the mean barometer during any month may differ greatly from that of the same month of another year.

As stated at the outset, the Durban pressures are for ten years, while only eight years are available at Kimberley; moreover, the

* From Blanford's *Climates and Weather of India.*

observing hours are different. Before the two may be compared, then, it is necessary first to determine the Durban means for the same eight years, and next to correct the readings of either for the diurnal oscillation. We are able, fortunately, in the case of Kimberley, to do this with some precision from the known hourly variation at Kenilworth. The result will be found in Table 38, the monthly numbers denoting the mean sea-level pressures at Durban from readings at IX. to XV. for the eight years 1890–1897, and the Kimberley means for the same years reduced to the mean of the same hours.

Although the period used is not so great as might be wished, some very remarkable facts stand out very plainly. First that the highest and lowest monthly pressures, occurring respectively in July and January, differ by 0·245 inch at Durban, and by 0·242 inch at Kimberley, which practically means an identical range. Now in free air, where there is a normal decrease of temperature with height, a point whose altitude is equal to that of Kimberley (4,042 feet) above sea-level at Durban would have a barometric range not much greater than one-half the observed range. We should have, in fact, counting both temperatures and pressures upwards from Durban, at the given altitude—

In July	26·14 inches
In January	26·01 ,,
For the year	26·08 ,,

At the same time it is not improbable that the Durban pressures would be rather different if there were no table-land behind it.

The range of monthly mean pressures at Mount Abu is but three-fifths of that at Karachi for a difference of elevation of 3,896 feet. Their monthly numbers are given in Table 38 for comparison with those of Kimberley. They illustrate very well how the indications of a mountain barometer differ from those of a table-land barometer. The orderly sequence of differences for the Indian stations is worth notice, these being least in summer and greatest in winter. Now all places whose altitudes are not very great have their pressures invariably greater in winter than in summer. But the difference of pressure between a sea-level station and an adjacent point at a moderate elevation is least in summer because the access of heat expands the air, thereby raising the surfaces of given pressure; and in the same way the cold of winter contracts the air, thereby lowering the surfaces. Evidently Mount Abu conforms to this law. In South Africa, on the contrary, the least differences come towards the end of the summer, the greatest near the end of the winter—some two months late for both phases.

A phenomenon like this is worth elucidating. Sir George Airy, whose gird at meteorology—because it requires neither money nor brains; or as he, more mildly, put it in the last report he wrote, "perhaps because it requires little of expense or science" *—was quite a hardy annual, seems to have believed that all ever done, or, for that matter, likely to be done, by meteorologists (except at Greenwich, where the meteorological work is "the best in the world") was to pile inches, or degrees, and decimal parts upon previous similar observations: Pelion and Ossa upon Olympus. The meteorologist's obvious retort is that astronomers have done their share of mountain piling in the past, with what they are pleased to describe as "fundamental" astronomy, and may do still more in the future, and yet not always succeed in scaling the high heavens. Neptune, for instance, was not discovered at Greenwich, nor would it have been later on, even though the Right Ascension of Uranus on, shall we say, 1847, August 31d. 14h. 27m. 38·9s. was somewhere about 1h. 6m. 11·37s.! But although

> "*ætherique ingenio supposuere suo*
> . . . *non ut ferat Ossan Olympus*
> *summaque Peliacus sidera langat apex*" †

may be occasionally true of astronomers, whether directed by Heaven or the Admiralty, who would argue that the present enormous bulk of the present volumes of fundamental astronomy published as Greenwich Observations should be curtailed? Not the meteorologist certainly. His only regret is that Airy should have risked adding to "hi montes" a Vale of Tempe by not inserting the necessary fourth decimal places, in seconds of arc, to the 1,294 elegant star-positions for January 1, 1880. Is it not, for example, sacrificing a reasonable accuracy to a most unreasonable brevity to call the R.A. of Alpha Ceti 2h. 56m. 0·328s., when the seconds should be 0·3275? Still less would the meteorologist argue that the meteorological observations taken at any astronomical observatory, even though they be not discussed by the observatory staff, should, for that reason, be discontinued. The industry that has accumulated there will be thankfully recognised by some future Titan. It is, indeed, much to be regretted that observers have not been so industrious in South Africa. Here, when extensive sets of observations are wanted, and that is at nearly every turn, they are not

* *Greenwich Observations*, 1880.
† Ovid, *Fasti*, Lib. i. 306, &c.

forthcoming, and for the simple reason that they never existed. Good observations at Bloemfontein, and at Port Nolloth, and plenty of them, would be invaluable in the framing of a pressure theory for the table-land. Still more so would be a set of good records from a chain of stations across the continent near S. Lat. 29°.

Failing such, as an experiment the monthly barometer results for Aliwal North, Philippolis, and Umtata, from the annual reports of the Cape Meteorological Commission have been compared with the observations for the same years at Durban.* They are each derived from one observation *per diem*, at VIII., of a marine barometer, the sluggishness of which may flatten the curves somewhat.

Umtata, below the high table-land, shows the normal winter maximum difference, and summer minimum, with very little retardation. Philippolis and Aliwal North both incline to Kimberley characteristics. The monthly rate of increase of mean pressure is pretty much the same for each station, *i.e.*, the pressure curve for each is to all intents and purposes an inverted curve of table-land temperatures. [See Tables 39 and 40.]

We may, it seems, without unduly magnifying the force of the evidence, regard the lagging in the differences of mean pressure as a peculiarity differentiating a table-land from a mountain in a germane latitude. The actual process seems to be much in this way :—

1. The annual mean temperature of the air immediately over the table-land being much greater than that of the free air over the coast at the same elevation, the layers of equal pressure that would otherwise be level planes are expanded upwards in surfaces that follow the contour of the land. Those portions of the surfaces protruding thus above the elevation proper to their given pressures push outwards against the normal surfaces over the coast—not sliding upon each other as von Siemens has truly said †—until equilibrium is established. That is, for any given latitude the barometer would read lower on the table-land and higher on the coast than it would if the table-land were replaced by a mountain of the same altitude, because of this outward extension.

* Some Durban results for VIII., Royal Observatory mean time, are published by the Cape Meteorological Commission each year; but they do not tally with those published direct by the Natal Observatory, and so have not been used here. It seems probable that before being sent to Cape Town they are corrected for latitude. If so, they are not really comparable with the results from the other coast ports published on one page as "Monthly Means of Barometer . . . reduced to 32° F. and Sea-level," none (or few at any rate) of which have undergone the latitude correction.

† "On the General System of Winds of the Earth" (*Phil. Mag.*, 1890). But it is largely a question of words, although, perhaps, not quite true in the sense in which von Siemens intended.

2. Starting now in the height of summer, when the temperatures over the table-land are the greatest possible, we have at any instant the whole atmospheric envelope of the southern hemisphere expanded upwards, the tendency of which is to decrease the differences of pressure between upper and lower stations. But the air being expanded over the high land not simply in terms of its altitude, but according to its temperature, the excess of volume presses coastwards, counteracting more or less completely the processes that make for a minimum pressure-difference.

3. During February pressures are rising generally in the southern hemisphere. Also the temperature is rising over the coast, but falling over the table-land: that is, the pressure surfaces are still rising over the coast, but have begun to sink over the interior. More of the inflow from the north, therefore, goes to the table-land stations than to the coast.

4. During March temperatures are falling generally, and pressures are rising, the surfaces of equal pressure are tending to sink. But the temperatures of the upper stations are falling very much faster than those of the coast, and hence a small excess of the still expanded air (it still being warmer than the mean) is pressing inwards.

5. During April and May temperatures are falling most rapidly at inland and coast stations alike. The pressure surfaces are still of themselves tending to sink faster over the interior than over the coast, but now it would seem are lost in the maximum effect of the general inflow from the north. In a lesser degree the same applies to June. There is some irregularity in the behaviour of the barometer at this season, which seems to be due to the barometric depression that annually (probably) spreads over the land for a fortnight or so towards the end of May. The general character of this depression will be best understood after reference to the daily numbers in Tables 5 and 17.

6. In July the mean temperatures of the table-land cease falling, and, indeed, saving for the annual cold wave of the month—to be mentioned again presently—would be actually rising; as the maximum temperatures are in spite of the cold wave. At the middle stations and on the coast, however, the fall continues both by night and by day. That is, the pressure surfaces over the coast and the slopes are still sinking, while over the higher land they are sinking no longer. At this time also the general pressure over the southern parallels is practically stationary at its highest amount. So the crests of the stationary or ascending pressure surfaces are free to extend laterally, adding something to the coast pressures [see Table 25] and deducting something from those of the interior.

7. In August the same state of things prevails. For although the temperature rises slightly over the coast, the rise on the table-land is at least four times as great; and thus while the seasonal fall of pressure has well set in, over the whole southern hemisphere, it is checked a little on the coast and increased on the table-land by the outward expansion arising from the more rapid increase of temperatures. In September the pressure surfaces are rising generally, and the differences begin again to decrease.

8. In October we see another increase in the difference of pressure. It is very plain at Aliwal North and Kimberley, and appears as a considerable temporary check in the curve rates of Philippolis and Umtata. Now at the coast stations the monthly rate of increase of temperature augments far into the summer, reaching its maximum from November to December. On the table-land the maximum rate is reached from August to September. The middle stations seem to feel the influence of both, having a marked break in their rates of temperature increase from September to October. Corresponding to this is the marked October decrease in the rate of fall of the barometer at Durban, where for pretty well a whole month the pressure curve lies above the inverted Kimberley temperature curve. A glance at the daily values in Tables 10 and 22 will be sufficient to prove this month of high relative pressure an essentially Durban phenomenon: the rate of fall of pressure from September to October being considerably checked there, slightly so at Umtata, and not at all at the higher stations. The interpretation is not obvious. Perhaps it is not unlikely that the check to the rate of rise of temperature at the middle stations may also indicate a sufficient check to the rise of the pressure surfaces to allow the expanding air of the table-land—which experiences no such check—to again, temporarily, push outwards over the coast. The check of the temperature increase concerns the maximum almost entirely.

The general trend of the changes just sketched in detail will be best understood by superimposing Fig. 2 upon Fig. 1; from which it will appear that the Durban pressure curve falls below the inverted Kimberley temperature curve in autumn, and above it in spring, whereas the Kimberley pressure curve is above its inverted temperature curve in summer, and below it in winter.* Of course it will be understood that the above sketch aims at neither completeness nor great exactitude. That unfortunately is out of the question, and

* Compare V.Bjerknes, "The Dynamic Principle of the Circulatory Movements in the Atmosphere" (*Monthly Weather Review*, Oct., 1900). This paper came after the above sketch in the text was written: too late for use here. It i of exceptional interest.

will so continue until meteorology is better served by the Legislature. There are chances here, too, for kites and balloons. Nor is it quite clear why the Kimberley wind-vane tends to make one complete, if at times vacillating, clockwise rotation per annum. That one depends to some extent and in some way upon the other is a reasonable idea. Certainly the Kimberley diurnal wind stratum is very shallow, and possibly the annual stratum is so also. The seasonal transfer of air from one hemisphere to the other may take place at a great altitude, and the transfer from coast to table-land and back somewhere between, in the middle reaches. The barometer necessarily integrates the combined effect of the three movements.

The chances of solving the problem of reducing the table-land pressures to sea-level are not simplified by our results so far, although the conditions may be made clear by future research along similar lines. And the difficulty exists not merely because, as is commonly stated, our knowledge of the temperature of the air is limited and fragmentary, but because the ordinary formula is insufficient. But at the least the annexed tabular matter ought to say to what extent it is likely to be so. It is a question whether it would not be possible, if we had the material, to make a synoptic weather-map for the higher stations reduced to, say, a 4,000-foot datum, and another for the coast and middle districts reduced to sea-level, combining the two by some suitable process afterwards. On the whole, however, it is likely that a weather-map depicting only proportional departures from the normal daily means will be the most useful tool of our future weather-bureau—when we get it!

Although the average monthly differences of pressure between Durban and Kimberley, deduced from two observations per diem, may not be so exact as they might be if they were deduced from one observation per diem for twice the number of years, yet for the annual mean difference they are doubtless quite as good. Assuming this much, we may calculate the values of the numerical coefficient in the formula—

$$Z = K \log . \frac{H}{h}$$

in which Z is the altitude of Kimberley in feet, H is the mean height of the barometer at Durban sea-level (mean low water), and h the mean height of the barometer at Kimberley, H and h being corrected and reduced to 32° F. K includes a number of petty factors; the gravity correction for both altitude and latitude, corrections for air-temperature, and for humidity. Since Durban and Kimberley are only about a degree of latitude and some 4,000 feet of altitude apart the gravity correction may be ignored for the time. The air-temperature factor is—

$$1 + \frac{T + t - 64}{900}$$

in which T is the mean temperature of Durban, and t that of Kimberley, the mean temperature of the intervening air-strata being supposed to be $\frac{1}{2}(T + t)$, which happens not to be quite the actual case. But whatever the actual mean temperature of the intervening air may be, an examination of the numbers in Table 35 will readily prove that the numerical value of the air-temperature factor for all the given places must lie between the limits 1·0733 and 1·0797, numbers equivalent at their full effect to an error of about 13 feet of elevation in excess or defect. Assuming this temperature factor to be also constant, we have yet to consider a further correction for diurnal range. Now the daily pressure values for Durban refer to observations at IX. and XV. N.M.T. (= mean time of 30° E.), the corresponding number for Kimberley referring to observations at VIII. and XX. C.M.T. (= mean time of 18° 29′ E.). That is, the Durban barometer was read at 9h. 4m. a.m., and 3h. 4m. p.m., local time, and the Kimberley barometer at 8h. 25m. a.m. and p.m. local time. As previously stated, the Kimberley values in Table 38 have been corrected, by the aid of the Kenilworth horary pressures, to agree approximately with readings taken at 9h. 4m. a.m. and 3h. 4m. p.m., Kimberley local time. It seemed proper to make such a correction, but since the mean differences at Durban between the pressures at IX. and XV. (N.M.T.) are only about three-quarters of those for the same hours (C.C.M.T.) at Kenilworth, it is possible that the increased accuracy is not in the same ratio as the extra labour. Obviously the correct method would be to reduce all the observations to the mean of the day, if we only had the observations.

Again in the comparison between Durban, Umtata, Aliwal North, and Philippolis, the times have been IX. N.M.T. at Durban, and VIII. C.C.M.T. at the other places, which reduces to, say,—

9h. 4m. a.m.	Durban local time,
8h. 25m. a.m.	Umtata ,,
8h. 17m. a.m.	Aliwal North local time,
8h. 11m. a.m.	Philippolis ,,

Fortunately on the mean of the year the South African barometer is not changing much between VIII. and IX., and thus the correction on account of difference of local time is very small—less in fact than the possible secular error of a single observation with a marine barometer—although in the case of Philippolis it may amount to fully 0·008 inch during the winter months. Making the necessary corrections from the Kenilworth observations, allowing for the differences of local time, we get finally the values, for 9h. 4m. local time, of Table 39.

Granting the cistern of the Kimberley barometer to have been 4,042 feet above the sea, and substituting this value of Z in the formula, we derive K = 64250 approximately. If this result hold for South Africa generally, we determine respective solutions for Z to be—

Umtata	2,352 feet
Aliwal North	4,362 ,,
Philippolis	4,556 ,,

Here Aliwal North comes out 12 feet higher than the railway level, and 32 feet higher than the altitude published by the Meteorological Commission; but Umtata is 48 feet less, and Philippolis 144 feet less than the Commission has said. It has never been explained how the altitudes given in the Annual Reports of the Meteorological Commission have been determined, but, since they are generally in round numbers, it is a fair inference that they claim no great excellence. Kenilworth (Kimberley) with the same factor, for some four years' mean, comes out at 3,928 feet.

Professor Guthrie, about twelve years ago, constructed a table of altitudes above Cape Town sea-level,* using K = 64300, and made a remarkable, not to say miraculous, agreement for quite a number of places all over the country between the altitudes by railway levelling and those by the barometer; the differences, for example, between the two methods being only 2 and 4 feet respectively at Aliwal North and Kimberley. He depended upon a mean pressure of 25·762 inches at Aliwal North, and 26·031 at Kimberley, at about 8 a.m. local time. The former agrees closely enough with the value in Table 39 (= 25·777 inches at 9h. 4m. a.m.); but the Kimberley value is almost certainly 0·04 inch too low at least. Moreover, he has a difference of only six feet between the barometer and the level at Bloemfontein, of all places! The observing is pretty feeble at many second-order stations in the world, and in South Africa especially, but if a worse lot of barometer results than that taken at the capital of the quondam "Free State" has ever been evolved, it ought to be carefully preserved—as a *record*. No confidence what-

* F. Guthrie, "Sea Levels in South Africa from barometric observations" (*Trans. S. Af. Phil. Soc.*, vol. v., p. 318).

ever can be placed in the pressure returns so far published from that place, and the fortuitous agreement between the two methods only proved that the factor brought the level into very bad company. It is hard to say what the mean pressure at Bloemfontein ought to be, for at the beginning, even before the novelty should have worn off, the observing hours and seasons seem to have been erratic; while throughout the "nineties" the whole operation has approached the ridiculous. Latterly the results may have been not more than 0·16 inch from the truth.

It seems not unlikely that the factor 64250 will give fair altitudes above sea-level when the upper and lower stations are near the same latitude. Thus, for example, we know that the pressure increases very rapidly from East London along the coast to Durban: then taking 4,350 as the altitude of the Aliwal North barometer we deduce a 9 a.m. mean sea-level pressure for the same latitude, say at Port Shepstone, of 30·125 inches.

When it is not convenient to employ logarithms, Babinet's excellent formula may be used with advantage.* It is—

$$Z = C \cdot \frac{H - h}{H + h}$$

where Z, H, h, are as before, and C a numerical coefficient containing, like K, a number of petty factors. The approximate value of C, for the stations previously considered, is 55900, and the resulting altitudes are—

Umtata	2,354 feet
Aliwal North	4,360 ,,
Philippolis	4,553 ,,
Kimberley	4,042 ,,
Kenilworth	3,928 ,,

Passing now from generalities to details we see, according to Fig. 2, that high pressures are rare in the summer, nothing exceeding 30·4 inches being at all likely at Durban from the end of November to the end of March, and that the high pressures, say exceeding 30·66 inches, belong almost exclusively to the three months beginning about the end of the third week of July, extreme minimum pressures being also common at the same period. Sometimes we find low minima prevailing in conjunction with low maxima, or high minima with high maxima—suggesting here and there a certain sort of annual periodicity—and then again high minima accompanying low maxima, or *vice versâ*, quite at random. Of the presumably

* See Greenhill, *Hydrostatics*, p. 310.

periodic phenomena we have the very interesting, deep, **W**-shaped depression covering the whole country from May 11–29, already spoken of; and the period of abnormal pressure from about September 25th to October 17th, felt at the coast, only, as an increase, but on the table-land as a slackening of pressure, and due doubtless to the overflow of heated and expanded air from inland coastwards when the transfer along the parallels is temporarily greater than the seasonal meridional drift to the other hemisphere.

It is significant that the occasional abnormal hot winds of Durban blow at the season when the air is thus supposed to expand outwards from the table-land. They exercise a striking disturbing influence upon the regularity of the curve of maximum temperatures (Fig. 1) between August and December. The Government astronomer for Natal thus describes some that visited Durban in the early summer of 1896:—

" Among the meteorological phenomena of the year calling for notice was the exceedingly high temperature registered on September 21st and October 3rd.

" September 21st was the hottest day recorded at the Observatory, and probably the hottest day experienced in Durban during the last twenty years. The early morning was cool, but shortly after 8 a.m. the wind shifted towards the N.W., and the temperature began to rise fast, the wind growing hotter and hotter, and the barometer fell slowly. By nine o'clock the temperature had risen from 68° to 85°, and by half-past ten o'clock it had risen to over 100°. Then the wind shifted back towards the N.E., and under the influence of the sea-breeze the temperature fell fast, until by eleven o'clock it was only a little above 90°. Then the wind went back to the N.W. and grew stronger, coming in sharp gusts, with the effect of sending the temperature up fast, until by noon it had reached 108°. By two o'clock the temperature reached its maximum, the thermometer then registering 109°·6, and it was still over 100° at three o'clock, not falling below 100° until after 4 p.m., after having been above 100° for over six hours. During the night the temperature fell steadily to 63°, the change of temperature in twelve hours, therefore, being over 48°.

" At the Observatory we have no record of so hot a day. It is true that once, previously, we have registered a higher temperature, and, curiously enough, that was on exactly the same date in the year 1890. Then the maximum temperature registered was 110°·6, or exactly a degree greater; but the intense heat was of far shorter duration, the temperature being only 70° at 6 a.m., and had fallen below 90° before 3 p.m., so that the temperature was only over 100° for less than three hours.

"On the morning of both September 16th and 17th there were hot winds of similar character, the maximum temperature registered on the 16th being 95°·2, and on the 17th was 100° exactly, but on this day the hot spell broke before noon from the wind shifting, or a much higher temperature would have been registered during the early part of the afternoon.

"On October 3rd a similar hot wind sprang up before 8 a.m., and the temperature rose rapidly, reaching 95° at nine o'clock, and 107°·9 shortly after noon. Fortunately the wind then shifted towards the east, and the temperature fell rapidly, until by half-past one it was below 90° again, and the rest of the afternoon was fairly cool.

The maximum temperatures registered at other stations on these days were as follows :—

	Sept. 17th.	Sept 21st.	Oct. 3rd.
"*Coast Stations :—*			
Stanger	103°	103°	104°
Verulam	109	111	101
Durban	100	110	108
Umzinto	70 ?	106	84
Port Shepstone	100	107	72
"*Mid-Country Stations :—*			
Richmond	97°	81°	105°
Maritzburg	99	100	102
New Hanover.........	100	92	99
Greytown	93	94	91
Impendhle	99	90	100
Howick	95	89	85
"*Up-Country Stations :—*			
Weenen	99°	97°	99°
Ladysmith	97	95	92
Dundee	90	93	89
Newcastle	89	89	90
Estcourt	72	92	92

"From these figures," continues Mr. Nevill, "it is apparent that these hot winds do not come from up-country as is commonly supposed, though the fact that they blow from the N.W. appears to point to this origin. They are purely a coast phenomenon, as the high temperature does not extend far inland.

"These coast hot winds appear to be due to an intensely heated lower stratum of air from three to five thousand feet in thickness, being confined beneath a uniform heavier upper stratum of cold air, which, owing to its homogeneity, cannot be broken through by the lower lighter stratum of hot air. There is good reason to believe that this arises from the approach from the N.E. of a thick mass of cold air slowly sinking from the upper strata of the atmosphere. As this impinges against the mountains and highlands up-country it is deflected, and drives the lower-lying hot strata of air partly before it, but in great part back along the low-lying surface toward the sea, in the form of a N.W. hot wind. The thicker the stratum of hot air, the further inland extends the hot wind, but usually the less intense the heat.

"Despite these hot winds the months of September and October were not abnormally hot, the intervening days being usually rather below the average temperature."

It is not to be denied that this interesting account, and the quoted temperatures, do prove the *very* high temperatures to be purely a coast phenomenon, but the assigned origin is not so certain, nor is it shown where the low-lying stratum of hot air gets its heat from. This is a problem of sufficient importance to justify rather more than a superficial notice. And there are certain material and related facts which may be of utility in assisting us, or some future investigator, in framing some sort of a solution. These facts reveal themselves very plainly in Table 41. In this Table the Durban pressures at 9 a.m., the Kimberley pressures at 8 a.m., and the maximum shade temperatures at both places, are arranged, as departures from the normal daily means of Tables 1–24, fcr the day of a hot wind and for three days before and after. There were six occasions to consider in the ten years 1890–9, three being in 1896. The average condition follows the separate details.

We notice at once that the rule at Durban is for the temperatures to rise gradually for two or three days before the final rapid development of heat. The pressures begin the period well above the normal —nearly a third of an inch in one instance, nearly a tenth of an inch on an average—the curve being almost the inverse of the temperature curve, and agreeing moderately well with the formula proposed above as connecting the annual curves of the same two elements at Kimberley. But now we have the conspicuous and noteworthy fact that at Kimberley the maximum temperatures, and the pressures, are both greatly above the normals throughout the week, the temperature departures, in particular, for the first three days being twice as great as those of Durban. But the maximum is reached a day earlier, and the succeeding fall is gradual. During the whole week the Kimberley pressures are slackening almost uniformly, a faint and scarcely perceptible minimum commanding the averages on the same day as the deep minimum of the coast

It appears, then, that for some days previous to a hot wind on the coast pressures and temperatures are both exceptionally high on the table-land. Such a peculiarity, occurring at a time when the surfaces of equal pressure are always greatly elevated over the interior, will obviously give an additional impetus to the (supposed) overflow of air common at this season. The paucity of the necessary meteorological records makes it impossible to assert with any confidence what will be the final result at the lower levels of the increased overflow. We know enough of the winds of Kimberley to be able to predict that the overflow will probably take a spiral path. But it is not at all certain to what extent and how far the operation will be propagated. Manifestly the gradual slackening of the high pressures above does not communicate an immediate increase below. Possibly the enforced outflow sets up some sort of compression in the upper, or rather middle reaches of the atmosphere over the coast, making a still further increase of temperature there ; which again sets up a vortex motion, and an upcast, where otherwise we should have had augmented pressure. The littoral high temperatures may therefore arise from the compression, *and friction*, of the expanding air of the high land upon the elastic walls of this natural chimney. Of course the compression of itself, whatever its possible superior limit, would not be competent to develop the observed degree of heat. That is convincingly argued by the terms of the "Characteristic Equation of a Perfect Gas," $pv = RT$.* Lastly, in further confirmation of the possibility that the factors of a hot wind originate on the table-land, it may be added that the phenomenon is almost invariably accompanied by clouds of the cirro-stratus type, and by a considerable falling off in the quantity of moisture present.

The May depression does not greatly affect the temperatures while it lasts, albeit colder nights herald its breaking up and cold days succeed. There is apparently not much doubt of its really being an annual event, the mean dates of the double minimum departing practically nothing from the 16th and 25th. There is a very similar depression at Adelaide (S. Aus.), but coming a little earlier, the dates of the double minimum being about the 11th and 17th. As will be seen from Fig. 2, the Durban maximum pressures are never very

* Preston, *Theory of Heat*, p. 127 ; Greenhill, *Hydrostatics*, p. 281.

high during the greater part of May, while the minima are at times extraordinarily low. So far as Kimberley is concerned it is the only depression of the mean curve having both depth and length.

But by far the most interesting of all the possibly annual phenomena is the narrow but deep depression recurring year after year near the middle of July. Speaking in averages, the barometer begins to fall at Durban on the 11th, is falling for four days, and rising for five to a point (on the 18th) rather higher than it originally fell from. At Kimberley the fall begins on the 12th and continues until the 15th —*i.e.*, it is still falling at Kimberley after the minimum has passed over Durban—rising from that time to the 20th. Apart from the difference of time, and the somewhat greater range at Durban, the depression is pretty much of the same aspect at both places with regard to the gradients; resembling in this the ordinary sporadic cyclonic disturbances that visit the country ubiquitously. Now it may be laid down as a rule, in a general way, that pressure is the inverse of temperature, the one being high while the other is low. But this rule does not rigidly apply to the July depression, nor for that matter to the prevailing conditions during the greater part of the month. On the contrary, the temperature begins the month by rising and falling with the pressure, next it does not respond one way or the other to the changes of pressure, then it begins to fall two days after the pressure has begun to fall, and to rise also two days after the pressure has risen; afterwards for a time it behaves normally. It is curious, too, that although the pressure wave is felt first at Durban by fully a day, the temperature wave is felt first at Kimberley, just as though the two waves were independent and travelling in opposite directions.

It needs no very keen discernment to see that we have here a very different class of depression to that which accompanies the hot winds of the coast. This one is common to high and low land without bias, and appears to be as much *communibus annis* as the mean pressure or temperature of any month. To show this better Table 42 has been constructed from all the materials available here (namely, eight years from Kimberley proper, three from Kenilworth, and fourteen from Durban), giving the daily readings of the barometer for nine days in July (10th–18th) during each year. It will be seen that the tendency to a minimum at the mean date not only holds for the ten years from which the averages of Tables 7 and 19 have been computed, but also for the years before and since. One cannot help regretting that the pressure conditions of Port Nolloth may not also be examined.

The atmosphere consists of a quantity of matter which cannot materially change in amount in any given not great interval of time. Hence a depression in one spot must be balanced by a crest in another.* Where, then, does the July depression come from? and what becomes of it? or rather, how does it originate? If it be essentially a planetary phenomenon, that is to say set directly in motion by outside influences, like the monthly mean temperatures, and not by any reflex terrestrial influence, then clearly we must expect a collateral process about the same time in other parts of the world, its simultaneous aspect varying probably according to the geographical conditions of the place. Does this then appear, in any manner, elsewhere, on or near the same parallel? The question is worth asking, although, unfortunately, only a shadow of a reply is to be anticipated for the simple reason that observations have not yet been piled upon previous observations industriously enough in the southern hemisphere. It has only been possible to attempt it for Adelaide and Cordoba besides Durban. The comparison, dealing with the whole month, for the two first and Kimberley, will be found in Table 43, the temperatures and pressures in the several columns having first been "bloxamed" in threes. The Kimberley numbers refer, as before, to eight years of barometer and ten of thermometer; the Adelaide numbers are for the twelve years 1885–96; † those of Cordoba for the years 1885–92 and 1894–7, the last year (1897) having been included to make up the twelve years because the results for 1893 were overlooked.‡ Table 43 is represented

* This obvious inference has been occasionally denied. Among the various explanations of the double diurnal oscillation of the barometer, ranging over the whole gamut from the utterly feeble to the egregiously stupid, it has been stated that the afternoon minimum is due to the loss of weight by the air due to heating; and that the daily pressure tide does not indicate any inward and outward movement, but simply an up and down one! Von Siemens languished fondly round a twin sister.

† From *Meteorological Observations made at the Adelaide Observatory*, by Sir Chas. Todd. The latitude of Adelaide is 34° 57′ S.

‡ And scarcely through any great fault of mine. Tomo ix. of the *Anales de la Oficina Met. Argentina* is published in two parts, both dealing with the meteorology of Cordoba, entitled respectively:

"Primera parte: Observaciones hechas en la Oficina Central."

"Segunda parte: Discusion de las observaciones hechas en la Of. Cent."

The first part, published in 1893, contains the complete registers 1872–92. The second part, dated 1894, is a full and very excellent discussion of the first, running to nearly 500 pages, with 25 plates. After the text above and the corresponding tables were complete, it was recollected that the register for 1893 was bound up, in the second part, between the discussion and the plates, put *there* because "debido à la demora en la publicacion de la segunda parte de este tomo, podemos incluir aqui las observaciones al año pasado [*i.e.*, 1893]." It has not been thought worth while to recompute the numbers, or to feel annoyed.

graphically in Fig. 4 in which the thin black line represents the temperature, and the thicker red line the pressure, at each place.

All three places begin the month with a rising temperature which in each case comes to its highest value about the 4th. From the 1st to the 13th the temperatures of Adelaide and Kimberley are much alike in their changes, and not greatly different in quantity. But between the 13th and 22nd there is a great dip at Kimberley, defining, in fact, the coldest period of the year, and apparently delaying the rise of temperature to such an extent as to materially alter the coefficients in the cosine formula; whereas the Adelaide temperatures show on the whole a gradual increase. The Cordoba temperatures fall uniformly from the 3rd to the 11th, the cold period lying between the 3rd and 20th. During their cold periods the temperature gradients at both Kimberley and Cordoba are nearly identical, and both by a coincidence have a "step" half-way down, although that at Cordoba is very small, the much larger one at Kimberley thrusting the actual minimum a full five days later than the date of its appearance at Cordoba. It is curious, however, that a much bigger step down is shown by the curve of mean daily temperatures of Cordoba for the period 1878–92, although the total fall occupies the same days of the year. A somewhat colder period visits Cordoba earlier and reaches its lowest mean temperature about June 21st. But it depends altogether on the lowness of the maxima, the July cold period, on the other hand, depending upon the lowness of the minima.

The Cordoba temperatures and pressures agree most consistently to differ, pulsating in opposite phases throughout the month. The Kimberley phases, on the contrary, have little in common or in contrast, such correspondence as there is suggesting that the temperature changes follow the pressure changes after a considerable interval of time. The same, though in a less degree, may be said of Adelaide.

It is, to say the least, surprising to find the relationship between the July pressure and temperature conditions so completely diverse as it is at Cordoba and Kimberley. For both stations are continental, both are at a considerable elevation, and both are near the central meridian of their respective continents. It goes to confirm the conclusion suggested by a comparison of the Durban and the Kimberley daily numbers, that the pressure wave and the temperature wave of the middle of July at Kimberley are maintained somehow in a different way even though they be started by the same agency. Perhaps the simplest view is that the depression comes in from the Indian Ocean attracted by the suitable temperature conditions that originate and prevail inland. Or we might adopt the working theory (not forgetting how easy it is to theorise when facts are few), which, however, is rather a geometrical conception than a mechanical possibility, that there is a certain temperature factor—if we may so call it—travelling round the earth from west to east, while a pressure factor is going with the sun, the opposite way. Upon this view the barometric depression of July 14th at Durban, 15th at Kimberley, 19th at Cordoba, and 21st at Adelaide, have a closely related origin. Whence it would follow that the crest showing at Kimberley about the 9th, 10th, 11th, appears at Cordoba about the 12th, Adelaide 14th and 15th, Kimberley again 18th, 19th, 20th, Cordoba 22nd, and Adelaide on the 26th ; and that the maximum points, therefore, in the curve for each continent are something more than an accidental effect of mere wave-length. Such Mauritius observations as could be culled from a few (nine years) odds and ends of starveling reports scattered over the years 1877 to 1894, fit into this scheme admirably. They give a curve for July agreeing in phase, though the amplitude is much less, with the Adelaide curve ; and also in aspect, though a day or two earlier in date, with the Kimberley curve.

Upon the whole it is not unlikely that while the pressure and temperature waves of the three continents are demonstrably not one and the same thing, yet they may arise from the same impulse: some similar arrangement of conditions producing like effects. For one relief we have much thanks :—Swarms of meteors, or sunspots, have been, or are to be, the cause of everything. The July barometric and thermometric depressions, however, at any rate, are exceptions. Neither sunspots nor meteors have any influence over them, physical or occult.

Note.—Some progress has been made in a fuller discussion of the minimum temperatures than is given here ; but since their treatment runs upon different lines it has been thought expedient to defer it for a separate communication later on. The hygrometric state of the air may not be neglected when the nocturnal cooling is under consideration, and therefore the Lee registers would be of limited utility in the same connection.

TABLE 1.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

Jan.	M	m	M−m	$\frac{M+m}{2}$	M′	m'	(M +)	(M =)	(M −)	(m +)	(m =)	(m −)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P +)	(P =)	(P −)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	86·3	67·3	19·0	76·8	95·1	59·6	5		5	5		5							30·014	30·329	29·692				9	1	10
2	85.3	68·3	17·0	76·8	90·2	62·7	7		3	6		4							·005	·264	·821				10		10
3	85·5	67·5	18·0	76·5	97·1	63·6	4		6	4	1	5	85·7	67·7	18·0	76·7	97·1	59·6	·001	·134	·783	30·007	30·329	29·692	12		8
4	87·0	68·9	18.1	77·9	94·2	64·1	7		3	7		3							29·914	·202	·652				5		15
5	83.0	68·3	14·7	75·6	90·4	65·0	4		6	5		5							·973	·182	·707				11		9
6	80·7	66·4	14·3	73·5	91·5	60·3	3		7	3		7	83·6	67·9	15·7	75·7	94·2	60·3	30·022	·285	·766	29·970	30·285	29·652	11		·9
7	82·5	64·8	17·7	73·6	86·5	61·2	2		8	2		8							·038	·213	·820				14		6
8	85·6	65·0	20·6	75·3	93·5	59·4	5		5	3	1	6							·023	·250	·705				13		7
9	85·4	66·3	19·1	75·8	89·9	62·3	6		4	3		7	84·5	65·4	19·1	74·9	93·5	59·4	29·974	·253	·796	30·012	30·253	29·705	8		12
10	86·5	67·8	18·7	77·1	94·8	63·2	6		4	6		4							·949	·129	·698				9		11
11	86·6	69·0	17·6	77·8	96·4	66·4	5		5	6	2	2							30·008	·230	·808				12		8
12	87·4	67·5	19·9	77·4	94·4	60·0	7		3	5	1	4	86·8	68·1	18·7	77·4	96·4	60·0	29·966	·219	·755	29·974	30·230	29·698	8		12
13	85·1	68·6	16·5	76·8	91·9	60·3	5		5	8		2							30·000	·187	·820				11		9
14	86·4	67·5	18·9	76·4	89·4	61·4	8		2	5	1	4							29·907	·245	·728				4		16
15	83·9	68·6	15·3	76·2	97·5	63·0	5		5	7		3	85·1	68·2	16·9	76·5	97·5	60·3	·965	·135	·630	29·957	30·245	29·630	12		8
16	83·8	68·3	15·5	76·0	91·4	64·6	4		6	4	1	5							30·008	·253	·603				12		8
17	85·5	68·3	17·2	76·9	95·4	61·4	5		5	6		4							·058	·235	·775				13		7
18	84·2	67·0	17·2	75·6	90·9	63·0	5		5	4	1	5	84·5	67·9	16·6	76·2	95·4	61·4	·019	·209	·865	30·028	30·253	29·603	10		10
19	85·4	66·9	18·5	76·1	94·0	59·2	6		4	4		6							·035	·160	·851				12		8
20	87·2	67·7	19·5	77·4	93·0	59·1	8	1	1	5		5							·007	·269	·720				11		9
21	85·1	68·6	16·5	76·8	96·3	64·6	6		4	7		3	85·9	67·7	18·2	76·8	96·3	59·1	·001	·195	·755	30·014	30·269	29·720	12		8
22	86·6	67·7	18·9	77·1	98·4	61·9	6	1	3	4		6							·023	·233	·824				11		9
23	86·5	67·7	18·8	77·1	95·2	60·7	6		4	6		4							·027	·296	·546				13		7
24	87·2	68·4	18·8	77·8	105·2	61·9	5		5	4	1	5	86·8	67·9	18·8	77·3	105·2	60·7	29·984	·270	·518	30·011	30·296	29·518	11		9
25	84·0	66·7	17·3	75·3	92·9	56·7	6		4	5		5							30·030	·263	·886				10		10
26	86·2	67·2	19·0	76·7	93·3	58·3	6		4	5		5							29·945	·347	·753				5		15
27	90·4	68·1	22·3	79·2	98·3	62·1	7		3	5		5	86·9	67·3	19·5	77·1	98·3	56·7	·928	·291	·621	29·968	30·347	29·621	5		15
28	85·0	69·2	15·8	77·1	93·1	62·3	5		5	8		2							30·025	·198	·872				12		8
29	85·0	66·9	18·1	75·9	96·5	62·5	7		3	5		5							·031	·200	·788				13		7
30	86·3	69·1	17·2	77·7	95·4	62·8	6		4	6		4	85·4	68·4	17·0	76·9	96·5	62·3	29·987	·290	·797	30·014	30·290	22·788	8		12
31	86·6	69·7	16·9	78·1	94·2	64·6	6		4	7		3							30·032	·228	·876				12		8

TABLE 2.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

Feb.	M	m	M − m	$\frac{M+m}{2}$	M′	m′	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	86·1	67·8	18·3	76·9	93·7	61·9	6		4	4		6							30·051	30·281	29·796				11		9
2	86·3	68·5	17·8	77·4	93·2	63·2	6		4	6	1	3	86·3	68·7	17·6	77·5	94·2	61·9	·002	·270	·758	30·028	30·281	29·758	9		11
3	86·5	68·6	17·9	77·5	94·7	60·5	6		4	5	1	4							·018	·218	·742				11		9
4	86·3	68·6	17·7	77·4	92·8	63·7	8		2	4	2	4							·020	·233	·802				10		10
5	85·1	69·7	15·4	77·4	90·8	64·6	6		4	7		3	86·0	69·0	17·0	77·5	94·7	60·5	29·996	·238	·807	30·011	30·238	29·742	8		12
6	84·5	69·4	15·1	76·9	89·8	63·0	6		4	7		3							·965	·197	·703				8		12
7	83·7	68·2	15·5	75·9	91·7	56·4	5		5	6		4							·997	·191	·842				10		10
8	83·7	68·1	15·6	75·9	89·8	61·4	3		7	5	1	4	84·0	68·6	15·4	77·3	91·7	56·4	·979	·249	·680	29·980	30·249	29·680	8		12
9	83·6	67·0	16·6	75·3	92·2	61·0	3	1	6	4		6							30·041	·339	·822				11		9
10	84·5	67·6	16·9	76·0	90·5	60·5	5		5	3	2	5							·005	·278	·820				8		12
11	84·4	67·6	16·8	76·0	90·8	63·7	4		6	2	1	7	84·2	67·4	16·8	75·8	92·2	60·5	29·990	·170	·663	30·012	30·339	29·663	11		9
12	86·1	67·5	18·6	76·8	96·6	61·8	6		4	3		7							·997	·271	·657				10		10
13	85·2	68·8	16·4	77·0	94·8	64·1	3	1	6	5	1	4							·988	·183	·737				8	1	11
14	87·4	68·9	18·5	78·1	92·1	64·6	6		4	6	1	3	86·2	68·4	17·8	77·3	96·6	61·8	30·017	·254	·853	30·001	30·271	29·652	11		9
15	86·5	69·2	17·3	77·8	93·4	63·6	5		5	6		4							·070	·271	·813				16		4
16	86·8	69·0	17·8	77·9	92·1	66·1	6		4	6	1	3							·001	·225	·749				9		11
17	86·2	68·6	17·6	77·4	91·7	63·2	6		4	5		5	86·5	68·9	17·6	77·7	93·4	63·2	29·962	·234	·617	30·011	30·271	29·617	9		11
18	86·1	68·0	18·1	77·0	93·5	56·4	5	1	4	6		4							·972	·238	·684				9		11
19	86·5	69·9	16·6	78·3	98·2	65·4	6		4	7		3							·999	·331	·721				8		12
20	85·3	70·9	14·4	78·1	91·0	65·9	5		5	8		2	86·0	69·6	16·4	77·8	98·2	56·4	30·000	·292	·816	29·990	30·331	29·684	7		13
21	85·1	68·9	16·2	77·0	91·6	65·4	7		3	4		6							29·993	·172	·769				11		9
22	85·2	68·5	16·7	76·8	91·2	63·4	7		3	5		5							30·018	·169	·882				10		10
23	88·2	69·4	18·8	78·8	98·2	64·6	7		3	6	2	2	86·2	68·9	17·3	77·5	98·2	63·4	29·989	·138	·670	30·000	30·172	29·670	11		9
24	85·4	69·5	15·9	77·5	90·0	65·5	5		5	6		4							30·128	·312	·874				16		4
25	85·9	67·6	18·3	76·7	89·4	63·2	6		4	3		7							·065	·285	·770				13	1	6
26	85·5	68·5	17·0	77·0	89·7	64·3	7		3	6		4	85·6	68·5	17·1	77·0	90·0	63·2	·049	·248	·875	30·080	30·312	29·770	11		9
27	85·4	67·6	17·8	76·5	92·1	61·4	6		4	3	1	6							·063	·358	·793				14		6
28	86·7	67·7	19·0	77·2	93·7	61·4	7		3	4		6							·001	·328	·770				9		11
29	86·1	69·9	16·2	78·0	89·7	66·3	2		1	2		1	86·0	67·9	18·1	77·0	93·7	61·4	29·923	29·968	·849	30·018	30·358	29·770	0		6

TABLE 3.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

Mar.	M	m	M−m	$\frac{M+m}{2}$	M′	m′	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches.	inches	inches	inches	inches			
1	86·3	69·1	17·2	77·7	93·5	65·0	6		4	8		2							29·997	30·189	29·707				11		9
2	84·2	68·8	15·4	76·5	88·5	64·3	7		3	6		4							30·084	·253	·787				12		8
3	81·4	66·3	15·1	73·8	87·4	63·2	4		6	4		6	84·0	68·1	15·9	76·0	93·5	63·2	·139	·296	·971	30·073	30·296	29·707	14		6
4	83·9	65·6	18·3	74·7	90·4	61·9	4		6	2		8							·155	·361	·854				12		8
5	83·8	64·9	18·9	74·3	95·3	60·5	4		6	3		7							·100	·280	·919				13		7
6	88·2	66·2	22·0	77·2	91·2	60·9	9	1	0	3		7	85·3	65·6	19·7	75·4	95·3	60·5	·018	·271	·758	30·091	30·361	29·758	8		12
7	85·5	69·4	16·1	77·4	90·1	65·4	8		2	8		2							·030	·231	·802				8		12
8	85·6	69·3	16·3	77·4	97·1	60·1	6		4	7		3							·035	·374	·787				7		13
9	84·2	67·4	16·8	75·8	91·0	59·6	7		3	6		4	85·1	68·7	16·4	76·9	97·1	59·6	·141	·388	·898	30·069	30·388	29·787	14		6
10	85·3	67·3	18·0	76·3	91·4	59·6	7		3	6		4							·041	·434	·695				9		11
11	86·9	68·5	18·4	77·7	90·3	62·7	7		3	7		3							·022	·452	·778				8	1	11
12	85·4	67·2	18·2	76·3	90·4	61·6	7		3	5	1	4	85·9	67·7	18·2	76·8	91·4	59·6	·044	·460	·778	30·036	30·460	29·778	8		12
13	87·7	66·9	20·8	77·3	95·9	60·5	8		2	4		6							·031	·444	·804				6		14
14	83·9	68·5	15·4	76·2	87·8	65·0	7		3	6		4							·058	·382	·765				10		10
15	84·2	67·9	16·3	76·0	89·8	64·1	6		4	7		3	85·3	67·8	17·5	76·5	95·9	60·5	·064	·400	·785	30·051	30·444	29·765	10		10
16	83·8	67·5	16·3	75·6	87·5	61·9	4		6	6		4							·107	·436	·878				10		10
17	84·7	67·5	17·2	76·1	91·5	64·1	6		4	4		6							·048	·374	·775				7		13
18	85·6	67·2	18·4	76·4	90·7	63.4	5	1	4	5		5	84·7	67·4	17·3	76·0	91·5	61·9	·121	·271	·914	30·092	30·436	29·775	16		4
19	83·4	68·1	15·3	75·7	89·5	64·8	6		4	6		4							·086	·274	·839				12		8
20	85·1	67·6	17·5	76·3	91·1	61·4	6	1	3	6		4							29·995	·232	·793				5		15
21	84·1	69·4	14·7	76·7	88·8	63·7	5		5	9		1	84·2	68·4	15·8	76·3	91·1	61·4	30·035	·198	·809	30·039	30·274	29·793	10		10
22	83·9	67·6	16·3	75·7	92·4	63·2	4	1	5	6		4							·037	·244	·741				10		10
23	83·8	66·1	17·7	74·9	87·8	56·5	6		4	4		6							·051	·260	·792				10		10
24	83·5	66·2	17·3	74·3	90·6	62·7	5		5	3		7	83·7	66·6	17·1	75·1	92·4	56·5	·069	·404	·795	30·052	30·404	29·741	8		12
25	83·5	65·3	18·2	74·4	92·2	58·7	6		4	4	1	5							·046	·356	·580				10		10
26	83·5	66·4	17·1	74·9	86·7	58·7	5	1	4	5	1	4							·050	·291	.786				11		9
27	83·3	66·4	16·9	74·8	87·3	61·4	3		7	4	1	5	83·4	66·0	17·4	74·7	92·2	58·7	·046	·195	·709	30·047	30·356	29·580	13		7
28	83·7	67·6	16·1	75·6	88·1	65·0	4		6	6		4							·051	·352	·799				8		12
29	80·0	66·1	13·9	73·0	87·7	61·4	2		8	2	2	6							·113	·318	·943				14		6
30	84·3	65·3	19·0	74·8	90·3	61·4	4		6	1		9	82·7	66·3	16·4	74·5	90·3	61·4	·040	·328	·804	30·068	30·352	29·799	9		11
31	84·4	66·6	17·8	75·5	90·9	62·7	6		4	6		4							29·989	·169	·693				7		13

TABLE 4.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

April	M	m	M − m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	82·2	64·7	17·5	73·4	90·6	59·6	6		4	6		4							30·083	30·403	29·802				8		12
2	78·5	64·2	14·3	71·3	90·3	58·3	4		6	7		3	81·7	65·2	16·5	73·4	90·9	58·3	·167	·406	30·004	30·080	30·406	29·693	11		9
3	83·6	62·6	21·0	73·1	88·3	56·4	6	1	3	5		5							·150	·337	29·933				14		6
4	83·5	64·7	18·8	74·1	86·5	56·7	9		1	7	1	2							·094	·379	·879				7		13
5	83·6	65·2	18·4	74·4	91·2	60·1	6	1	3	8		2	83·5	64·2	19·3	73·8	91·2	56·4	·028	·300	·804	30·091	30·379	29·804	5		15
6	83·1	65·5	17·6	74·3	88·0	60·7	8		2	6		4							·099	·326	·956				8		12
7	81·2	64·2	17·0	72·7	92·1	61·0	6		4	5	1	4							·098	·420	·759				9		11
8	82·8	65·3	17·5	74·0	86·6	59 6	6	1	3	6		4	82·4	65·0	17·4	73·7	92·1	59·6	·151	·448	·931	30·116	30·448	29·759	13		7
9	83·5	63·7	19·8	73·6	91·2	56·7	7		3	5		5							·067	·368	·749				7		13
10	84·2	64·8	19·4	74·5	92·1	56 9	9		1	7		3							·104	·396	·704				9		11
11	84·3	63·6	20.7	73·9	94·9	60·0	6		4	5	1	4	84·0	64·0	20·0	74·0	94.9	56·7	·115	·451	·886	30·095	30·451	29·704	10		10
12	83·9	63·3	20·6	73·6	93·7	58·3	7	1	2	5		5							·038	·454	·675				7		13
13	82·1	62·9	19·2	72·5	87 5	56 9	6		4	5		5							·046	·292	·791				8		12
14	82·5	63·9	18·6	73·2	88·1	56·9	7		3	6	1	3	82·8	63·4	19·4	73·1	93·7	56·9	·118	·320	·935	30·067	30·454	29·675	11		9
15	83·2	62·8	20·4	73·0	90 6	56·5	7		3	4	1	5							·122	·604	·799				10		10
16	82·6	63·0	19·6	72·8	89·4	56·2	5		5	4	1	5							·073	·410	·690				8		12
17	79·9	63·7	16·2	71·8	87·5	58·3	4		6	6	1	3	81·9	63·2	18·7	72·5	90·6	56 2	·130	·256	·978	30·108	30·604	29·690	13		7
18	80·5	63·9	16·6	72·2	86·8	56·0	4		6	6		4							·125	·320	·925				11		9
19	82·1	63·1	19·0	72·6	90·1	56·7	5		5	5		5							·115	·289	·903				13		7
20	80·0	63·3	16·7	71·6	86·7	57·4	4		6	5		5	80·9	63·4	17·5	72·1	90·1	56·0	·121	·285	·856	30·120	30·320	29·856	11		9
21	80·0	62·4	17·6	71·2	84·6	55·3	5		5	5		5							·116	·358	·836				12		8
22	82·3	61·3	21·0	71·8	86·9	57·8	6		4	1		9							·032	·336	·770				7		13
23	84·5	63·2	21·3	74·8	98·1	60 0	7		3	4	1	5	82·3	62·3	20·0	72·3	98·1	55·3	25·994	·261	·773	30·047	30·358	29·770	6		14
24	81·5	63·6	17·9	72·6	86·3	58·7	4		6	5		5							30·083	·483	·819				10		10
25	80·6	62·9	17·7	71·7	87·2	56·7	6		4	5		5							·036	·218	·759				8		12
26	78·4	62·5	15·9	70·5	85 2	57·6	3		7	4	2	4	80·2	63·0	17·2	71·6	87·2	56·7	·147	·381	·991	30·089	30·483	29·759	12		8
27	78·2	59·9	18·3	69·0	85·4	55·5	2		8	3		7							·274	·456	·962				18		2
28	79·2	58·8	20·4	69·0	83·8	53·8	1	1	8	1	1	8							·176	·400	·921				14		6
29	81·7	61·1	20·6	71·4	85·3	55·1	6		4	4		6	79·7	59 9	19·8	69·8	85·4	53·8	·138	·342	·811	30·196	30·456	29·811	12		8
30	79·2	61·9	17·3	70·5	88·3	56·5	4		6	3		7							·182	·361	·903				16		4

TABLE 5.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

May	M	m	M−m	$\frac{M+m}{2}$	M′	m′	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	81·9	61·8	20·1	71·8	86·3	57·4	10		0	8		2							30·105	30·316	29·789				8		12
2	82·5	6·1	20·4	72·3	88·3	58·2	8		2	9		1	81·2	61·9	19·3	71 5	88·3	56·5	·101	·366	·721	30·129	30 366	29 721	10		10
3	80·0	61·3	18·7	70·6	87·6	51·1	7		3	8		2							·161	·370	·999				11		9
4	79·6	61·4	18·2	70·5	86·3	53·3	7		3	9		1							·131	·491	·846				9		11
5	78·9	60·0	18·9	69·4	88·7	50·6	5	1	4	8		2	79·5	60 9	18·6	70·2	88·7	50·6	·102	·391	·829	30·131	30·491	29·829	7		13
6	81·0	59·7	21·3	70·3	86·7	52·4	6	1	3	7		3							·111	·454	·729				10		10
7	78·2	60·7	17·5	69·5	84.2	52·6	6		4	7		3							·097	·401	·689				8		12
8	76·3	58·9	17·4	67·6	81·3	55·1	5		5	5		5	78·5	59·8	18·7	69·1	86·7	52·4	·150	·481	·781	30·119	30·481	29·689	10		10
9	77·2	58·7	18·5	67·9	82·3	53·7	5		5	5		5							·260	·622	30·106				19		1
10	78·7	57·8	20·9	68·2	82·0	47·4	5		5	4		6							·235	·495	·013				14		6
11	79·5	57·6	21·9	68·5	83·0	46·6	7		3	3		7	78·5	58·0	20·5	68 2	83·0	46 6	·131	·440	29·964	30·209	30·622	29·964	8		12
12	80·0	58·4	21·6	69·2	85·6	47·9	7		3	6		4							·096	·350	·845				7		13
13	80·6	59·3	21·3	69·9	91·3	49 9	6		4	8		2							·133	·431	·765				8		12
14	79·0	58·9	20·1	68·9	82·7	52 9	6		4	5		5	79·9	58·9	21·0	69·4	91·3	47·9	·172	·434	·884	30·134	30·434	29·765	11		9
15	81·0	58·2	22·8	69·6	89·6	53·7	8		2	4	1	5							·066	·360	·780				4		16
16	80·5	59·8	20·7	70·1	89·4	55·6	7		3	7		3							·052	·237	·770				4		16
17	78·7	59·5	19·2	69·1	85·8	56 5	6		4	6		4	80·1	59·2	20 9	69·6	89·6	53·7	·085	·286	·857	30·068	30·360	29 770	7		13
18	79·9	60·4	19·5	70·1	88·1	56 2	5		5	7		3							·077	·476	·822				7		13
19	76·8	60·6	16·2	68·7	82·9	54·2	5		5	6		4							·139	·423	·935				9		11
20	78·0	58·1	19·9	68·0	86·8	54·2	5		5	4		6	78·2	59·7	18·5	68·9	88·1	54·2	·167	·464	·922	30·128	30·476	29 822	11		9
21	78·1	57·3	20·8	67·7	83·4	51·3	4	1	5	4		6							·093	·373	·649				8		12
22	76·8	58·8	18·0	67·8	84·0	54·7	3		7	4		6							·139	·337	·682				12		8
23	77·4	56·2	21·2	66·8	81·7	45·0	5		5	2		8	77·4	57·4	20·0	67·4	84·0	45 0	·094	·401	·788	30·109	30·401	29·649	9		11
24	80·6	57·7	22·9	69·1	90·7	47·9	7		3	6		4							·083	·430	·797				8		12
25	76·2	57·2	19·0	66·7	85·8	48·8	3		7	4		6							·128	·268	·809				11		9
26	79·0	56·3	22·7	67·6	86·8	49·7	6		4	5	1	4	78·6	57·1	21·5	67 8	90 7	47·9	·054	·381	·507	30·088	30·430	29·507	4		16
27	75·8	59·0	16·8	67·4	83·2	52·6	4		6	4		6							·134	·491	·792				11		9
28	72·2	55·2	17·0	63·7	81·1	52·0	2		8	2		8							·299	·541	·749				17		3
29	75·1	53·4	21·7	64·2	83·6	48 8	3		7	0		10	74·4	55·9	18·5	65·1	83·6	48·8	·318	·644	30 029	30·250	30·644	29·749	16		4
30	76·5	55·0*	21·5*	65·7*	82·2	49·7*	3		7	1		8*							·312†	·610	·126				18		1
31	76·9	55·4	21·5	66·1	82·7	49 9	3		7	1		9							·264	·472	·079				17		3

* Minimum Temperature not recorded May 30, 1890.

† Pressure at 9 a.m. not recorded May 30, 1890.

TABLE 6.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

June	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	76·1	56·1	20·0	66·1	82·0	49·7	4	1	5	7		3	76·5	55·5	21·0	66·0	82·7	49·7	30·244	30·577	29·948	30·273	30·610	29·948	12		8
2	75·2	54·9	20·3	65·0	81·0	48·8	3		7	4	1	5							·195	·599	·903				7		13
3	79·1	55·5	23·6	67·3	89·5	51·7	5	1	4	5		5							·153	·618	·780				9		11
4	77·6	55·8	21·8	66·7	83·1	48·8	7		3	5		5	77·3	55·4	21·9	66·3	89·5	48·8	·200	·429	·929	30·183	30·618	29·780	9		11
5	78·8	55·3	23·5	67·0	85·4	51·5	6	1	3	3		7							·143	·387	·951				4	1	15
6	77·6	55·5	22·1	66·5	83·0	51·9	6	1	3	7		3							·192	·408	·868				10		10
7	76·9	55·6	21·3	66·2	82·0	51·9	5	1	4	4		6	77·8	55·5	22·3	66·6	85·4	51·5	·187	·507	30·017	30·174	30·507	29·868	6		14
8	76·2	55·3	20·9	65·7	84·0	51·9	5		5	7		3							·206	·455	29·949				11		9
9	73·9	55·6	18·3	64·7	80·1	51·3	3		7	7		3							·329	·617	30·099				16		4
10	74·5	54·1	20·4	64·3	78·7	49·7	2		8	4		6	74·9	55·0	19·9	64·9	84·0	49·7	·254	·522	29·856	30·263	30·617	29·856	12		8
11	78·4	54.5	23·9	66·4	82·0	51·0	6		4	4		6							·178	·510	·889				9		11
12	77·8	55·6	22·2	66·7	86·7	52·4	5		5	6	1	3							·186	·579	·927				6		14
13	78·2	54·3	23·9	66·2	84·1	51·0	5		5	4		6	78·1	54·8	23·3	66·4	86·7	51·0	·156	·593	·880	30·173	30·593	29·880	7		13
14	78·4	54·8	23·6	66·6	88·3	48·4	4	2	4	4		6							·203	·676	·742				8		12
15	74·0	55·3	18·7	64·6	82·1	47·4	3		7	4		6							·299	·614	30·112				12		8
16	75·0	54·5	20·5	64·7	79·4	48·8	3		7	5		5	75·8	54·9	20·9	65·3	88·3	47·4	·233	·537	29·950	30·245	30·676	29·742	9		11
17	75·4	54·8	20·6	65·1	83·7	50·6	4		6	5		5							·240	·555	·878				11		9
18	75·5	54·7	20·8	65·1	79·4	47·4	4		6	6		4							·328	·554	·878				16		4
19	76·9	52·6	24·3	64·7	82·5	48·4	5		5	3		7	75·9	54·0	21·9	65·0	83·7	47·4	·284	·481	30·066	30·284	30·555	29·878	15		5
20	77·4	52·5	24·9	64·9	80·8	48·6	6		4	1		9							·205	·380	29·983				10		10
21	77·9	52·7	25·2	65·3	85·8	48·8	6		4	2		8							·173	·385	·996				8		12
22	78·2	53·7	24·5	65·9	82·2	46·8	7	1	2	3		7	77·8	53·0	24·9	65·4	85·8	46·8	·124	·360	·813	30·167	30·385	29·813	5		15
23	76·7	55·1	21·6	65·9	81·7	49·3	4		6	6		4							·174	·442	·881				6		14
24	78·1	54·3	23·8	66·2	84·6	49·5	6		4	4		6							·206	·410	·855				14		6
25	78·0	53·8	24·2	65·9	83·9	48·3	5		5	3		7	77·6	54·4	23·2	66·0	88·9	48·3	·237	·535	·991	30·206	30·535	29·855	12		8
26	76·7	54·8	21·9	65·7	86·3	48·3	5		5	5		5							·233	·536	30·023				8		12
27	77·2	55·4	21·8	66·3	88·3	47·9	5	1	4	6		4							·253	·625	29·926				11		9
28	76·3	54·7	21·6	65·5	82·6	49·2	5		5	5		5	76·7	55·0	21·8	65·8	88·3	47·9	·258	·517	·999	30·248	30·625	29·926	12		8
29	77·5	53·9	23·6	65·7	80·5	51·5	7	1	2	4		6							·190	·436	30·016				7		13
30	75·1	54·9	20·2	65·0	80·2	52·8	3	1	6	6		4							·297	·519	·088				14		6

TABLE 7.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

July	M	m	M−m	$\frac{M+m}{2}$	M′	m′	(M +)	(M =)	(M −)	(m +)	(m =)	(m −)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	75·9	54·0	21·9	64·9	83·2	48·1	5		7	4		6	76·2	54·3	21·9	65 2	83·2	48·1	30·299	30·580	29·988	30·262	30·580	29·988	11		9
2	77·1	53·8	23·3	65·4	82·2	49·2	7		3	4		6							·273	·524	30·061				10	1	9
3	77·9	53·4	24·5	65·6	84·9	50·1	6		4	4		6							·256	·507	29·990				11		9
4	77·6	54·1	23·5	65·8	82·3	49·2	7		3	4	1	5	77·5	53·8	23·7	65·6	84·9	49·2	·259	·547	·914	30·263	30·547	29·914	11		9
5	77·3	55·9	21·4	66·6	80·8	50·2	7	1	2	5		5							·260	·647	·993				10		10
6	76·1	55·4	20·7	65·7	81·7	50·6	6		4	7	1	2							·223	·601	·993				9		11
7	76·3	53·9	22·4	65·1	87·0	51·3	5		5	4		6	76·6	55·1	21·5	65·8	87·0	50·2	·175	·510	·983	30·219	30·647	29·983	5		15
8	74·0	54·4	19·6	64·2	78·0	50·6	5		5	6	1	3							·239	·410	30·067				10		10
9	75·3	52·7	22·6	64·0	81·6	48·8	4		6	3		7							·206	·449	29·825				11		9
10	76·9	53·6	23·3	65·2	87·2	46·5	5		5	5		5	75·4	53·6	21·8	64·5	87·2	46·5	·206	·517	·883	30·214	30·517	29·825	7		13
11	74·4	55·9	18·5	65·1	82·2	50·2	3		7	5		5							·308	·632	30·042				11		9
12	73·6	53·4	20·2	63·5	82·2	47·7	3		7	3		7							·285	·619	29·995				13		7
13	76·4	52·2	24·2	64·3	81·8	48·6	5		5	2		8	74·8	53·8	21·0	64·3	82·2	47·7	·196	·430	·990	30·263	30 632	29·990	7		13
14	77·4	53·1	24·6	65·4	82·7	45·7	7		3	4		6							·117	·380	·688				6		14
15	74·3	54·9	19·4	64·6	81·8	49·7	2	1	7	6		4							·169	·415	·933				8		12
16	73·5	53·1	20·4	63·3	90·8	49·2	2		8	5		5	75·2	53·7	21·5	64·4	90·8	45·7	·180	·397	·722	30·155	30·415	29·688	10		10
17	71·1	53·0	18·1	62·0	80·8	46·1	2		8	4		6							·277	·508	30·013				11		9
18	73·6	51·7	21·9	62·6	85·8	47·4	3		7	1		9							·358	·568	·018				15		5
19	77·6	52·9	24·7	65·2	93·6	47·4	5		5	3		7	74·1	52·5	21·6	63·3	93·6	46·1	·299	·703	29·809	30·311	30·703	29·809	13		7
20	76·6	52·3	24·3	64·3	80·5	46·6	7		3	3		7							·314	·801	·869				15	1	4
21	77·0	52·9	24·1	64·9	87·3	42·3	6		4	5		5							·281	·550	·863				12		8
22	80·8	52·9	27·9	66·8	89·0	47·7	8		2	4		6	78·1	52·7	25·4	65·4	89·0	42·3	·159	·472	·945	30·251	30·801	29·863	6		14
23	76·0	55·6	20·4	65·8	79·5	47·2	6		4	5		5							·244	·486	·930				11		9
24	75·9	53·8	22·1	64·8	83·0	49·7	5		5	3	1	6							·259	·565	·996				10		10
25	77·6	54·1	23·5	65·8	82 4	51·0	6		4	4	1	5	76 5	54·5	22·0	65·5	83·0	47·2	·293	·575	30·034	30·265	30·575	29·930	12		8
26	76·8	54·5	22·3	65·6	83·5	48·3	6		4	5	1	4							·262	·519	22·851				13		7
27	74·8	54·2	20·6	64·5	81·8	51·1	6		4	4	3	3							·230	·463	·940				9		11
28	76·4	54·4	22·0	65·4	89·0	49·5	4		6	6		4	76·0	54·4	21·6	65·2	89·0	48·3	·225	·537	·927	30·239	30·537	29·851	9		11
29	78·2	54·4	23·8	66·3	88·9	47·7	7		3	5		5							·189	·464	·882				6		14
30	77·7	55·5	22·2	66·6	88·8	50·1	5	1	4	7		3							·173	·492	·899				4		16
31	74·1	56·8	17·3	65·4	79·0	49·9	4		6	8		2	76·7	55·6	21·1	66·1	88·9	47·7	·247	·649	·853	30·203	30·649	29·853	9		11

TABLE 8.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

Aug.	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	74·3	55·8	18·5	65·0	85·2	50·1	2		8	3		7							30·215	30·655	29·892				12		8
2	74·1	54·4	19·7	64·2	80·3	49·3	2		8	3		7							·266	·488	·996				13		7
3	77·4	54·3	23·1	65·8	80·4	46·6	7		3	3	1	6	75·3	54·8	20·5	65·0	85·2	46·6	·175	·458	·882	30·219	30·655	29·882	11		9
4	81·5	55·1	26·4	68·3	98·2	49·2	7		3	5		5							·106	·346	·700				4		16
5	74·8	57·2	17·6	66·0	80·0	49·9	7		3	6		4							·186	·353	·927				10		10
6	76·3	56·9	19·4	66·6	84·5	51·1	5		5	5		5	77·5	56·4	21·1	66·9	98·2	49·2	·263	·541	·968	30·185	30·541	29·700	13		7
7	79·0	55·6	23·4	67·3	84·4	50·8	8		2	4		6							·175	·545	·982				7		13
8	78·2	56·8	21·4	67·5	91·7	51·1	6		4	5		5							·197	·521	·892				9		11
9	75·4	57·1	18·3	66·2	88·1	51·1	4		6	5		5	77·5	56·5	21·0	67·0	91·7	50·8	·155	·513	·865	30·176	30·545	29·865	10		10
10	77·7	57·9	19·8	67·8	84·9	49·5	8		2	6		4							·183	·380	·883				8		12
11	77·0	56·1	20·9	66·5	86·3	49·3	7		3	5		5							·167	·440	·750				10		10
12	77·3	56·4	20·9	66·8	97·8	50·4	6		4	5		5	77·3	56·8	20·5	67·0	97·8	49·3	·185	·460	·641	30·178	30·460	29·641	12		8
13	72·7	55·7	17·0	64·2	81·0	52·4	4		6	3		7							·256	·614	·902				13		7
14	71·9	55·9	16·0	63·9	76·8	52·0	2		8	4		6							·303	·507	30·019				13		7
15	78·6	53·6	25·0	66·1	83·1	47·5	7		3	2		8	74·4	55·1	19·3	64·7	83·1	47·5	·179	·498	29·740	30·246	30·614	29·740	10		10
16	76·5	56·7	19·8	66·6	83·3	52·0	4		6	5		5							·187	·428	·765				11		9
17	75·9	57·7	18·2	66·8	78·8	53·8	6		4	5		5							·240	·715	·988				12		8
18	78·5	56·9	21·6	67·7	87·1	51·3	7		3	4		6	77·0	57·1	19·9	67·0	87·1	51·3	·201	·682	·775	30·210	30·715	29·765	9	1	10
19	76·6	56·3	20·3	66·4	80·7	47·7	7	1	2	5		5							·159	·535	·860				8		12
20	74·7	57·0	17·7	65·8	80·8	48·6	5		5	6		4							·221	·448	·841				12		8
21	75·6	55·9	19·7	65·7	94·9	50·6	4		6	2		8	75·6	56·4	19·2	66·0	94·9	47·7	·280	·573	·841	30·220	30·573	29·841	13		7
22	75·3	56·9	18·4	66·1	82·2	51·7	4		6	4		6							·281	·604	·820				12		8
23	79·1	56·6	22·5	67·8	102·9	51·5	7		3	5		5							·181	·589	·752				11		9
24	77·4	57·9	19·5	67·6	83·1	50·8	7		3	7		3	77·3	57·1	20·2	67·2	102·9	50·8	·223	·472	30·011	30·228	30·604	29·752	10		10
25	75·5	58·1	17·4	65·8	83·1	55·1	6		4	8		2							·223	·468	29·911				12		8
26	74·3	57·6	16·7	65·9	83·3	52·8	5		5	7		3							·230	·553	·786				12		8
27	76·8	57·8	19·0	67·3	96·2	52·4	5		5	6		4	75·5	57·8	17·7	66·6	96·2	52·4	·161	·510	·577	30·205	30·553	29·577	10		10
28	76·4	57·1	19·3	66·7	81·3	53·3	5		5	7		3							·172	·503	·889				7		13
29	76·8	56·9	19·9	66·8	93·2	53·8	5		5	3		7							·141	·474	·621				7		13
30	74·0	55·9	18·1	64·9	82·2	52·4	5		5	5		5	75·7	56·6	19·1	66·1	93·2	52·4	·153	·512	·886	30·155	30·512	29·621	7		13
31	78·6	58·8	19·8	68·7	89·4	51·5	8		2	8		2							·157	·542	·970				6		14

TABLE 9.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

Sept.	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	77 8	57·3	20·5	67·5	88·9	53·3	6		4	3		7							26·198	30·376	29 885				13		7
2	72·7	54·4	18·3	63·5	79·5	46·5	3		7	2		8	76 4	56·8	19 6	66·6	89 4	46·5	·338	·729	·812	30·231	30·729	29·812	17		3
3	73·7	55·8	17·9	64·7	79·5	49·7	3		7	3		7							·285	·620	·899				15		5
4	78·1	55·7	22·4	66·9	82 9	48·3	7		3	3		7							·137	·388	·966				9		11
5	76·8	57·3	19·5	67·0	80·9	50·2	6		4	3	1	6	76·	56 3	19·9	66 2	82 9	48·3	·139	·319	·772	30·187	30·620	29·772	10		10
6	77 4	58·0	19·4	67·7	90·0	51·5	5	1	4	4		6							·176	·498	·837				12		8
7	75 9	59·2	16·7	67·5	84·0	53·7	5		5	6	1	3							·109	·420	·862				8		12
8	76·1	60·7	15·4	68·4	85·8	56·0	5		5	6		4	76 5	59·3	17·2	67 9	90 0	51·5	·095	·444	·730	30·127	30·498	29·730	9		11
9	73·2	57·6	15·6	65 4	80·0	50·8	4		6	3		7							·163	·359	·779				12		8
10	74·2	57·8	16·4	66 0	78·5	51·5	4		6	6	1	3							·154	·526	·674				10		10
11	76 3	55·3	21·0	65·8	90 9	50·1	3		7	2		8	74·6	56 9	17·7	65·7	90 9	50·1	·213	·656	·857	30·177	30·656	29·674	12		8
12	76·8	57·0	19 8	66·9	83·6	51·5	4		6	3		7							·183	·442	·856				12		8
13	78·4	57 3	21 1	67·8	82·4	52 9	6		4	4		6							·107	·502	·812				10		10
14	79·6	59 5	20·1	69 5	90·3	51·5	6		4	5		5	78·3	57·9	20 3	68 1	90·3	51·5	·184	·440	·852	30·158	30·502	29·812	11		9
15	77·1	59·7	17 4	68·4	87·4	51·7	6	1	3	6		4							·210	·446	·964				11		9
16	80·1	59 0	21·1	69·5	95·4	51·7	5		5	6		4							·119	·576	682				8		12
17	79·9	59·6	20·3	69·7	100 1	54·0	7		3	6		4	79 0	59·4	19 6	69·2	100·1	51·7	·119	·509	·875	30 149	30·576	29 682	6		14
18	75·4	59·7	15 7	67·5	79·1	49·5	4		6	6		4							·182	·497	30·021				9		11
19	77·8	59·2	18·6	68·5	84 9	52·4	6		4	7		3							·096	·330	29·813				7		13
20	77·7	60·3	17·4	69·0	84·1	53·3	6		4	7	1	2	77·0	59·7	17 3	69 3	84 9	49·5	·125	·407	·834	30 134	30·497	29 813	8		12
21	84 9	59 8	25·1	72 3	110 6	53·7	6		4	8		2							·034	·527	·607				5		15
22	80·0	60·2	19·8	70 1	94·8	51·3	8		2	7	1	2							·034	·345	·601				5		15
23	76·1	60·2	15·9	68·1	87 3	53·7	6		4	7		3	80 3	60·1	20 2	70 2	110·6	51·3	·112	·452	·733	30·060	30·527	29·601	9		11
24	76 0	58·2	17·8	67·1	85·6	52·8	3		7	4		6							? ·249	? ·610	·978				16		4
25	75 8	58·2	17·6	67·0	83 6	51·5	4		6	4		6							·157	·453	·868				10		10
26	76·7	59·5	17 2	68 1	79·9	56·2	6	1	3	3	1	6	76·2	58·6	17·6	67·4	85·6	51·5	·149	·516	·845	30·185	? 30·610	29·845	9		11
27	77 0	59·8	17 2	68·4	87 3	55·8	6		4	6		4							·123	·689	·765				6		14
28	76·8	60·4	16·4	68·6	84·5	52 9	6		4	7		3							·081	·394	·784				7		13
29	76 9	59 5	17·4	68·2	87 9	52·8	5		5	4		6	76 9	59·9	17·0	68·4	87 9	52 8	·124	·475	695	30·109	30·689	29·765	6		14
30	79·5	60 0	19 5	69·7	84 8	53·8	7	1	2	7		3							·125	·426	·754				9		11

TABLE 10.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

.	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	81·0	60·3	20·7	70·6	88·5	53·8	8		2	4		6							30·076	30·392	29·760				8		12
2	75·8	63·5	12·3	69·6	82·7	55·6	4		6	5		5	78·8	61·3	17·5	70·0	88·5	53·8	·164	·471	·911	30·122	30·471	29·754	11		9
3	79·7	60·7	19·0	70·2	107·8	54·9	5		5	4		6							·092	·505	·664				8		12
4	77·7	61·5	16·2	69·6	84·7	56·6	5		5	5		5							·140	·519	·726				12		8
5	77·9	62·0	15·9	69·9	86·3	43·6	4		6	7		3	78·4	61·4	17·0	69·9	107·8	48·6	·137	·661	·612	30·123	30·661	29·612	10		10
6	76·4	60·0	16·4	68·2	84·9	48·4	4		6	3	1	6							·161	·562	·804				11		9
7	77·1	58·7	18·4	67·9	85·6	51·1	6		4	2		7							·141	·317	·968				12		8
8	78·1	60·5	17·6	69·3	84·6	53·3	7		3	4		6	77·2	59·7	17·5	68·4	85·6	48·4	·116	·485	·805	30·139	30·562	29·804	10		10
9	76·6	60·6	16·0	68·6	83·2	51·5	4		6	6		4							·158	·567	·961				10	1	9
10	76·4	60·9	15·5	68·6	83·7	49·7	2		8	5		5							·177	·455	·886				15		5
11	78·7	60·7	18·0	69·7	88·5	52·9	5		5	4		6	77·2	60·7	16·5	68·9	88·5	49·7	·074	·345	·869	30·136	30·567	29·869	8		12
12	79·1	61·0	18·1	70·0	87·4	55·8	6		4	4		6							·024	·489	·706				3		17
13	74·4	60·8	13·6	67·4	83·1	53·7	3		7	5		5							·150	·362	·912				13		7
14	76·6	59·6	17·0	68·1	82·2	51·9	4		6	5		5	76·7	60·5	16·2	68·6	87·4	51·9	·123	·430	·640	30·099	30·489	29·640	10		10
15	76·0	59·6	16·4	67·8	81·9	53·7	3		7	4		6							·228	·448	·978				17		3
16	77·9	61·3	16·6	69·6	83·3	53·8	6		4	6		4							·185	·532	·671				15		5
17	78·8	61·4	17·4	70·1	82·4	53·1	7		3	6		4	77·6	60·8	16·8	69·2	83·3	53·1	·120	·393	·859	30·178	30·532	29·671	10		10
18	82·1	61·0	21·1	71·6	89·7	52·8	9		1	4		6							·050	·218	·891				5		15
19	80·0	64·8	15·2	72·4	84·2	60·0	7		3	8		2							·042	·204	·750				6		14
20	80·9	63·9	17·0	72·4	88·3	60·5	7		3	8		2	81·0	63·2	17·8	72·1	89·7	52·8	·053	·302	·839	30·048	30·302	29·750	5		15
21	77·4	65·8	11·6	71·6	86·7	58·0	6		4	9		1							·070	·315	·734				7		13
22	80·6	64·4	16·2	72·5	94·3	55·1	7		3	8		2							·029	·487	·737				6		14
23	74·1	63·6	10·5	68·8	86·0	54·6	3		7	6		4	77·4	64·6	12·8	71·0	94·3	54·6	·125	·637	·847	30·075	30·637	29·734	10		10
24	77·2	61·2	16·0	69·2	87·0	54·9	4		6	4		6							·067	·535	·844				7		13
25	78·9	61·2	17·7	70·0	89·0	57·5	6		4	3		7							·118	·413	·809				10		10
26	79·0	60·7	18·3	69·8	89·9	55·5	4		6	3		7	78·4	61·0	17·4	69·7	89·9	54·9	·102	·625	·629	30·096	30·625	29·629	9		11
27	77·8	62·0	15·8	69·9	86·2	54·2	4		6	6		4							·101	·477	·804				9		11
28	81·6	62·6	19·0	72·1	87·3	55·5	8		2	5	1	4							·010	·367	·712				7		13
29	79·2	62·7	16·5	70·9	84·0	55·8	5	1	4	7		3	79·5	62·4	17·1	70·9	87·3	54·2	·033	·329	·795	30·048	30·477	29·712	6		14
30	80·2	61·3	18·9	70·7	86·8	55·1	7		3	4		6							·038	·353	·730				11		9
31	76·5	61·6	14·9	69·0	86·9	54·4	4	1	5	4		6							·153	·421	·931				13		7

TABLE 11.

MEAN DAILY TEMPERATURE AND PRESSURE OF THE AIR AT DURBAN, NATAL, 1888–1897.

Nov.	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	82·8	61·6	21·2	72·2	88·7	56·0	6		4	2		8	79·8	61·5	18 3	70·6	88·7	54·4	30·092	30·327	29·785	30·113	30·421	29·730	15		5
2	83·2	62·6	20·6	72·9	97·9	57·8	5		5	4		6							29·941	·223	·704				4		16
3	83·7	65·7	18·0	74·7	94·2	62·3	6		4	7		3							·961	·279	·714				4		16
4	79·3	64 2	15·1	71·7	87 2	59·6	3		7	5		5	82 1	64·2	17·9	73·1	97·9	57·8	30·023	·441	·550	29·978	30·441	29·550	11		9
5	77·0	61·8	15·2	69·4	88·8	52·2	2		8	3		7							·084	·288	·886				14		6
6	82·3	63·0	19·3	72·6	86·2	54·6	6		4	5		5							28·999	·222	·763				7	1	12
7	80·0	63·3	16·7	71 6	89·0	58·5	4		6	4		6	79·8	62·7	17·1	71·2	89·0	52·2	30·048	·313	·774	30·044	30·313	29·763	12		8
8	80·9	63·5	17·4	72 2	88·0	56·7	5		5	3		7							·121	·512	·744				15		5
9	81·0	63·0	18·0	72·0	91·2	55·5	4		6	4		6							·091	·534	·699				12		8
10	83·3	63·4	19·9	73·3	87·6	54·6	7		3	4		6	81·7	63·3	18·4	72·5	91·2	54·6	·019	·400	·744	30·077	30·534	29·744	10		10
11	79·6	63·6	16·0	71·6	87·6	58·5	3		7	4		6							29·999	·243	·764				8		12
12	82·2	63·7	18·5	72 9	93·0	57·4	5		5	4		6							30 064	·519	·719				15		5
13	80 7	61·4	19·3	71·0	89·5	52·8	5		5	1	1	8	80·8	62·9	17·9	71·8	93·0	52·8	·012	·321	·750	30·025	30·519	29 719	9		11
14	82·3	63·9	18·4	73·1	90·6	60·1	5		5	3		7							·054	·254	·851				13		7
15	80·1	65·3	14·8	72·7	89·0	57·1	5		5	7		3							·081	·338	·880				15		5
16	85·7	65·0	20·7	75·3	97·6	59·1	8		2	7		3	82·7	64·7	18·0	73·7	97·6	57·1	·037	·219	·758	30·057	30·338	29·758	12		8
17	86·1	65·7	20·4	75·9	91·4	61·2	8		2	7		3							29 940	·202	·668				5		15
18	81·0	65·1	15·9	73·0	97·8	59·6	3		7	7		3							·958	·173	·664				8		12
19	78·2	63 7	14·5	70 9	87 0	58·2	2		8	5		5	81·8	64·8	16 9	73 2	97·8	58·2	30·040	·375	·794	29·979	30 375	29 664	12		8
20	79·2	63·3	15 9	71·2	86·0	59 2	5	1	4	3	1	6							·099	·376	·870				13		7
21	82·9	64·7	18·2	73·8	91·6	57·4	5		5	5		5							·036	·401	·696				12		8
22	81·8	64·4	17·4	73·1	92·6	59·4	6		4	6		4	81·3	64 1	17·2	72·7	92 6	57 4	·048	·251	·868	30·061	30·401	29 696	9	1	10
23	84·3	64·2	20 1	74·2	98·0	59·2	5		5	5		5							·015	·240	·652				13		7
24	81·3	65·9	15·4	73·6	90·3	60·5	4		6	7		3							024	·303	·715				10		10
25	86·0	64·8	21·2	75·4	94·6	57·8	6		4	6		4	83 9	65·0	18 9	74·4	98·0	57·8	·014	·291	·768	30·018	30·303	29·652	8		12
26	83·3	65·8	17·5	74·5	92·8	59 8	6		4	8		2							·013	·260	·662				11		9
27	83·0	66·7	16 3	74·8	93·2	58·3	6		4	7		3							29 999	·452	·810				4		16
28	87·1	65·6	21·5	76·3	104·7	60·7	8		2	6	1	3	84·5	66·0	18·5	75·2	104·7	58·3	·935	·265	·705	19·982	30·452	29·662	5		15
29	84·5	67·6	16·9	76·0	91·5	57·4	6		4	7		3							·958	·203	·548				7		13
30	83·8	67·3	16·5	75·5	92·6	57·8	5		5	8		2							·997	·405	·595				6		14

TABLE 12.

Mean Daily Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

Dec.	M	m	M−m	$\frac{M+m}{2}$	M′	m′	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	81·2	66·1	15·1	73·6	89·8	59·6	2		8	3		7	83·2	67·0	16·2	75·1	92·6	57·4	29·976	30·370	29·694	29·977	30·405	29·548	7		13
2	83·5	65·0	18·5	74·2	91·4	61·2	4		6	3		7							30·069	·305	·882				13		7
3	85·7	64·6	21·1	75·1	92·9	58·2	6		4	3		7							29·993	·243	·750				9		11
4	83·0	65·4	17·6	74·2	88·5	61·3	5		5	3		7	84·1	65·0	19·1	74·5	92·9	58·2	·989	·213	·726	30·019	30·305	29·726	8		12
5	85·6	66·1	19·5	75·8	94·1	60·5	6		4	5		5							·989	·360	·659				7	1	12
6	84·9	65·3	19·6	75·1	92·4	60·3	6	1	3	3		7							·946	·185	·659				9		11
7	85·2	66·8	18·4	76·0	94·0	63·2	5	1	4	6		4	85·2	66·1	19·1	75·6	94·1	60·3	30·018	·266	·669	29·984	30·360	29·659	15		5
8	82·1	65·9	16·2	74·0	88·8	63·2	4		6	5		5							·061	·295	·802				12		8
9	82·3	65·8	16·5	74·0	88·9	60·9	6		4	5		5							·032	·265	·780				12		8
10	82·0	63·9	18·1	73·0	92·1	55·3	3	2	5	4		6	82·1	65·2	16·9	73·7	92·1	55·3	·066	·342	·692	30·053	30·342	29·692	12		8
11	85·9	65·6	20·3	75·7	98·4	60·1	5		5	4		6							·032	·346	·630				12		8
12	84·8	67·0	17·8	75·9	94·5	55·8	5		5	6		4							29·976	·300	·701				8		12
13	84·5	67·2	17·3	75·8	93·9	62·3	5		5	6		4	85·1	66·6	18·5	75·8	98·4	55·8	·968	·300	·697	29·992	30·346	29·630	7		13
14	82·5	67·8	14·7	75·1	99·9	63·0	5		5	6		4							·983	·261	·596				8		12
15	85·3	65·4	19·9	75·3	93·0	56·0	6		4	5		5							·925	·231	·524				8		12
16	86·5	66·1	20·4	76·3	98·0	58·3	8		2	6		4	84·8	66·4	18·4	75·6	99·9	56·0	·970	·274	·672	29·959	30·274	29·524	9		11
17	82·6	66·4	16·2	74·5	95·1	58·0	5		5	6		4							30·012	·358	·701				11		9
18	84 9	65·5	19·4	75·2	95·5	58·3	5		5	6		4							29·989	·243	·832				9		11
19	86·5	66·9	19·6	76·7	96·6	60·9	7		3	6		4	84·7	66·3	18·4	75·5	96·6	58·0	·941	·179	·703	29·981	30·358	29·701	7		13
20	83·0	66·3	16·7	74·6	98·5	58·7	5		5	5		5							·969	·273	·672				8		12
21	84·7	67·6	17·1	76·1	96·2	57·2	6		4	7		3							·997	·208	·697				12		8
22	85·4	65·5	19·9	75·4	89·1	56·9	6		4	4		6	84·4	66·5	17·9	75·4	98·5	56·9	30·003	·244	·657	29·990	30·273	29·657	12		8
23	85·6	68·0	17·6	76·8	90·9	55·6	8		2	9		1							29·987	·275	·762				10		10
24	85·1	67·1	18·0	76·1	94·0	60·0	6		4	6		4							30·082	·369	·825				16		4
25	85·2	65·5	19·7	75·3	96·3	58·5	4		6	4		6	85·3	66·9	18·4	76·1	96·3	55·6	·021	·252	·748	30·030	30·369	29·748	13		7
26	86·2	65·4	20·8	75·6	94·9	60·3	5		5	5		5							·045	·212	·833				12		8
27	84·9	67·5	17·4	76·2	95·3	63·7	6		4	7		3							29·971	·100	·790				7		13
28	86·1	68·4	17·7	77·2	95·5	65·2	7		3	9		1	85·7	67·1	18·6	76·4	95·5	60·3	·989	·185	·820	29·988	30·212	29·790	9		11
29	86·3	68·7	17·6	77·5	95·5	64·6	6		4	9		1							·959	·247	·800				5		15
30	80 5	66·2	14·3	73·3	92·8	60·0	2		8	6		4							30·060	·339	·824				10		10
31	82·9	63·7	19·2	73·3	91·3	60·5	4		6	2		8	83·2	66·2	17·0	74·7	95·5	60·0	·059	·417	·722	30·026	30·417	29·722	12		8

TABLE 13.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1887–1897.

Jan.	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3+m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	91·1	59·2	31·9	75·1	100·4	52·8	5		5	5		5							25·934	26·194	25·823				6		10
2	91·4	60·2	31·2	78·8	99·5	54·0	5		5	4		6							·943	·162	·815				5		11
3	93·0	61·1	31·9	77·0	98·5	56·0	6		4	5	1	4	91·8	60·2	31·6	76·0	100·4	52·8	·930	·086	·781	25·936	26·194	25·781	9		7
4	91·7	61·9	29·8	76·8	102·8	55·3	5		5	7		3							·899	·080	·758				4	1	11
5	92·3	60·9	31·4	76·6	101·5	55·3	6		4	5		5							·919	·015	·832				7		9
6	90·5	60·0	30·5	75·2	101·7	54·8	4		6	5		5	91·5	60·9	30·6	76·2	102·8	54·8	·908	25·992	·818	25·909	26·080	25·758	6		10
7	89·0	58·4	30·6	73·7	101·2	48·7	3		7	3		7							·933	26·078	·850				5		11
8	90·4	58·6	31·8	74·5	98·0	52·0	4		6	3		7							·970	·041	·851				9		7
9	91·8	59·1	32·7	75·4	98·3	51·2	4		6	4		6	90·4	58·7	31·7	74·5	101·2	48·7	·941	·115	·828	25·948	26·115	25·828	7		9
10	95·8	60·3	35·5	78·0	101·0	55·5	9		1	4		6							·919	·077	·807				5		11
11	93·3	61·1	32·2	77·2	103·0	50·3	7		3	7		3							·943	·062	·801				10		6
12	93·8	62·9	30·9	78·3	102·7	50·5	6		4	9		1	94·3	61·4	32·9	77·8	103·0	50·3	·943	·088	·816	25·935	26·088	25·801	7		9
13	92·5	61·7	30·8	77·1	100·0	57·3	6		4	6		4							·927	·101	·758				6		10
14	93·7	61·9	31·8	77·8	102·1	56·3	6		4	7		3							·913	·119	·720				5		11
15	95·1	62·8	32·3	78·9	102·3	57·6	6		4	7		3	93·8	62·1	31·7	77·9	102·3	56·3	·932	·054	·799	25·924	26·119	25·720	8		8
16	93·3	60·8	32·5	77·0	102·5	51·0	5		5	6		4							·978	·078	·902				12		4
17	92·2	61·8	30·4	77·0	103·3	51·5	4		6	6		4							·982	·060	·854				11		5
18	92·9	60·9	32·0	76·9	100·9	56·0	7		3	5		5	92·8	61·2	31·6	77·0	103·3	51·0	·947	·056	·860	25·969	26·078	25·854	8		8
19	87·6	60·7	26·9	74·1	100·7	45·5	2		8	8		2							·964	·093	·813				10	1	5
20	89·5	58·8	30·7	74·1	101·6	48·3	3		7	5		5							·942	·096	·800				9		7
21	87·6	60·5	27·1	74·0	101·0	56·5	4		6	4		6	88·2	60·0	28·2	74·1	101·6	45·5	·951	·054	·871	25·952	26·096	25·800	9		7
22	89·2	60·5	28·7	74·8	102·0	53·3	4		6	5		5							·963	·076	·860				11		5
23	89·3	59·4	29·9	74·3	105·6	52·7	3		7	5		5							·967	·060	·979				11		5
24	89·9	61·0	28·9	75·5	102·0	57·0	4		6	5		5	89·5	60·3	29·2	74·9	105·6	52·7	·964	·114	·815	25·965	26·114	25·797	8		8
25	89·6	59·7	29·9	74·6	100·2	48·5	6		4	4		6							·935	·085	·825				7		9
26	91·7	59·7	32·0	75·7	102·7	49·0	4	1	5	2		8							·899	·049	·806				3		13
27	94·4	59·6	34·8	77·0	105·0	53·0	6	1	3	3		7	91·9	59·7	32·2	75·8	105·0	48·5	·902	25·984	·785	25·912	26·085	25·785	5		11
28	95·1	61·1	34·0	78·1	103·2	56·8	6		4	5		5							·945	26·058	·866				7		9
29	95·3	60·7	34·6	78·0	106·0	52·3	9		1	4		6							·955	·064	·874				8	1	7
30	94·2	62·4	31·8	78·3	107·2	57·7	5		5	7		3	94·9	61·4	33·5	78·1	107·2	52·3	·952	.066	·862	25·951	26·066	25·862	10		6
31	95·3	61·9	33·4	78·6	108·5	56·3	7		3	6		4							·962	.091	·880				11		5

TABLE 14.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

Feb.	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	92·7	62·1	30·6	77·4	106·2	56·0	6		4	7		3							25·974	26·056	25·907				9		7
2	88·7	61·6	27·1	75·1	98·5	57·3	6		4	7		3	92·2	61·9	30·3	77·0	108·5	56·0	·965	·172	·764	25·967	26·172	25·764	6		10
3	87·7	59·9	27·8	73·8	96·6	54·8	4		6	5		5							·943	·110	·718				5		11
4	89·8	61·2	28·6	75·5	98·2	57·5	5		5	6		4							·941	·083	·803				7		9
5	83·1	61·3	21·8	72·2	95·3	58·5	4		6	5		5	86·9	60·8	26·1	73·8	98·2	54·8	·944	·079	·832	25·943	26·110	25·718	4		12
6	86·4	60·2	26·2	73·3	97·0	56·3	3		7	6		4							·933	·076	·769				5		11
7	85·1	59·8	25·3	72·4	95·0	51·5	3		7	5		5							·944	·097	·836				4		12
8	87·0	57·9	29·2	72·5	96·4	48·7	3		7	5		5	86·2	59·3	26·9	72·7	97·0	48·7	·930	·078	·835	25·936	26·097	25·769	5		11
9	86·0	60·3	25·7	73·1	96·0	54·0	3		7	5		5							·955	·113	·853				6		10
10	87·5	59·2	28·3	73·3	96·7	56·2	4		6	2		8							·945	·085	·841				5	1	10
11	89·8	59·8	30·0	74·8	100·1	56·7	5		5	2		8	87·8	59·8	28·0	73·8	100·1	54·0	·936	·030	·834	25·945	26·113	25·834	4		12
12	88·5	59·5	29·0	74·0	99·2	52·2	6		4	6		4							·965	·105	·866				5		11
13	88·1	58·0	30·1	73·0	96·3	50·5	6		4	3		7							·959	·082	·883				5		11
14	89·9	59·8	30·1	74·8	102·5	55·4	7		3	5		5	88·8	59·1	29·7	73·9	102·5	50·5	·991	·060	·916	25·972	26.105	25·866	12		4
15	90·9	60·1	30·8	75·5	100·3	55·0	7		3	6		4							26·009	·092	·890				11		5
16	90·4	61·3	29·1	75·8	99·3	59·5	8		2	7		3							25·981	·138	·758				8		8
17	93·1	60·6	32·5	76·8	100·5	56·0	9		1	6		4	91·5	60·7	30·8	76·1	100·5	55·0	·936	·069	·675	25·975	26·138	25·675	8		8
18	91·8	61·4	30·4	76·6	101·0	57·0	7		3	6		4							·951	·079	·781				8		8
19	91·7	58·6	33·1	75·1	103·0	52·5	7		3	3		7							·982	·193	·828				7		9
20	90·9	60·5	30·4	75·7	100·5	52·0	6		4	6		4	91·5	60·2	31·3	75·8	103·0	52·0	·998	·177	·890	25·977	26·193	25·781	8		8
21	87·4	59·6	27·8	73·5	98·0	48·5	4		6	5		5							·985	·108	·863				9		7
22	90·4	58·7	31·7	74·5	99·8	51·8	6		4	4		6							·982	·106	·865				8		8
23	91·5	59·8	31·7	75·6	98·5	52·0	6		4	4		6	89·8	59·4	30·4	74·2	99·8	48·5	·988	·151	·862	25·985	26·151	25·862	8		8
24	89·1	60·2	28·9	74·6	97·3	50·0	4		6	5		5							26·032	·147	·982				16		0
25	87·0	59·8	27·2	73·4	97·5	51·7	3		7	4		6							·038	·143	·935				14		2
26	88·3	60·1	28·2	74·2	100·0	53·2	5		5	6		4	88·1	60·0	28·1	74·0	100·0	50·0	·013	·108	·928	26·028	26·147	25·928	11		5
27	91·9	59·7	32·2	75·8	100·4	53·4	8		2	4		6							·016	·157	·887				11	1	4
28	87·1	61·6	25·5	74·3	100·0	58·0	4		6	6		4							·014	·141	·924				10		6
29	85·0	61·0	24·0	73·0	92·8	59·8	1	1	1	2		1	88·9	60·7	28·2	74·8	100·4	53·4	25·944	25·960	·917	26·007	26·157	25·887	0		4

TABLE 15.

Mean Daily Temperature and Pressure on the Air at Kimberley, Cape Colony, 1888–1897.

Mar.	M	m	M − m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	$M_3 - m_3$	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	86·6	60·0	26·6	73·3	95·0	55·0	7		3	9		1							26·008	26·124	25·830				9		7
2	87·4	59·2	28·2	73·3	98·1	52·0	7	1	2	6		4							·044	·127	·914				11		5
3	87·7	58·6	29·1	73·1	97·0	54·5	8		2	5		5	87·2	59·3	27·9	73·2	98·1	52·0	·052	·183	·953	26·035	26·183	25·830	10		6
4	87·9	57·3	30·6	72·6	96·2	55·5	9		1	5		5							·051	·180	·921				10		6
5	89·2	60·8	28·4	75·0	97·0	56·5	9		1	8		2							·043	·152	·911				10		6
6	88·3	61·6	26·7	74·9	95·0	55·5	8		2	9		1	88·5	59·9	28·6	74·2	97·0	55·5	·026	·159	·863	26·040	26·180	25·863	7		9
7	88·2	60·5	27·7	74·3	97·1	56·3	9		1	8		2							·002	·213	·842				6		10
8	88·2	58·1	30·1	73·1	97·0	44·0	6	1	3	7		3							·003	·185	·904				5		11
9	85·0	59·2	25·8	72·1	98·3	53·3	6		4	7		3	87·1	59·3	27·8	73·2	98·3	44·0	·025	·148	·848	26·010	26·213	25·842	11		5
10	87·0	59·4	27·6	73·2	100·0	52·3	6		4	7		3							·002	·129	·813				6		10
11	85·2	59·6	25·6	72·4	99·3	52·0	6		4	7		3							·004	·149	·895				6		10
12	86·5	59·2	27·3	72·8	99·8	51·0	6	2	2	6		4	86·2	59·4	26·8	72·8	100·0	51·0	·013	·119	·933	26·006	26·149	25·813	5		11
13	85·8	58·7	27·1	72·2	97·0	49·3	7		3	6		4							25·997	·090	·916				6		10
14	84·3	59·1	25·2	71·7	100·6	51·8	7		3	7		3							·999	·112	·868				5		11
15	83·4	59·2	24·2	71·3	89·3	51·5	5		5	6		4	84·5	59·0	25·5	71·7	100·6	49·3	26·024	·157	·868	26·007	26·157	25·868	8		8
16	83·3	57·6	25·7	70·4	89·4	52·0	6		4	7		3							·041	·179	·897				8		8
17	81·4	57·8	23·6	69·6	91·7	52·7	4		6	6		4							·050	·211	·893				9		7
18	82·3	56·7	25·6	69·5	90·7	52·6	4		6	5		5	82·3	57·4	24·9	69·8	91·7	52·0	·062	·199	·953	26·053	26·211	25·893	11		5
19	82·8	58·4	24·4	70·6	93·2	54·0	5		5	6		4							·033	·143	·914				7		9
20	82·6	59·8	22·8	71·0	93·0	56·5	4	1	5	7	1	2							·013	·140	·927				7		9
21	81·9	56·4	25·5	69·1	90·2	52·3	4		6	3		7	82·4	58·2	24·2	70·3	93·2	52·3	·020	·130	·942	26·022	26·143	25·914	7		9
22	82·1	56·2	25·9	69·1	90·3	45·0	4		6	3		7							·029	·113	·891				9		7
23	83·7	54·9	28·8	69·3	91·4	41·5	6		4	4		6							·031	·110	·870				10		6
24	80·4	54·6	25·8	67·5	91·8	43·2	3		7	1		9	82·1	55·2	26·9	68·6	91·8	41·5	·043	·154	·839	26·034	26·154	25·839	12		4
25	78·0	54·5	23·5	66·3	87·5	47·5	3		7	2		8							·021	·118	·810				9		7
26	80·2	55·5	24·7	67·8	86·4	50·3	3		7	4		6							·036	·140	·859				10		6
27	82·3	55·5	26·8	68·9	89·6	45·8	4	1	5	5		5	80·2	55·2	25·0	67·7	89·6	45·8	·031	·138	·839	26·029	26·140	25·810	11		5
28	80·3	56·3	24·0	68·3	86·2	45·0	4	1	5	2		8							·041	·132	·948				11		5
29	80·4	55·4	25·0	67·9	85·7	49·6	2		8	1		9							·047	·194	·966				8		8
30	79·1	54·5	24·6	66·8	87·0	50·5	3		7	1		9	79·9	55·4	24·5	67·7	87·0	45·0	·023	·225	·903	26·037	26·225	25·903	7		9
31	81·8	54·2	27·6	68·0	91·0	51·0	3	1	6	2		8							·026	·149	·856				10		6

TABLE 16.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

April	M	m	M−m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	78·6	51·7	26·9	65·1	91·3	41·2	6		4	7		3							26·065	26·231	25·899				6		10
2	76·1	51·3	24·8	63·7	90·5	42·5	6		4	5		5	78·8	52·4	26·4	65·6	91·3	41·2	·102	·270	·988	26·064	26·270	25·856	10		6
3	79·3	52·1	27·2	65·7	89·4	37·0	8		2	5		5							·131	·252	26·064				14		2
4	81·6	53·4	28·2	67·5	90·5	42·0	8		2	8		2							·098	·245	·008				9		7
5	80·3	53·6	26·7	66·9	92·2	44·3	9		1	7		3	80·4	53·0	27·4	66·7	92·2	37·0	·058	·167	25·925	26·096	26·252	25·925	7		9
6	78·8	53·7	25·1	66·2	89·6	49·0	7		3	8		2							·068	·180	·968				6		10
7	78·6	53·2	25·4	65·9	91·0	46·3	7	1	2	8		2							·092	·235	·996				7		9
8	78·5	51·4	27·1	64·9	87·2	44·5	7		3	5	1	4	78·6	52·8	25·8	65·7	91·0	44·5	·071	·218	·934	26·077	26·235	25·934	6		10
9	80·1	53·0	27·1	66·5	89·3	43·2	7		3	9		1							·037	·217	·830				5		11
10	78·2	52·9	25·3	66·5	88·5	40·3	5		5	7		3							·058	·234	·793				8		8
11	75·0	53·8	21·2	64·4	85·0	45·3	6		4	7		3	77·8	53·2	24·6	65·5	89·3	40·3	·060	·256	·800	26·052	26·256	25·793	6		10
12	74·9	52·3	22·6	63·6	82·3	46·8	5		5	5	1	4							·050	·265	·816				5		11
13	74·4	49·3	25·1	61·8	84·3	40·0	6		4	5		5							·074	·203	·954				8		8
14	76·5	49·3	27·2	62·9	88·5	41·0	6		4	3		7	75·3	50·3	25·0	62·8	88·5	40·0	·091	·193	·950	26·072	26·265	25·816	10		6
15	78·0	52·0	26·0	65·0	86·3	43·5	8		2	6		4							·084	·237	·890				8		8
16	76·8	51·5	25·3	64·1	84·5	42·8	7		3	6	1	3							·067	·228	·899				7		9
17	75·7	50·5	25·2	63·1	85·4	36·5	7		3	7		3	76·8	51·3	25·5	64·0	86·3	36·5	·075	·143	26·008	26·075	26·237	25·890	6		10
18	74·3	51·1	23·2	62·7	84·0	38·0	4		6	7		3							·094	·218	25·980				8		8
19	72·7	49·9	22·8	61·3	79·0	40·0	5		5	6		4							·096	·197	·952				11		5
20	71·8	49·9	21·9	60·8	84·2	42·4	3		7	5		5	72·9	50·3	22·6	61·6	84·2	38·0	·102	·207	·933	26·097	26·218	25·933	12		4
21	74·6	49·3	25·3	61·9	82·8	41·8	4		6	4		6							·084	·191	·937				9		7
22	74·0	48·3	25·7	61·1	80·6	38·0	6		4	4		6							·045	·187	·906				7		9
23	74·1	49·3	24·8	61·7	83·4	39·3	4		6	4	1	5	74·2	49·0	25·2	61·6	83·4	38·0	·031	·179	·864	26·053	26·191	25·864	5		11
24	71·8	50·6	21·2	61·2	80·1	41·3	3		7	5	1	4							·042	·207	·857				8		8
25	69·0	47·7	21·3	58·3	80·3	39·6	2		8	2		8							·066	·203	·896				7		9
26	67·7	46·3	21·4	57·0	75·3	37·3	0		10	3		7	69·5	48·2	21·3	58·8	80·3	37·3	·127	·228	26·017	26·078	26·228	25·857	12		4
27	69·6	44·7	24·9	57·1	81·0	35·0	1		9	2		8							·151	·238	25·952				14		2
28	72·1	47·3	24·8	59·7	84·0	37·0	2		8	4		6							·148	·277	·979				12		4
29	73·6	47·4	26·2	60·5	79·6	40·3	5		5	3		7	71·8	46·5	25·3	59·1	84·0	35·0	·146	·278	·964	26·148	26·278	25·952	12		4
30	74·2	47·8	26·4	61·0	78·2	39·5	3		7	2		8							·126	·219	·965				13		3

TABLE 17.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

May	M	m	M−m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	76·0	48·5	27·5	62·2	80·5	43·3	10		0	10		0							26·103	26·234	25·909				7		9
2	74·5	49·7	24·8	62·1	80·3	43·0	9		1	10		0	74·9	48·7	26·2	61·8	80·5	39·5	·132	·276	26·001	26·120	26·276	25·909	10		6
3	70·1	48·0	22·1	59·0	78·3	31·0	8		2	8		2							·130	·231	·027				8		8
4	70·9	47·1	23·8	59·0	77·4	36·5	8		2	8		2							·079	·256	25·918				6		10
5	68·3	46·5	21·8	57·4	82·7	33·3	6		4	7		3	69·8	47·2	22·6	58·5	82·7	31·0	·095	·292	·922	26·101	26·292	25·918	5		11
6	66·8	44·9	21·9	55·8	73·8	34·7	6		4	6		4							·106	·287	·832				8		8
7	66·4	40·3	26·1	53·3	78·3	33·0	5		5	3		7							·128	·273	·999				8		8
8	66·7	41·5	25·2	54·1	79·3	34·5	5		5	4		6	66·6	42·2	24·4	54·4	79·3	33·0	·150	·293	26·005	26·128	26·293	25·832	11		5
9	67·0	43·0	24·0	55·0	78·0	35·5	3		7	5		5							·179	·436	·064				10		6
10	68·0	43·4	24·6	55·7	73·7	37·0	7		3	4		6							·163	·377	·032				7		9
11	71·3	43·7	27·6	57·5	76·6	36·6	8		2	6		4	68·8	43·4	25·4	56·1	78·0	35·5	·112	·342	25·990	26·151	26·436	25·990	4		12
12	68·5	44·4	24·1	56·4	78·3	36·3	5		5	6		4							·092	·217	·907				7		9
13	68·8	42·7	26·1	55·7	79·0	36·0	6		4	4		6							·110	·246	·934				9		7
14	71·4	43·7	27·7	57·5	76·0	34·0	9		1	6		4	69·6	43·6	26·0	56·6	79·0	34·0	·097	·220	·892	26·100	26·246	25·892	9		7
15	69·0	46·4	22·6	57·7	78·6	39·0	6		4	7		3							·069	·244	·849				7		9
16	66·4	42·3	24·1	54·3	76·0	37·0	5		5	5		5							·076	·191	·999				3		13
17	68·2	43·2	25·0	55·7	78·0	38·5	5		5	5		5	67·9	44·0	23·9	56·0	78·6	37·0	·056	·194	·870	26·067	26·244	25·849	3		13
18	67·6	42·3	25·3	54·9	75·7	34·2	6		4	6		4							·077	·244	·936				5		11
19	66·5	41·4	25·1	53·9	74·2	28·5	5		5	4		6							·102	·276	·962				6		10
20	66·8	40·6	26·2	53·7	81·0	35·3	4		6	4		6	67·0	41·4	25·6	54·2	81·0	28·5	·112	·267	·920	26·097	26·276	25·920	8		8
21	67·4	42·0	25·4	54·7	77·7	36·2	6		4	6		4							·104	·268	·938				7		9
22	64·7	40·1	24·6	52·4	77·8	28·0	5	1	4	5		5							·099	·259	·975				7		9
23	65·9	40·4	25·5	53·1	78·8	29·3	6		4	5		5	66·0	40·8	25·2	53·4	78·8	28·0	·069	·231	·902	26·091	26·268	25·902	4		12
24	63·7	40·6	23·1	52·1	79·4	30·5	5		5	4		6							·099	·226	·940				8		8
25	64·1	38·9	25·2	51·5	80·0	27·3	4		6	2	1	7							·122	·259	·994				8		8
26	63·4	38·8	24·6	51·1	78·6	28·5	3		7	4		6	63·7	39·4	24·3	51·5	80·0	27·3	·111	·266	·930	26·111	26·266	25·930	7		9
27	61·6*	38·6	23·0*	50·1*	73·2*	29·0	1		8	4		6							·157	.297	·985				11	1	4
28	62·3	37·0	25·3	49·6	67·3	31·5	0		10	1		9							·224	·336	26·109				15		1
29	64·6	37·0	27·6	50·8	69·4	30·3	3		7	1		9	62·8	37·5	25·3	50·1	73·2	29·0	·238	·423	·154	26·206	26·423	25·985	16		0
30	65·7	39·0	26·7	52·3	69·7	31·8	5	1	4	1		9							·220	·374	·094				15		1
31	67·2	39·9	27·3	53·5	73·0	35·3	5		5	2		8							·192	·296	·028				14		2

* Nine days: maximum temperature not recorded May 27, 1891.

TABLE 18.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

June	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	66·7	41·6	25·1	54·1	73·6	35·3	8		2	9		1	66·5	40·2	26·4	53·4	73·6	31·8	26·179	26·359	26·003	26·197	26·374	23·003	7		9
2	65·3	41·0	24·3	53·1	74·2	33·5	7		3	8		2							·154	·411	25·870				5		11
3	62·5	37·9	24·6	50·2	68·6	28·0	5	1	4	4	1	5							·161	·355	·966				6		10
4	64·8	38·1	26·7	51·4	70·4	34·0	7		3	4		6	64·2	39·0	25·2	51·6	74·2	28·0	·154	·266	26·022	26·156	26·411	25·870	7		9
5	64·1	37·3	26·8	50·7	76·6	31·3	7		3	4	1	5							·154	·254	25·958				8		8
6	63·9	37·7	26·2	50·8	68·8	28·5	6		4	5		5							·155	·318	·999				7		9
7	62·4	37·0	25·4	49·7	69·5	28·8	4		6	5		5	63·5	37·3	26·2	50·4	76·6	28·5	·167	·321	26·009	26·159	26·321	25·958	8		8
8	62·5	37·5	25·0	50·0	70·2	31·2	5		5	5		5							·198	·328	·002				10		6
9	65·0	37·8	27·2	51·4	71·0	31·2	7		3	5		5							·212	·368	·014				12		4
10	63·0	39·2	23·8	51·1	71·4	33·3	6		4	6		4	63·5	38·2	25·3	50·8	71·4	31·2	·167	·368	25·938	26·192	26·368	25·938	8		8
11	62·9	39·7	23·2	51·3	72·5	32·7	4		6	6		4							·156	·377	·915				5		11
12	63·6	38·1	25·5	50·8	74·0	30·5	6		4	6		4							·173	·420	26·023				6		10
13	63·7	38·3	25·4	51·0	72·0	28·2	5		5	5		5	63·4	38·7	24·7	51·0	74·0	28·2	·193	·415	·022	26·174	26·420	25·915	7		9
14	61·0	36·5	24·5	48·7	71·2	26·3	4		6	4		6							·217	·477	·093				10		6
15	62·5	35·7	26·8	49·1	69·0	27·0	4		6	3		7							·178	·443	25·990				10		6
16	63·8	37·5	26·3	50·6	69·0	26·5	7	1	2	6		4	62·4	36·6	25·8	49·5	71·2	26·3	·130	·314	·915	26·175	26·477	25·915	6	1	9
17	62·7	37·4	25·3	50·0	71·0	27·5	5		5	4		6							·161	·295	·858				9		7
18	61·2	35·7	25·5	48·4	69·5	27·4	3		7	3		7							·229	·367	26·016				12		4
19	62·8	36·8	26·0	49·8	69·7	25·0	6		4	4		6	62·2	36·6	25·6	49·4	71·0	25·0	·219	·389	·077	26·203	26·389	25·858	10		7
20	63·1	36·2	26·9	49·6	68·2	29·7	5		5	4		6							·197	·317	·060				9		6
21	63·6	35·9	27·7	49·7	68·8	30·3	6		4	4		6							·144	·280	25·997				7		9
22	63·8	36·6	27·2	50·2	70·0	30·5	5		5	4		6	63·5	36·2	27·3	49·8	70·0	29·7	·125	·245	26·006	26·155	26·317	25·997	6		10
23	63·4	37·3	26·1	50·3	72·8	31·5	5		5	5		5							·160	·307	·041				4		12
24	61·9	36·1	25·8	49·0	70·6	29·0	5		5	3	1	6							·192	·340	·041				9		7
25	62·8	37·0	25·8	49·9	71·7	29·5	3		7	5		5	62·7	36·8	25·9	49·7	72·8	29·0	·201	·349	25·999	26·184	26·349	26·999	11		5
26	63·0	36·7	26·3	49·8	70·7	31·0	4		6	4		6							·178	·346	·919				9		7
27	63·1	36·8	26·3	49·9	71·8	32·5	6		4	3		7							·170	·319	·916				8		8
28	63·6	36·8	26·8	50·2	69·8	29·9	6		4	4		6	63·2	36·8	26·4	50·0	71·8	29·9	·172	·288	26·101	26·173	26·346	25·916	8		8
29	63·7	37·5	26·2	50·6	74·3	30·5	6		4	4	1	5							·172	·261	·100				6		10
30	62·3	36·5	25·8	49·4	70·0	29·5	5		5	3		7							·186	·342	25·983				8		8

TABLE 19.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

July	M	m	M−m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	$M_3=m_3$	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	61·7	36·4	25·3	49·0	72·7	26·8	4		6	5		5	62·6	36·8	25·8	49·7	74·3	26·8	26·164	26·338	25·930	26·174	26·342	25·930	8		8
2	63·4	37·5	25·9	50·4	73·7	32·0	7		3	6		4							·185	·310	26·021				7		9
3	65·9	39·1	26·8	52·5	72·8	33·3	7		3	8		2							·220	·349	·086				11		5
4	66·5	38·4	28·1	52·4	72·7	32·0	6		4	7		3	65·3	38·3	27·0	51·8	73·7	32·0	·220	·423	·053	26·208	26·423	26·021	11		5
5	64·1	38·0	26·1	51·0	71·6	32·5	7		3	7		3							·199	·470	·047				6	1	9
6	63·3	38·1	25·2	50·7	69·4	31·0	4		6	6		4							·158	·435	25·980				6		10
7	61·9	35·3	26·6	48·6	72·8	29·0	2	1	7	4		6	63·1	37·1	26·0	50·1	72·8	29·0	·166	·371	26·055	26·174	26·470	25·980	5		11
8	62·6	34·1	28·5	48·3	72·3	26·8	4		6	3		7							·194	·335	25·950				11		5
9	65·1	34·8	30·3	49·9	76·6	28·6	5	1	4	5		5							·200	·357	·996				10	1	5
10	62·9	35·7	27·2	49·3	71·2	30·3	5		5	5		5	63·5	34·9	28·6	49·2	76·6	26·8	·202	·299	·939	26·199	26·357	25·950	11		5
11	62·2	35·8	26·4	49·0	69·8	20·0	4		6	5		5							·198	·374	·908				11		5
12	62·4	36·5	25·9	49·4	71·7	26·5	4		6	6		4							·207	·389	·971				9		7
13	64·6	35·0	29·6	49·8	72·9	26·4	6		4	5		5	63·1	35·8	27·3	49·4	72·9	20·0	·170	·369	·923	26·192	26·389	25·908	9		7
14	62·9	37·4	25·5	50·1	71·3	30·0	3		7	4		6							·123	·274	·896				6		10
15	59·0	34·2	24·8	46·6	70·8	30·3	3		7	3		7							·117	·301	·934				3		13
16	59·2	32·9	26·3	46·0	70·4	27·5	3		7	2		8	60·4	34·8	25·6	47·6	71·3	27·5	·141	·294	·961	26·127	26·301	25·896	9		7
17	57·2	32·1	25·1	44·6	71·1	25·3	1		9	3	1	6							·213	·394	26·035				10		6
18	61·7	32·2	29·5	46·9	73·8	26·0	2		8	2		8							·220	·385	·021				9		7
19	62·7	35·5	27·2	49·1	72·9	27·0	4		6	3	1	6	60·5	33·3	27·2	46·9	73·8	25·3	·221	·422	25·937	26·218	26·422	25·937	10		6
20	63·0	34·7	28·3	48·8	76·4	25·3	4		6	2		8							·231	·508	·963				12		4
21	65·9	35·6	30·3	50·7	74·0	27·3	6		4	5		5							·191	·460	26·002				8	1	7
22	67·8	37·5	30·3	52·6	80·0	32·7	8		2	5		5	65·6	35·9	29·7	50·7	80·0	25·3	·168	·336	·050	26.197	26·508	25·963	6	1	9
23	68·0	38·1	29·9	53·0	78·3	32·0	8		2	5		5							·170	·288	25·963				10		6
24	65·5	37·3	28·2	51·4	76·7	32·3	6		4	4		6							·201	·322	26·075				10		6
25	67·5	37·1	30·4	52·3	74·8	27·0	8		2	5		5	67·0	37·5	29·5	52·2	78·3	27·0	·214	·357	·048	26·195	26·357	25·963	10		6
26	69·4	37·4	32·0	53·4	74·9	29·7	8	1	1	7		3							·175	·313	25·954				8		8
27	67·4	38·7	28·7	53·0	78·0	27·5	8		2	8		2							·153	·313	·963				7		9
28	68·0	37·7	30·3	52·8	77·7	22·3	6		4	7		3	68.3	37·9	30·4	53·1	78·0	22·3	·121	·259	·980	26·150	26·313	25·954	4		12
29	69·3	40·0	29·3	54·6	79·0	28·5	8		2	8		2							·093	·233	·947				4		12
30	65·6	37·2	28·4	51·4	76·7	25·5	5		5	5		5							·141	·330	26·019				5		11
31	66·2	33·8	32·4	50·0	74·4	25·0	7		3	3		7	67·0	37·0	30·0	52·0	79·0	25·0	·164	·392	·041	26·133	26·392	25·947	5		11

TABLE 20.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

Aug.	M	m	M−m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°	°						°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	64·5	35·3	29·2	49·9	75·7	28·8	2		8	0		10							26·181	26·423	26·055				12		4
2	65·1	36·0	29·1	50·5	76·9	27·5	2		8	3		7							·161	·367	25·929				9		7
3	68·5	37·7	30·8	53·1	75·0	28·0	3		7	3		7	66·0	36·3	29·7	51·1	76·9	27·5	·135	·344	·942	26·159	26·423	25·229	8		8
4	69·3	36·6	32·7	52·9	77·3	30·3	3		7	1		9							·120	·323	·993				8		8
5	68·1	38·4	29·7	53·2	76·4	29·5	4		6	3		7							·119	·290	·908				8		8
6	70·6	37·9	32·7	54·2	80·2	26·5	6		4	3		7	69·3	37·6	31·7	53·4	80·2	26·5	·124	·293	·912	26·121	26·323	25·908	9		7
7	70·6	40·5	30·1	55·5	82·0	29·5	6		4	4		6							·110	·261	·958				7		9
8	70·1	40·4	29·7	55·2	80·0	32·0	7		3	4		6							·092	·266	·952				5		11
9	70·9	41·3	29·6	56·1	83·0	30·0	7		3	6	1	3	70·5	40·7	29·8	55·6	83·0	29·5	·122	·310	·913	26·108	26·310	25·913	8		8
10	72·0	39·8	32·2	55·9	82·0	29·0	7		3	5		5							·132	·308	·857				8		8
11	71·3	41·4	29·9	56·3	79·8	31·0	6		4	6		4							·119	·266	·913				8		8
12	68·7	39·2	29·5	53·9	82·0	31·0	3		7	4		6	70·7	40·1	30·6	55·4	82·0	29·0	·125	·298	·962	26·125	26·308	25·857	9		7
13	68·0	38·4	29·6	53·2	80·3	28·3	5		5	4		6							·158	·305	26·017				11		5
14	69·3	39·0	30·3	54·1	77·2	28·7	5		5	5		5							.156	·260	25·902				12		4
15	71·7	43·0	28·7	57·3	78·3	29·3	5		5	5		5	69·7	40·1	29·6	54·9	80·3	28·3	.128	·311	·919	26·147	26·311	25·902	10		6
16	72·1	43·7	28·4	57·9	78·0	34·7	7		3	7		3							·095	·241	·950				5	1	10
17	70·5	44·2	26·3	57·3	79·3	35·5	6		4	8		2							·110	·232	·866				9		7
18	71·1	42·7	28·4	56·9	81·3	34·5	6		4	7		3	71·2	43·5	27·7	57·3	81·3	34·5	·111	·247	·992	26·105	26·247	25·866	7		9
19	71·9	41·0	30·9	56·4	81·4	28·0	7		3	7		3							·096	·219	·918				6		10
20	70·0	39·5	30·5	54·7	78·3	31·0	7		3	5		5							·126	·310	26·026				6	1	9
21	71·8	40·2	31·6	56·0	80·0	31·3	6		4	3	1	6	71·2	40·2	31·0	55·7	81·4	28·0	·154	·372	25·995	26·125	26·372	25·918	10		6
22	74·2	42·7	31·5	58·4	84·6	35·0	7		3	5		5							·126	·301	·927				9		7
23	73·8	43·3	30·5	58·5	83·7	36·0	8		2	6		4							·113	·265	·945				7		9
24	71·8	42·8	29·0	57·3	80·4	34·0	7		3	7		3	73·3	42.9	30·4	58·1	84·6	34·0	·118	.320	·929	26·119	26·320	25·927	9		7
25	73·1	43·8	29·3	58·4	80·6	30·5	8		2	7		3							·136	·314	·995				8		8
26	71·7	42·4	29·3	57·0	80·7	31·5	7		3	6		4							·150	·326	26·008				8		8
27	71·7	44·0	27·7	57·8	83·0	33·5	6		4	8		2	72·2	43·4	28·8	57·8	83·0	30·5	·118	·312	25·963	26·135	26·326	25·963	7		9
28	71·4	42·5	28·9	56·9	79·8	31·6	7		3	5		5							·077	·244	·927				5		11
29	69·7	42·0	27·7	55·8	79·0	32·3	3		7	6		4							·079	·251	·843				5		11
30	69·4	41·7	27·7	55·5	84·5	28·6	4		6	6		4	70·2	42·1	28·1	56·1	84·5	28·6	·108	·318	·982	26·088	26·318	25·843	6		10
31	71·9	40·9	31·0	56·4	85·6	28·7	5		5	6		4							·129	·345	26·037				6		10

TABLE 21.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

Sept.	M	m	$M-m$	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°													inches	inches	inches	inches	inches	inches			
1	71·4	41·7	29·7	56·5	82·2	33·5	2		8	2		8							26·125	26·276	25·941				11		5
2	72·5	37·6	34·9	55·0	86·3	29·3	3		7	3		7	71·9	40·1	31·8	56·0	86·3	28·7	·156	·385	·915	26·137	26·385	25·915	12		4
3	74·4	42·1	32·3	58·2	88·0	34·7	3		7	5		5							·144	·396	26·005				11		5
4	75·1	42·2	32·9	58·6	88·7	31·0	4		6	2	2	6							·149	·359	25·960				13		3
5	76·9	41·9	35·0	59·4	89·5	36·5	4		6	2		8	75·5	42·1	33·4	58·8	89·5	31·0	·109	·242	·958	26·134	26·396	25·958	11		5
6	77·6	43·8	33·8	60·7	87·0	36·2	6		4	3		7							·089	·253	·936				8		8
7	76·2	46·8	29·4	61·5	89·0	35·3	5		5	7		3							·072	·258	·895				6		10
8	72·8	43·2	29·6	58·0	87·0	36·5	3		7	3		7	75·5	44·6	30·9	60·0	89·0	35·3	·048	·164	·850	26·070	26·258	25·850	6		10
9	74·0	42·2	31·8	58·1	88·8	25·5	4		6	3	1	6							·051	·183	·726				9	1	6
10	73·3	40·6	32·7	56·9	87·6	32·0	4		6	3		7							·103	·218	·934				10	1	5
11	75·1	42·5	32·6	58·8	85·0	31·5	3		7	3		7	74·1	41·8	32·3	57·9	88·8	25·5	·116	·221	·993	26·090	26·218	25·726	13		3
12	76·6	42·5	34·1	59·5	88·3	31·5	6		4	4		6							·088	·213	·816				10		6
13	78·4	44·3	34·1	61·3	94·0	33·0	6		4	4		6							·086	·234	·921				9		7
14	78·7	44·7	34·0	61·7	93·8	36·0	5		5	4		6	77·9	43·8	34·1	60·8	94·0	31·5	·107	·239	·990	26·094	26 239	25·816	10		6
15	81·2	46·8	34·4	64·0	94·8	32·7	7		3	7		3							·092	·231	·903				10		6
16	83·6	48·3	34·3	65·9	93·4	41·5	8		2	8		2							·055	·216	·919				6		10
17	79·7	47·7	32·0	63·7	94·3	34·7	6		4	7		3	81·5	47·6	33·9	64·5	94·8	32·7	·071	·206	·944	26·073	26·231	25·903	7		9
18	80·4	46·3	34·1	63·3	93·3	37·0	5		5	6		4							·057	·234	·905				6		10
19	80·3	48·3	32·0	64·3	94·5	40·0	6		4	7		3							·060	·174	·942				6	1	9
20	81·0	47·3	33·7	64·1	96·0	39·5	7		3	6		4	80·6	47·3	33·3	63·9	96·0	37·0	·064	·252	·833	26·060	26·252	25·833	6		10
21	81·7	46·9	34·8	64·3	93·4	34·5	8		2	5	1	4							·039	·323	·772				4	1	11
22	77·0	46·5	30·5	61·7	92·2	29·7	4		6	6		4							·048	·268	·857				7		9
23	75·2	43·3	31·9	59·2	89·7	33·0	3		7	3		7	78·0	45·6	32·4	61·8	93·4	29·7	·076	·297	·856	26·054	26·323	25·772	11		5
24	78·0	43·0	35·0	60·5	92·6	32·7	5		5	3	1	6							·090	·259	·962				9		7
25	79·9	45·9	34·0	62·9	90·0	32·0	5		5	7		3							·055	·213	·920				6	1	9
26	83·8	49·0	34·8	66·4	91·0	38·0	7		3	9		1	80·6	46·0	34·6	63·3	92·6	32·0	·018	·256	·801	26·054	26·259	25·801	4		12
27	83·7	50·3	33·4	67·0	92·8	39·8	7		3	8		2							·008	·246	·740				4		12
28	81·5	47·1	34·4	64·3	92·3	38·3	6		4	6		4							·020	·189	·857				4		12
29	82·5	48·0	34·5	65·2	94·8	35·7	7		3	7		3	82·6	48·5	34·1	65·5	94·8	36·7	·050	·229	·861	26·026	26·246	25·740	6		10
30	85·5	48·4	37·1	66·9	96·6	34·3	8		2	7		3							·015	·150	·851				3		13

TABLE 22.

The Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

Oct.	M	m	M−m	$\frac{M+m}{2}$	M′	m′	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	84·8	49·6	35·2	67·2	97·7	43·3	6		4	2		8							26·009	26·114	25·910				8		8
2	82·9	49·2	33·7	66·0	96·4	39·0	4		6	4		6	84·4	49·1	35·3	66·7	97·7	34·3	·045	·127	·957	26·023	26·150	25·851	10		6
3	83·8	49·0	34·8	66·4	96·3	39·2	4		6	4		6							·057	·215	·839				11		5
4	81·3	49·6	31·7	65·4	95·7	40·0	4		6	2		8							·038	·262	·809				9		7
5	83·1	47·5	35·6	65·3	91·4	30·3	5		5	2		8	82·7	48·7	34·0	65·7	96·3	30·3	·034	·351	·883	26·043	26·351	25·809	6		10
6	84·0	47·7	36·3	65·8	91·3	40·5	4		6	1	1	8							·030	·345	·915				5		11
7	82·8	48·5	34·3	65·6	93·8	39·5	6		4	4		6							·048	·186	·807				12		4
8	82·4	50·0	32·4	66·2	97·2	35·5	4		6	6		4	83·1	48·7	34·4	65·9	97·2	35·5	·037	·239	·883	26·038	26·345	25·807	8		8
9	83·1	51·1	32·0	67·1	92·0	38·0	4		6	7		3							·066	·286	·867				10		6
10	84·8	50·6	34·2	67·7	89·7	43·0	6		4	2	1	7							·058	·281	·908				8	1	7
11	86·9	51·1	35·8	69·0	94·5	43·8	7		3	5		5	84·9	50·9	34·0	67·9	94·5	38·0	25·999	·183	·799	26·041	26·286	25·799	7		9
12	87·2	53·3	33·9	70·2	93·6	44·5	6		4	6		4							·980	·166	·821				6		10
13	84·6	49·3	35·3	66·9	98·5	36·0	5		5	4		6							26·006	·153	·764				7		9
14	84·2	49·9	34·3	67·0	99·2	37·2	6		4	7		3	85·3	50·8	34·5	68·0	99·2	36·0	·027	·129	·919	26·004	26·166	25·764	8		8
15	86·6	50·8	35·8	68·7	99·4	37·7	7		3	3		7							·041	·175	·905				9		7
16	86·6	55·2	31·4	70·9	102·4	46·5	6		4	7		3							·049	·224	·860				10		6
17	84·9	53·8	31·1	69·3	98·8	48·3	4		6	7		3	86·0	53·3	32·7	69·6	102·4	37·7	·061	·223	·877	26·050	26·224	25·860	11		5
18	89·9	53·4	36·5	71·6	101·9	46·7	7		3	7		3							·010	·166	·862				9		7
19	86·6	57·0	29·6	71·8	102·0	49·3	7		3	6	1	3							25·987	·095	·849				6		10
20	87·6	55·0	32·6	71·3	102·0	46·3	8		2	9		1	88·0	55·1	32·9	71·5	102·0	46·3	·995	·119	·846	25·997	26·166	25·846	4		12
21	88·1	56·2	31·9	72·1	103·0	43·0	7		3	9		1							26·002	·116	·901				5		11
22	87·9	53·7	34·2	70·8	100·9	43·0	6		4	7		3							25·994	·109	·883				7		9
23	85·5	51·0	34·5	68·2	101·7	43·4	4		6	4		6	87·2	53·6	33·6	70·4	103·0	43·0	·997	·164	·876	25·998	26·164	25·876	5		11
24	85·4	52·6	32·8	69·0	97·6	47·0	5		5	3		7							·948	·067	·844				4		12
25	84·1	51·2	32·9	67·6	99·6	41·3	4		6	5		5							26·013	·130	·902				7		9
26	88·5	52·8	35·7	70·6	99·7	41·2	7		3	5		5	86·0	52·2	33·8	69·1	99·7	41·2	25·998	·259	·829	25·986	26·259	25·829	5		11
27	88·5	55·7	32·8	72·1	96·0	46·5	7		3	8		2							26·010	·269	·847				5		11
28	80·7	54·6	26·1	67·6	102·0	48·0	4		6	7	1	2							·021	·154	·857				8		8
29	83·6	52·0	31·6	67·8	97·0	42·2	5		5	4	1	5	84·3	54·1	30·2	69·2	102·0	42·2	·015	·086	·910	26·015	26·269	25·847	9		7
30	84·6	52·5	32·1	68·5	99·6	41·3	4		6	5		5							·029	·141	·919				7		9
31	82·6	50·8	31·8	66·7	99·8	36·0	3		7	6		4							·077	·169	·921				11		5

TABLE 23.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

Nov.	M	m	M−m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	88·7	51·9	36·8	70·3	96·3	45·0	3		7	3		7	85·3	51·7	33·6	68·5	99·8	36·0	26·035	26·196	25·893	26·047	26·196	25·893	12		4
2	92·4	54·4	38·0	73·4	101·3	45·8	7		3	3		7							25·972	·122	·792				9		7
3	90·0	54·8	35·2	72·4	100·3	46·5	5		5	4		6							·969	·101	·776				8		8
4	88·2	53·6	34·6	70·9	97·8	45·4	6		4	3		7	90·2	54·3	35·9	72·2	101·3	45·4	·976	·133	·835	25·972	26·133	25·776	8		8
5	87·7	53·8	33·9	70·7	101·4	37·6	4		6	5	1	4							26·018	·086	·814				11		5
6	85·1	53·1	32·0	69·1	97·0	39·0	3		7	5		5							·032	·123	·950				13		3
7	88·1	53·9	34·2	71·0	99·0	43·2	4		6	4		6	87·0	53·6	33·4	70·3	101·4	37·6	·024	·135	·939	26·025	26·135	25·814	12	1	3
8	90·4	54·6	35·8	72·5	99·5	45·5	5		5	4		6							·032	·185	·862				12		4
9	89·0	56·3	32·7	72·6	97·0	49·8	6		4	5		5							·051	·269	·930				13	1	2
10	88·1	55·8	32·3	71·9	97·0	44·3	4		6	6		4	89·2	55·6	33·6	72·4	99·5	44·3	·020	·142	·903	26·034	26·269	25·862	12		4
11	90·3	55·1	35·2	72·7	100·1	43·8	5		5	4		6							25·995	·126	·862				10		6
12	89·6	56·1	33·5	72·8	100·9	47·5	3		7	5		5							·977	·221	·821				9		7
13	90·1	55·7	34·4	72·9	101·4	49·3	6		4	7		3	90·0	55·6	34·4	72·8	101·4	43·8	·967	·157	·834	25·980	26·221	25·821	5		11
14	91·2	56·2	35·0	73·7	101·3	45·0	5		5	5		5							26·007	·133	·902				9		7
15	92·2	56·8	35·4	74·5	101·4	47·3	6		4	5		5							·023	·142	·852				10	1	5
16	92·8	57·2	35·6	75·0	107·3	50·5	7		3	6		4	92·1	56·7	35·4	74·4	107·3	45·0	·007	·114	·889	26·012	26·142	25·852	12		4
17	89·9*	57·6	32·3*	73·7*	103·4	41·0	6		3	6		4							25·974	·061	·914				6		10
18	86·2	54·9	31·3	70·5	106·2	42·9	4		6	5		5							·945	·077	·854				4		12
19	89·0	55·3	33·7	72·1	104·9	47·3	5		5	5		5	88·4	55·9	32·5	72·1	106·2	41·0	·920	·083	·778	25·946	26·083	25·778	2		14
20	88·2	53·9	34·3	71·0	103·0	45·3	4		6	4		6							·966	·190	·818				5		11
21	88·1	53·8	34·3	70·9	99·6	47·2	5		5	2		8							·984	·202	·809				6		10
22	91·1	54·2	36·9	72·6	102·0	49·6	5		5	4		6	89·1	54·0	35·1	71·5	103·0	45·3	·989	·139	·816	25·980	26·202	25·809	8		8
23	93·0	58·6	34·4	75·8	107·5	53·0	8		2	7		3							·974	·072	·787				7		9
24	89·6	57·6	32·0	73·6	102·4	50·7	5		5	5		5							·975	·191	·859				8		8
25	91·5	56·9	34·6	74·2	98·7	43·7	6		4	8		2	91·4	57·7	33·7	74·5	107·5	43·7	·980	·080	·888	25·976	26·091	25·787	8		8
26	90·1	60·2	29·9	75·1	101·7	53·0	7		3	9		1							·956	·087	·834				6		10
27	90·8	57·4	33·4	74·1	101·0	49·5	6		4	7		3							·926	·122	·807				4		12
28	90·4	58·2	32·2	74·3	100·0	51·5	5		5	6		4	90·4	58·6	31·8	74·5	101·7	49·5	·939	·132	·764	25·940	26·132	25·764	5		11
29	90·9	57·8	33·1	74·3	99·9	52·5	7		3	7		3							·948	·093	·665				8		8
30	93·6	58·2	35·4	75·9	105·8	48·8	7		3	7		3							·973	·182	·847				5		11

* Nine days: maximum temperature not recorded November 17, 1892.

TABLE 24.

Mean Daily Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

Dec.	M	m	M−m	$\frac{M-m}{2}$	M′	m′	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	M_3	m_3	M_3-m_3	$\frac{M_3+m_3}{2}$	M'_3	m'_3	P	MP	mP	P_3	MP_3	mP_3	(P+)	(P=)	(P−)
	°	°	°	°	°	°							°	°	°	°	°	°	inches	inches	inches	inches	inches	inches			
1	89·1	59·5	29·6	74·3	102·0	47·2	3	1	6	5		5	91·2	58·5	32·7	74·8	105·8	47·2	26·002	26·140	25·886	25·974	26·182	25·665	13		3
2	90·5	56·4	34·1	73·4	99·2	47·3	4		6	3		7							·005	·114	·900				12		4
3	93·0	57·5	35·5	75·2	103·6	49·7	6		4	3		7							25·966	·081	·885				9		7
4	94·4	57·8	36·6	76·1	101·0	51·2	7		3	3		7	92·6	57·2	35·4	74·9	103·6	47·3	·945	·115	·813	25·972	26·115	25·813	6		10
5	95·5	58·7	36·8	77·1	104·8	54·0	7		3	4		6							·914	·064	·791				4		12
6	95·6	57·6*	38·0*	76·6*	106·3	53·0	7		3	2		7							·939	·101	·846				4		12
7	96·0	60·2	35·8	78·1	106·4	52·2	5		5	6		4	95·7	58·8	36·9	77·2	106·4	52·2	·966	·128	·816	25·940	26·128	25·791	10	1	5
8	93·9	59·7	34·2	76·8	105·4	51·7	6		4	4		6							·957	·051	·837				9		7
9	95·6	60·9	34·7	78·2	105·3	54·5	6	1	3	6		4							·976	·070	·885				11		5
10	95·2	59·3	35·9	77·2	105·6	48·7	6		4	6		4	94·9	60·0	34·9	77·4	105·6	48·7	·989	·108	·916	25·974	26·108	25·837	12		4
11	94·4	61·3	33·1	77·8	103·4	51·5	5		5	7		3							·989	·076	·855				10		6
12	92·2	59·3	32·9	75·6	107·3	53·8	5		5	4		6							·944	·103	·833				7		9
13	90·5	59·4	31·1	75·0	104·8	50·5	4		6	4		6	92·4	60·0	32·4	76·2	107·3	50·5	·917	·020	·768	25·950	26·103	25·768	5		11
14	88·1	59·3	28·8	73·7	103·3	52·5	5		5	6		4							·912	·045	·724				6		10
15	89·0	59·3	29·7	74·1	100·0	50·0	2		8	6		4							·919	·083	·773				7		9
16	88·4	57·1	31·3	72·7	101·8	45·3	2		8	5		5	88·5	58·6	29·9	73·5	103·3	45·3	·966	·145	·832	25·932	26·145	25·724	8		8
17	90·6	58·2	32·4	74·4	100·0	43·5	3		7	4		6							·952	·113	·836				7		9
18	89·9	57·0	32·9	73·4	96·8	48·5	2		8	4		6							·932	·040	·797				3		13
19	91·5	59·4	32·1	75·4	101·0	46·8	5		5	6		4	90·7	58·2	32·5	74·4	101·0	43·5	·914	·041	·680	25·933	26·113	25·680	3		13
20	90·4	58·7	31·7	74·5	99·5	49·3	7		3	4		6							·948	·045	·773				9		7
21	91·1	59·5	31·6	75·3	98·0	43·0	6		4	6		4							·973	·078	·827				11	1	4
22	92·7	59·7	33·0	76·7	100·8	42·5	6		4	6		4	91·4	59·3	32·1	75·3	100·8	42·5	·972	·095	·759	25·964	26·095	25·759	10		6
23	94·1	58·4	35·7	76·2	105·3	46·5	6		4	4		6							·936	·071	·797				7		9
24	92·9	58·5	34·4	75·7	104·8	51·0	4		6	4		6							·954	·054	·857				8		8
25	93·5	60·4	33·1	76·9	101·8	46·0	6		4	7		3	93·5	59·1	34·4	76·3	105·3	46·5	·976	·058	·856	25·955	26·071	25·797	10		6
26	94·9	60·2	34·7	77·5	104·4	49·0	7		3	6	1	3							·972	·085	·791				10		6
27	95·6	62·6	33·0	79·1	102·3	57·2	8		2	8		2							·979	·098	·844				11		5
28	98·4	62·0	36·4	80·2	105·6	56·3	9		1	9		1	96·3	61·6	34·7	78·9	105·6	49·0	·954	·098	·801	25·968	26·098	25·791	9		7
29	94·1	62·3	31·8	78·2	101·0	58·2	6		4	9		1							·944	·045	·871				7		9
30	91·1	59·2	31·9	75·1	97·0	55·0	6		4	5		5							·947	·122	·801				5		11
31	91·1	58·7	32·4	74·9	103·7	53·5	7		3	4		6	92·1	60·1	32·0	76·1	103·7	53·5	·972	·156	·764	25·954	26·156	25·764	8		8

* Nine days: minimum temperature not recorded December 6, 1892.

TABLE 25.

Mean Monthly Temperature and Pressure of the Air at Durban, Natal, 1888–1897.

	M	m	M − m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	P	MP	mP	(P+)	(P=)	(P−)	Cloud %	Moisture.
	°	°	°	°	°	°							inches	inches	inches					gr.
Jan.	85·6	67·7	17·8	76·6	105·2	56·7	173	2	135	160	9	141	29·997	30·347	29·518	319	1	300	60·2	7·2
Feb.	85·7	68·6	17·1	77·1	98·2	56·4	160	3	120	144	14	125	30·010	30·358	29·617	287	2	277	59·6	7·6
March	84·4	67·2	17·2	75·8	97·1	56·5	174	5	131	159	6	145	30·059	30·460	29·580	310	1	309	51·8	7·3
April	81·8	63·2	18·6	72·5	98·1	53·8	166	5	129	148	11	141	30·107	30·604	29·675	308	0	292	42·4	6·4
May	78·5	58·5	20·0	68·5	91·3	45·0	169	3	138	159	2	148	30·145	30·644	29·507	313	0	306	33·5	5·3
June	76·8	54·7	22·1	65·7	89·5	46·8	144	11	145	139	2	159	30·219	30·676	29·742	296	1	303	25·9	4·6
July	76·1	54·0	22·1	65·0	93·6	42·3	157	3	150	138	9	163	30·241	30·801	29·688	305	2	313	26·9	4·4
Aug.	76·4	56·5	19·9	66·5	102·9	46·6	172	1	137	151	1	158	30·201	30·715	29·577	314	1	305	37·0	4·9
Sept.	77·2	58·5	18·6	67·9	110·6	46·5	158	4	138	143	6	146	30·151	30·729	29·601	291	0	309	51·2	5·6
Oct.	78·2	61·6	16·6	69·9	107·8	48·4	164	2	144	158	3	149	30·107	30·661	29·612	294	1	325	65·5	6·0
Nov.	82·2	64·3	17·9	73·2	104·7	52·2	154	1	145	154	3	143	30·023	30·534	29·550	299	2	299	64·1	6·5
Dec.	84·4	66·2	18·2	75·3	99·9	55·3	163	4	143	164	0	146	30·003	30·417	29·524	309	1	310	63·8	7·0
Year	80·6	61·8	18·8	71·2	110·6	42·3	1954	44	1655	1822	66	1764	30·105	30·801	29·507	3645	12	3648	48·4	6·0

Mean Monthly Temperature and Pressure of the Air at Kimberley, Cape Colony, 1888–1897.

	M	m	M − m	$\frac{M+m}{2}$	M′	m'	(M+)	(M=)	(M−)	(m+)	(m=)	(m−)	P	MP	mP	(P+)	(P=)	(P−)	Cloud %	Humidity %
	°	°	°	°	°	°							inches	inches	inches					
Jan.	92·0	60·6	31·4	76·3	108·5	45·5	161	2	147	161	1	148	25·941	26·194	25·720	239	3	254	30·2	56
Feb.	88·9	60·1	28·7	74·5	106·2	48·5	150	1	132	143	0	140	25·972	26·193	25·675	219	2	231	35·3	56
March	84·0	57·7	26·3	70·8	100·6	41·5	168	8	134	162	1	147	26·027	26·225	25·810	261	0	235	33·4	62
April	75·4	50·5	24·9	62·9	92·2	35·0	157	1	142	159	5	136	26·085	26·278	25·793	258	0	222	25·7	63
May	67·4	42·4	25·0	54·9	82·7	27·3	169	2	138	153	1	156	26·123	26·436	25·832	253	1	242	22·9	63
June	63·3	37·5	25·8	50·4	76·6	25·0	162	2	136	139	4	157	26·175	26·477	25·858	238	1	241	18·4	62
July	64·3	36·3	28·0	50·3	80·0	20·0	163	3	144	153	2	155	26·179	26·508	25·896	251	4	241	14·2	55
Aug.	70·5	40·7	29·8	55·6	85·6	26·5	172	0	138	155	2	153	26·123	26·423	25·843	245	2	249	21·3	54
Sept.	78·3	45·0	33·3	61·6	96·6	25·5	157	0	143	150	5	145	26·075	26·396	25·726	238	5	237	16·3	48
Oct.	85·1	51·8	33·3	68·4	103·0	30·3	166	0	144	158	5	147	26·022	26·351	25·764	237	1	258	27·3	46
Nov.	89·9	55·8	34·1	72·8	107·5	37·6	159	0	140	156	1	143	25·985	26·269	25·665	247	3	230	25·6	48
Dec.	92·7	59·3	33·4	76·0	107·3	42·5	168	2	140	160	1	148	25·956	26·156	25·680	251	2	243	25·7	51
Year	79·3	49·8	29·5	64·5	108·5	20·0	1952	21	1678	1849	28	1775	26·055	26·508	25·665	2937	24	2883	24·7	55

TABLE 26.

Values of y in the Simple Sine Curve of Temperature.

Durban.

x	M		$\frac{M+m}{2}$		m	
°		°		°		°
0	Oct. 31	80·6	Oct. 24	71·2	Oct. 16	61·8
15	Nov. 15	81·9	Nov. 9	72·8	Nov. 1	63·7
30	30	83·0	24	74·2	16	65·4
45	Dec. 15	84·0	Dec. 9	75·4	Dec. 1	67·0
60	31	84·8	24	76·4	16	68·1
75	Jan. 15	85·2	Jan. 9	77·0	Jan. 1	68·9
90	31	85·4	24	77·2	16	69·1
105	Feb. 15	85·2	Feb. 9	77·0	Feb. 1	68·9
120	29	84·8	24	76·4	16	68·1
135	Mar. 15	84·0	Mar. 9	75·4	Mar. 1	67·0
150	31	83·0	24	74·2	16	65·4
165	April 15	81·9	April 9	72·8	April 1	63·7
180	30	80·6	24	71·2	16	61·8
195	May 15	79·3	May 9	69·6	May 1	59·9
210	31	78·2	24	68·2	16	58·2
225	June 15	77·2	June 9	67·0	June 1	56·6
240	30	76·4	24	66·0	16	55·5
255	July 15	76·0	July 9	65·4	July 1	54·7
270	31	75·8	24	65·2	16	54·5
285	Aug. 15	76·0	Aug. 9	65·4	Aug. 1	54·7
300	31	76·4	24	66·0	16	55·5
315	Sept. 15	77·2	Sept. 9	67·0	Sept. 1	56·6
330	30	78·2	24	68·2	16	58·2
345	Oct. 15	79·3	Oct. 9	69·6	Oct. 1	59·9

Kimberley.

x	M		$\frac{M+m}{2}$		m	
°		°		°		°
0	Sept. 20	79·3	Sept. 28	64·5	Oct. 4	49·8
15	Oct. 4	83·1	Oct. 12	67·9	20	52·9
30	20	86·6	28	71·0	Nov. 4	55·9
45	Nov. 4	89·7	Nov. 12	73·7	20	58·4
60	20	92·0	28	75·8	Dec. 4	60·3
75	Dec. 4	93·5	Dec. 12	77·1	20	61·5
90	20	94·0	28	77·5	Jan. 4	61·9
105	Jan. 4	93·5	Jan. 12	77·1	20	61·5
120	20	92·0	28	75·8	Feb. 4	60·3
135	Feb. 4	89·7	Feb. 12	73·7	20	58·4
150	20	86·6	28	71·0	Mar. 4	55·9
165	Mar. 4	83·1	Mar. 12	67·9	20	52·9
180	20	79·3	28	64·5	April 4	49·8
195	April 4	75·5	April 12	61·1	20	46·7
210	20	72·0	28	58·0	May 4	43·7
225	May 4	68·9	May 12	55·3	20	41·2
240	20	66·6	28	53·2	June 4	39·3
255	June 4	65·1	June 12	51·9	20	38·1
270	20	64·6	28	51·5	July 4	37·7
285	July 4	65·1	July 12	51·9	20	38·1
300	20	66·6	28	53·2	Aug. 4	39·3
315	Aug. 4	68·9	Aug. 12	55·3	20	41·2
330	20	72·0	28	58·0	Sept. 4	43·7
345	Sept. 4	75·5	Sept. 12	61·1	20	46·7

TABLE 27.

VALUES OF y IN THE SIMPLE SINE CURVE OF MINIMUM TEMPERATURE DIFFERENCES.

x		y	Observed temp. diff.	Deviation.
°		°	°	°
0	Sept. 30	12·0	11·7	—0·3
30	Oct. 31	9·3	9·2	—0·1
60	Nov. 30	7·3	7·7	+0·4
90	Dec. 31	6·6	7·0	+0·4
120	Jan. 31	7·3	7·8	+0·5
150	Feb. 29	9·3	9·0	—0·3
180	Mar. 31	12·0	11·8	—0·2
210	April 30	14·7	14·5	—0·2
240	May 31	16·7	16·7	0·0
270	June 30	17·4	17·5	+0·1
300	July 31	16·7	16·8	+0·1
330	Aug. 31	14·7	14·7	0·0

TABLE 28.

Numerical Coefficients in Lambert's Formula.

Durban.

	Max. Temp.	Mean Temp.	Min. Temp.	Pressure.
	°	°	°	inches
p	+ 80·6000	+ 71·2000	+ 61·8000	+ 30·105000
p_1	+ 4·9309	+ 6·0655	+ 6·9268	— 0·117244
q_1	+ 1·1193	+ 0·9785	+ 0·7186	+ 0·006410
p_2	+ 0·3667	— 0·0333	— 0·7417	+ 0·008580
q_2	+ 0·2598	+ 0·7667	+ 1·0536	+ 0·004474
p_3	— 0·2333	0·0000	— 0·1333	— 0·005000
q_3	— 0 3167	— 0·2667	— 0·2000	+ 0·004166
p_4	— 0·1833	0·0000	— 0·1083	+ 0·007500
q_4	0·0000	+ 0·0866	+ 0·2165	— 0·007650

Kimberley.

	Max. Temp.	Mean Temp.	Min. Temp.	Pressure.
	°	°	°	inches
p	+ 79·3000	+ 64·5000	+ 49·8000	+ 26·055000
p_1	+ 13·8658	+ 13·0145	+ 12·1587	— 0·108570
q_1	— 5·1024	— 3·0640	— 0·4455	+ 0·029990
p_2	— 1·0500	— 1·0833	— 1·1333	+ 0·003500
q_2	+ 1·2124	+ 1·2124	+ 1·2990	— 0·006062
p_3	— 0·0833	— 0·1833	— 0·2167	— 0·008667
q_3	— 0·2167	— 0·2000	— 0·1833	+ 0·000833
p_4	— 0·1167	— 0·0667	+ 0·0333	+ 0·001500
q_4	— 0·2309	— 0·1443	— 0·1443	— 0·005000

TABLE 29.

Evaluating the Cosine Curve for Kimberley in S. Lat. 28° 42′.

Mean Date.	Sun's Declination.	Sun's Zenith Distance. Z	Sun's Semi-diameter.	Cos Z.	Heat Coefficient S².	Temp. y	Differences C − O
	° ′ ″	° ′	″			°	°
Jan. 16	20 53 8 S	7 49	977·6	·991	·955702	92·3	+ 0·3
Feb. 15	12 34 34 S	16 7	973·3	·961	·947307	89·6	+ 0·7
Mar. 16	1 37 46 S	27 4	966·3	·890	·931736	83·7	− 0·3
April 16	9 51 50 N	38 34	958·1	·782	·917956	75·5	+ 0·1
May 16	19 9 54 N	47 52	951·1	·671	·903591	67·3	+ 0·1
June 16	23 19 59 N	52 2	946·7	·615	·896241	63·3	0·0
July 16	21 20 34 N	49 3	946·4	·655	·895673	65·8	+ 1·5
Aug. 16	13 40 30 N	42 22	950·2	·739	·902880	71·8	+ 1·3
Sept. 16	2 56 4 N	31 38	957·0	·851	·915849	80·0	+ 1·7
Oct. 16	8 59 27 S	19 43	965·4	·941	·931997	87·2	+ 2·1
Nov. 16	19 34 16 S	10 8	973·0	·984	·946729	91·3	+ 1·4
Dec. 16	23 20 57 S	5 21	977·5	·996	·955506	92·7	0·0

TABLE 30.

Some Other Values in the Cosine Formula.

Mean Date.	*Bloemfontein.* Z	y	M	C − O = y − M	*Aliwal North.* Z		M	C − O = y − M
	° ′	°	°	°	° ′	°	°	°
Jan. 16	8 12	86·3	86·3	0·0	9 48	83·5	83·3	+ 0·2
Feb. 15	16 32	84·2	85·3	− 1·1	18 6	81·4	82·9	− 1·5
Mar. 16	27 29	79·6	80·7	− 1·1	29 3	76·8	78·3	− 1·5
April 16	38 59	73·3	75·0	− 1·7	40 33	70·6	72·1	− 1·5
May 16	48 17	67·0	67·5	− 0·5	49 53	64·4	65·6	−1·2
June 16	52 27	64·1	64·1	0·0	54 1	61·5	61·5	0·0
July 16	49 28	65·9	64·2	+ 1·7	51 2	63·4	61·7	+ 1·7
Aug. 16	42 47	70·5	69·1	+ 1·4	44 21	67·8	66·1	+ 1·7
Sept. 16	32 3	76·9	75·6	+ 1·3	33 37	74·0	72·4	+ 1·6
Oct. 16	20 8	82·3	80·6	+ 1·7	21 42	79·5	77·2	+ 2·3
Nov. 16	10 33	85·4	83·5	+ 1·9	12 7	82·7	80·4	+ 2·3
Dec. 16	5 46	86·6	86·6	0·0	7 20	83·8	83·8	0·0

TABLE 31.

Monthly Variations in the Cosine Formula.

	Kimberley. Formular Variation.	*Kimberley.* Observed Variation.	*Bloemfontein.* Formular Variation.	*Bloemfontein.* Observed Variation.
	°	°	°	°
Jan.–Feb.	—2·7	—3·1	—2·1	—1·0
Feb.–Mar.	—5·9	—4·9	—4·6	—4·6
Mar.–April	—8·2	—8·6	—6·3	—5·7
April–May	—8·2	—8·0	—6·3	—7·5
May–June	—4·0	—4·1	—2·9	—3·4
June–July	+2·5	+1·0	+1·8	+0·1
July–Aug.	+6·0	+6·2	+4·6	+4·9
Aug.–Sept.	+8·2	+7·8	+6·4	+6·5
Sept.–Oct.	+7·2	+6·8	+5·4	+5·0
Oct.–Nov.	+4·1	+4·8	+3·1	+2·9
Nov.–Dec.	+1·4	+2·8	+1·2	+3·1
Dec.–Jan.	—0·4	—0·7	—0·3	—0·3

	Aliwal North. Formular Variation.	*Aliwal North.* Observed Variation.	*Mean Table-Land.* Formular Variation.	*Mean Table-Land.* Observed Variation.
	°	°	°	°
Jan.–Feb.	—2·1	—0·4	—2·3	—1·5
Feb.–Mar.	—4·6	—4·6	—5·0	—4·7
Mar.–April	—6·2	—6·2	—6·9	—6·8
April–May	—6·2	—6·5	—6·9	—7·3
May–June	—2·9	—4·1	—3·3	—3·9
June–July	+1·9	+0·2	+2·1	+0·4
July–Aug.	+4·4	+4·4	+5·0	+5·2
Aug.–Sept.	+6·2	+6·3	+6·9	+6·9
Sept.–Oct.	+5·5	+4·8	+6·0	+5·5
Oct.–Nov.	+3·2	+3·2	+3·5	+3·6
Nov.–Dec.	+1·1	+3·4	+1·2	+3·1
Dec.–Jan.	—0·3	—0·5	—0·3	—0·5

TABLE 32.

Some Hourly Values in the Cosine Formula.

1. *Winter:* June and July.

	Z		*y* (diurnal)	*y* (annual)	Observed Temp.
	°	′	°	°	°
VII.	88	49	37·0	24·1	37·0
VIII.	77	34	44·4	36·2	41·6
IX.	67	31	51·7	47·9	49·4
X.	59	17	56·9	56·4	54·7
XI.	53	45	60·2	61·7	58·9
Noon	51	46	61·4	63·5	61·4

2. *Summer:* December and January.

	Z		*y* (diurnal)	*y* (annual)	Observed Temp.
	°	′	°	°	°
VII.	66	37	67·7	50·6	67·7
VIII.	53	44	73·5	64·3	72·3
IX.	40	39	78·6	76·0	76·6
X.	27	30	82·4	85·0	80·3
XI.	14	23	84·8	90·6	83·6
Noon	5	34	85·6	92·5	85·6

TABLE 33.

Comparative Table of Maximum Temperatures.

1. *Coast Stations.*

	Durban.	East London.	Port Elizabeth.	Mossel Bay.	Cape L'Agulhas	Simonstown.	Average.
	°	°	°	°	°	°	°
Jan.	85·6	76·3	75·7	76·0	72·9	78·9	77·6
Feb.	85·7	75·9	76·1	75·8	72·9	78·5	77·5
Mar.	84·4	75·2	74·7	74·1	70·9	77·3	76·1
April	81·8	73·6	71·8	71·0	67·4	71·7	72·9
May	78·5	71·2	69·5	68·5	65·0	67·5	70·0
June	76·8	71·0	68·0	67·8	62·7	64·2	68·4
July	76·1	69·2	65·8	65·3	60·8	63·3	66·7
Aug.	76·4	69·2	66·3	65·8	61·1	64·0	67·1
Sept.	77·2	69·5	66·6	66·6	62·7	67·0	68·3
Oct.	78·2	70·4	68·3	68·3	64·8	69·5	69·9
Nov.	82·2	72·6	70·8	70·9	67·9	72·1	72·7
Dec.	84·4	75·7	73·6	73·8	70·9	75·6	75·7
Year	80·6	72·5	70·6	70·3	66·6	70·8	71·9

2. *Middle Stations.*

	Umtata.	Queenstown.	Somerset East.	Graaff Reinet.	Prince Albert.	Worcester.	Average.
	°	°	°	°	°	°	°
Jan.	79·1	82·9	84·4	88·0	82·6	86·1	83·9
Feb.	80·1	82·1	84·0	87·6	79·6	86·1	83·2
Mar.	79·1	79·0	80·3	82·8	73·0	83·7	79·7
April	75·8	74·0	75·2	76·2	69·1	75·2	74·2
May	71·7	67·8	69·5	71·0	64·4	68·5	68·8
June	70·0	65·0	67·1	68·6	61·9	64·6	66·2
July	70·0	64·5	66·4	67·2	61·5	63·2	65·5
Aug.	72·2	66·9	69·7	69·7	64·9	65·0	68·1
Sept.	73·1	72·6	73·1	74·9	70·8	69·7	72·4
Oct.	73·3	76·2	76·2	79·1	73·9	74·0	75·5
Nov.	77·6	80·1	79·3	82·6	80·0	79·3	79·8
Dec.	79·4	82·3	81·9	86·7	81·6	83·1	82·5
Year	75·1	74·4	75·6	77·9	71·9	74·9	75·0

3. *Table-Land Stations.*

	Kimberley.	Bloemfontein.	Aliwal North.	Philippolis.	Average.
	°	°	°	°	°
Jan.	92·0	86·3	83·3	83·9	86·4
Feb.	88·9	85·3	82·9	82·2	84·8
Mar.	84·0	80·7	78·3	76·9	80·0
April	75·4	75·0	72·1	69·8	73·1
May	67·4	67·5	65·6	62·9	65·9
June	63·3	64·1	61·5	59·6	62·1
July	64·3	64·2	61·7	60·6	62·7
Aug.	70·5	69·1	66·1	65·5	67·8
Sept.	78·3	75·6	72·4	71·7	74·5
Oct.	85·1	80·8	77·2	76·2	79·8
Nov.	89·9	83·5	80·4	79·8	83·4
Dec.	92·7	86·6	83·8	82·5	86·4
Year	79·3	76·6	73·8	72·6	75·6

TABLE 34.

COMPARATIVE TABLE OF MINIMUM TEMPERATURES.

1. *Coast Stations.*

	Durban.	East London.	Port Elizabeth.	Mossel Bay.	Cape L'Agulhas.	Simons-town.	Average.
	°	°	°	°	°	°	°
Jan.	67·7	64·3	63·9	63·9	62·6	63·8	64·4
Feb.	68·6	64·7	64·2	64·0	63·2	64·2	64·8
Mar.	67·2	62·9	62·0	61·9	61·2	62·4	62·9
April	63·2	59·0	57·9	57·4	57·6	58·3	58·9
May	58·5	53·5	53·9	53·6	54·2	55·2	54·8
June	54·7	50·3	51·3	50·8	51·5	53·0	51·9
July	54·0	48·3	49·0	48·7	50·0	51·5	50·2
Aug.	56·5	51·3	50·9	49·9	50·6	51·7	51·8
Sept.	58·5	54·6	53·2	52·2	52·2	53·4	54·0
Oct.	61·6	57·3	55·8	55·2	55·2	56·1	56·9
Nov.	64·3	59·9	58·5	57·9	57·8	58·8	59·5
Dec.	66·2	62·9	61·5	61·2	60·3	61·4	62·3
Year	61·8	57·4	56·8	56·4	56·4	57·5	57·7

2. *Middle Stations.*

	Umtata.	Queens-town.	Somerset East.	Graaff Reinet.	Prince Albert.	Wor-cester.	Average.
	°	°	°	°	°	°	°
Jan.	60·0	58·0	57·3	58·2	59·8	58·5	58·6
Feb.	60·3	58·7	58·1	60·0	54·7	59·6	58·6
Mar.	58·6	55·6	56·1	56·8	51·1	57·3	55·9
April	51·7	48·7	50·5	50·3	47·4	51·2	50·0
May	42·9	41·5	45·1	44·4	44·1	46·7	44·1
June	36·9	38·0	41·9	40·1	40·4	43·0	40·0
July	36·2	36·3	39·7	36·9	38·9	40·3	38·0
Aug.	42·0	40·1	42·5	39·8	40·6	42·3	41·2
Sept.	47·3	44·9	45·4	45·2	46·3	46·2	45·9
Oct.	51·6	49·0	48·4	49·6	51·1	49·7	49·9
Nov.	55·4	52·9	51·9	53·2	57·6	53·2	54·0
Dec.	58·4	56·1	55·2	57·0	59·0	56·2	57·0
Year	50·1	48·3	49·3	49·6	49·2	50·4	49·5

3. *Table-Land Stations.*

	Kimberley.	Bloemfontein.	Aliwal North.	Philippolis.	Average.
	°	°	°	°	°
Jan.	60·6	59·2	55·9	56·5	58·1
Feb.	60·1	58·7	55·9	56·9	57·9
Mar.	57·7	54·4	52·0	54·2	54·6
April............	50·5	46·5	43·7	45·9	46·7
May	42·4	37·6	36·0	38·2	38·6
June	37·5	31·7	29·4	32·2	32·7
July	36·3	30·0	28·2	32·1	31·7
Aug.	40·7	35·7	33·9	36·4	36·7
Sept.	45·0	42·6	40·2	40·7	42·1
Oct.	51·8	48·7	46·0	46·2	48·2
Nov.	55·5	53·3	50·0	51·7	52·6
Dec.	59·3	57·1	54·5	54·8	56·4
Year	49·8	46·3	43·8	45·5	46·4

TABLE 35.

Comparative Table of Mean Temperature.

1. *Coast Stations.*

	Durban.	East London.	Port Elizabeth.	Mossel Bay.	Cape L'Agulhas.	Simonstown.	Average.
	°	°	°	°	°	°	°
Jan.	76·6	70·3	69·8	70·0	67·7	71·3	71·0
Feb.	77·1	70·3	70·2	69·9	68·0	71·4	71·2
Mar.	75.8	69·0	68·3	68·0	66·0	69·8	69·5
April	72·5	66·3	64·9	64·2	62·5	65·0	65·9
May	68·5	62·3	61·7	61·0	59·6	61·4	62·4
June	65·7	60·7	59·6	59·3	57·1	58·6	60·2
July	65·0	58·7	57·4	57·0	55·4	57·4	58·5
Aug.	66·5	60·3	58·6	57·8	55·9	57·8	59·5
Sept.	67·9	62·1	59·9	59·4	57·5	60·2	61·2
Oct.	69·9	63·8	62·0	61·8	60·0	63·8	63·5
Nov.	73·2	66·2	64·6	64·4	62·8	65·5	66·1
Dec.	75·3	69·3	67·5	57·5	65·6	68·5	69·0
Year	71·2	65·0	63·7	63·4	61·5	64·2	64·8

2. *Middle Stations.*

	Umtata.	Queenstown.	Somerset East.	Graff Reinet.	Prince Albert.	Worcester.	Average.
	°	°	°	°	°	°	°
Jan.	69·5	70·5	70·8	73·1	71·2	72·3	71·2
Feb.	70·2	70·4	71·1	73·8	67·2	72·9	70·9
Mar.	68·8	67·3	68·2	69·8	62·0	70·5	67·8
April	63·7	61·3	62·8	63·2	58·2	63·2	62·1
May	57·3	54·6	57·3	57·7	54·3	57·6	56·5
June	53·5	51·5	54·5	54·3	51·1	53·8	53·1
July	53·1	50·4	53·1	52·1	50·2	51·7	51·8
Aug.	57·1	53·5	56·1	54·8	52·8	53·7	54·7
Sept.	60·2	58·8	59·2	60·0	58·5	58·0	59·1
Oct.	62·5	62·6	62·3	64·3	62·5	61·8	62·7
Nov.	66·5	66·5	65·6	67·9	68·8	66·3	66·9
Dec.	68·9	69·2	68·5	71·8	70·3	69·7	69·7
Year	62·6	61·3	62·5	63·8	60·5	62·7	62·2

3. *Table-Land Stations.*

	Kimberley.	Bloemfontein.	Aliwal North.	Philippolis.	Average.
	°	°	°	°	°
Jan.	76·3	72·8	69·6	70·2	72·2
Feb.	74·5	72·0	69·4	69·6	71·4
Mar.	70·8	67·5	65·2	65·5	67·3
April	62·9	60·7	57·9	57·9	59·9
May	54·9	52·6	50·8	50·5	52·2
June	50·4	47·9	45·4	45·9	47·4
July	50·3	47·1	45·0	46·3	47·2
Aug.	55·6	52·4	50·0	51·0	52·3
Sept.	61·6	59·1	56·3	56·2	58·3
Oct.	68·4	64·8	61·6	61·2	64·0
Nov.	72·8	68·4	65·1	65·7	68·0
Dec.	76·0	71·8	69·2	68·7	71·4
Year	64·5	61·5	58·8	59·0	61·0

TABLE 36.

Comparative Table of Range of Temperature.

1. *Coast Stations.*

	Durban.	East London.	Port Elizabeth.	Mossel Bay.	Cape L'Agulhas.	Simonstown.	Average.
	°	°	°	°	°	°	°
Jan.	17·8	12·0	11·8	12·1	10·3	15·1	13·2
Feb.	17·1	11·2	11·9	11·8	9·7	14·3	12·7
Mar.	17·2	12·3	12·7	12·2	9·7	14·9	13·2
April	18·6	14·6	13·9	13·6	9·8	13·4	14·0
May	20·0	17·7	15·6	14·9	10·8	12·3	15·2
June	22·1	20·7	16·7	17·0	11·2	11·2	16·5
July	22·1	20·9	16·8	16·6	10·8	11·8	16·5
Aug.	19·9	17·9	15·4	15·9	10·5	12·3	15·3
Sept.	18·6	14·9	13·4	14·4	10·5	13·6	14·2
Oct.	16·6	13·1	12·5	13·1	9·6	13·4	13·0
Nov.	17·9	12·7	12·3	13·0	10·1	13·3	13·2
Dec.	18·2	12·8	12·1	12·6	10·6	14·2	13·4
Year	18·8	15·1	13·8	13·9	10·2	13·3	14·2

2. *Middle Stations.*

	Umtata.	Queenstown.	Somerset East.	Graff Reinet.	Prince Albert.	Worcester.	Average.
	°	°	°	°	°	°	°
Jan.	19·1	24·9	27·1	29·8	22·8	27·6	25·2
Feb.	19·8	23·4	25·9	27·6	24·9	26·5	24·7
Mar.	20·5	23·4	24·2	26·0	21·9	26·4	23·7
April	24·1	25·3	24·7	25·9	21·7	24·0	24·3
May	28·8	26·3	24·4	26·6	20·3	21·8	24·7
June	33·1	27·0	25·2	28·5	21·5	21·6	26·2
July	33·8	28·2	26·7	30·3	22·6	22·9	27·4
Aug.	30·2	26·8	27·2	29·9	24·3	22·7	26·9
Sept.	25·8	27·7	27·7	29·7	24·5	23·5	26·5
Oct.	21·7	27·2	27·8	29·5	22·8	24·3	25·5
Nov.	22·2	27·2	27·4	29·4	22·4	26·1	25·8
Dec.	21·0	26·2	26·7	29·7	22·6	26·9	25·5
Year	25·1	26·1	26·3	28·3	22·7	24·5	25·5

3. *Table-Land Stations.*

	Kimberley.	Bloemfontein.	Aliwal N.	Philippolis.	Average.
	°	°	°	°	°
Jan.	31·4	27·1	27·4	27·4	28·3
Feb.	28·7	26·6	27·0	25·3	26·9
Mar.	26·3	26·3	26·3	22·7	25·4
April	24·9	28·5	28·4	23·9	26·4
May	25·0	30·1	29·6	24·7	27·4
June	25·8	32·4	32·1	27·4	29·4
July	28·0	34·2	33·5	28·5	31·0
Aug.	29·8	33·4	32·2	29·1	31·1
Sept.	33·3	33·0	32·2	31·0	32·4
Oct.	33·3	32·1	31·2	30·0	31·7
Nov.	34·1	30·2	30·4	28·1	30·7
Dec.	33·4	29·5	29·3	27·7	30·0
Year	29·5	30·3	30·0	27·1	29·2

TABLE 37.

COMPARATIVE TEMPERATURES OF MOUNT ABU AND KARACHI.

	Mount Abu.			*Karachi.*		
	Max.	Min.	Mean.	Max.	Min.	Mean.
	°	°	°	°	°	°
Jan.	68	52	58	77	54	65
Feb.	69	53	60	79	57	68
Mar.	79	62	69	86	67	76
April	85	67	75	89	72	80
May	89	71	79	93	79	85
June	84	69	75	93	82	87
July	75	66	70	90	81	84
Aug.	73	65	68	88	79	82
Sept.	76	65	69	88	77	82
Oct.	79	64	70	91	72	80
Nov.	74	57	64	86	62	72
Dec.	70	53	59	79	56	67
Year			68			77

TABLE 38.

COMPARATIVE BAROMETRIC PRESSURES AT DURBAN AND KIMBERLEY (S. AFRICA), AND AT KARACHI AND MOUNT ABU (INDIA).

	Durban.	Kimberley.	Diff.	Karachi.	Mount Abu.	Diff.
	inches	inches	inches	inches	inches	inches
Jan.	29·990	25·927	4·063	30·02	26·15	3·87
Feb.	30·003	25·963	4·040	29·98	26·10	3·88
Mar.	30·050	26·011	4·039	29·88	26·08	3·80
April	30·115	26·070	4·045	29·79	26·03	3·76
May	30·164	26·111	4·053	29·65	25·96	3·69
June	30·216	26·163	4·053	29·52	25·86	3·66
July	30·235	26·169	4·066	29·49	25·82	3·67
Aug.	30·200	26·109	4·091	29·57	25·86	3·71
Sept.	30·138	26·055	4·083	29·69	25·96	3·73
Oct.........	30·101	25·998	4·103	29·86	26·09	3·79
Nov.	30·029	25·968	4·061	29·96	26·13	3·83
Dec.	30·001	25·940	4·061	30·03	26·14	3·89
Year	30·103	26·040	4·063	29·79	26·02	3·77
Range of Monthly Mean	0·245	0·242		0·54	0·33	

TABLE 39.

Comparative Pressures at Selected Stations.

	Durban. 1890–9 D	Umtata. 1890–9 U	Aliwal N. 1890–9 A	Philippolis. 1891–9 P	D—U 1890–9	D—A 1890–9	D—P 1891–9
	inches	inches	inches	inches	inches	inches	inches
Jan.	30·006	27·602	25·676	25·491	2·404	4·330	4·515
Feb.	30·036	27·628	25·710	25·537	2·408	4·326	4·508
Mar.	30·077	27·664	25·743	25·573	2·413	4·334	4·501
April	30·153	27·710	25·805	25·613	2·443	4·348	4·541
May	30·208	27·762	25·841	25·660	2·446	4·367	4·552
June	30·264	27·812	25·895	25·712	2·452	4·369	4·546
July	30·272	27·814	25·889	25·714	2·458	4·383	4·562
Aug.	30·248	27·783	25·848	25·672	2·465	4·400	4·579
Sept.	30·180	27·728	25·794	25·611	2·452	4·386	4·563
Oct.	30·129	27·681	25·734	25·558	2·448	4·395	4·562
Nov.	30·060	27·634	25·700	25·525	2·426	4·360	4·524
Dec.	30·030	27·613	25·681	25·511	2·417	4·349	4·518
Year	30·139	27·703	25·777	25·598	2·436	4·362	4·540
Range of Monthly Mean	0·266	0·212	0·219	0·223	0·052	0·047	0·047

TABLE 40.

Increases of Barometric Pressure Month by Month.

	Durban.	Umtata.	Aliwal N.	Philippolis.	Kimberley.
	inches	inches	inches	inches	inches
J—F	+ ·030	+ ·026	+ ·046	+ ·046	+ ·036
F—M ...	+ ·041	+ ·036	+ ·033	+ ·036	+ ·048
M—A ...	+ ·076	+ ·046	+ ·062	+ .040	+ ·059
A—M ...	+ ·055	+ ·052	+ ·036	+ ·047	+ ·041
M—J	+ ·056	+ ·050	+ ·054	+ ·052	+ ·052
J—J	+ ·008	+ ·002	— ·006	+ ·002	+ ·006
J—A	— ·024	— ·031	— ·041	— ·042	— ·060
A—S	— ·068	— ·055	— ·054	— ·061	— ·054
S—O	— ·051	— ·047	— ·060	— ·053	— ·057
O—N	— ·069	— ·047	— ·034	— ·033	— ·030
N—D	— ·030	— ·021	— ·019	— ·014	— ·018
D—J	— ·024	— ·011	— ·005	— ·020	— ·013

TABLE 41.

Temperatures and Pressures Characteristic of the Hot Winds of Durban.

Durban.

A. *Temperatures.*

	Aug. 23, 1897.	Sept. 17, 1896.	Sept. 21, 1896.	Sept. 21, 1890.	Oct. 3, 1896.	Dec. 26, 1899.	Average.
	°	°	°	°	°	°	°
3rd day before ...	− 4·9	+ 0·3	+ 2·7	− 5·3	− 2·3	+ 0·4	− 1·5
2nd ,, ,, ...	+ 0·7	+ 3·0	+ 3·0	+ 5·6	+ 2·1	+ 4·9	+ 3·2
1st ,, ,, ...	+ 5·1	+ 15·3	+ 2·9	+ 6·4	+ 6·1	− 0·3	+ 5·9
	+ 23·8	+ 20·3	+ 24.7	+ 25·7	+ 28·1	+ 15·5	+ 23·0
1st day after......	− 2·0	+ 2·7	+ 4·4	− 11·5	+ 6·2	+ 6·3	+ 1·0
2nd ,, ,, ...	− 8·4	+ 3·0	+ 3·6	+ 4·3	+ 7·2	− 1·7	+ 1·3
3rd ,, ,, ...	− 1·6	+ 2·9		− 1·9	+ 0·4	− 2·4	− 0·5

B. *Pressures.*

	Aug. 23, 1897.	Sept. 17, 1896.	Sept. 21, 1896.	Sept. 21, 1890.	Oct. 3, 1896.	Dec. 26, 1899.	Average.
	inch.	inch.	inch.	inch.	inch.	inch.	inch.
3rd day before ...	+ ·147	+ ·039	+ ·010	+ ·315	− ·133	+ ·179	+ ·093
2nd ,, ,, ...	+ ·051	+ ·095	+ ·153	+ ·028	+ ·034	+ ·076	+ ·073
1st ,, ,, ...	− ·150	− ·121	+ ·095	− ·036	− ·009	+ ·160	− ·009
	− ·242	− ·158	− ·170	− ·066	− ·214	− ·163	− ·169
1st day after......	+ ·054	+ ·010	+ ·008	+ ·240	+ ·014	− ·006	+ ·053
2nd ,, ,, ...	+ ·125	+ ·153	− ·199	+ ·152	− ·112	− ·030	+ ·015
3rd ,, ,, ...	− ·035	+ ·095		+ ·115	+ ·009	− ·303	− ·024

Kimberley.

A. *Temperatures.*

	Aug. 23, 1897.	Sept. 17, 1896.	Sept. 21, 1896.	Sept. 21, 1890.	Oct. 3, 1896.	Dec. 26, 1899.	Average.
	°	°	°	°	°	°	°
3rd day before ...	+ 1·6	+ 15·1	+ 12·9	+ 2·1	− 0·8	+ 5·5	+ 6·1
2nd ,, ,, ...	+ 8·2	+ 13·6	+ 14·2	+ 7·5	+ 4·6	+ 9·2	+ 9·5
1st ,, ,, ...	+ 10·6	+ 9·8	+ 15·0	+ 5·4	+ 13·5	+ 5·0	+ 9·9
	+ 9·9	+ 14·6	+ 11·7	+ 5·6	+ 12·5	+ 0·6	+ 9·1
1st day after......	− 4·8	+ 12·9	+ 15·2	− 6·3	+ 14·4	− 6·4	+ 4·2
2nd ,, ,, ...	+ 5·9	+ 14·2	− 7·9	+ 1·8	+ 8·3	− 10·6	+ 2·0
3rd ,, ,, ...	+ 1·2	+ 15·0		+ 5·0	− 0·3	− 10·9	+ 2·0

B. *Pressures.*

	Aug. 23, 1897.	Sept. 17, 1896.	Sept. 21, 1896.	Sept. 21, 1890.	Oct. 3, 1896.	Dec. 26, 1899.	Average.
	inch.	inch.	inch.	inch.	inch.	inch.	inch.
3rd day before ...	+ ·054	+ ·026	+ ·100	+ ·130	+ ·035	+ ·169	+ ·086
2nd ,, ,, ...	+ ·017	+ ·070	+ ·114	+ ·098	+ ·078	+ ·208	+ ·098
1st ,, ,, ...	·000	+ ·100	+ ·108	+ ·026	− ·017	+ ·191	+ ·068
	− ·091	+ ·051	+ ·010	+ ·028	+ ·040	+ ·150	+ ·022
1st day after......	+ ·039	+ ·100	− ·074	+ ·102	+ ·039	+ ·081	+ ·048
2nd ,, ,, ...	+ ·023	+ ·114	− ·049	+ ·082	+ ·057	+ ·027	+ ·042
3rd ,, ,, ...	− ·049	+ ·108		+ ·045	+ ·075	− ·158	+ ·004

TABLE 42.

BAROMETER READINGS AT 32° F. DURING THE ANNUAL DEPRESSION OF JULY.

Durban, 9 a.m.

July	10	11	12	13	14	15	16	17	18
	inches	inches	inches	inches	inches	inches	inches	inches	inches
1885	30·485	30·452	30·273	30·291	30·352	30·083	29·970	30·485	30·448
6	·374	·085	·016	29·918	·323	·485	30·255	·159	·164
8	·150	·632	·537	30·194	·166	·042	·331	·478	·553
9	29·965	·120	·106	·094	·051	·276	·114	·390	·561
1890	30·517	·515	·425	·341	·324	·175	29·903	·211	·444
1	·445	·248	·264	·149	·105	·411	30·373	·388	·476
2	·258	·467	·619	·274	·042	29·983	·249	·508	·503
3	·354	·578	·487	·430	·251	30·304	·397	·383	·231
4	·054	·234	29·995	·225	·325	·398	·295	·204	·160
5	·090	·043	30·326	·152	·036	·147	·156	·174	·450
6	·277	·334	·440	·471	·380	·278	·093	·013	·448
7	·234	·196	·106	·095	29·834	·050	·268	·142	·082
8	·404	·312	·129	·154	30·012	·200	·052	·481	·424
1899	·497	·466	·304	·302	·222	·040	·248	·236	·289

Kimberley (*or Kenilworth*), 8 a.m.

1890	26·283	26·314	26·307	26·290	26·269	26·155	25·961	26·091	26·154
1	·294	·224	·190	·104	·057	·172	26·236	·284	·325
2	·272	·329	·370	·302	·125	25·934	·220	·394	·385
3	·296	·374	·389	·369	·271	26·200	·226	·245	·157
4	·129	·064	·129	·240	·274	·301	·289	·214	·178
5	·051	25·908	·004	25·966	25·986	25·987	·002	·194	·308
6	·208	26·217	·261	26·298	26·247	30·151	·045	·172	·317
7	·261	·213	·164	·056	25·896	·122	·207	·172	·128
8	·360	·319	·250	·236	26·173	·245	·177	·345	·405
9	·403	·356	·327	·283	·213	·155	·211	·240	·284
1900	·251	·292	·312	·325	·052	·148	·237	·226	·271

TABLE 43.

Comparative Mean July Pressures and Temperatures for a Single Station in each of the three Southern Continents.

A. *Pressure.* B. *Temperature.*

July	Kimberley.	Cordoba.	Adelaide.	Kimberley.	Cordoba.	Adelaide.
	inches	inches	inches	°	°	°
1	26·182	28·546±	30·187±	49.6	51·9±	51·5±
2	·190	28·537	30·206	50·6	52·2	52·0
3	·208	·532	·211	51·8	52·6	52·5
4	·213	·537	·164	52·0	52·4	52·7
5	·192	·559	·118	51·4	51·2	52·5
6	·174	·576	·098	50·1	50·1	51·7
7	·173	·587	·110	49·2	49·2	50·7
8	·187	·588	·124	48·9	48·8	50·4
9	·199	·597	·118	49·2	47·7	50·3
10	·200	·636	·131	49·4	46·7	50·2
11	·202	·671	·157	49·2	46·0	50·0
12	·192	·684	·203	49·4	46·4	50·1
13	·167	·649	·245	49·8	48·0	50·8
14	·137	·623	·270	48·8	49·8	50·9
15	·127	·601	·268	47·6	50·8	51·4
16	·157	·570	·257	45·7	51·5	51·5
17	·191	·568	·224	45·8	51·9	51·9
18	·218	·578	·189	46·9	52·8	51·6
19	·224	·565	·143	48·3	54·2	51·5
20	·214	·546	·111	49·5	55·1	51·0
21	·197	·549	·101	50·7	54·8	50·8
22	·176	·616	·131	52·1	53·2	50·8
23	·180	·659	·160	52·3	51·5	51·0
24	·195	·646	·199	52·2	51·7	51·5
25	·197	·604	·214	52·4	51·7	51·3
26	·181	·566	·231	52·9	52·6	51·3
27	·150	·561	·214	53·1	52·0	51·1
28	·122	·573	·196	53·5	52·4	51·3
29	·118	·580	·163	52·9	52·5	51·8
30	·133	·569	·151	52·0	54·3	51·8
31	·162	28·528±	30·155±	50·4	56·5±	51·3±

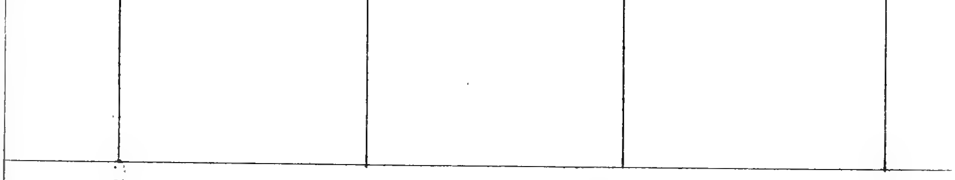


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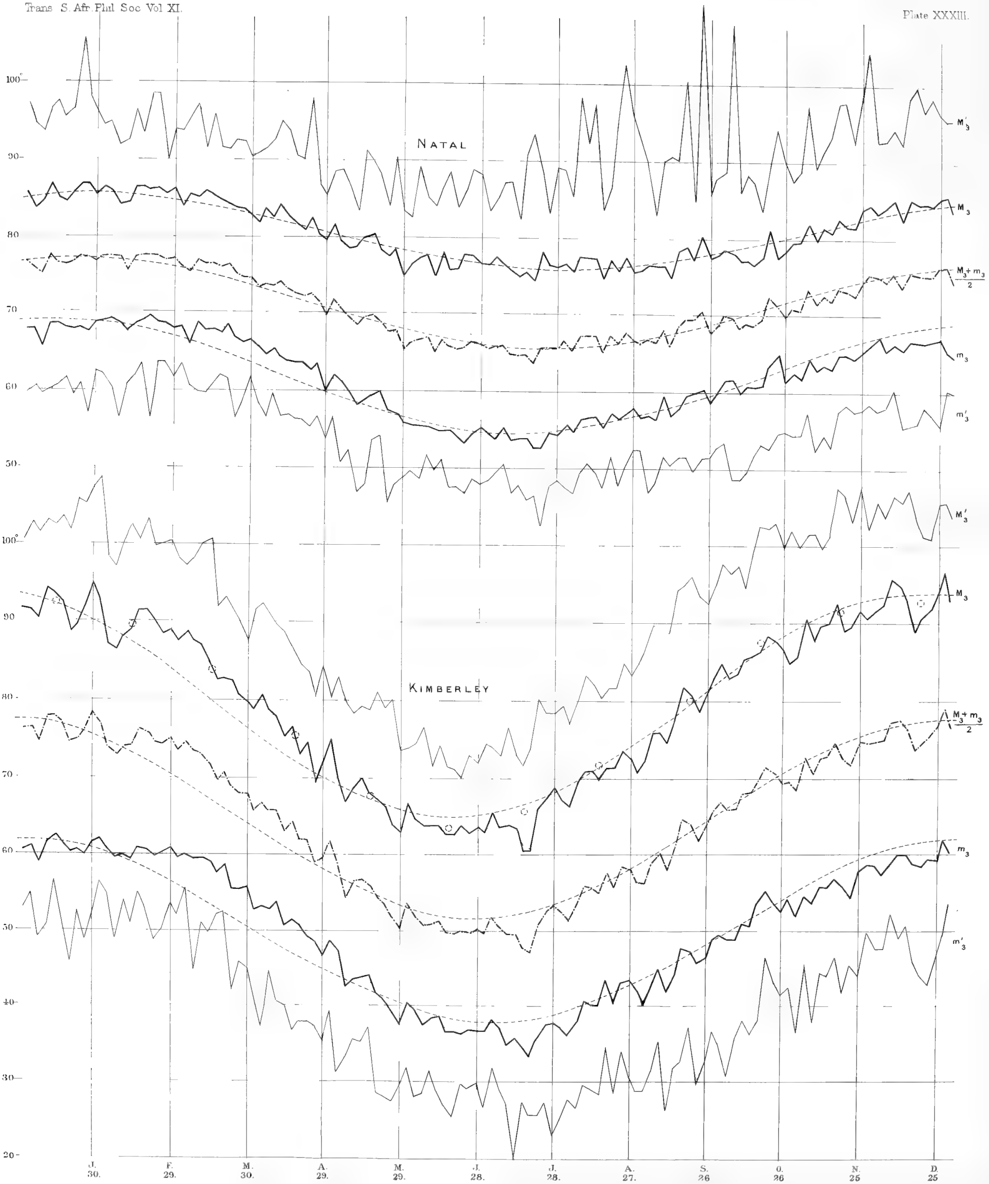
TABLE 43.

Comparative Mean July Pressures and Temperatures for a Single Station in each of the three Southern Continents.

A. *Pressure.* B. *Temperature.*

July	Kimberley.	Cordoba.	Adelaide.	Kimberley.	Cordoba.	Adelaide.
	inches	inches	inches	°	°	°
1	26·182	28·546 ±	30·187 ±	49.6	51·9 ±	51·5 ±
2	·190	28·537	30·206	50·6	52·2	52·0
3	·208	·532	·211	51·8	52·6	52·5
4	·213	·537	·164	52·0	52·4	52·7
5	·192	·559	·118	51·4	51·2	52·5
6	·174	·576	·098	50·1	50·1	51·7
7	·173	·587	·110	49·2	49·2	50·7
8	·187	·588	·124	48·9	48·8	50·4
9	·199	·597	·118	49·2	47·7	50·3
10	·200	·636	·131	49·4	46·7	50·2
11	·202	·671	·157	49·2	46·0	50·0
12	·192	·684	·203	49·4	46·4	50·1
13	·167	·649	·245	49·8	48·0	50·8
14	·137	·623	·270	48·8	49·8	50·9
15	·127	·601	·268	47·6	50·8	51·4
16	·157	·570	·257	45·7	51·5	51·5
17	·191	·568	·224	45·8	51·9	51·9
18	·218	·578	·189	46·9	52·8	51·6
19	·224	·565	·143	48·3	54·2	51·5
20	·214	·546	·111	49·5	55·1	51·0
21	·197	·549	·101	50·7	54·8	50·8
22	·176	·616	·131	52·1	53·2	50·8
23	·180	·659	·160	52·3	51·5	51·0
24	·195	·646	·199	52·2	51·7	51·5
25	·197	·604	·214	52·4	51·7	51·3
26	·181	·566	·231	52·9	52·6	51·3
27	·150	·561	·214	53·1	52·0	51·1
28	·122	·573	·196	53·5	52·4	51·3
29	·118	·580	·163	52·9	52·5	51·8
30	·133	·569	·151	52·0	54·3	51·8
31	·162	28·528 ±	30·155 ±	50·4	56·5 ±	51·3 ±



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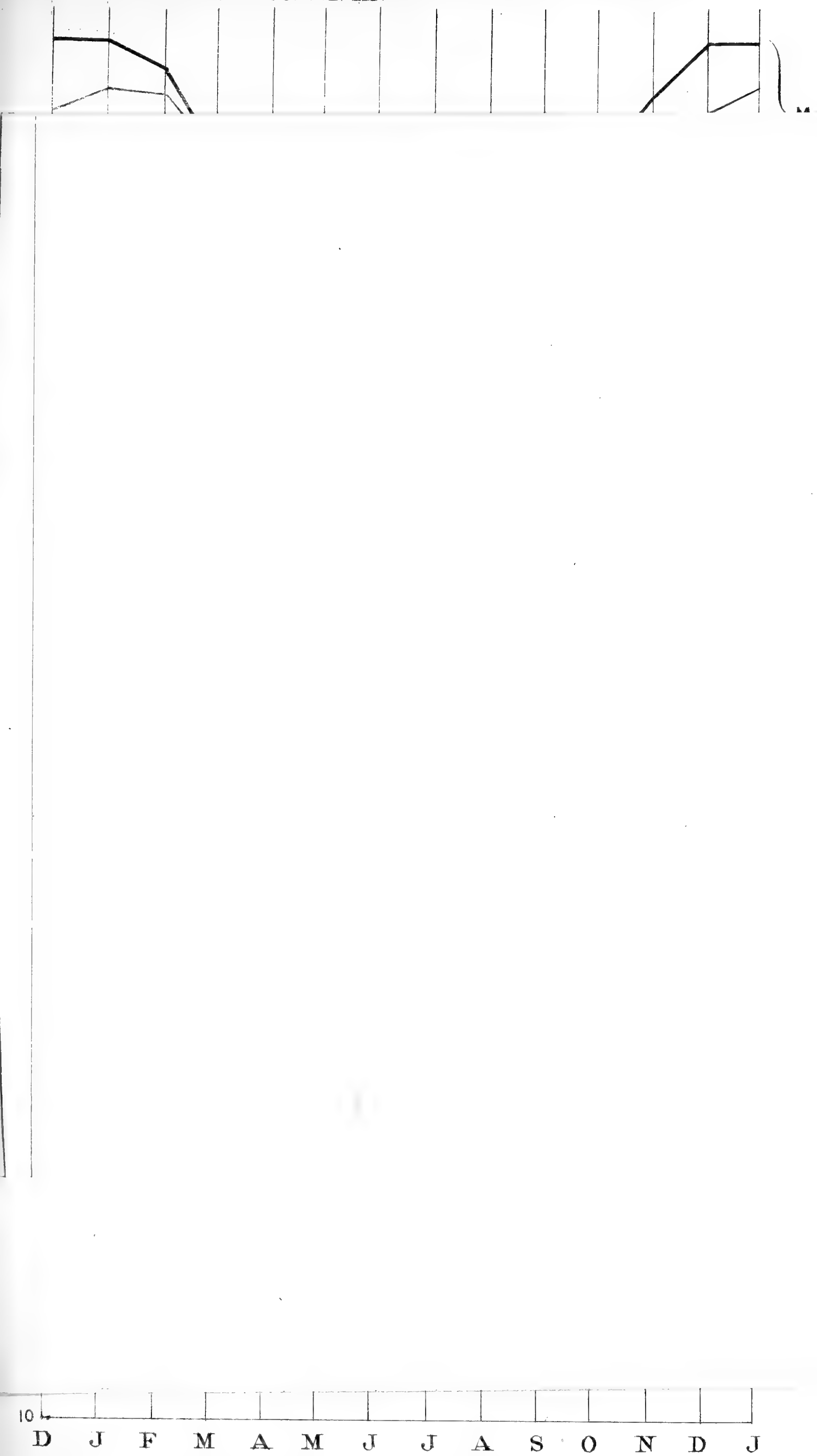

Table-Land Stations.
Middle ,,
Coast ,,

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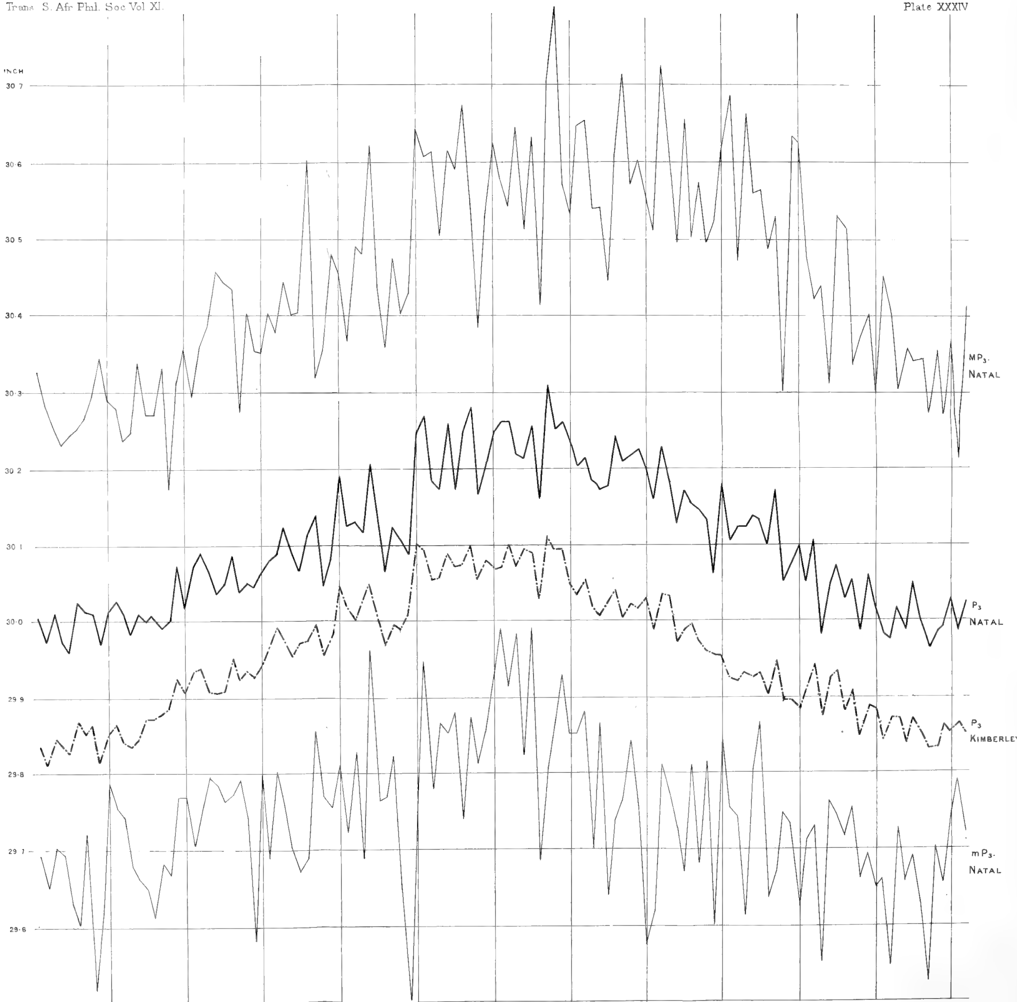

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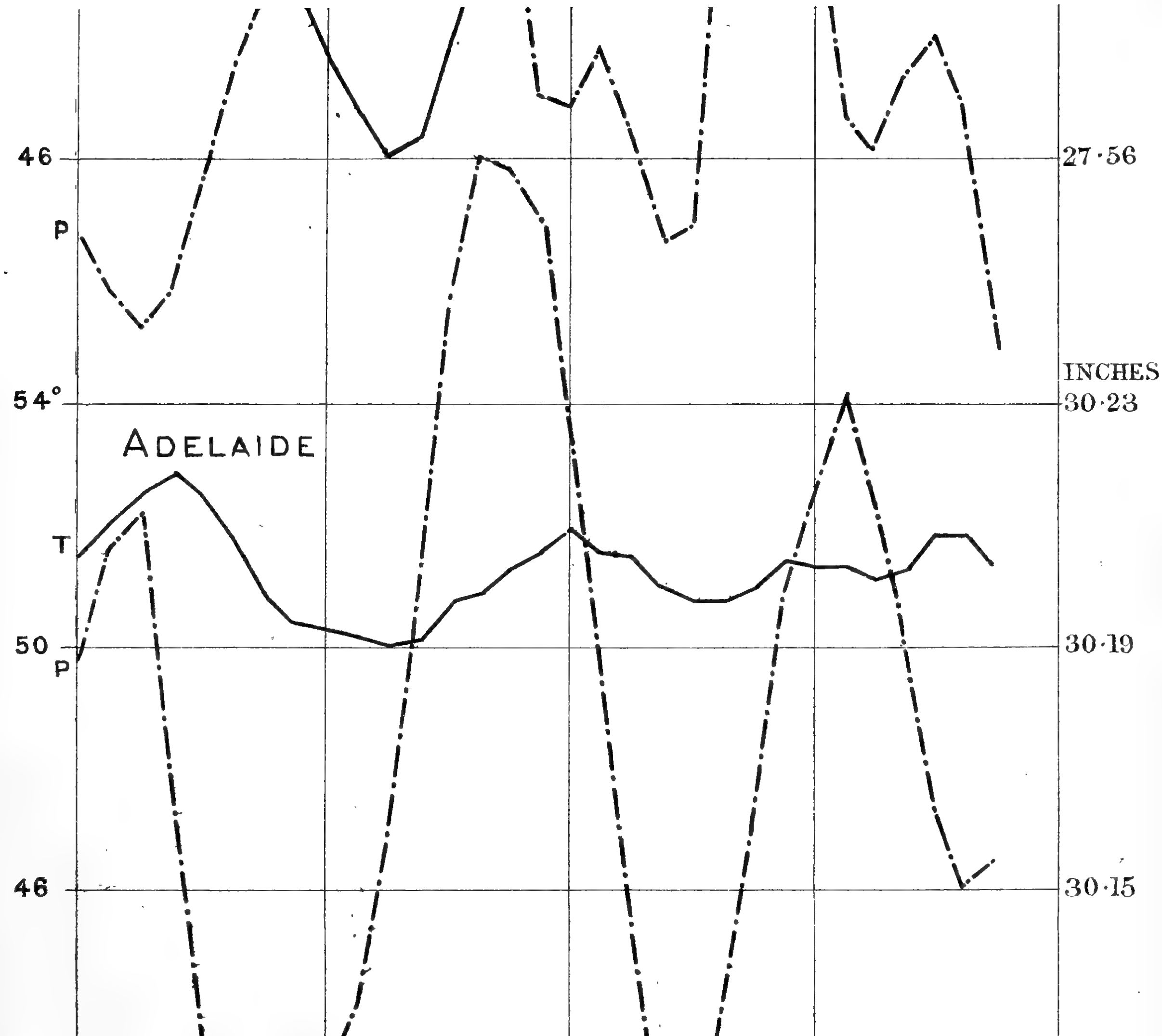

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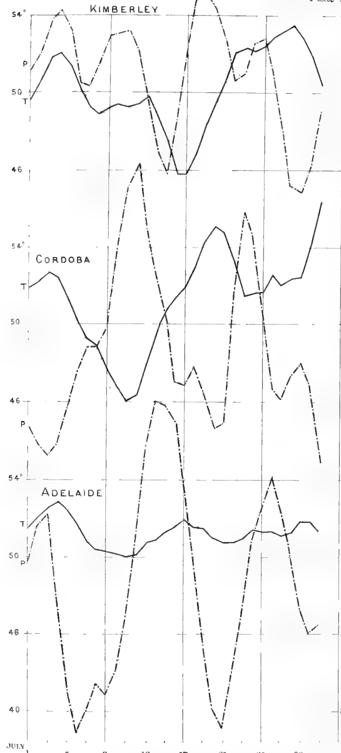

West, Newman lith.

J. R. SUTTON. PRESSURE AND TEMPERATURE RESULTS

ON THE SOUTH AFRICAN *THERAPHOSIDÆ*, OR "BAVIAAN" SPIDERS, IN THE COLLECTION OF THE SOUTH AFRICAN MUSEUM.

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The South African species of *Theraphosidæ* * were until recently comprised in the single genus *Harpactira*. In 1897 two new genera were recognised by Pocock and two more are added in this paper. These five genera may be distinguished as follows :—

a. Chelicerae without scopulæ on the sides .. .. *Harpactirella*, nov.
b. Cheliceræ with a thick scopula of feathery hairs on the outer surface above.
  a^1. Cheliceræ with a row of modified stridulating bristles extending obliquely or horizontally across the naked area on the lower part of the outer surface ; inner surface with a scopula above .. .. *Harpactira*, Auss.
  b^1. Cheliceræ without a row of stridulating bristles on the outer surface and without a scopula on the inner surface.
    a^2. Thoracic fovea nearly circular, enclosing a central tubercle or large horn .. .. *Ceratogyrus*, Poc.
    b^2. Thoracic fovea normal, transverse or procurved.
      a^3. Outer surface of cheliceræ with a strong transverse impression posteriorly. Fovea strongly procurved .. .. *Cœlogenium*, nov.
      b^3. Outer surface of cheliceræ without a strong posterior impression. Fovea at most slightly procurved .. .. .. *Pterinochilus*, Poc.

* For the information of collectors I may mention that these comprise the medium-sized and large, hairy, four-lunged spiders, generally known in South African Dutch as the "Baviaan Spinnekop" (Baboon Spider) and locally also as the "Tarantula" and "Monkey-fingered Spider," from the resemblance of the padded feet to the fingers of a monkey. They may be known from other four-lunged spiders, such as the Trap-door Spiders, &c., by having the tips of the legs, as well as the under surface of the two distal leg joints covered with a dense pad of short iridescent hairs. Another characteristic of these spiders is that when attacked they raise their front legs and jaws in a threatening manner and face their enemy.

Gen. HARPACTIRA, Auss.

1. Harpactira atra (Latr.).

1832. *Mygale atra*, Latreille, Nouv. Ann. Mus. d'hist. nat., *v.* 1, p. 70.

1837. *M. funebra*, Walckenaer, Ins. apt., *v.* 1, p. 226, ♂ and ♀ from "Cape of Good Hope."

1842. *M. coracina*, C. L. Koch, Arach., *v.* 9, p. 37, f. 714, ♂ from "Cape of Good Hope."

1842. *M. funebris*, C. L. Koch, ibid., p. 81, f. 742 and 743, ♀ and juv. from "Cape of Good Hope."

1897. *Harpactira atra*, Pocock, P.Z.S., 1897, p. 749, ♂ and ♀ from Simons Town, ♂ from Zululand, juv. from Worcester.

The Museum possesses the following specimens:—

(*a*) Thirteen ♂ and a number of ♀ and juv. from various parts of the Cape Peninsula.

♂. *Colour.*—Limbs and carapace black or nearly so, more rarely chestnut-brown; the hairs on the legs olivaceous black (olive-brown in brown individuals), the long hairs often brownish distally; the hairs on the carapace, including those at the margins, uniformly olivaceous black (olivaceous in brown individuals); the under coat of shorter hairs on the abdomen black (olive-brown in brown individuals), the middle coat dense, composed of stiff black bristles, the outer coat of long foxy-red hairs.

Carapace as long as the metatarsus together with from $\frac{1}{3}$ to slightly over $\frac{2}{5}$ of the tarsus of fourth leg, and as long as the tibia together with $\frac{5}{6}$–$\frac{8}{9}$ of the metatarsus of first leg.

Tibia of first leg short and thick, $2\frac{3}{4}$–3 times as long as high in the middle, its length mostly slightly less than, but sometimes equal to, that of the metatarsus and generally about equal to the distance from the centre of the fovea to the hind margin of the ocular tubercle, rarely greater or considerably less than this distance, at any rate not exceeding the distance from the fovea to the middle of the ocular tubercle. *Metatarsus* only slightly curved, its length equal to the distance from the fovea to some point on the ocular tubercle.

Bulb of pedipalp with the process gradually tapering from the stout base to the slender, subulate, distal part, which is terete and shows scarcely any or no sigmoid flexure.

Posterior spinners short, the apical segment obtusely conical in form (when not grooved on the under side), equal to or a little longer than the penultimate segment, and shorter than the ocular tubercle.*

* The length of the segments of the spinners is taken on the under side near the lateral margin.

♀. *Colour.*—Limbs and carapace mostly dark chestnut or blackish brown; the hairs on the carapace olivaceous to black-olivaceous, the lateral fringe often pale; the hairs on the legs mostly dark olive to olive-brown; the shorter hairs of the abdomen black-olivaceous to brown, the middle coat composed of black or brown hairs and less bristly than in the ♂, the long reddish hairs often much paler than in the ♂. (In immature specimens the dark dorsal pattern found on the abdomen in *tigrina*, &c., is generally very distinct. In the adult this pattern is generally obliterated, but in some of the browner individuals, particularly females, it may be indistinctly observed, together with numerous small yellowish but not very distinct spots on the sides.)

Carapace a little shorter than, or slightly or considerably longer than the metatarsus and tarsus of fourth leg, and as long as the tibia and metatarsus together with from $\frac{1}{2}$ to the whole of the tarsus of first leg.

Tibia of first leg short and thick, $2\frac{2}{5}$–$2\frac{1}{2}$ times as long as high in the middle, its length varying from nearly $\frac{3}{4}$ to $\frac{4}{5}$ of the distance from the centre of the fovea to the hind margin of the ocular tubercle in the adult, and only very slightly exceeding the length of the metatarsus.

Apical segment of posterior spinners very short, slightly shorter than the penultimate segment.

*Measurements.**—Total length ♂ 26–34, largest ♀ 43; length of carapace in ♂ $11\frac{1}{4}$–$14\frac{1}{2}$, in ♀ 18; length of tibia of first leg in largest ♂ $7\frac{1}{2}$, ♀ $7\frac{1}{2}$, of metatarsus in ♂ 8, in ♀ 7; distance from centre of fovea to anterior margin of carapace in ♂ $9\frac{1}{4}$, to posterior margin of ocular tubercle in ♂ $7\frac{2}{3}$, in ♀ $10\frac{1}{2}$.

Lower group of notes on chelicerae formed of 10–18 spines † irregularly arranged 2–3 deep, more rarely more or less regularly biseriate, very slightly, scarcely, or not at all separated from the setæ of the inferior fringe.

(*b*) One ♂ and a number of ♀ and juv. from Robben Island in Table Bay, collected by Mr. R. M. Lightfoot, Mr. A. Tucker, and myself. Resemble the specimens from the Peninsula.

* Total length includes the chelicerae but not the spinners; the length of the leg segments is taken along the middle dorsal line; the length of the carapace is its greatest not its median length. The measurements are in millimetres.

† These spines in this as in the other species are short posteriorly and mostly curved in a sigmoid fashion, becoming gradually longer anteriorly and merging here insensibly into the setæ of the oral fringe. Inferiorly the notes are distinguishable from the adjacent posterior setæ of the fringe by being much shorter and mostly diverging from them in direction. The upper series of notes in *atra* varies in number from 5–11 and is generally uniseriate but sometimes irregularly arranged 2–3 deep.

(*c*) One ♂ from Gordons Bay, Stellenbosch Div. (*Dr. Geo. Corstorphine*). The legs shorter than in the examples from the Cape Peninsula, the tibia of first leg scarcely $2\frac{1}{2}$ times as long as high, the carapace as long as the metatarsus together with nearly $\frac{1}{3}$ of the tarsus of fourth leg and slightly longer than the tibia and metatarsus of first leg.

(*d*) One ♀ from Darling, Malmesbury Div.

These are the only localities known to me outside of the Peninsula, but Pocock records a ♂ from Zululand and a young ♀ from Worcester.

H. atra is fairly common about the Peninsula and Robben Island. It lives in silk-lined holes under stones on the hillsides or in open sandy plains where there are no stones, sometimes utilising portions of old mole burrows for its dwelling.

2. Harpactira marksi, n. sp.

(*a*) Two ♂ and 2 ad. ♀ (types, No. 2161) from Gutverwacht Mission Station, Piquetberg Div., collected by the Rev. Richard Marks.

♂. *Colour* of limbs and carapace a rich dark chestnut-brown or almost black; the under coat of short hairs on the limbs dark olivaceous, the long hairs pale foxy-red distally, the white transverse fringe at the apex of the segments very conspicuous; the hairs on the carapace uniformly dark olive-green, but some of those at the margins pale foxy-red at apex; the rich dark olivaceous hairy coat of the abdomen almost uniform in colour, spotted with yellow at most at the sides, the middle coat of bristly hairs black, the long hairs pale foxy-reddish.

Carapace as long as the metatarsus, or as the metatarsus and $\frac{1}{6}$ of the tarsus of fourth leg, and equal to the tibia together with $\frac{1}{2}$–$\frac{3}{5}$ of the metatarus of first leg.

Tibia of first leg $4\frac{1}{6}$–$4\frac{1}{3}$ times as long as high in the middle, its length equal to or slightly less than that of the metatarsus and slightly exceeding or slightly less than the distance from the centre of the fovea to the anterior margin of the carapace. *Metatarsus* strongly curved in the middle, its length slightly exceeding the distance from the fovea to the anterior margin of the carapace.

Bulb of pedipalp with the process rather long and slender, becoming gradually thinner from the base to slightly beyond the middle, the distal $\frac{2}{5}$ being filiform, very fine and slender, terete, with slight or no sigmoid flexure at the apex.

Apical segment of posterior spinners subfusiform (when not grooved below), about $1\frac{1}{2}$–$1\frac{3}{4}$ times as long as the penultimate segment and $1\frac{1}{3}$–$1\frac{1}{2}$ times as long as the ocular tubercle.

♀. *Colour* much the same as in ♂, the limbs and carapace a rich dark brown, the coat of short hairs on the limbs and trunk a more greyish olivaceous, the abdomen thickly speckled all over with grey spots and with a few obliquely transverse dark lines on the back, the fringe at the margins of the carapace pale foxy-reddish.

Carapace somewhat shorter than the metatarsus and tarsus of fourth leg and slightly or considerably longer than the tibia and metatarsus of first leg.

Tibia of first leg 3 times as long as high in the middle, its length a little exceeding that of the metatarsus, and from $\frac{7}{8}$ of to slightly less than the distance from the fovea to the hind margin of the ocular tubercle.

Apical segment of posterior spinners shorter than in the ♂ and (when not grooved below) slightly conical in form, about $\frac{1}{5}$–$\frac{1}{4}$ longer than the penultimate segment and only a little longer than the ocular tubercle.

Measurements.—Total length in ♂ 33–41, in ♀ 49; length of carapace in ♂ 14–16, in ♀ 18; length of tibia of first leg in largest ♂ 10, ♀ 9, of metatarsus ♂ 10, ♀ 8; distance from centre of fovea to anterior margin of carapace in ♂ 10, to posterior margin of ocular tubercle in ♀ 9·2.

Lower cluster of stridulating notes on the cheliceræ composed of 8–20 spines, irregularly arranged 2–3 deep or more or less regularly biseriate, sometimes situated in the margin of the inferior fringe of setæ but more often slightly separated from, although very close to, the latter.

(*b*) One ♂ from Elizabethfontein, Clanwilliam Div. (1,000 feet elevation, *Miss M. Bergh*). A very small specimen, measuring only about 24 mm. in length, with the carapace 10½ mm. long; the tibia of first leg only 4 times as long as high; the carapace slightly shorter than the metatarsus of fourth leg.

The conspicuous white bands of the legs contrasting with the rich dark brown and dark olive-green background give the males described above a very handsome appearance, not so noticeable in the more sombre but otherwise very similarly coloured ♂ of *atra*.

(*c*) One ♂, found on the mountain-side at the entrance to Kogmans Kloof near Ashton, Robertson Div., by my wife. This is a very small example, measuring only 20 mm. in length. Tibia of first leg 4 times as long as high, its length a little exceeding that of the metatarsus, and exceeding the distance from the fovea to the anterior margin of carapace; metatarsus much less strongly curved than in the types; apical segment of spinners very long, more than twice as long as the penultimate segment; carapace and limbs brown, the shorter hair-covering olivaceous, but the leg segments without an apical fringe of conspicuously white hairs. There appears to be no sufficient reason for separating this form from the typical *marksi.*

3. Harpactira gigas, Poc.

1898. *H. g.*, Pocock, Ann. Mag. N. H. s. 7, *v.* 1, p. 316, ♀ from Barberton, Transvaal.

The Museum possesses a single large dried ♀ from Barberton, agreeing exactly with the type in its proportions, as given by Pocock. The posterior spinners are somewhat shrivelled up, but the apical segment exceeds the penultimate segment in length, and is at least not shorter than the ocular tubercle.

4. Harpactira namaquensis, n. sp.

(*a*) Three ♂, 2 ♀, and several juv. (types, No. 3975), all from Ookiep, excepting one which came from Kraaifontein (*Dr. R. H. Howard*); 2 ♂ and 1 ♀ from Concordia (*J. H. C. Krapohl*); 1 ♀ from Steinkopf; all these localities in the Div. of Namaqualand, Cape Colony.

♂. *Colour* of limbs and carapace dark brown to black; under coat of short hairs on the legs mouse-grey to mouse-brown, the tips of the shorter bristles and the distal part of the long hairs pale brownish to whitish; the dense hair at the lateral borders and the radiating bands on the carapace pale ochraceous to pale cream-coloured, the dark hairs almost or quite absent, even alongside of the ocular tubercle; abdomen almost uniformly golden-brown, the middle coat of bristles dark brown to nearly black.

Carapace somewhat longer or shorter than the metatarsus of fourth leg, and equal to the tibia together with over $\frac{1}{3}$ but less than $\frac{1}{2}$ the metatarsus of first leg.

Tibia of first leg $4\frac{1}{2}$–5 times as long as high in the middle, its length distinctly and generally considerably less than that of the metatarsus, but subequal to or more or less considerably exceeding the distance from the fovea to the anterior margin of carapace. *Metatarsus* strongly curved in the middle and always much longer than the distance from the fovea to the anterior margin of carapace.

Bulb of pedipalp with the process rather long, almost terete, thick throughout the greater part of its length, excepting the distal $\frac{1}{5}$ or $\frac{1}{4}$, which becomes rather suddenly very slender, filiform, and flexible.

Spinners very long, the apical segment subfusiform, from $1\frac{1}{2}$ to nearly twice as long as the penultimate segment, and from $1\frac{1}{2}$ to nearly twice as long as the ocular tubercle.

♀. *Colour* of limbs and carapace mostly brown, sometimes nearly black; abdomen dark brown, thickly speckled with grey spots and patches, the usual dark pattern on the back indistinct.

Carapace as long as the metatarsus together with from $\frac{3}{4}$ to the whole of the tarsus of fourth leg, and shorter than or slightly exceeding the tibia and metatarsus of first leg.

Tibia of first leg $3–3\frac{2}{5}$ times as long as high in the middle, its length equalling or slightly exceeding that of the metatarsus, and from $\frac{6}{7}$ of to equal to the distance from the fovea to the hind margin of the ocular tubercle.

Apical segment of posterior spinners subfusiform, the proportions as in the male.

Measurements of Ookiep specimens.—Total length of ♂ 37–48, of ♀ 49; length of carapace in ♂ $17\frac{1}{4}–18\frac{1}{2}$, in ♀ 20; length of tibia of first leg in largest ♂ 13, in ♀ $10\frac{1}{2}$, of metatarsus in ♂ 14, in ♀ 10; distance from fovea to anterior margin of carapace in ♂ 12, to posterior margin of ocular tubercle in ♀ 11.

The lower group of notes on the cheliceræ are 8–15 in number, and either irregularly arranged and not at all or scarcely separated from the setæ of the inferior fringe, or more or less regularly uniseriate and then generally very slightly separated from the fringe, this latter being generally the case in the males.

(*b*) One ♂ and several ♀ and juv.; old spirit specimens labelled "Touws River," Worcester Div. (*Dr. W. P. Le Feuvre* and *W. Mellet*). The apex of the process of the pedipalpal bulb is unfortunately broken off in the ♂, but otherwise these specimens do not appear to differ from the Namaqualand form.

(*c*) One ♂, an old spirit specimen labelled "British Kaffraria." This locality is very vague and doubtful, but the specimen is interesting on account of the proportions, the tibia of the first leg being only $4\frac{1}{3}–4\frac{2}{5}$ times as long as high, its length only equalling the distance from the fovea to the anterior margin of the ocular tubercle. Other characters much as in the types.

5. Harpactira cafreriana (Walck.).

1837. *Mygale cafreriana*, Walckenaer, Ins. Apt. *v*. 1, p. 225, pl. 5, f. 1D (♂) and 1E (pedipalpal bulb), ♂ and ♀ from "Caffraria."

1837. ?*M. villosa*, Walckenaer, ibid., p. 226, ♀ from "Cape of Good Hope."

1842. *M. cafreriana*, C. L. Koch, Die Arachn. *v.* 9, p. 80, f. 741, ♂ from "Cape of Good Hope."

(*a*) One ♂ recently found by Mr. Harold A. Fry at Swellendam.

♂. *Colour.*—Carapace and limbs almost black; the under coat of short hairs on the limbs and abdomen bright reddish orange, the long hairs on these parts whitish distally and only very faintly tinged with red; abdomen with distinct black markings above similar to those in *tigrina*, the bristles of the middle coat reddish orange, excepting in the black bands where they are black; the triangular cephalic portion of the carapace densely covered with brilliant orange-red hairs, dark hairs being absent, the thoracic portion also covered with similar hairs arranged in radiating, more densely hairy stripes alternating with less hairy interspaces, the latter almost entirely without dark hairs. Under surface of coxæ and sternum brownish black, with brownish black hairs.

Carapace as long as the metatarsus and $\frac{1}{3}$ of the tarsus of fourth leg, and equal to the tibia together with nearly $\frac{3}{4}$ of the metatarsus of first leg.

Tibia of first leg proportioned almost exactly as in the Port Elizabeth ♂ of *tigrina;* the tibia 4 times as long as high in the middle, its length equal to that of the metatarsus together with $\frac{1}{5}$ of the tarsus, and just exceeding the distance from the centre of the fovea to the middle of the ocular tubercle. *Metatarsus* slightly curved, subequal in length to the distance from the fovea to the hind margin of the ocular tubercle.

The arcuate process of the *bulb of the pedipalp* becoming gradually thinner to beyond the middle, the distal part very slender and filiform, simply curved outwards at the apex, but without distinct sigmoid flexure.

Apical segment of posterior spinners about $\frac{1}{4}$ longer than the penultimate segment, and equalling or even slightly exceeding the ocular tubercle in length.

Lower series of notes on the cheliceræ composed of about 2–3 rows of spines and widely separated from the inferior fringe of setæ,* the distance between the latter and the posteriormost notes being quite $\frac{1}{4}$–$\frac{1}{3}$ of the distance between the upper and the lower group of notes.

Measurements.—Total length 30; length of carapace $12\frac{1}{2}$; length of tibia of first leg 7·8, of metatarsus 7; distance from fovea to anterior margin of carapace $8\frac{1}{2}$, to posterior margin of ocular tubercle 6·9.

(*b*) One ♀ (33 mm. long and apparently almost mature) found on

* Anteriorly the notes pass over insensibly into the setæ of the fringe, as in the other species.

the mountain-side at the village of Caledon by Mr. Geo. French. Carapace and limbs brown; hairy covering on upper side of limbs and abdomen much the same as in the ♂ from Swellendam; on the carapace, however, which is considerably rubbed, there are some olivaceous hairs between the reddish orange stripes and also behind the ocular tubercle, but not alongside of it. Carapace a little shorter than the tarsus and metatarsus of fourth leg, and equal to the tibia, metatarsus and $\frac{1}{5}$ of the tarsus of first leg. Tibia of first leg 3 times as long as high, its length equal to that of the metatarsus together with about $\frac{1}{5}$ of the tarsus, and about $\frac{9}{10}$ of the distance from the fovea to the hind margin of the ocular tubercle. Apical segment of posterior spinners a little longer than the penultimate segment, and about equal to the ocular tubercle in length. The distance between the posteriormost notes of the lower group and the setæ of the inferior fringe about $\frac{1}{2}$ the distance between the upper and lower group of notes.

(*c*) One ♂ and 2 immature specimens (the largest 25 mm. long) collected by Mr. H. A. Fry in the Bredasdorp Div. The ♂ closely resembles the example from Swellendam, but is less red, the short hairs of the trunk and limbs being testaceous yellow, while there are a number of black-olivaceous hairs on the carapace in the darker spaces between the yellow stripes and also on a large, lozenge-shaped, median area behind, but not alongside of, the tubercle on the cephalic portion. The long hairs also more foxy-red. Apical segment of spinners nearly $\frac{1}{4}$ longer than the ocular tubercle. Process of bulb very fine, not compressed distally. Carapace as long as the tibia and $\frac{3}{5}$ of the metatarsus of first leg. Total length 29 mm. The Bredasdorp form may possibly be separable as a local colour variety.

The immature specimens resemble the ♂, excepting that the hair covering is much less red, the short hairs being more yellow and the long hairs whitish. The proportions of the tibia of the first leg as in the ♀ from Caledon. The apical segment of the spinners about $\frac{1}{4}$ longer than the penultimate segment, and decidedly longer than the ocular tubercle.

The spines of the lower group of notes on the cheliceræ in the ♂ are arranged irregularly and 3–4 deep.

(*d*) A large immature specimen (28 mm. in length) and 3 smaller ones from Slanghoek, Worcester Div., collected by Mr. R. Francke and myself. In the larger example the short hairs are yellowish, the proportions of the tibia of the first leg are as in the ♀ from Caledon, and the apical segment of the spinners is considerably longer than the ocular tubercle.

(*e*) An immature specimen (26 mm. in length) from Jonkershoek, in the Stellenbosch Div., found by myself. The short hairs are yellowish.

(*f*) Three immature specimens (the largest 23 mm. in length) from Knysna, collected by myself. Darker specimens, the short hairs on the legs and abdomen greenish-yellow to light olivaceous, the carapace with olivaceous hairs between the yellow stripes.

H. cafreriana is easily recognised by the position of the lower group of notes, which is much more isolated posteriorly than in any of the other species known to me. *H. chrysogaster*, Poc., with similar notes is probably merely a colour variety. The apical segment of the posterior spinners is longer than the penultimate segment (up to $\frac{1}{4}$ longer), and subequal to or more or less considerably longer than the ocular tubercle.

Walckenaer describes the colour of his specimens as "rouge clair, uniforme dans les femelles, gris de souris dans le mâle," meaning, I presume, that the female is of a uniform light reddish colour and the male reddish, mingled with mouse-grey. Koch's male is described as of a "very beautiful yellowish red, almost fiery red," colour. In both cases the carapace is represented as uniformly coloured, and therefore most like that of our example from Swellendam. In size our specimens nearly resemble the two figured males. The pedipalpal bulb, as figured by Walckenaer, is also closely similar, except that the process is more arcuate than in our examples.

H. villosa (Walck.) is said to be like *cafreriana*, except that it is more hairy. These two species are probably identical.

6. Harpactira tigrina, Auss.

1875. *H. t.*, Ausserer, Verh. zoo.-bot. Ges. Wien, *v.* 25, p. 185, ♀ from Algoa Bay. The type is in the British Museum.

1897. *H. t.*, Pocock, P.Z.S. 1897, p. 748, pl. 43, f. 5 (spinners), ♀ or young from Port Elizabeth, Eastern Karroo, East London, Pondoland, Kei Road (Kingwilliamstown Div.), Matabeleland and Somaliland.

(*a*) One ♂, 3 ♀, and 1 juv. from Port Elizabeth, collected by Mr. J. L. Drège.

♂. *Colour.*—Carapace and limbs chestnut-brown; the coat of short hairs on the legs grey-yellowish, the long hairs pale distally and brownish; the carapace with numerous radiating stripes of pale ochraceous silky hairs, the hairs between the stripes olivaceous; abdomen with an under coat of grey-yellowish silky hairs, with distinct black dorsal pattern, the middle coat of bristles dark brown to nearly black, the long hairs pale, with brownish or reddish tinge.

Carapace about as long as the metatarsus and half the tarsus of fourth leg, and as long as the tibia and $\frac{3}{4}$ of the metatarsus of first leg.

Tibia of first leg 4 times as long as high in the middle, its length equal to that of the metatarsus together with $\frac{1}{4}$ of the tarsus, and almost equal to the distance from the fovea to the anterior margin of the ocular tubercle. *Metatarsus* only very slightly curved, its length equal to the distance from the fovea to the posterior margin of the ocular tubercle.

Process of pedipalpal bulb stoutish, not filiform but rather broad and distinctly laterally compressed distally, with well-marked sigmoid flexure at the apex.

Apical segment of posterior spinners obtusely conical in form and a little (about $\frac{1}{5}$) longer than the penultimate segment, but a little shorter than the ocular tubercle.

♀. *Colour.*—Carapace and limbs chestnut to mahogany-brown; the short hairs on the legs mouse-grey; the stripes on the carapace pale ochraceous to pale cream-coloured; the coat of shorter hairs on the abdomen dark, thickly speckled all over with mouse-grey or mouse-brown spots, the dorsal surface with a very distinct black pattern.

Carapace slightly or considerably longer than the metatarsus and tarsus of fourth leg, and equal to the tibia, metatarsus and $\frac{2}{5}$ to $\frac{1}{2}$ the tarsus of first leg.

Tibia of first leg $2\frac{3}{4}$ times as long as high in the middle, its length being from over $\frac{3}{4}$ up to $\frac{6}{7}$ of the distance from the fovea to the hind margin of the ocular tubercle, and equal to the metatarsus and $\frac{1}{5}$–$\frac{1}{4}$ of the tarsus.

Apical segment of spinners obtusely conical in form (when not grooved below), and equal to or a little longer than the penultimate segment, but decidedly shorter than the ocular tubercle.

Measurements.—Total length of largest specimens ♂ 28, ♀ 42; length of carapace ♂ 12, ♀ $18\frac{1}{2}$, of tibia of first leg ♂ $7\frac{1}{4}$, ♀ $8\frac{1}{4}$, of metatarsus ♂ 6·2, ♀ 7; distance from fovea to anterior margin of carapace in ♂ 8, to posterior margin of ocular tubercle in ♀ $10\frac{1}{3}$.

The lower group of notes on the cheliceræ are composed of 8–13 spines arranged in one or two more or less regular series, or irregularly and about 2 deep, the whole group being in some cases not separated from the setæ of the inferior fringe, while in others it is distinctly, although only very slightly, separated from the fringe.

(*b*) Five ♂ and a number of ♀ and juv. from Dunbrody on the Sundays River, Uitenhage Div. (about 34 miles north of Port

Elizabeth), collected by the Rev. J. A. O'Neil. The hairs on the carapace and on the femora of the legs sometimes golden-yellow in the ♂ ; the radiating stripes on the carapace sometimes very faint. The carapace in the ♂ as long as the metatarsus and $\frac{1}{5}$–$\frac{2}{5}$ of the tarsus of fourth leg, and equal to the tibia and $\frac{1}{2}$ the metatarsus of first leg. In the ♀ the carapace is a little shorter or longer than the metatarsus and tarsus of fourth leg, and equal to the tibia, metatarsus and $\frac{1}{6}$–$\frac{1}{3}$ of the tarsus of first leg. The tibia of first leg longer than in the Port Elizabeth form, its length in the ♂ being 4$\frac{1}{2}$–5 times its height in the middle and equal to the length of the metatarsus together with from $\frac{1}{3}$ to nearly $\frac{1}{2}$ of the tarsus, and always (generally considerably) exceeding the distance from the centre of the fovea to the anterior margin of the carapace; the length of the metatarsus equal to the distance from the fovea to near the middle of the ocular tubercle. In the ♀ the tibia of the first leg is 2$\frac{5}{6}$–3 times as long as high, its length varying from $\frac{9}{10}$ of to almost equal to the distance from the fovea to the hind margin of the ocular tubercle, and equal to the metatarsus together with $\frac{1}{5}$–$\frac{1}{4}$ of the tarsus. The apical segment of the spinners shaped as in the specimens from Port Elizabeth and equal to or more generally (especially in the ♂) a little longer than the penultimate segment, sometimes quite $\frac{1}{4}$ longer in the ♂, but always shorter than the ocular tubercle. The lower series of notes on the cheliceræ often composed of a more or less regularly uniseriate series, and generally slightly but distinctly separated from the inferior fringe, the distance between the posteriormost notes and the adjacent inferior setæ being as usual many times less than the distance between the upper and lower group of notes. Total length ♂ 25$\frac{1}{2}$–33, largest ♀ 42; length of carapace ♂ 11$\frac{1}{2}$–14, ♀ 16$\frac{1}{4}$, of tibia of first leg in largest ♂ 10$\frac{1}{2}$, ♀ 7·8, of metatarsus ♂ 8, ♀ 6$\frac{1}{2}$; distance from fovea to anterior margin of carapace in ♂ 9, to posterior margin of ocular tubercle in ♀ 8$\frac{1}{2}$.

(*c*) Two ♂ and 4 ♀ from East London, collected by Mr. John Wood. Most of these specimens are remarkable for their large size and darker colouration, the carapace and limbs being often blackish brown. The stripes on the carapace and the shorter hairs on the femora and patellæ of the legs are golden-yellow in the ♂. In the ♂ the tibia of the first leg is 4$\frac{2}{5}$ to 4$\frac{3}{4}$ times as long as high, its length being equal to the distance from the fovea to the anterior margin of the ocular tubercle or even a little exceeding the distance from the fovea to the anterior margin of the carapace, and equal to the length of the metatarsus together with about $\frac{1}{3}$ of the tarsus. The metatarsus is a little longer or shorter than the distance from the fovea to the posterior margin of the ocular tubercle. The carapace is as long as the fourth metatarsus together with $\frac{2}{5}$–$\frac{1}{2}$ of the tarsus, and equal to the first tibia together with $\frac{1}{2}$–$\frac{2}{3}$ of the metatarsus. In the ♀ the tibia of the first leg is 3 or very slightly over 3 times as long as high, its length being equal to that of the metatarsus together with about $\frac{1}{4}$ of the tarsus, while the carapace is as long as or considerably longer than the fourth metatarsus and tarsus together, and as long as the tibia, metatarsus, and $\frac{1}{5}$–$\frac{3}{5}$ of the tarsus of first leg. The apical segment of the spinners is longer than usual, being longer than the penultimate segment and generally equal to or only very slightly (rarely considerably) shorter than the ocular tubercle. Total length of largest ♂ and ♀ 37, 55; length of carapace ♂ 16$\frac{3}{4}$, ♀ 24, of tibia of first leg ♂ 10$\frac{1}{2}$, ♀ 11$\frac{1}{2}$, of metatarsus ♂ 8$\frac{1}{2}$, ♀ 9$\frac{1}{2}$; distance from fovea to anterior margin of carapace in ♂ 11$\frac{1}{4}$, to posterior margin of ocular tubercle in ♂ 9, in ♀ 13$\frac{1}{2}$.

(*d*) Four large ♀ and 1 ♂ collected by Mr. F. A. Pym, near Kingwilliamstown. Large specimens, closely resembling those from East London.

(*e*) Two ♂ found at Bizana, East Pondoland, by Mr. E. H. L. Schwarz and Mr. A. W. Rogers of the Geological Commission. Very darkly coloured specimens closely resembling those from East London.

The Museum also possesses females from Port Alfred in the Bathurst Division (dry ex., *Miss Bowker*), Umtata (*L. H. Sitwell*), and the Bedford Div. (*E. S. Stephenson*).

7. Harpactira dictator, n. sp.

(*a*) Three ♂ and 2 ad. ♀ (types, No. 8838), all from Bonnie Vale Farm, in the Swellendam Div. (close to Bushmans Drift on the Breede River and a few miles from Ashton). They were dug out of the ground and collected by Mr. Charles Groom during the construction of a water-furrow.

♂. *Colour.*—Carapace and limbs black or almost black; the coat of short hairs on the limbs mouse-grey, the tips of the shorter bristles, the distal part of the long hairs, and the apical fringe of the leg segments pale or whitish, tinged with foxy-red; carapace with a marginal fringe and numerous radiating bands composed of pale, reddish-yellow, silky hairs, these bands, however, not so well defined as in *tigrina;* the interspaces with blackish-green hairs; abdomen with an undercoat of silky reddish-yellow hairs, a middle coat of stiff black bristles, and a coat of long, pale, foxy-reddish hairs, but without distinct spots or dark pattern above; sternum and under side of coxæ of legs black, with black or red-tipped hairs, the coxa of pedipalps paler.

Carapace subequal to the fourth metatarsus in length or longer (as long as this segment together with up to nearly $\frac{1}{2}$ the tarsus), as long as the tibia together with $\frac{1}{4}$–$\frac{2}{3}$ of the metatarsus of first leg.

Tibia of first leg $4\frac{2}{5}$–$5\frac{1}{3}$ times as long as high, its length subequalling or a little exceeding that of the metatarsus, and slightly or considerably exceeding the distance from the fovea to the anterior margin of the carapace. *Metatarsus* strongly curved in the middle, its length equalling or exceeding the distance from the fovea to the anterior margin of carapace.

Process of pedipalpal bulb as in *tigrina*, the distal portion being stoutish and laterally compressed, with distinct sigmoid flexure.

Apical segment of posterior spinners much as in *marksi*, somewhat fusiform, $1\frac{1}{3}$–$1\frac{3}{5}$ times as long as the penultimate segment and a little (up to $\frac{1}{4}$) longer than the ocular tubercle.

♀. *Colour.*—Carapace and limbs dark chestnut-brown; the pale hairs on the carapace mouse-grey, the dark ones dark green or dark brown; abdomen with the under coat of dark brown hairs thickly speckled all over with mouse-grey spots and furnished with the usual dark pattern above, the middle coat variable, of brown or black, mostly pale-tipped bristles.

Carapace subequal to or considerably longer than the metatarsus and tarsus of fourth leg, and only slightly longer than the tibia and metatarsus of first leg.

Tibia of first leg nearly $3\frac{1}{2}$ times as long as high in the middle, its length equal to that of the metatarsus together with $\frac{1}{5}$–$\frac{1}{4}$ of the tarsus, and a little less than the distance from the fovea to the hind margin of the ocular tubercle.

Apical segment of posterior spinners about $1\frac{3}{5}$ times as long as the penultimate segment, and from a little to $\frac{1}{4}$ longer than the ocular tubercle.

Measurements.—Total length ♂ 36–45, largest ♀ (abdomen not distended) 55; length of carapace in ♂ $15\frac{1}{4}$–20, in ♀ 26, of tibia of first leg in largest ♂ 13, ♀ $13\frac{1}{2}$, of metatarsus ♂ 12·1, ♀ 11·8; distance from fovea to anterior margin of carapace in ♂ $12\frac{1}{2}$, to posterior margin of ocular tubercle in ♀ 14·8.

The lower series of notes on the cheliceræ generally consists of a single row of 6–9 spines (sometimes irregularly arranged about 2 deep) and is not at all or scarcely separated from the inferior fringe of setæ.

(*b*) One ♂ from Zandvliet Farm at Ashton, Robertson Div., collected by Mr. Ernest de Wet. Carapace and limbs dark brown.

(*c*) One ♂ from the Pass at Avontuur, near Storms Vlei, Swellendam Div., found by myself under a stone. Colour of carapace and limbs dark brown.

The Museum also possesses females of the same species from Slanghoek (*R. Francke*), Rabiesberg near Nuy River Station (*W. F. Purcell*), and Worcester (*I. Meiring*), all in the Div. of Worcester. Also, a dried ♀ from Ladismith, Cape Colony (*W. E. Fry*). In several of these specimens the apical segment of the posterior spinners is scarcely as long as the ocular tubercle, although always longer than the penultimate segment, while the tibia of the first leg may be only 3 times as long as high. The carapace may be as long as the tibia, metatarsus and $\frac{1}{4}$ of the tarsus of first leg.

This species closely resembles *H. lineata*, Poc., in the proportions of the carapace and legs, but in the latter species the apical segment of the posterior spinners is presumably shorter than the penultimate segment (see P.Z.S., 1897, p. 745).

The species described above may be distinguished from the following table:—

MALES.

a. Distal part of the process of pedipalpal bulb slender, filiform and very flexible, with very slight or no sigmoid flexure.
- *a*[1]. Lower group of notes on outer surface of cheliceræ very close to the setæ of the inferior fringe.
  - *a*[2]. Metatarsus of 1st leg only slightly curved, its length equal to the distance from the fovea to some point on the ocular tubercle. Apical segment of spinners shorter than the ocular tubercle. Carapace without pale radiating stripes .. .. 1. *H. atra* (Latr.)
  - *b*[2]. Metatarsus of 1st leg generally strongly curved in the middle, its length exceeding the distance from the fovea to the anterior margin of the carapace. Apical segment of spinners not shorter than the ocular tubercle.
    - *a*[3]. Carapace without pale radiating stripes. Tibia of 1st leg 4–4$\frac{1}{3}$ times as long as high in the middle. Process of bulb becoming gradually thinner from the base to slightly beyond the middle, the distal $\frac{2}{5}$ being very fine and filiform .. .. 2. *H. marksi*, n. sp.
    - *b*[3]. Carapace with distinct pale radiating stripes of hairs. Tibia of 1st leg 4$\frac{1}{3}$–5 times as long as high in the middle. Process of bulb becoming rather suddenly thinner at the commencement of the distal fourth or fifth of its length .. 4. *H. namaquensis*, n. sp.
- *b*[1]. Lower group of notes remote from the inferior fringe, the distance between the posteriormost notes and the nearest setæ being $\frac{1}{4}$–$\frac{1}{3}$ of the distance between the upper and lower group of notes .. 5. *H. cafreriana* (Walck.)

b. Process of pedipalpal bulb stoutish, compressed to the apex, the distal part rather broad and flattened but not filiform, with distinct sigmoid flexure. Carapace with radiating stripes of paler hairs.
- *a*[4]. Metatarsus of 1st leg only slightly curved, its length equal to the distance from the fovea to near the middle of the ocular tubercle or less. Apical

segment of spinners 1–1¼ times as long as the penultimate segment and less than or at least not exceeding the ocular tubercle in length.
6. *H. tigrina*, Auss.

b^4. Metatarsus of 1st leg strongly curved in the middle, its length equalling or exceeding the distance from the fovea to the anterior margin of carapace. Apical segment of spinners longer, subequal to or exceeding the ocular tubercle in length .. .. 7. *H. dictator*, n. sp.

FEMALES.

a. Lower group of notes on the outer surface of the cheliceræ remote from the inferior fringe, the distance between the posteriormost notes and the nearest setæ from ¼ to nearly ½ of the distance between the upper and lower group of notes .. .. 5. *H. cafreriana* (Walck.)

b. Lower group of notes very close to the inferior fringe of setæ.

a^1. Carapace without radiating stripes of paler hairs.*

a^2. Apical segment of spinners much shorter than the ocular tubercle.
1. *H. atra* (Latr.)

b^2. Apical segment of spinners at least as long as the ocular tubercle.

a^3. Carapace not longer than metatarsus and tarsus of 4th leg.
2. *H. marksi*, n. sp.

b^3. Carapace considerably longer than metatarsus and tarsus of 4th leg.
3. *H. gigas*, Poc.

b^1. Carapace with radiating stripes of whitish to yellow hairs.

a^4. Tibia of 1st leg equalling or only slightly exceeding the metatarsus in length. Carapace shorter than or subequal to the 4th metatarsus and tarsus, and slightly exceeding the tibia and metatarsus of 1st leg. Apical segment of spinners subfusiform and very long, 1½ times to nearly twice as long as the ocular tubercle.. 4. *H. namaquensis*, n. sp.

b^4. Tibia of 1st leg as long as the metatarsus together with $\frac{1}{5}$–¼ of the tarsus.

a^5. Apical segment of spinners considerably shorter than or subequal to the ocular tubercle, and often subconical in shape. Carapace as long as the tibia, metatarsus and $\frac{1}{6}$–$\frac{2}{5}$ of the tarsus of 1st leg. Tibia of 1st leg 2¾ to about 3 times as long as high. 6. *H. tigrina*, Auss.

b^5. Apical segment of spinners subequal to or at most ¼ longer than the ocular tubercle. Carapace subequal to or longer (by at most ¼ of the tarsus) than the tibia and metatarsus of 1st leg. Tibia of 1st leg 3–3½ times as long as high.. .. .. 7. *H. dictator*, n. sp.

The following species of *Harpactira* have been recently described by Pocock, but I have not been able to identify any of them with certainty from specimens in the Museum :—

H. lineata, Poc., P.Z.S., 1897, p. 749, ♀ from "South Africa." Resembles *tigrina*, Auss., and *dictator*, n. sp.

H. curvipes, Poc., ibid., p. 750, ♀ from Natal. Uniform mouse-brown in colour; the metatarsus of fourth leg distinctly bowed, convex internally.

H. chrysogaster, Poc., ibid., p. 750, pl. 43, f. 5a & 5b, ♂ from "South Africa." Probably identical with *cafreriana* (Walck.), from

* According to Pocock *gigas* belongs here; in our example the carapace is rubbed.

which it differs in having the carapace and limbs clothed with greenish black instead of orange or yellowish hairs.

H. curator, Poc., Ann. Mag. N. H. s. 7, *v.* 2, p. 199, pl. 8, f. 7 (pedipalpal bulb of ♂), 1898, ♂ and ♀ from Malvern, Natal. Appears to resemble *tigrina* in its colouration and also in the shape of the pedipalpal bulb.

H. pulchripes, Poc., ibid., *v.* 7, p. 287, 1901, ♀ from Brakkloof, near Grahamstown.

In the Museum are also a number of female specimens from various parts of South Africa, which I have been unable to identify. As it is very difficult to recognise a species from a diagnosis of the ♀ only, none of these specimens are here described as new.

Gen. PTERINOCHILUS, Poc.

Pterinochilus crassispina, n. sp.

(*a*) One ♂ (type, No. 6252) from the Metopo District, Matabeleland, collected by Mr. R. Pillans.

♂. *Colour.*—Carapace dark chestnut-brown, covered with almost uniformly brownish olivaceous hairs, without paler radiating stripes, the marginal fringe composed of yellow and whitish hairs intermixed with some dark ones; the short hairs on the upper side of the femora and patellæ of legs olivaceous brown, those on the tibiæ grey-olivaceous, those on the metatarsi and tarsi whitish intermingled with pale olivaceous hairs; the hairs on the cheliceræ and pedipalps mostly olivaceous; the undercoat on the abdomen composed of golden-brownish hairs mingled with blackish-brown hairs, the latter forming a pattern of paired oblique lines on the posterior part of the dorsal surface, as in *Harpactira;* the middle coat on the abdomen of blackish-brown bristles; the long hairs on the abdomen and limbs mostly dark at base, foxy-red in the middle and white distally; sternum and the under side of the coxæ and abdomen covered with dark olive-brown hairs; apical fringe of white hairs on the segments of the limbs very conspicuous, as in *Harpactira marksi*, n. sp.

Carapace broad, evenly elliptical, its width quite $\frac{4}{5}$ of the length, its length equal to that of the fourth metatarsus together with $\frac{1}{4}$ of the tarsus, and to the tibia together with $\frac{1}{5}$ of the metatarsus of first leg; ocular tubercle somewhat wider than long, its length about twice its distance from the anterior margin of carapace; the anterior median eyes large, their diameter equal to the long diameter of the anterior laterals and much greater than that of the posterior medians.

Tibia of first leg normal, $3\frac{3}{4}$ times as long as high in the middle, its length scarcely less than that of the metatarsus and equal to the distance from the fovea to a point on the ocular tubercle, midway between the posterior margin and the middle of the latter. *Metatarsus* straight, not hollowed out at base on the inner side.

Process of pedipalpal bulb arcuate, stoutish, striated externally, strongly flattened distally and slightly twisted, bent outwards rather suddenly near the apex, the apex itself rounded, with keel-like dilatation.

Cheliceræ with the lower non-scopulate portion of the outer surface only slightly narrower than the scopula and provided behind with an oblique patch of very fine, rather sparsely distributed hairs, which are directed forwards and downwards.*

Apical segment of posterior spinners subconical, equalling the penultimate segment in length and considerably shorter than the ocular tubercle.

Measurements.—Total length 32; length of carapace 13, width $10\frac{1}{2}$; length of tibia and of metatarsus of first leg $7\frac{1}{2}$; distance from fovea to posterior margin of ocular tubercle 7, to anterior margin of carapace 9.

(*b*) One ♂ and 1 ♀ from Vryburg in Bechuanaland, Cape Colony (*Mrs. A. W. Fincham*).

♂ with the hairs on the carapace more of a dark bronzy olivaceous colour, the distal segments of the legs scarcely paler than the proximal segments, the under surface of trunk with dark chocolate-brown hairs. Carapace as long as the fourth metatarsus together with $\frac{1}{3}$ of the tarsus, and only a little shorter than the tibia and metatarsus of first leg. Tibia of first leg about $3\frac{1}{4}$–$3\frac{1}{3}$ times as long as high, its length slightly less than that of the metatarsus and subequal to the distance from the fovea to the posterior margin of the ocular tubercle, the length of the metatarsus just exceeding this distance.

♀. Carapace with numerous radiating stripes of pale cream-coloured hairs, the interspaces clothed with dark greenish-brown hairs; the 3 distal leg segments clothed with greyish hairs, the femur and patella with more olive-brown hairs and with 2 longitudinal grey stripes above; abdomen dark, densely speckled with cream-coloured confluent spots, the usual dark dorsal pattern distinct. Carapace slightly shorter than the metatarsus and tarsus of fourth leg, and as long as the tibia, metatarsus and $\frac{1}{2}$ the tarsus of first leg. Tibia of first leg $2\frac{2}{3}$ times as long as high, its length equal to that of the metatarsus, together with about $\frac{1}{6}$ of the tarsus, and

* A similar patch occurs in *Harpactirella*, nov.

slightly more than $\frac{4}{5}$ of the distance from the fovea to the hind margin of the ocular tubercle.

Total length ♂ 34, ♀ 36; length of carapace ♂ $15\frac{1}{4}$, ♀ 15, width ♂ $12\frac{1}{2}$, ♀ 12·2; length of tibia of first leg ♂ 8, ♀ $6\frac{1}{2}$, of metatarsus ♂ 8·2, ♀ 5·8; distance from fovea to posterior margin of ocular tubercle in ♂ 8, in ♀ $8\frac{1}{3}$.

(*c*) One ♂ from a collection containing East African insects, &c., presented by Dr. J. D. F. Gilchrist. Hair-covering dark greenish-brown, including the fringe of carapace and the hair on legs and abdomen, the long hairs reddish distally and pale at the tips. Carapace as long as the fourth metatarsus together with nearly $\frac{1}{2}$ of the tarsus, and only slightly shorter than the tibia and metatarsus of first leg.

(*d*) One dried ♂ from the Zambesi River (*J. Fry*).

Pale stripes are entirely absent from the carapace in all the males, the latter being in good condition in the spirit specimens and in nowise rubbed. Although the ♀ example is so differently marked, I believe it to belong to the same species, as it has similar eyes and spinners.

P. nigrofulvus, Poc., from Barberton, Transvaal, appears to be a nearly allied species with somewhat similar pedipalpal bulb, but the carapace is provided with radiating stripes of golden hairs, and the apical segment of the posterior spinners is presumably elongated as in *P. vorax*, Poc.

The following South African species of *Pterinochilus* could not be identified from the specimens in the Collection:—

P. nigrofulvus, Poc., Ann. Mag. N. H., s. 7, *v.* 1, p. 317, 1898, ♂ and ♀ from Barberton.

P. lugardi, Poc., ibid., *v.* 6, p. 318, 1900, ♂ from near Lake Ngami.

P. schönlandi, Poc., ibid., ♂ from Grahamstown.

Harpactira elevata, Karsch, Monatsb. Ak. wiss. Berlin, 1878, p. 316 (♂ and ♀ from Tette and Mozambique), probably also belongs to *Pterinochilus*, as suggested by Pocock.

Gen. CŒLOGENIUM, nov.

Carapace about $\frac{1}{3}$ longer than wide, the cephalic portion moderately convex in the ♀, the fovea moderately deep, strongly procurved, semicircular in form and situated more posteriorly than in *Harpactira*, its distance from the hind margin of the carapace only $\frac{1}{3}$ of its distance from the anterior margin along the median line. Ocular tubercle and eyes as in *Harpactira*. Fourth pair of legs slightly shorter than the first pair, the patella and tibia of the fourth pair also a little shorter than those of the first pair. Tibia of pedipalp spined at the apex below. Tibiæ and metatarsi of legs also spined, at least at the apex, excepting the metatarsus of the first pair. Scopula of first and second metatarsus thick, reaching as in *Harpactira* almost or quite to the base, that of third and fourth metatarsus leaving the basal fourth or third of the segment free, that of fourth metatarsus divided by a band of setæ, the other scopulæ entire. Outer surface of cheliceræ with a strong transverse depression commencing suddenly near hind margin, occupying the whole width of the outer surface, and extending anteriorly up to the apex; the outer scopula very large, occupying the greater portion of the depression, the narrow, non-scopulate, inferior portion with sparsely distributed, fine, long hairs in the middle; inner surface of chelicerae without scopula. Posterior sternal sagilla near the margin.

Type.—*C. pillansi*, n. sp.

This genus belongs to Pocock's sub-family *Harpactirinæ* and would fall together with *Harpactira* in Simon's table of the *Selenocosmieæ*.

Cœlogenium pillansi, n. sp.

Type.—One example (♀ or juv., No. 5749) from Rhodesia, found by Mr. R. Pillans.

Colour.—Carapace mahogany-brown, covered with golden-yellow hairs forming radiating stripes (only visible when dried); chelicerae with yellow hairs above; the hairs on the legs, including the long hairs on the under side of the femora, mostly yellowish, mingled, especially on the patellæ and tibiæ, with some black ones; the anterior surface of the pedipalps and of the first 2 pairs of legs darker, with short olive-green hairs; abdomen golden-yellow, with dark pattern above; sternum and under side of coxæ of legs yellowish brown, with dark hairs, the posterior coxæ pale yellowish below, with pale yellowish hairs; coxæ of pedipalps brownish yellow below, with fiery red oral fringe; under side of abdomen yellowish, with a posterior transverse row of 4 small dark spots.

Carapace about $\frac{1}{3}$ longer than wide, considerably longer than the metatarsus and tarsus and almost as long as the tibia and metatarsus of fourth leg, as long as the tibia, metatarsus and $\frac{1}{5}$ of the tarsus of first leg. Ocular tubercle distant from anterior margin nearly $\frac{1}{3}$ of its length, the anterior median eyes not large.

Tibia of first leg about $2\frac{1}{2}$ times as long as high in the middle, its length equal to that of the metatarsus, together with nearly $\frac{1}{4}$ of the tarsus. Tibia of first leg with 1, of second with 1–2, of third and fourth with 2 apical spines below; no other spines on the tibiæ.

Metatarsus of first leg not spined, that of second leg with 1, that of third and fourth legs with several apical spines, the third and fourth metatarsus with 1–2 other spines near the middle of the segment as well.

Apical segment of posterior spinners subfusiform, about $\frac{3}{4}$ longer than the penultimate segment and $\frac{1}{3}$ longer than the ocular tubercle.

Measurements.—Total length 28 ; length of carapace 9·8, width 7 ; length of tibia of first leg 5, of metatarsus 4·1 ; distance from centre of fovea to hind margin of ocular tubercle 6.

Gen. CERATOGYRUS, Poc.

Ceratogyrus bechuanicus, n. sp.

Locality.—Two ad. ♂ (dried, No. 4539) from Mochuli in Bechuanaland (*Miss Neethling*).

♂. *Colour.*—Carapace black, clothed with pinkish-white hairs, forming radiating stripes, and especially dense at the sides ; cephalic portion with a large patch of dark olivaceous hairs on each side of the ocular tubercle ; some such hairs also between the radiating stripes on the thoracic portion ; the horn of the fovea clothed with dark olivaceous hairs and striped with white ; limbs clothed on the upper surface with mouse-brown and grey hairs intermixed, the tibiæ with a pair of distinct or indistinct rows of white dashes ; the sides and under surface of the limbs with the short hairs paler whitish-grey, but the short hairs on the anterior and under surfaces of the pedipalps and first two pairs of legs intensely velvety black on the femora and patellæ, and to a lesser extent on the tibiæ also ; the long hairs on the legs dark at base, brownish distally, those on the under side of the femora foxy-reddish, the whitish or pinkish white apical fringe of the leg segments very conspicuous ; the shorter hairs on the abdomen greyish white, the longer ones foxy-reddish ; under surface of abdomen, sternum, and coxæ deep velvety black.

Carapace about $\frac{1}{4}$ longer than wide, longer than the patella and tibia of fourth leg, subequal to those of first leg, but considerably shorter than the metatarsus and tarsus of fourth leg ; the horn of the fovea very large and long, becoming very gradually narrower towards the apex, which is rounded and not pointed, its length along the upper side about $1\frac{2}{3}$ of its width at the base ; seen from the side the upper edge of the horn appears strongly curved.

Tibia of first leg about four times as long as high in the middle, its length equal to that of the metatarsus together with $\frac{1}{5}$ of the tarsus, and exceeding the distance from the anterior edge of the fovea to the anterior margin of the carapace. *Metatarsus* distinctly curved, its length a little less than or a little exceeding the distance from the fovea to the anterior margin of the carapace.

Process of pedipalpal bulb arcuate, stoutish, the distal portion strongly laterally compressed and flattened, curved outwards, the apex suddenly pointed like the nib of a pen with a very short point.

Apical segment of posterior spinners very much longer than the penultimate segment, and about $1\frac{1}{3}$ times as long as the ocular tubercle.

Measurements.—Length of carapace $19\frac{1}{4}$–$21\frac{1}{2}$, width $16\frac{1}{3}$–$17\frac{1}{3}$; length of foveal horn in largest ♂ 7, width at base 4·2, height of apex above thorax 2·8; distance of fovea from anterior margin of carapace 12; length of tibia of first leg $12\frac{3}{4}$, of metatarsus $11\frac{1}{2}$.

In the large size of the foveal horn this species most nearly resembles *C. darlingi*, Poc., of which only the female has been described. In the latter species, however, the horn is more conical and more erect and straight (see Pocock, P.Z.S., 1897, pl. 43, f. 1 & 1a), whereas in *bechuanicus* it is not conical, much more inclined and strongly curved backwards.

The following species are not in the Collection:—

Ceratogyrus darlingi, Poc., P.Z.S., 1897, p. 754, pl. 42, f. 5; pl. 43, f. 1, 1a, ♀ from Enkeldoorn, S. of Salisbury, in Mashonaland.

Ceratogyrus marshalli, Poc., ibid., p. 754, pl. 43, f. 2–2b, ♂ from the same locality.

Gen. HARPACTIRELLA, nov.

Carapace about $\frac{1}{4}$–$\frac{2}{5}$ times longer than wide, the cephalic portion moderately convex in the ♀ but lower in the ♂, the fovea moderately deep, transverse or nearly so, its position as in *Harpactira*. Ocular tubercle and eyes as in *Harpactira*. Legs much as in *Harpactira*, the fourth pair not shorter than the first. Tibia of pedipalps with apical spines. Tibiæ and metatarsi of legs also spined, at least at the apex in the third and fourth pairs, but the metatarsi of first and second pairs not spined at the apex. Patella and tibia of fourth pair together subequal to or slightly exceeding the same segments of the first leg. Scopula of first and second metatarsus thick, reaching as in *Harpactira* almost or quite to the base, that of third and fourth metatarsus leaving the basal fourth or third of the segment free, that of fourth metatarsus divided by a band of setæ, the other scopulæ entire. Sides of chelicerae without feathery scopulæ, the outer surface furnished posteriorly with an obliquely transverse patch of very fine, rather sparsely distributed hairs, which are directed downwards and forwards. Sternal sagilla marginal. Tibia of first leg in ♂ furnished with a strong spur bearing one of the two apical spines as in *Harpactira*, but the spine longer than the spur.

Type.—*H. treleaveni*, n. sp.

On the outer surface of the cheliceræ a horizontal row of 2–4 long red setæ, resembling the upper series of stridulating bristles of *Harpactira*, is frequently found. They are situated more forward in the anterior part of the middle third at a little distance from the red inferior fringe, just above where the hairs of the latter are most abbreviated. These setæ may be absent, or hidden amongst other but darker hairs, or they may stand out isolated and very conspicuous. The outer surface in a very young *Harpactira*, before the scopula and the lower group of stridulating notes have been formed, is very similar to that of an adult *Harpactirella*, having a similar posterior patch of fine hairs, but it may be distinguished at once by the position of the upper series of stridulating bristles. In the young *Harpactira* this series is always well developed, with the posterior bristles situated some distance behind the middle of the chelicera, whereas in *Harpactirella* the posterior bristle, when distinguishable, is situated in the middle or, more generally, some distance anterior to the middle.

The absence of scopulæ from the sides of the cheliceræ is apparently the only character which distinguishes this genus from *Harpactira*, with which it would fall in Simon's table of the Selenocosmieæ. The genus includes the four small species described below from the south-western parts of Cape Colony, and also several other forms from Cape Colony, Natal, and the Transvaal, of which, however, we possess at present only female examples. The largest specimen (from Dunbrody, Uitenhage Div.) measures 35 mm. in length, but this length appears to be quite exceptional in the genus.

1. Harpactirella treleaveni, n. sp.

Locality.—One ♂ (type, No. 4496) found by Mr. F. Treleaven on the Cape Town side of Table Mountain; also 1 ♂ and a large number of ♀ and juv. from various parts of the Cape Peninsula, mostly under stones (Signal Hill, Cape Town, slopes of Devils Peak and Table Mountain, Camps Bay, collected by F. Treleaven, C. L. Leipoldt, and myself).

♂. *Colour.*—Carapace and limbs chestnut-brown; carapace clothed with olivaceous or greenish-black hairs, but without paler radiating stripes, the marginal fringe paler; the short hairs on the legs also olivaceous or greenish-black, the longer hairs greenish-brown or black, pallid or white distally; the hairs on the abdomen more golden olivaceous, with the usual dark pattern above, the long hairs whitish distally; seen in spirits the upper surface and sides of the abdomen in the lighter-coloured type-specimen appear dark brown and thickly speckled with yellow confluent spots; under side of abdomen pale yellowish, with brownish to blackish hairs and with a dark spot on each side of each of the posterior lung-books and a transverse row of 4 much smaller spots in the posterior part of the abdomen; under side of coxæ and sternum pale brown to blackish-brown, with brown or blackish hairs.

Carpace narrow, about $\frac{2}{5}$ longer than broad, slightly longer than the metatarsus and $\frac{1}{2}$ the tarsus of fourth leg, but about as long as the tibia and metatarsus of first leg.

Tibia of first leg about $2\frac{2}{3}$–3 times as long as high in the middle, a little longer than the metatarsus, and almost equal in length to the distance from the fovea to the centre of the ocular tubercle. *Metatarsus* straight (except perhaps quite at the base), its length subequalling or slightly exceeding the distance from the fovea to the posterior margin of the ocular tubercle. Tibia of first, second, and third legs with 2, that of fourth leg with 3 apical spines; metatarsus of first and second legs not spined, that of third and fourth legs with several spines at the apex and also on the upper and lower surface and on the sides.

Pedipalpal bulb with the arcuate process slender and terete, much longer than the bulb, the distant portion filiform and lightly curving outwards.

Apical segment of posterior spinners short, equalling the penultimate segment and equalling or slightly exceeding the ocular tubercle in length.

♀. *Colour.*—Carapace and limbs light brown to brownish-yellow, often pale ochraceous in the younger individuals; the hairs on the carapace and abdomen golden-olivaceous, golden-brown, or mouse-brown; the carapace without radiating stripes of paler hairs; under surface of abdomen often with a dark spot on each of the anterior lung-books and several scattered spots in addition to the spots described for the male.

Carapace subequalling or a little shorter than the metatarsus and tarsus of fourth leg, and equal to the tibia, metatarsus, and from $\frac{2}{3}$–$\frac{3}{4}$ of the tarsus of first leg.

Tibia of first leg about $2\frac{1}{2}$ times as long as high in the middle, its length equal to that of the metatarsus together with about $\frac{1}{7}$–$\frac{1}{5}$ of the tarsus. Tibia of first leg with 0–2, that of second leg with 0–1, that of third leg with 1–2, that of fourth leg with 2–4 apical spines; no other spines on the tibiæ; metatarsus spined as in ♂; first leg shorter than the fourth by $\frac{1}{2}$–$\frac{2}{3}$ of the tarsus of the latter.*

Apical segment of posterior spinners equal to or slightly longer or shorter than the ocular tubercle, and equal to or slightly longer than the penultimate segment.

Measurements.—Total length ♂ 16½, largest ♀ 21½; length of carapace ♂ 6⅔, ♀ 8⅔, width ♂ 4·8, ♀ 6½; length of tibia of first leg ♂ 3⅔, ♀ 4, of metatarsus ♂ 3⅓, ♀ 3½; distance from fovea to posterior margin of ocular tubercle ♂ 3·1, ♀ 4½.

This species is fairly common round Cape Town. It lives in silk-lined holes under stones, like *Harpactira.*

2. Harpactirella longipes, n. sp.

(*a*) One ♂ (type, No. 3567) found by Mr. C. L. Leipoldt at the village of Clanwilliam.

♂. *Colour* much the same as in the ♂ of *treleaveni,* but the spots on the under side of the abdomen are not marked and the hairs on the upper side of the abdomen are yellowish.

Carapace about ⅖ longer than wide, as long as the metatarsus together with ⅓ of the tarsus of fourth leg, and the tibia together with about ½ of the metatarsus of first leg.

Tibia of first leg almost 4 times as long as high in the middle, its length slightly exceeding that of the metatarsus and also the distance from the fovea to the anterior margin of carapace. *Metatarsus* slightly but distinctly curved proximally to the middle, its length subequal to the distance from the fovea to the anterior margin of carapace. Spines of the legs as in *treleaveni.*

Pedipalpal bulb turbinate; the process short, arcuate and slender, only slightly longer than the bulb, its distal portion filiform, curving outwards at the apex.

Apical segment of posterior spinners subfusiform, about ¾ longer than the penultimate segment and a little longer than the ocular tubercle.

Measurements.—Total length 18; length of carapace 7·8, width 5½; length of tibia of first leg 5·1, of metatarsus 5; distance from fovea to anterior margin of carapace 5.

(*b*) One ♂ from Porterville, Piquetberg Div. (*Max Schlechter*). Carapace with yellow hairs; the limbs with mouse-brown hairs; the abdomen with ochre-yellow hairs. Carapace only a little longer than the metatarsus of fourth leg, and slightly longer than the tibia

* The coxæ are included in the length.

and $\frac{1}{3}$ of the metatarsus of first leg. Tibia of first leg a little more than 4 times as long as high, its length slightly exceeding that of the metatarsus and nearly equal to the distance from the fovea to the middle of the cheliceræ; the length of the metatarsus much exceeding the distance from the fovea to the anterior margin of the carapace. Process of pedipalpal bulb apparently with the tip broken off. Apical segment of spinners about $\frac{1}{3}$ longer than the penultimate segment. Total length 17; length of metatarsus of first leg $5\frac{1}{4}$; distance from fovea to anterior margin of carapace $4\frac{3}{4}$.

(*c*) The Museum also possesses an apparently nearly mature ♀ (measuring $30\frac{1}{2}$ mm. in length) from Olyvenbosch Kraal, near the Bergvlei River in Clanwilliam Div., just north of the Piquetberg Range, and 4 smaller examples from Onder Bergvlei near the above locality, all from Mr. C. L. Leipoldt; also, an immature specimen from Boschkloof Waterfall in the Cedarbergen, collected by Mr. R. Pattison. From the length of the posterior legs these specimens would appear to belong to this species. The colour is pale ochraceous to brownish yellow, the abdomen being spotted above as in *treleaveni*.

In the largest example the carapace is about equal to the metatarsus and $\frac{1}{2}$ the tarsus of the fourth leg, and to the tibia and metatarsus of the first leg. The tibia of first and second legs with a basal spine below and another on the inner (anterior) surface, that of third and especially of fourth leg with several spines below and on the sides, in addition to the ordinary spines at the apex. The first leg is shorter than the fourth by the length of the tarsus of the latter.

In the smaller examples the legs are relatively shorter, and the spines on the tibiæ are mostly absent, excepting those at the apex.

The apical segment of the posterior spinners is equal to or slightly exceeds the penultimate segment, and is subequal to the ocular tubercle in length.

3. Harpactirella karrooica, n. sp.

Locality.—One ♂ (type, No. 3432), 1 large ♀ and 3 immature examples collected by myself round the village of Prince Albert.

♂. *Colour.*—Carapace and legs chestnut-brown; the hairs on the carapace, abdomen, and legs cream-coloured, the long hairs pallid; under side of coxæ and sternum pale brown, that of abdomen pale yellowish.

Carapace about $\frac{1}{4}$ longer than wide, almost as long as the metatarsus and $\frac{1}{2}$ the tarsus of fourth leg, and somewhat shorter than the tibia and metatarsus of first leg.

Tibia of first leg $3\frac{1}{2}$ times as long as high, its length equal to that of the metatarsus together with $\frac{1}{6}$ of the tarsus, and to the distance from the fovea to the anterior margin of the ocular tubercle. *Metatarsus* scarcely curved, its length only slightly exceeding the distance from the fovea to the posterior margin of the ocular tubercle. *Legs* spined as in the ♂ of *treleaveni* (in the first left leg the tibial spur bears two apical spines and the metatarsus has a spine near the base anteriorly).

Pedipalpal bulb subturbinate; the process much longer than the bulb, scarcely curved in the proximal part, the middle part strongly laterally compressed; seen from the side the process appears broader and band-like up to the commencement of the distal third, where it suddenly narrows, the distal third being very slender, filiform, and curved gradually outwards.

Apical segment of posterior spinners subconical, short, subequal to the penultimate segment, but shorter than the ocular tubercle.

♀. *Colour.*—Carapace and legs lighter brown, the shorter hairs on the carapace golden-yellow, those on the limbs mouse-brown and mouse-grey, those on the abdomen yellowish; under side of abdomen dark brown, with pale yellowish hairs, the lung-books infuscated laterally. (The immature examples paler, with the abdomen spotted above as in *treleaveni.*)

Carapace equal in length to the metatarsus and $\frac{2}{3}$ of the tarsus of fourth leg, and to the tibia and metatarsus of first leg.

Tibia of first leg about 3 times as long as high, its length very slightly exceeding that of the metatarsus and only a little less than the distance from the fovea to the posterior margin of the ocular tubercle. Spine armature of the legs as in the ♀ of *treleaveni.* (In one case the third tibia has an external spine in addition to the apical ones.) First leg shorter than the fourth by $\frac{1}{2}$ the tarsus of the latter.

Apical segment of spinners as in ♂.

Juv.—In the 3 young individuals the tibia of the first leg is equal to the metatarsus together with about $\frac{1}{4}$ of the tarsus in length, the apical segment of the spinners is slightly shorter than the penultimate segment, and the carapace is only slightly shorter than the metatarsus and tarsus of fourth leg. First leg shorter than the fourth by about $\frac{4}{5}$ of the tarsus of the latter.

Measurements.—Total length ♂ 17, ♀ 28; length of carapace ♂ $7\frac{1}{4}$, ♀ $8\frac{3}{4}$, width ♂ $5\frac{1}{2}$, ♀ 7; length of tibia of first leg ♂ $4\frac{1}{4}$, ♀ 4·6, of metatarsus ♂ $3\frac{3}{4}$, ♀ $4\frac{1}{2}$; distance from fovea to posterior margin of ocular tubercle ♂ $3\frac{1}{2}$, ♀ 4·8.

4. Harpactirella lightfooti, n. sp.

Types.—Four apparently mature ♀ and 2 smaller specimens (types, No. 3219), found by Mr. R. M. Lightfoot at the Paarl, Cape Colony.

♀. *Colour.*—Carapace blackish-brown, covered with dark olive-greenish hairs and provided with well-defined radiating stripes and a marginal fringe of pale cream-coloured or slightly pinkish hairs, the cephalic portion clothed with yellowish hairs, those round the ocular tubercle bright golden-yellow (in the small specimens all the hairs on the carapace are golden-yellow); the shorter hairs on the legs olive-greenish, those on the distal segments of the posterior legs pallid; longer hairs on the legs pale; abdomen with yellow or greyish-yellow hairs and the usual dark pattern above; under side of coxæ and sternum dark blackish brown, with hairs of the same colour; under side of abdomen dark, the opercula of the lung-books pale yellow, infuscated laterally.

Carapace slightly or very distinctly longer than the metatarsus and tarsus of fourth leg, and only a little longer (by at most $\frac{1}{6}$ of the tarsus) than the tibia and metatarsus of first leg.

Tibia of first leg about 3–3$\frac{1}{4}$ times as long as high, its length equalling or slightly exceeding (by at most $\frac{1}{7}$ of the tarsus) that of the metatarsus, and a little less than the distance from the fovea to the hind margin of the ocular tubercle. First leg subequal to the fourth or only slightly shorter (by at most $\frac{1}{5}$ of the tarsus of the latter). Spines on the legs much the same as in *treleaveni.*

Apical segment of spinners about $\frac{1}{2}$–$\frac{3}{4}$ longer than the penultimate segment, and scarcely longer or as much as $\frac{1}{4}$ longer than the ocular tubercle.

Measurements of largest ♀.—Total length 30; length of carapace 12, width 8$\frac{1}{3}$; length of tibia of first leg 5$\frac{3}{4}$, of metatarsus 5$\frac{1}{2}$; distance from fovea to posterior margin of ocular tubercle 6$\frac{3}{4}$; length of first leg (including coxa) 35, of fourth leg 35.

This is a larger and blacker species than any of those described above.

The 4 species may be determined from the following table:—

MALES.

a. Tibia of first leg longer than the distance from the fovea to the anterior margin of carapace .. .. *H. longipes*, n. sp.

b. Tibia of first leg shorter than the distance from the fovea to the anterior margin of the carapace.

*a*ꜝ. Process of pedipalpal bulb slender, becoming gradually thinner from the base to slightly beyond the middle, which is not laterally compressed. *H. treleaveni*, n. sp.

b^1. Process of bulb strongly laterally compressed in the middle portion, appearing, when seen from the side, band-like up to the commencement of the distal third, where it suddenly narrows, the distal third being very fine and filiform .. .. *H. karrooica*, n. sp.

FEMALES.

a. Carapace (in adult) equal to the metatarsus and $\frac{1}{2}$ the tarsus of the fourth leg in length .. .. *H. longipes*, n. sp.

b. Carapace equal to the metatarsus together with $\frac{2}{3}$ or more of the tibia of fourth leg.

a^1. First leg subequal to the fourth or only slightly shorter (by at most $\frac{1}{5}$ of the tarsus of the latter) .. .. *H. lightfooti*, n. sp.

b^1. First leg shorter than the fourth by $\frac{1}{2}$ or more of the tarsus of the latter.

a^2. Carapace equal to the tibia, metatarsus and from $\frac{2}{5}$–$\frac{3}{4}$ of the tarsus of first leg.. .. .. *H. treleaveni*, n. sp.

b^2. Carapace equal to the tibia and metatarsus of first leg. *H. karrooica*, n. sp.

NEW SOUTH AFRICAN TRAP-DOOR SPIDERS OF THE FAMILY *CTENIZIDÆ* IN THE COLLECTION OF THE SOUTH AFRICAN MUSEUM.

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First Assistant in the Museum.

(Communicated September 4, 1901.)

The South African *Ctenizidæ* appear to be very imperfectly known, comparatively few species having been hitherto described. The present paper contains descriptions of 19 apparently new species belonging to 10 genera, of which 4 are new, but this by no means exhausts the number of new forms in the Collection as a number of new species, unfortunately represented by female specimens only, and belonging principally to the genera *Hermacha* and *Hermachastes*, have been left undescribed pending the discovery of the males.

Gen. STASIMOPUS Sim.

Stasimopus leipoldti n. sp.

Type: 1 ♀ (No. 2909) found by Mr. C. L. Leipoldt near the village of Clanwilliam, Cape Colony.

♀. *Colour.*—Carapace brown, yellowish posteriorly; cheliceræ blackish brown, with coppery hairs anteriorly; pedipalps and 2 anterior pairs of legs brown, the coxæ of the legs brownish yellow, the 2 posterior pairs of legs lighter brown above, more or less pale yellowish at the sides and below in most of the segments; abdomen pale yellowish, the genital operculum covered with black hairs; sternum brownish yellow, the anterior and lateral borders brown, the posterior border pale yellowish.

Carapace as long as the patella and tibia together with a little over half the metatarsus of first leg, and equal to the tibia, metatarsus and about $\frac{1}{4}$–$\frac{1}{5}$ of the tarsus of fourth leg.

Ocular area very wide, its width behind equal to the metatarsus together with $\frac{3}{5}$ of the tarsus of first leg, and almost equal to the fourth metatarsus; the anterior row, when viewed from above, with the posterior margins in a straight line and the anterior margins in a procurved line, the eyes equidistant, the median ones distant from the anterior margin of the carapace by considerably more than their diameter, the lateral eyes very large, almost or quite circular, distant from the anterior margin by about $\frac{1}{2}$ their diameter; the posterior row very distinctly recurved, a line joining the anterior margins of the lateral eyes passing through or a little behind the centres of the median eyes, the latter almost circular, slightly larger than the lateral eyes; the outer edges of the posterior median eyes at least as wide apart as the outer edges of the anterior lateral eyes; carapace with a patch of bristles before and behind the anterior median eyes.

Pedipalps with a broad band of shortish spines on the outer sides of the tibia and tarsus; the inner side of the tarsus with 4–5 longish spines distally; the inner side of the tibia with a single longish spine near the base; the tarsus with a tiny patch of 5–7 sharp spinules at the base on the outer part of the upper surface; the tibia without distal spinules above; the patella not spined.

Legs.—Tibia of first leg slightly shorter than the metatarsus and equal in length to the width of the anterior row of eyes; anterior surface of tarsus and metatarsus with a broad band of close-set, short, stout spines in the lower part; the posterior surface of these segments and of the tibia with a corresponding band of spines, but the inferiormost spines on the tibia and metatarsus longish; anterior side of tibia with a few (7–9) short distal spines; upper surface of metatarsus with a posterior basal patch of sharp spinules occupying about $\frac{1}{4}$ of the length of the segment; upper surface of tibia with a corresponding tiny distal patch of 10–12 spinules. Second leg spined like the first, except that there are only 2–4 spinules, besides the inferior row, on the posterior surface of the tarsus, only 3–5 on the anterior surface of the tibia, and about 20 in the upper distal patch on the tibia. Third leg with a few distal anterior and 0–1 posterior spinules on the tarsus; metatarsus with a band of about 10–12 spines arranged roughly in 2 rows along the upper part of the anterior surface and with a similar band of shorter spines along the posterior surface; tibia with a few stout distal spines on each side; patella with a few spines scattered along anterior surface; upper surface of tibia with a small distal patch of red spinules occupying about $\frac{1}{3}$ of the length of the segment; the base of the metatarsus with a few similar spines above; patella without spinules at the distal edge; metatarsus without apical tuft of bristles below. Fourth leg without posterior spines, the 3 distal segments with some scattered spines on the anterior surface; anterior part of upper surface of patella with a dense patch of sharp red spinules, the length of the patch less than $\frac{1}{2}$ that of the upper side of the segment; metatarsus with an infero-posterior apical transverse row of 6–7 equal setæ.

Measurements.—Total length 29 mm.; length of carapace 9, width 8; width of ocular area $4\frac{1}{2}$; length of tibia of first leg $3\frac{1}{2}$, of metatarsus $3\frac{3}{4}$, of fourth metatarsus 4·9.

The characters afforded by the eyes distinguish this species sharply from any other hitherto described.

Gen. GORGYRELLA nov.

Sternum with 3 pairs of sagilla, all more or less remote from the margin, the posterior pair larger, oval, slightly further from the lateral margin opposite the base of the third leg than from one another, the 2 anterior pairs small, placed midway between the median line and the lateral margin opposite the bases of the first and second legs respectively, or the anterior pair nearer the lateral margin. Posterior part of under surface of the coxæ of first and second legs and especially the infero-posterior surface of that of third leg with a large area densely studded with minute, sharp, dentiform spinules. Lateral margins of carapace lightly sinuated above the base of the third leg on each side. Chelicerae produced at the inner angles in front into a prominent lobe, which bears about 5 short, stout, conical teeth on the sides and apex, the lateral part of the anterior edge of the chelicerae armed with a row of long bristles, with or without a short conical tooth near the lobe. Other characters as in *Acanthodon.*

Type: *G. namaquensis* n. sp.

Gorgyrella namaquensis n. sp.

(*a*) *Type:* 1 ♀ (No. 8469) found by Mr. A. W. Rogers and Mr. E. H. L. Schwarz near the foot of the western slope of the Giftberg, south of Van Rhyns Dorp, Cape Colony, during one of their expeditions in connection with the Geological Survey. The spider was found in a subterranean nest closed by a trap-door.

♀. *Colour.*—Carapace and limbs pale ochraceous, the chelicerae yellowish brown; abdomen dirty pale yellowish, without spots; coxæ of pedipalps and the labium reddish brown.

Carapace (measured laterally to the ocular area) as long as the tibia, metatarsus and $\frac{1}{2}$ the tarsus of fourth leg, and equal to the patella, tibia and $\frac{4}{5}$ of the metatarsus of first leg.

Ocular area wider than long, its length almost equal to the distance between the posterior lateral eyes, its width only very slightly less than the length of the metatarsus of first leg. The area formed by the anterior lateral and anterior median eyes slightly wider behind than in front, and about $1\frac{3}{5}$ times as long as wide behind; the median eyes slightly over an eye's diameter apart; the lateral eyes slightly larger, less than an eye's diameter apart, each situated on the anterior side of a low tubercle with the visual axis directed obliquely upwards at an angle of about 30° to the horizontal. The posterior row of eyes lightly procurved; the median ones the smallest of the 8, their distance apart slightly greater than their distance from the lateral eyes, their outer margins slightly further apart than those of the anterior median eyes; the lateral eyes much nearer to the anterior edge of the carapace than to one another.

Pedipalps with a band of long and short stout spines on the lower part of both the inner and outer surfaces of the tarsus and tibia; patella with a single internal spine; femur with a pair of stout, long, distal, internal spines, in addition to numerous, stout, spiniform setæ along the inner inferior edge.

Legs.—First leg with the tibia as long as the metatarsus and $\frac{1}{2}$ the tarsus; outer and inner surfaces of the tarsus, metatarsus, and tibia with a band of spines similar to those on the pedipalps, but the anterior band on the tibia abbreviated proximally, the tibia and metatarsus also often with a spine below; patella not spined, but with a few, stout, distal, spiniform setæ below. Second leg spined like the first, except that the proximal posterior spines of the tibia are long and setiform. Tarsus of third leg with a few distal spinules below; the metatarsus with a band of short spinules along both anterior and posterior upper edges and 0–1 distal setiform spine below; the tibia with a pair of similar but broader bands of spinules; the patella with the anterior band only, of which the distal 5–6 spines form a transverse row overhanging the distal edge of the segment, the posterior upper edge also with a pair of apical spinules. Fourth leg with a group of infero-anterior spinules distally on the tarsus, and with several pairs of similarly situated spines and spiniform setæ on the metatarsus; tibia with 0–1 external spine at the base; patella with a broad band of short spinules along the anterior upper edge.

Genital operculum with the posterior striæ on its surface near to the lightly convex posterior margin.

Measurements.—Total length 30; length of carapace $9\frac{1}{2}$, width $8\frac{1}{4}$; length of tibia of first leg 3·6; width of ocular area $2\frac{3}{4}$.

(*b*) 1 ♀, an old specimen labelled "Ookiep," Namaqualand Div., Cape Colony. (*C. Warden.*) Closely resembling the type, but the metatarsus of third leg with a distal inferior spine instead of a setiform spine, and the patella with 4 apical spinules at the upper posterior edge.

Gen. ACANTHODON Guérin.

1. Acanthodon cregoei n. sp.

Type : 1 ♂ (No. 981) found at Durban, Natal, by Mr. J. P. Cregoe, in October, 1896.

♂. *Colour.*—Brown, the distal segments of second leg and the 2 posterior pairs of legs more yellowish in parts; sternum pale yellowish; coxæ of legs pale yellowish, those of pedipalps brownish; abdomen black, the under side pale yellowish, the genital operculum brownish behind.

Carapace with a broad band of setiferous granules on each side on the cephalic portion, the thoracic portion sparsely granular; its length equalling that of the metatarsus together with $\frac{1}{4}$ of the tarsus of fourth leg, and that of the metatarsus together with $\frac{1}{2}$ the tarsus of first leg.

Ocular area very distinctly longer than wide. The area formed by the anterior median and anterior lateral eyes only very slightly wider in front than behind and almost twice as long as its posterior width; the median eyes about $\frac{1}{2}$ an eye's diameter apart; the lateral eyes slightly larger than the median eyes, much less than $\frac{1}{2}$ an eye's diameter apart, each situated on the anterior side of a very prominent tubercle with the visual axis quite horizontal. The posterior row of eyes procurved, the median ones small, a little nearer to the lateral eyes than to one another, their outer margins the same distance apart as those of the anterior median eyes.

Pedipalps.—Tibia turgid, about twice as long as the patella or tarsus and less than twice as long as high, its upper edge strongly convex, its lower edge also convex, the distal part of the infero-external surface deeply excavated in the form of a large concave notch, the proximal and outer margins of which are furnished with a broad semicircular band of short close-set spinules; tarsus provided with a group of spines on the apical dorsal prominence; the process of the bulb broad and strongly flattened at the base but rapidly narrowing to the middle, the distal half narrow, flattened, with slight spiral twist, dilated again at the apex, which is very obliquely truncated.

Legs.—First leg with the tibia equal to the metatarsus in length, slightly wider in the middle than the femur, slightly incrassated distally on the inner side and furnished here with 2 stout black processes, of which the distal and lower one is very broad and obtuse and bears a short spiniform process at its upper angle, the other process turgid, sharply conical at the apex; patella armed with a couple of subsetiform spines at the apex below; tibia armed below with 4 external but no internal spines; metatarsus very distinctly curved proximally (when seen from the side), concave also internally at the base and slightly incrassated internally at the end of the basal fourth, the eminence bearing one short spine and 3–4 stout spiniform setæ; distal part of metatarsus with 1–2 internal and 3 infero-external spines; tarsus with 1 internal and 1–2 external spines. Second leg with 2–3 slender spines at the apex of the patella below; the tibia with about 6 outer and 3 inner long slender spines below; metatarsus curved, with 1 internal and 2 external spines at the apex below and 3 others along the lower outer edge; tarsus with 1 inner and 3 outer short spines. Third leg with a band of short spinules along upper anterior edge of patella, only 1 or 2 of the distal stout spinules overhanging the distal edge, the posterior upper distal edge with 2–3 stout spinules; tibia with 7–9 short spinules along anterior upper edge, 1 on posterior surface and several slender spines or spiniform setæ on inferior surface; metatarsus slightly curved, with a number of spines below and several at the sides; tarsus with several spinules in front and behind. Fourth leg with a band of spinules along anterior upper edge of patella from the base to a little beyond the middle; tibia with setiform spines below; metatarsus slightly curved, with setiform spines below, including 3 at the apex; tarsus with 2 posterior and several anterior spines. All the tarsi scopulate below. Metatarsi not scopulate.

Sternum with 2 pairs of small sagilla opposite the bases of the legs of the first and second pairs.

Measurements.—Total length 11; length of carapace $4\frac{2}{3}$, width 4; length of tibia of first leg 3·6.

Related to *A. thorelli* (Cambr.), but in the latter the area formed by the anterior median and lateral eyes is wider behind than in front.

2. Acanthodon kolbei n. sp.

Types: 2 ♀ from the Kentani District in the Transkei, Cape Colony (No. 4543, *Dr. F. C. Kolbe*).

♀. *Colour.*—Carapace yellowish brown; chelicerae dark brown; pedipalps and the 2 anterior pairs of legs brown, the 2 posterior pairs yellowish brown to brownish yellow; sternum brownish yellow, darker at the lateral and posterior margins; the labium and the coxæ of the pedipalps brown, the coxæ of posterior legs pale yellowish, those of anterior legs brownish yellow; abdomen pale yellowish, with black hairs, the upper surface more or less provided with infuscate reticulation along the median region, the setiferous tubercles also infuscated, the genital operculum brown.

Carapace (measured on the outer side of the frontal eye tubercles) as long as the tibia, metatarsus and about $\frac{4}{5}$ of the tarsus of fourth leg, and as the patella, tibia and about $\frac{4}{5}$ of the metatarsus of first leg.

Ocular area as long as or very slightly longer than wide, its width from slightly over $\frac{1}{2}$ to nearly $\frac{3}{5}$ of the length of the metatarsus of first leg. The area formed by the anterior lateral and anterior median eyes very distinctly wider in front than behind and about twice as long as its posterior width; the median eyes less than an eye's diameter apart; the lateral eyes a little larger, about an eye's diameter apart, each situated on the anterior side of a very prominent tubercle with the visual axis quite horizontal, the upper margin of the eye a little lower than the summit of the tubercle but the lower margin scarcely raised above the level of the carapace. The posterior row of eyes rather strongly procurved, the median eyes very small, very distinctly nearer to the lateral eyes than to one another, their outer margins very distinctly wider apart than those of the anterior median eyes; the lateral eyes much nearer to the anterior edge of the carapace than to one another.

Pedipalps spined as in *Gorgyrella namaquensis* (p. 351), the femur with 2–3 stout distal spines and with slender setæ.

Legs spined much as in *Gorgyrella namaquensis*. First leg with the tibia as long as the metatarsus and $\frac{1}{2}$ the tarsus, the anterior band of spines on the tibia reaching to the base; the under side not spined mesially. Second leg also spined to the base on the anterior side of the tibia. Metatarsus of third leg with the lateral spines of moderate length, the under side with a couple of spiniform setæ and 1–2 long apical spines; tibia with a narrow band of short spinules along anterior upper edge, the posterior upper edge with only a couple of spinules; the anterior band of short spinules on the patella abbreviated proximally, with none or only 1–2 of the distal spinules overhanging the distal edge of the segment, and with only 1 posterior distal spinule above. Fourth leg with a band of several, long, stout spines on lower surface of the metatarsus; the tibia with a long, slender, apical spine below; the patella with a small band of about a dozen short spinules at the base along upper anterior edge, the band not reaching to the middle of the segment.

Sternal sagilla very small but distinct, quite marginal, 1 opposite the base of each of the legs of the first 2 pairs. *Labium* with 2–3 apical teeth in a single row.

Abdomen sparsely tuberculate above.

Measurements.—Total length 20; length of carapace $8\frac{1}{2}$, width 6·6; length of tibia of first leg 3·4; width of ocular area 1·8.

This species may possibly be the ♀ of *cregoei*, in which, however, the outer margins of the anterior median eyes are as far apart as those of the posterior median eyes and almost as far apart as those of the anterior lateral eyes.

The nest, which was also obtained by Dr. Kolbe, is tubular, about 10 mm. in diameter throughout its greater part, but at about 10 mm. from the opening it commences to widen gradually and reaches 15 mm. at the opening. The edges of the tube expand horizontally at the opening and form a broad rim about 4 mm. wide round two-thirds of the circumference. The lid is flat and not thickened, merely closing against the rim. The hinge is very broad, being nearly as broad as the greatest diameter between the outer edges of the rim. Greatest width of lid (taken parallel to hinge) 24 mm., least width (at right angles to hinge) 17 mm., width of hinge 20 mm.

Gen. CYRTAUCHENIUS Thor.

1. Cyrtauchenius o'neili n. sp.

Type: 1 ♀ (No. 8506) found by the Rev. J. A. O'Neil at Dunbrody on the Sundays River, Uitenhage Div., Cape Colony.

♀. *Colour.*—Carapace chestnut-brown, the lateral borders narrowly white for some distance behind, the white border produced on its medial side just opposite the space between the third and fourth legs; chelicerae reddish black; femora of pedipalps and of first 2 pairs of legs strongly infuscated, the patellæ, tibiæ and part of the metatarsi ochraceous above and below but infuscated at the sides, the tarsi and distal part of the metatarsi blackish brown to nearly black; the 2 posterior pairs of legs pale ochraceous to brownish yellow, lightly infuscated in parts, especially at the sides, the femora infuscated above; abdomen pale yellowish, the sides and upper surface dark violet-brown anteriorly; sternum pale yellow, broadly infuscated at the sides; coxæ of pedipalps brownish red, those of the legs pale yellowish below, the anterior ones lightly infuscated in places.

Carapace $\frac{1}{4}$ longer than wide, as long as the tibia and metatarsus of fourth leg and as the tibia, metatarsus and tarsus of first leg.

Ocular area scarcely more than twice as wide as long; the anterior row only slightly narrower, lightly procurved, the eyes equidistant, the laterals much larger than the small medians, which are situated on a tubercle; the posterior row transverse, the laterals subreniform, larger than the medians but slightly shorter than the anterior laterals; the posterior laterals ½ their long diameter from the anterior laterals and much less than this distance from the posterior medians; the posterior median eyes elongate, much further from the anterior median eyes than from the posterior lateral eyes, their distance from the latter being only ½ their lesser diameter.

Pedipalps with 1 external and 0–1 internal basal spines below on the tarsus and with 4 apical spines below on the tibia.

Legs.—Tarsi and metatarsi of first and second pairs of legs thickly scopulate to the base (basal half of second metatarsus on inner side only). Tarsus I with a couple of short distal spinules externally, almost hidden in the scopula, II with 3–4 short outer spines, III and IV strongly aculeate externally and with a few distal spinules below, III also with a posterior dorsal series. Metatarsus I with 3 apical, 2 middle and 2 basal spines below, II with 2–3 apical, 3 middle and 2 basal spines below, III numerously spined on both outer and inner surfaces above and with several pairs of long spines below, IV numerously spined along inferior outer surface and with 2 inner spines above. Tibia I and II each with a single strong apical spine below, III and IV with a pair of long apical spines below, III also with 3–6 anterior, 3 posterior dorsal, and 2 distal posterior short spines, IV also with 2 spines on the inner surface and with a row of paired spiniform setæ on the under surface. Patella III covered with short spines on the anterior surface, the dorsal surface with 1–2 stout posterior spines, IV with short sharp spinules at the base externally. Femur IV with a dense group of strong short spines at the apex above and externally. Claws of anterior legs with 5–6 teeth in each row, those of posterior legs muticous.

Posterior sternal sagilla very large, pear-shaped, near to the median line, their distance apart about ½ their length and less than their distance from the lateral margin, the sagilla opposite the bases of the second pair of legs of moderate size, quite near the margin, the anterior sagilla marginal and small.

Coxæ of pedipalps with 4–6 inconspicuous very minute granules along the basal edge anteriorly. Coxæ of fourth leg with the median basal naked area short, occupying only about ⅙ of the length of the segment; the similar area on the under side of the third coxa long oval, reaching to the middle of the segment.

Apical segment of *posterior spinners* ½ longer than the penultimate segment and much longer than the ocular area.

Measurements.—Total length 24; length of carapace 8, width 6¼.

2. Crytauchenius lateralis n. sp.

Type: 1 ♀ (No. 4232) from Dunbrody on the Sundays River, Uitenhage Div. (*Rev. J. A. O'Neil*).

♀. *Colour.*—Carapace dark chestnut-brown, the lateral borders white behind for some distance, the white part widened angularly on its median side between the bases of the third and fourth legs, the cephalic portion darker at the lateral margins and provided with a broad median dark band; chelicerae dark brown; legs pale ochraceous, the femora and the sides of the more distal segments more or less infuscated; abdomen pale yellowish below, tinged with violet-brown at the sides and above, especially at the base; sternum pale yellowish, broadly infuscated at the sides; coxæ pale yellowish, lightly infuscated.

Carapace at least $\frac{1}{3}$ longer than wide.

Ocular area slightly more than twice as wide as long and very slightly wider behind than in front, the hind margins of the anterior eyes in a straight line, the anterior margins of the posterior eyes also in a straight line, but the posterior margins forming a strongly recurved line; posterior lateral eyes much larger than the anterior median eyes and scarcely smaller than the anterior lateral eyes, scarcely further from the latter than from the posterior median eyes, which are round and only slightly smaller than the small anterior median eyes and twice as far from the latter as from the posterior lateral eyes; lateral eyes only $\frac{1}{3}$ of their long diameter apart, the posterior ones not or scarcely reniform.

Pedipalps spined below on the tarsus and tibia, the coxæ muticous.

Legs.—Tarsi I and II with a short distal inferior spine, III with several anterior and inferior spines and a posterior dorsal row of 4 spines, IV with numerous short external spines and a number of longer distal ones below. Metatarsi I and II with 3 apical, 2 middle and 2 basal spines below, most of them, particularly the apical ones, powerful; III with a number of spines along the upper part of anterior surface, a uni- or bi-seriate series along the postero-dorsal edge, and a number of long spines below, especially at the apex; IV with numerous, long, stout spines below, and a row of 2–3 along the inner upper edge. Tibiæ I and II each with a single, stout, apical, outer spine and several other long setiform spines below; III and IV with a pair of long apical spines below, III also with 8–9 upper anterior, 2 postero-dorsal, 1–2 dorsal, and 2 distal posterior spines, IV also with 2 internal spines above and a double series of long spiniform setæ below. Patella III covered with short spines on the anterior surface, and with 2 stout spines along the postero-dorsal margin, IV with a few, short, dark spinules at the base externally. Femur IV with a dense group of short, stout, apical spines above and externally. Claws of anterior legs with about 6 teeth in each row; inner claw of posterior legs with a row of 4 short teeth at the base and a row of 3 teeth at the middle, the outer claw with 1 short basal tooth. Tarsus of first and second legs rather thickly scopulate, the metatarsus of first leg with the scopula absent from the proximal half, metatarsus of second leg slightly scopulate at the apex only.

Posterior sternal sagilla very slightly more than their own length apart and about ½ their length from the lateral margin.

Posterior spinners with the apical segment about ½ longer than the penultimate segment (measured along under side).

Measurements.—Total length 18; length of carapace 5·8, width 4·2.

3. Cyrtauchenius nigriceps n. sp.

Type.—1 ♂ (No. 4204) from Johannesburg, found by Mr. J. P. Cregoe.

♂. *Colour.*—Carapace reddish yellow, the cephalic portion blackish red; cheliceræ black; legs and pedipalps, including the coxæ, and the sternum pale ochraceous; abdomen pale yellowish below and at the sides, blackish brown above.

Carapace a little more than ¼ longer than wide, with a row of stout, curved, marginal spines on each side above the bases of the 2 posterior pairs of legs, the upper surface also with a group of setæ and sigmoid spines posteriorly.

Ocular area about 2⅓ times as wide as long, the sides subparallel; the anterior row of eyes very slightly procurved, the lateral eyes only about ⅓ longer than the medians, the latter rather large, slightly further from one another than from the lateral eyes; the posterior row of eyes transverse, their anterior margins forming a slightly procurved, their posterior margins a slightly recurved line, the laterals as far or slightly further from the anterior lateral eyes than from the posterior median eyes, shorter than the former but much larger than the latter and about as long as the anterior medians, which are much larger than the posterior median eyes.

Pedipalps unspined; the tibia long, lightly convex along the under side; the tarsus short, truncated; the bulb subglobular, its process slender, about as long as the bulb, with short spiral curve, the distal portion very fine and filiform, ending in a fine point.

Legs.—All the tarsi scopulate to the base. Metatarsus of first leg much slenderer than the tibia, lightly concave internally, equal in length to the tibia and a little longer than the distance from the centre of the fovea to the anterior margin of the carapace but not quite twice as long as the tarsus. Metatarsi I and II scopulate distally for about $\frac{1}{3}$ of their length. Tarsus I unspined, II with 4 small outer spines, III with several internal and a number of external spines, some of the latter stouter, IV with a distal group of small spines internally and a double series of longer spines externally. Metatarsus I with 1 inner and 2 outer apical spines and an outer row of 2 other spines below, the inner surface also with a stout spine near the base; II with 2–3 apical and 3 other stout spines at or near the outer inferior margin, 1 apical inner spine and with or without another inferior and a superior inner spine; III numerously spined on all sides; IV numerously spined below, with a row of 3 spines along the inner upper edge. Tibia I with 9–10 strong spines along the inner surface, including a distal pair, and a row of 6–8 similar spines along the outer inferior edge, II with long spines below and 3 spines along the inner upper edge, III spined on all the surfaces, the anterior surface with a broad band of about a dozen short spines, IV with 3 apical spines and several pairs of long setiform spines below, the inner surface with about 4 spines above. Patellæ I and II with an apical spine below, I also with 3 and II with 2 spines along upper inner edge, III with numerous short spines on the anterior surface and a row of 3 stout spines on the dorsal surface, IV with a stout apical spine below. Femora with several rows of spines above, IV with a distal group of short stout spines at upper outer edge. All the claws with a double series of teeth below, the anterior claws with about 6–8 teeth in a row, those of fourth leg with 4–6 teeth in each row.

Abdomen spined near the base above.

Posterior spinners with the apical segment apparently a little longer, or at least not shorter, than the penultimate segment (seen from below).

Posterior sternal sagilla moderately large, their distance apart scarcely exceeding their length but distinctly exceeding their distance from the lateral margin.

Measurements.—Total length 14; length of carapace $5\frac{3}{4}$, width $4\frac{1}{2}$; length of metatarsus of first leg 3·8.

Gen. HOMOSTOLA Sim.

Homostola zebrina n. sp.

(*a*) *Types:* 3 ♀ (No. 8445) from Pietermaritzburg, collected by Mr. Claude Fuller, Government Entomologist of Natal.

♀. *Colour* (in spirits).—Carapace pale yellow (or testaceous yellow, with the sides of the thoracic portion pale yellow), the cephalic portion with a broad, faintly infuscate, median stripe in the middle and a narrow, darker, median line behind, the lateral borders of the cephalic portion dark brown, the fovea broadly infuscated, with some short infuscate lines radiating from it; legs and pedipalps pale yellow to ochraceous; cheliceræ reddish black to blackish brown; sternum pale yellow, the sagilla and the anterior part often yellowish brown; the coxæ, including those of the pedipalps, either all pale yellowish, or the anterior ones yellowish brown; abdomen pale yellowish, the upper surface with numerous dark brown spots and stripes, amongst which an interrupted median stripe and several pairs of transverse stripes may be distinguished, the under surface with a dark spot on each side behind.

Eyes all placed on the ocular tubercle, the eyes of the anterior row equally distant from one another or the medians slightly nearer to each other than to the lateral eyes, the hind margins of the eyes in a straight line or almost so, the laterals large, less than their smaller diameter from the margin of the carapace, much larger than the median eyes. The posterior row as wide as the anterior row, the anterior margins of the eyes in a straight line or almost so, the lateral eyes larger than the anterior medians but smaller than the anterior laterals, their distance from the latter and from the posterior medians about $\frac{1}{3}$ of their long diameter.

Legs.—Tibia of first leg as long as the metatarsus and $\frac{1}{3}$ of the tarsus. All the tarsi without spines. Metatarsi I and II with 2 apical and 1–2 other outer spines below, II often with a small inner spine below in addition; III and IV with paired spines below and with strong spines along both the outer dorsal and inner dorsal edge. Tibia I without spines, II with several stout setiform spines below, III with a pair of long apical spines, followed by a couple of long setiform spines below, the posterior surface with 1 apical and 1 superior basal spine, the anterior surface with 2 superior spines near the middle, IV with a pair of apical spines followed by several stout spiniform setæ below, the inner surface with 2–3 stout spines in a row. Patella III with a row of 2–3 very stout spines on anterior surface and a broad band of short setiform spinules along antero-dorsal surface, IV with a short band of similar spinules at the base. Femur III with a transverse apical row of short setiform spines at the outer dorsal edge, IV with a group of short spines and short setiform spines at the apex above. Tarsi and metatarsi of first and second legs thickly scopulate to the base. Claws of first leg biseriately dentated below, the basal row composed of 4–5 teeth, of which the distal one is longest, the row nearest the axis of the leg composed of a single small tooth or tubercle nearer the middle of the claw; claws of fourth leg with 3 unequal teeth at the base, the inner claw with an additional tooth near the middle, nearer the axis of the leg.

Coxæ of pedipalps with a large group of teeth at the base in front; the *labium* with an apical row of 5–6 and a second row of 2–4 teeth.

Apical segment of *posterior spinners* a little over $\frac{1}{2}$ as long as the penultimate segment.

Measurements.—Total length of largest ♀ 23; length of carapace $8\frac{1}{2}$; length of tibia of first leg $3\frac{1}{2}$.

Closely allied to *H. vulpecula* Sim. from Zululand, but the latter is said to have the legs and abdomen dark fulvous and 6–7 teeth on the claws of the posterior legs.

(*b*) In the Museum is also an old dried ♀ specimen without abdomen from Durban, Natal, collected by Colonel J. H. Bowker.

Gen. STICTOGASTER nov.

Carapace almost glabrous, slightly more than $\frac{1}{4}$ longer than wide; the cephalic portion in the ♀ strongly convex; the thoracic portion depressed, the fovea deep and wide, procurved. Ocular area parallel-sided, a little over twice as wide as long, all the eyes situated on the tubercle, the anterior row lightly procurved, the posterior row slightly or more strongly recurved, the posterior lateral eyes very close to the posterior medians and much further from the anterior lateral eyes, the lateral eyes equal or the posterior ones somewhat smaller than the anterior ones; the eyes of the anterior row equidistant from one another, the laterals scarcely twice as large as the median eyes. Posterior sternal sagilla moderately large, oval, about their own length from the lateral margin and slightly over to $1\frac{1}{2}$ times that distance apart, the 2 anterior pairs small, those opposite the second pair of legs nearly twice their own length from the lateral margin; the 3 sagilla of each side almost in a straight line. Labium about $1\frac{1}{2}$ times as wide as long, its anterior part thickly covered with numerous teeth. Maxillæ wide, with a group of teeth at the base in front. Cheliceræ with 2 rows of 7–10 teeth each below and a few additional teeth between these posteriorly, the anterior teeth of the outer row strong, commencing far forwards; the anterior edge armed on the inner part with a row of about 4 large, broad, subequal spines, and in the outer part with a row of long setiform spines intermixed with some short sharp ones. Tarsus of pedipalp with several short spines below, those of the legs unspined. Tarsus and distal part of metatarsus of first leg and the tarsus of second leg with a thin scopula of short hairs, tarsi of third and fourth legs thickly covered below with fine bristles. All the metatarsi and tibiæ with strong spines or spiniform setæ. Claws of anterior legs biseriately dentate, with several teeth in each row; claws of fourth leg with a basal row of teeth. Metatarsi of anterior legs much longer than the tarsi. Coxæ as in *Homostola* Sim., the coxæ of the third and fourth legs having the inferior medio-basal naked area quite short but that at the anterior lower edge long, reaching beyond the basal third of the segment. Posterior spinners with the apical segment short and hemispherical.

Type: *S. reticulatus* n. sp.

This genus falls into Simon's group *Cyrtauchenieæ*, and appears to be related to *Aptostichus* Sim. or *Homostola* Sim. and especially to *Bessia* Poc.

Stictogaster reticulatus n. sp.

Types: 2 ♀ from Bonnie Vale Farm at Bushmans Drift on the Breede River, Swellendam Div. (near Ashton), found by Mr. Charles Groom.

♀. *Colour* (in spirits).—Carapace pale greenish yellow (the cephalic portion and the region round the fovea brownish yellow in one specimen), faintly infuscated, the cephalic portion with brown lateral borders and with or without an infuscate median line; chelicerae yellowish brown; legs pale greenish yellow, the upper surface of the patellæ and tibiæ and often also the greater portion of the distal segments pale ochraceous; abdomen pale yellowish, the upper surface thickly covered with an irregular network of purplish black, in which an irregular median stripe may be made out, the under surface with some scattered black marks on its posterior half and a few also on the medial side of the posterior lung-books.

Eyes of the anterior row with their hind margins forming a slightly procurved line, their distance apart equalling or a little exceeding the diameter of the median eyes, the lateral eyes not very large, scarcely twice as long as the median eyes, their distance from the margin of the carapace less than their shorter diameter; the eyes of the posterior row with their anterior margins forming a slightly or considerably recurved line, the median eyes subequal to or only slightly smaller than the anterior median eyes, the posterior lateral eyes as long as or a little shorter than the anterior lateral eyes and separated from them by $\frac{1}{2}$ or more than $\frac{1}{2}$ their long diameter but much nearer to the posterior median eyes.

Legs.—Tibia of first leg equal to the metatarsus and $\frac{1}{6}$ or less of the tarsus. Metatarsi I and II with 2–4 apical, 0–1 inner, and 2 outer strong spines below, II with 1–2 strong spines along the upper inner edge as well, III with 3 apical, 0–1 outer, and 2 inner spines or spiniform setæ below, and with 2 outer and 3 inner spines at or near the upper margin, IV with several pairs of spines below and a row of 2 along the upper inner edge. Tibiæ I and II with a couple of long setiform spines below, II with or without an upper inner spine in addition, III with 1–2 outer apical spines or spiniform setæ below, 1–2 dorsal spines and 1 short apical internal spine, IV with a number of long spines and setiform spines below and with or without 2–3 spines or spiniform setæ along the inner surface. Patella III with a row of about 6 short stout spines along anterior surface, accompanied by short stout setiform spines, IV with numerous stout spiniform setæ along upper outer surface. Femora as in *Homostola zebrina* (p. 360), Claws of first leg with 3, sometimes 4, teeth in the basal row, of which the distal tooth is longest, the row nearest the axis of the leg more distal, composed of 2–3 small teeth; claws of fourth leg with 2–3 basal teeth.

Labium with about 25 teeth in 4–5 rows.

Apical segment of *posterior spinners* $\frac{1}{2}$ as long as the penultimate segment.

Measurements.—Total length 20; length of carapace 7, width $5\frac{1}{2}$; length of tibia of first leg $3\frac{1}{2}$.

Gen. HERMACHASTES Poc.*

1. Hermachastes lightfooti n. sp.

Types: 8 ♂ (Nos. 657, 8543, 8550) and 2 ♀, all from the Cape Town side of Signal Hill, found under stones.

♂. *Colour.*—Carapace pale ochraceous, the cephalic portion often faintly infuscated, more darkly so along the median line and towards the lateral borders; cheliceræ, pedipalps, and legs pale ochraceous; sternum and under side of the coxæ of legs pale yellowish; under surface of abdomen and the greater part of the lateral surface (also in the posterior part) pale yellowish, with a large spot above and a small one in front of each of the posterior spinners; the upper surface of the abdomen with an irregular black pattern, showing

* In all the species of this genus the inferior claw of the legs is large and very distinct, and the ocular area is at least twice as wide as long. In the ♀ and young the claws of the legs are biseriately dentate below, one of the rows being more distal than the other although both generally overlap for a portion of their length; in the ad. ♂ the two are united to a single, long, spirally curving, numerously toothed row.

numerous small and some large, pale yellowish spots (the latter sometimes arranged in a double series) but without the well-defined, obliquely transverse stripes found in *H. collinus* Poc., &c.

Carapace as long as the metatarsus and $\frac{1}{3}$–$\frac{2}{5}$ of the tarsus of fourth leg, and subequal to or a little shorter than the tibia and metatarsus but longer than the metatarsus and tarsus of first leg; bottom of fovea transverse.

Chelicerœ longish, with 10–11 large teeth in the inner row below; the under side (measured along the middle of the groove) almost as long as the sternum or longer.

Labium and coxæ of pedipalps muticous.

Posterior spinners with the distal segment subequal to or even exceeding the penultimate in length; anterior spinners $1\frac{1}{2}$ to twice their diameter apart.

Pedipalps.—Process shorter than the bulb, curved and moderately slender.

Legs.—Tarsi muticous. Metatarsus I straight, the under surface without spines, excepting 2 (sometimes 1 or 3) along the inner and also along the outer edge, the inner surface besides with 2 large curved spines near the middle and a smaller spine near the apex (the latter sometimes absent), the outer surface also with a couple of spines in addition to those along the lower edge; II spined much as I, but the middle of the segment generally with only 1 spine on the inner surface and none at the inner inferior edge; III and IV numerously spined. Tibia I with 2 stout, spur-like, distal spines, each raised on a low tubercle, the apical spur broad, simply curved, situated on the inner inferior edge, the other spur longer and slenderer, with sigmoid curvature, situated in the middle line of the inner surface at a little distance ($\frac{1}{4}$–$\frac{1}{5}$ of the length of the segment) from the apex; under surface of tibia with 1 slender, inner, apical spine and 3 spines along the outer edge, the outer surface with 0–1 and the inner surface with 1–3 other spines in addition; tibia II with several spines below, a couple on the inner surface, and 0–1 on the outer surface; III and IV with a number of spines. Patella III with a row of 3 spines on the outer surface and often also an apical spine at the inferior outer edge. Femora spined above. Tarsi I and II scopulate to the base, metatarsi I and II broadly scopulate below almost to the base, the row of setæ dividing all these scopulæ composed of small fine bristles; tarsus III with a mesial band of longer setæ and a narrow band of scopular hairs on each side of it below; metatarsus III with a thin scopula, excepting in the basal part.

♀. *Colour* as in ♂, or the whole carapace faintly infuscated and most of the leg segments more or less tinged with olive-greenish.

Carapace as long as the tibia and metatarsus of fourth leg but slightly exceeding the tibia, metatarsus, and tarsus of first leg; bottom of the fovea very distinctly or only slightly procurved.

Cheliceræ as in the ♂, but the under side longer than the sternum.

Posterior spinners with the apical segment shorter than the penultimate segment but exceeding half its length; anterior spinners separated by about twice their diameter or more.

Labium with 2–4 apical teeth in a single row. Coxæ of pedipalps with 2–4 teeth at the base.

Pedipalps with some spines on the tarsus and tibia below.

Legs.—Tibia of first leg equal in length to the metatarsus. Tarsi without spines, the anterior ones furnished below with numerous longish hairs and fine bristles but not distinctly scopulate, the posterior ones with stouter bristles. Metatarsi I and II with one apical inner and 1–2 outer spines below, III and IV with 3 strong apical spines below, 3 spines along the posterior upper edge, and 2 along or near the anterior upper edge, IV also with 2–4 other spines below in 2 rows. Tibiæ I and II without spines, II with some stout spiniform setæ below, III and IV with 1–2 apical spines and some paired spiniform setæ below, III also with 1 distal spine and 1 superior basal (often setiform) spine on the posterior surface, 1 posterior basal spine on the dorsal surface, and 1 stout submesial spine on the anterior surface, IV with a stout distal spine and a couple of more proximal and slenderer spines or spiniform setæ on the inner surface. Patella III with a row of 3 stout spines on anterior surface. Femur IV with an apical transverse row of stout setæ and setiform spines on the outer and upper edges. Claws of anterior legs with 2–4 teeth in the basal row and 2–4 small teeth in the row nearest the axis of the leg, the latter row wholly distal to the former; claws of fourth leg with 2 teeth in the basal row, the inner claw also with a more distal row of 2–3 teeth, the outer claw with or without a small, more distal tooth nearer the axis of the leg.

Measurements.—Total length ♂ $9\frac{3}{4}$–$12\frac{1}{4}$, ♀ $14\frac{1}{3}$; length of carapace ♂ $4\frac{1}{5}$–$4\frac{1}{2}$, ♀ 5.

This species has relatively short legs and long cheliceræ.

2. Hermachastes sagittarius n. sp.

(*a*) *Type:* 1 ♂ (No. 7814) found under a stone at Brandvlei, Worcester Div., by myself.

♂. *Colour.*—Pale ochraceous; the cephalic portion of the carapace with a median and 2 lateral, well-marked, fusco-olivaceous bands; the under side of the sternum, coxæ, and especially of the posterior femora very pale, almost white; the abdomen coloured as in *H. lightfooti*, except that the black of the upper surface forms a series of well-marked, obliquely transverse stripes, separated by broader parallel bands of pale yellow and united along the median line.

Carapace equal in length to the metatarsus and $\frac{1}{5}$ of the tarsus of fourth leg, and to the metatarsus and $\frac{3}{4}$ of the tarsus or the tibia and $\frac{3}{5}$ of the metatarsus of first leg; fovea slightly recurved.

Cheliceræ slender, with 8–10 teeth in the inner series, the under side (measured along the groove) distinctly less than the sternum in length.

Labium and *coxæ* of pedipalps muticous.

Posterior spinners with the apical segment subequal to the penultimate segment.

Pedipalps.—Process shorter than the bulb, strongly curved and rather stout, but not so stout as in *H. collinus*, the apex bluntish.

Legs.—Tarsi muticous. Metatarsus I straight, except quite at the base, where it is concave below, the under surface without spines, excepting an apical one at the inner and 3 along the outer edge, the inner surface besides with 4 large curved spines in a row, the 2 proximal ones with slight sigmoid curvature, the outer surface also with 1–2 spines in addition to those along the inferior edge; II spined as in I, excepting that there are only 2 slender spines on the inner surface instead of the 4 spines; III and IV numerously spined. Tibia I as in *H. lightfooti*, except that the more proximal spur is almost or quite as broad as, and only a little longer than the apical spur and without well-marked sigmoid curvature, while there are 2 spines along the inferior inner edge, of which the distal one is stoutish, spur-like, and situated on the base of the tubercle which bears the large apical spur; tibiæ II–IV as in *H. lightfooti*. Patellæ all with 1–2 spines, III also with an anterior row of 3 spines. Femora, claws, and scopulæ as in *H. lightfooti*.

(*b*) 2 large and 2 smaller ♀ and 3 nearly mature ♂ (No. 3313) from round the village of Worcester, found by Mr. R. M. Lightfoot. As the young males do not appear to differ from the females except in the shape of the apical segment of the pedipalps, the following description applies to them as well.

♀. *Colour* as in the ♂, but the carapace faintly infuscated, excepting on the pale ochraceous band on each side of the dark median stripe of the cephalic portion; the cheliceræ also for the most part weakly infuscated; under side pale ochraceous; the femora of the legs often faintly tinged with greenish.

Carapace as long as the metatarsus and tarsus of fourth leg and almost as long as the tibia and metatarsus of the first leg in the large ♀ ; fovea transverse, sometimes very slightly procurved.

Chelicerœ stouter, with 8–9 teeth in the inner series, the under side almost equalling the sternum in length.

Posterior spinners with the apical segment only about ½ as long as the penultimate segment.

Labium with 2–4 apical teeth. *Coxœ* of pedipalps with 15–30 teeth at the base.

Tibia of first *leg* equal to the metatarsus in length. Anterior tarsi scopulate below. Metatarsi I and II with 2 (sometimes 3) inner and 3 outer spines below, II often also with an inner dorsal spine, III and IV also spined. Tibiæ I and II with 1–3 apical spines and several setiform spines below, and often also with 1–2 spines or setiform spines at the upper inner edge ; III and IV with 2–3 apical spines and some paired spiniform setæ below, III also with 1 distal, 0–1 middle and 1 superior basal spine on posterior surface, 1 posterior basal spine on dorsal surface, and 1–2 spines along the middle of the anterior surface, IV with a row of (generally 3) spines and setiform spines along the inner surface. Patella III, with 3 stout spines along the anterior surface. Femur IV with a group of stout spiniform setæ along the anterior and upper apical edges. Claws with about 5 long teeth in the basal row furthest from the axis of the leg ; the row nearest this axis more distal but still opposite to the other row for a considerable portion of its length and composed of 7–9 teeth in the anterior legs, but almost entirely distal to the other row and composed of only 5–6 (sometimes only 4) teeth in the fourth pair of legs.

Measurements.—Total length ♂ 10½, ♀ 19½ ; length of carapace ♂ 4¼, ♀ 6⅓, width ♂ 3·4, ♀ 4·9.

The specimens from Worcester and the ♂ from Brandvlei all evidently belong to the same species, the localities being only half a dozen miles apart.

3. Hermachastes validus n. sp.

Types : 1 ♂, 1 large and 5 smaller ♀, dug out of the earth at Bonnie Vale Farm near Bushmans Drift on the Breede River, Swellendam Div. (near Ashton), by Mr. Charles Groom.

♂. *Colour.*—Carapace strongly infuscated ; chelicerae brownish black, reddish near the base ; femora strongly infuscated above and distally at the sides, the sides and under surface otherwise pale ochraceous ; tibia of first leg blackish red all round, the metatarsus and tarsus also red ; the remaining segments of the other legs pale ochraceous and more or less infuscated, the distal segments being paler; coxæ and sternum pale ochraceous; abdomen very pale yellowish, marked as in *H. sagittarius.*

Carapace as long as the metatarsus and $\frac{1}{3}$ of the tarsus of fourth leg, and equal to the metatarsus and about $\frac{4}{5}$ of the tarsus or the tibia and $\frac{3}{5}$ of the metatarsus of first leg. Fovea strongly recurved.

Cheliceræ with 11–14 teeth in the inner row below, the under side (measured along the groove) considerably shorter than the sternum.

Labium and *coxæ* of pedipalps muticous.

Posterior spinners with the apical segment slightly more than $\frac{1}{2}$ as long as the penultimate segment (measured below).

Pedipalps.—Tibia strongly gibbous on the outer surface at the commencement of the distal third; the process of the palpal organ shorter than the bulb, strongly curved, stout, broad and flattened, the apex somewhat pointed.

Legs very stout; the tarsi muticous. Metatarsus I lightly but distinctly curved, the under side lightly concave, without spines, excepting an apical one at the inner and 3 along the outer edge, the inner surface besides with 3 long, lightly curved spines in the basal half and a small distal one, all in a row, sometimes also with a short mesial spine at the upper inner edge, the outer surface also with a mesial spine; II spined much as in I, but the inner inferior edge with an additional spine in the middle; III and IV numerously spined. Tibia I short and stout, its dorsal length only about $2\frac{1}{5}$ times its height distally, the segment strongly incrassated below distally, the apical tubercle rather large, bearing 2 short, blunt, very broad, lightly curved, subequal, spur-like spines, of which the outer one (representing the inner, apical, inferior spine of the previous species) is narrower than the inner, and separated from it by a conical process of the tubercle, which fits into a concavity at the base of the inner spur; the more proximal tubercle on the inner surface bearing a larger, very strong, spur-like spine with strong sigmoid curvature; under side of tibia with an apical outer spine, 3 spines in the middle and a pair at the base, the inner surface also with a row of 3 spines above and the outer surface with 1–2 spines in the upper part; tibia II with several spines below, 3 along the upper inner edge and 1 on the outer surface. All the patellæ spined, III with the usual anterior row of 3 spines. Femora spined above. Tarsi I–III with a thick, very wide scopula, divided by a broad dense band of bristles, IV also scopulate below. Metatarsi I and II also scopulate, except in the basal part, the scopulæ divided by a band of bristles, III with a thin patch of scopular hairs in the distal part.

♀ *Colour.*—In the largest example the cheliceræ are black, the carapace and the femora of the legs very dark olivaceous brown, the 2 longitudinal bands on the cephalic portion of the carapace and the remaining leg segments reddish ochraceous, and the under side of the coxæ and the sternum fuscous-brown. In all the other, presumably not quite mature, examples, the chelicerae, the carapace, the femora of the legs, the under side of the coxæ and the sternum are pale greenish or yellowish green, the 2 longitudinal stripes on the cephalic portion of the carapace and the remaining leg segments pale ochraceous. The abdomen is as in the ♂.

Carapace slightly longer than the metatarsus and tarsus of fourth leg, but a little shorter than tibia and metatarsus of first leg (in the younger examples longer than these segments of the first leg). Fovea more or less distinctly procurved or merely transverse.

Cheliceræ with about 10 teeth in the inner row, the under side distinctly shorter than the sternum.

Posterior spinners with the apical segment short, half or a little more than half as long as the penultimate segment.

Labium with 2–5 apical teeth in 1–2 rows. *Coxæ* of pedipalps with a large basal area with 40–50 teeth.

Legs as in the ♀ of *H. sagittarius*, but the inferior distal spine in metatarsi I and II often accompanied by 1 or 2 other spines, and patella III often with an additional spine on the anterior surface above or below the row of 3 spines.

Measurements.—Total length ♂ 16, ♀ $25\frac{1}{2}$; length of carapace ♂ $7\frac{1}{2}$, ♀ $8\frac{3}{4}$.

This species is chiefly remarkable for its powerful build, shown especially in the anterior pair of legs in the ♂.

4. Hermachastes cambieræ n. sp.

Type: 1 ♂ (No. 8345) from Houw Hoek, Caledon Div., named after my wife, who discovered the specimen.

♂. *Colour.*—Carapace pale ochraceous, the cephalic portion and part of the thoracic portion more or less infuscated; cheliceræ pale ochraceous, with infuscate lines; legs pale yellowish olivaceous, in parts, especially the patellæ above and the femora at the sides, pale ochraceous; under side of coxæ and the sternum pale ochraceous; abdomen pale yellowish, the markings similar to those of *H. lightfooti.*

Carapace equal in length to the metatarsus of the fourth leg, and to the metatarsus and $\frac{2}{5}$ of the tarsus of the first leg. Fovea slightly recurved.

Cheliceræ with 9 teeth in the inner row; the under side much shorter than the sternum.

Labium and *coxæ* of pedipalps muticous.

Posterior spinners longish, with the apical segment about ½ or slightly more than ½ as long as the penultimate segment.

Pedipalps.—Process of palpal organ longer than the bulb, slender, lightly curved, pointed at the apex.

Legs.—Tarsi muticous. Metatarsus I straight, not concave below at the base, the under surface with an inner apical spine and 3 spines along the outer edge, the inner surface besides with 2–5 long spines without sigmoid curvature, the outer surface with 2 spines, the dorsal surface with 0–1 spine; II with 2–3 outer and 2 inner spines below, also 2 along the inner and 2 along the outer surfaces, and 1 on the dorsal surface; III and IV numerously spined. Tibia I rather stout, appearing parallel-sided and not incrassated at the apex, when seen from the side, the 2 distal tubercles strong, the apical one bearing 2 short, subequal, very broad spurs, one of which (the modified inner apical spine of the inferior surface) is situated at the apex of the tubercle, while the other and slightly shorter one is more proximal and situated on the upper inner edge of the tubercle near its base; the more proximal tubercle situated at the end of the middle third of the segment and much further from the apex than is the case in any of the other species, bearing a very strong, broad and sharply pointed spur; under surface of tibia with 1 inner (mesial) and 3 outer spines, the inner surface with a row of 3 and the outer surface with 1–2 other spines; II with 3 apical, 2 mesial and 2 basal spines below, also 2 on the inner and 1 on the outer surface; III and IV with a number of spines. Patellæ I–III spined, III with the usual row of 3 spines on the anterior surface. Femora spined above. Tarsi I–III scopulate below, the scopulæ divided by a narrow band of short steæ in I and II, and by a broader band of longer setæ in III. Metatarsi I and II broadly scopulate, except in the basal part, the scopulæ divided by stoutish setæ, III thinly scopulate in the distal third.

Measurements.—Total length 11; length of carapace 4¾.

Differs from all other species in the more proximal position of the inner tubercle on the tibia of the first leg.

5. Hermachastes inermis n. sp.

(*a*) *Types:* 3 ♂ (No. 3664) collected by Mr. M. Schlechter at Pakhuisberg, Clanwilliam Div.

♂. *Colour.*—Carapace pale ochraceous, the cephalic portion infuscated, with a longitudinal ochraceous stripe extending from each side of the ocular area; cheliceræ pale ochraceous, with infuscate lines; legs pale ochraceous, the femora with some weakly infuscated lines above; sternum and under side of coxæ pale yellowish; abdomen pale yellowish, the upper surface and generally also the posterior part of the sides strongly blackened, with numerous pale yellowish dots and spots, but without well-defined, obliquely transverse, dark stripes.

Carapace slightly exceeding or slightly shorter than the fourth metatarsus, and equal to the metatarsus and $\frac{3}{5}$ of the tarsus and to the tibia and $\frac{1}{2}$ the metatarsus of first leg. Fovea scarcely recurved.

Cheliceræ with about 11 teeth in the inner row below; the under side distinctly shorter than the sternum.

Labium with 1–2 small apical teeth. *Coxæ* of pedipalps with about 4 such teeth at the base.

Posterior spinners with the apical segment subequal to or longer than the penultimate segment.

Pedipalps.—Process of palpal organ about as long as the bulb, curved and very slender, except at the base.

Legs long; the tarsi muticous. Metatarsi I and II straight, not concave at the base below, the inferior surface with 2 inner and 2–4 outer spines (the apical outer spine being often doubled), the inner surface besides with 2 and the outer surface with 1–2 other spines; III and IV numerously spined. Tibia not at all or only feebly incrassated at the apex on the inner side below, but without the pair of tubercles found in the previous species; the under side with 2 spines at the base, 1–3 in the middle and 3 at the apex, the 2 apical spines at the inner inferior edge close together, not thicker than the outer apical spine but long and slender, with more or less distinct sigmoid curvature, the outer side of the tibia also with 0–1, the inner side with 2 other spines; II spined much as in I, except that the 2 inner, inferior, apical spines are slenderer and straighter; III and IV with a number of spines. Patellæ often with a spine, III with only 2 spines in the row on the anterior surface. Femora spined above. All the tarsi scopulate below, the scopulæ divided by a rather narrow band of short setæ in I–III and by a broad band of stouter setæ in IV. Metatarsi I–III more sparsely scopulate distally, the scopulæ divided by long setæ, IV with a few scopular hairs (sometimes almost absent) sparsely scattered over the distal third.

Measurements.—Total length 12–14; length of carapace $5\frac{1}{4}$–6.

(*b*) 1 ♂ from the Onder Bokkeveld (in the neighbourhood of

Nieuwoudtville and Oorlogs Kloof), Calvinia Div., also collected by Mr. M. Schlechter. Paler than the typical specimens, the abdomen with the black markings confined to the dorsal surface and forming obliquely transverse bands separated by broader yellow spaces; the legs longer, the carapace being much shorter than the fourth metatarsus and equal to the metatarsus and $\frac{1}{7}$ of the tarsus and to the tibia and $\frac{1}{6}$–$\frac{1}{5}$ of the metatarsus of the first leg; the chelicerae with 8 teeth; the coxae of the pedipalps with 7–8 teeth at the base.

This is a very long-legged species, easily distinguishable from all other species of the genus by the absence of the distal pair of spur-bearing tubercles on the inner side of the tibia of the first leg.

The *males of the genus Hermachastes* may be distinguished as follows:—

a. Inner side of tibia of first leg with a pair of distal tubercles, each bearing 1–2 stout spurs (modified spines).

- a^1. Tibia of first leg strongly incrassated at the apex below, very thick and only about $2\frac{1}{5}$ times as long above as high at the apex; the apical tubercle bearing 2 broad spurs. All the tarsi thickly and broadly scopulate. Swellendam Div. .. .. *H. validus* n. sp.
- b^1. Tibia of first leg longer and slenderer, the fourth tarsus not broadly scopulate.
  - a^2. Apical tubercle of first tibia bearing 2 short, equally and very broad spurs; the spur of the more proximal tubercle distant $\frac{1}{3}$ of the length of the segment from the apex. Caledon Div. .. .. .. *H. cambieræ* n. sp.
  - b^2. Apical tubercle of first tibia with only 1 broad spur at its apex and with a much slenderer spur or spine on or near its base externally; the spur of the more proximal tubercle less than $\frac{1}{4}$ of the length of the segment from the apex.
    - a^3. Metatarsus III not scopulate. Apical segment of posterior spinners considerably shorter than the penultimate segment. Posterior tarsi generally spined. Cape Div. .. .. *H. collinus* Poc.
    - b^3. Metatarsus III thinly but distinctly scopulate below in the distal $\frac{1}{2}$ at least. Apical segment of posterior spinners subequal to or longer than the penultimate segment. Tarsi muticous.
      - a^4. Carapace as long as the metatarsus and $\frac{3}{4}$ of the tarsus of first leg. Process of palpal organ stoutish. Under side of chelicerae (measured along the groove) distinctly shorter than the sternum. Worcester Div. .. .. *H. sagittarius* n. sp.
      - b^4. Carapace longer than the metatarsus and tarsus of first leg. Process of palpal organ slender. Under side of chelicerae almost as long as or longer than the sternum. Cape Div. *H. lightfooti* n. sp.

b. Tibia of first leg without a pair of distal spur-bearing tubercles, all the spines being normal. All the tarsi scopulate. Clanwilliam and Calvinia Divs. *H. inermis* n. sp.

The *females of Hermachastes* are often only with difficulty separable from one another, but the 4 species described may be distinguished as follows :—

a. Under side of cheliceræ (measured along the middle of the groove) longer than the sternum. Coxæ of pedipalps with very few (2–4) teeth at the base. Claws of anterior legs with 2–4 teeth in each row; claws of fourth leg with 2–3 teeth in each row, but the outer claw with 0–1 tooth in the inner row. Anterior tarsi not distinctly scopulate below. Cape Div. .. .. *H. lightfooti* n. sp.

b. Under side of cheliceræ sometimes subequalling but generally distinctly shorter than the sternum. Coxæ of pedipalps with a number (15–50) of teeth at the base. Claws of anterior legs with 5–9 teeth in each row; claws of fourth leg with 4–6 teeth in each row, but the outer claw sometimes with only 3 teeth in the inner row. Anterior tarsi distinctly scopulate.

- a^1. Outer claw of fourth leg with 3–4 (very rarely 5) teeth in the inner row. The oblique black stripes on posterior ½ of the dorsal surface of abdomen more or less distinctly continued over the sides to the ventral surface. Posterior tarsi muticous or spined. Coxæ of pedipalps with 30–42 basal teeth. Cape Div. .. .. *H. collinus* Poc.
- b^1. Outer claw of fourth leg with 5–6 (sometimes only 4) teeth in the inner row. The oblique black dorsal stripes for the most part not continued over the sides to the ventral surface posteriorly. Posterior tarsi muticous.
  - a^2. Coxæ of pedipalps with 15–30 teeth at the base. Worcester Div. *H. sagittarius* n. sp.
  - b^2. Coxæ of pedipalps with 40–50 teeth at the base. Swellendam Div. *H. validus* n. sp.

GEN. HERMACHA Sim.*

1. HERMACHA LANATA n. sp.

Type: 1 ♂ (No. 3639) collected by Mr. M. Schlechter in the Bokkeveld, east of Pakhuisberg, Clanwilliam Div.

♂. *Colour.*—Carapace brown, with darker radiating stripes, the cephalic portion more yellowish laterally, the surface thickly covered in places with pale cream-coloured, long, mostly appressed, silky

* In both sexes of the species of this genus known to me the claws of all the legs are biseriately dentate below, the rows being opposite to one another, composed of numerous teeth, and of about equal length, each extending from the base up to or beyond the middle of the claw. The inferior claw is minute in the anterior pairs of legs but distinct in the posterior pairs. The rastellum is composed of slender or moderately stout setæ, sometimes with a few slender spines in addition. The anterior surface of the cheliceræ is always thickly covered with numerous, short, stout bristles, as in the other members of the family. The females may be readily distinguished from those of *Hermachastes* by the broad, dense, entire scopula which covers the whole under surface of the tarsi and metatarsi of the 2 anterior pairs of legs. The posterior spinners in both sexes are frequently very long and the anterior ones widely separated, as in the *Diplurideæ*, and it is very probable that the species described by Ausserer as *Brachythele capensis* belongs to this genus. In the adult male the tibia of the first leg is much stouter than the metatarsus and its outer apical spine below is stout and spur-like. By far the greater number of the *Ctenizidæ* usually found in collections made in South Africa belong to the genera *Hermachastes* and *Hermacha*.

hairs, the margins with fine black bristles in addition, especially behind; cheliceræ reddish black, with pale cream-coloured hairs above; sternum pale ochraceous; coxæ and femora of legs pale yellowish olivaceous, the legs becoming paler and more ochraceous distally; abdomen pale yellowish below and at the sides, the upper surface black, speckled with numerous, small, pale yellowish spots.

Carapace as long as the metatarsus and $\frac{1}{2}$ the tarsus of the fourth leg, and equal to the tibia and $\frac{5}{6}$ of the metatarsus but much longer than the metatarsus and the tarsus of the first leg. Fovea transverse at the bottom.

Ocular area less than twice as wide as long; the anterior row of eyes strongly procurved (seen from above), the lateral eyes scarcely $\frac{1}{2}$ longer than the medians, their distance from the anterior margin of the carapace almost twice the diameter of the median eyes; posterior eyes forming a scarcely recurved row, equal in size, the laterals separated by nearly their own length from the anterior lateral eyes and much smaller than the anterior median eyes, the medians very close to the laterals and much further from the anterior median eyes.

Labium muticous. *Coxæ* of pedipalps with a large, very numerously toothed area at the base.

Posterior spinners rather short (contracted), much shorter than the sternum and than $\frac{1}{2}$ the abdomen, the distal segment subequal to or perhaps longer than the second segment, these 2 segments together apparently only as long as the stout basal segment. Anterior spinners short, only about their own diameter apart.

Cheliceræ with 6 teeth in the inner row below, the outer row composed of about 2–3 minute posterior teeth; rastellum composed of rather slender setæ.

Pedipalps.—Femur and patella with 1 or 2 spines above. Tibia with 5–6 spines on the distal $\frac{1}{2}$ of the inner surface, the outer surface with 2 spines along the inferior edge behind and a longitudinal row of 2 (1 apical and 1 submesial) spines along the middle. Tarsus unspined. Bulb turbinate, the process long and slender, nearly straight, longer than the bulb, reaching to the base of the tibia.

Legs.—Metatarsi I and II straight, the under surface with 2 outer and 2 inner spines (including an apical pair), the inner surface besides with 2 straight spines and the outer surface with 1 spine, II sometimes with 5 spines on the inner and 2 on the outer surfaces; III and IV numerously spined. Tibia I robust but not incrassated, the under surface with 1 outer apical, 3 submesial and 3 basal spines but no inner apical one, the outer apical spine spur-like, much stouter than the others and lightly curved, placed on a slight tubercle, the inner surface also with a longitudinal row of 3 strong spines nearer the upper edge and the outer surface with a row of 3 spines along the middle; II with 1 inner apical and 3 outer spines on under surface and a row of 3 along inner surface; III with 3 apical, 1 mesial and 2 basal spines below, also 2 on outer, 1 on dorsal and 2 on inner surfaces; IV with paired spines below, besides 3–5 on the outer and 3 on the inner surfaces. Patellæ with 1–2 internal spines, I and II also with 1, III with 3 and IV with 2 external spines. Femora spined above. Tarsi I–III scopulate below, the scopulæ entire in I and II, divided by a moderately wide band of setæ in III, IV with a very broad band of setæ below and a strip of scopula, equalling the band of setæ in width, on each side of it. Metatarsus I scopulate in the distal $\frac{1}{2}$–$\frac{3}{5}$, II scopulate to near the base, the scopulæ entire, broad and moderately dense, III with a few scopular hairs in the distal part. Inferior claws of anterior legs very minute, hidden by the scopula and only with difficulty distinguishable, those of posterior legs small but distinct.

Measurements.—Total length 13; length of carpace 6, width 4·6.

This species is evidently very closely allied to the type of the genus, *H. caudata* Sim., from Delagoa Bay, but it differs in the spine armature.

2. Hermacha sericea n. sp.

Type: 1 ♂ (No. 3666) found by Mr. L. Mally during a journey in Van Rhyns Dorp Div. and the western part of the Calvinia Div., Cape Colony.

♂. *Colour* yellowish brown; carapace with some indistinct, dark brown stripes radiating from the fovea, the hairs as in the preceding species but more yellowish; legs paler distally, with an under coat of fine, yellowish, mostly appressed, silky hairs, in addition to the more erect, fine, black bristles; under side paler, pale ochraceous; abdomen hairy, pale yellowish below and at the sides but without markings, the upper surface with numerous blackish-brown markings.

Carapace as long as the metatarsus and $\frac{1}{4}$ of the tarsus of the fourth leg, and equal to the metatarsus and the tarsus and to the tibia and $\frac{2}{3}$ of the metatarsus of first leg. Fovea large, rotund.

Ocular area less than twice as wide as long; anterior row of eyes with the hind margins in a straight line, the lateral eyes large, more than twice as long as the small median eyes, their distance from the anterior margin of the carapace scarcely equalling the diameter of the medians; posterior eyes with their anterior margins forming a scarcely recurved line, the medians smaller than the anterior median eyes, much smaller than the posterior laterals and much nearer to the latter than to the former, the posterior lateral eyes much larger than the anterior medians but smaller than the anterior laterals and separated from them by a space about equal to $\frac{1}{2}$ their own length.

Labium muticous. *Coxæ* of pedipalps with a small patch of about 20 small teeth at the base.

Posterior spinners long, almost as long as the sternum and labium together and $\frac{1}{2}$ as long as the abdomen, the 3 segments subequal in length, the stout basal one being only slightly longer than each of the other two, the distal segment slender, considerably longer than the anterior spinners, which are slightly more than twice their own diameter apart.

Cheliceræ with 8 teeth in the inner row below, the outer row represented by about 3 very minute posterior teeth; anterior surface covered as usual with numerous, short, stout setæ; the rastellum composed of numerous, long, rather slender setæ.

Pedipalps.—Femur and patella with a spine above. Tibia with 5 spines on the distal $\frac{1}{2}$ of the inner surface, the outer surface with 2 spines along the inferior edge behind and a longitudinal row of 2 (1 apical and 1 mesial) spines along the middle. Tarsus with a group of short stout spines at the apex above. The bulb is subspherical, the process slender and lightly curved, longer than the bulb but ending at a little distance from the base of the tibia.

Legs.—Metatarsus I straight, with 1 outer apical spine below, 1 outer and 1 inner spine near the base below, and 1 long, almost straight spine on the inner surface a little behind the middle; II spined as in I, but with an inner apical spine below in addition and 1–2 spines on the inner surface; III and IV numerously spined. Tibia I robust but not incrassated, the under surface with a double row of spines along each edge, viz., 1 apical, 2 mesial and 2 basal spines along the outer and 2 apical, 2 mesial and 1 basal spine along the inner edge, the apical outer spine spur-like, stouter than the others, placed on a slight tubercle, the inner surface also with a longitudinal row of 2 strong spines nearer the superior edge; II with an outer row of 3–4 and an inner row of 2–3 spines below and 2 superior spines on the inner surface; III with 3 apical spines and 2 other pairs of spines below, also 2 spines on outer, 1 on dorsal and 2 on inner surfaces; IV with paired spines below, besides 2 others on the outer and 2 on the inner surfaces. Patellæ with 1–2 internal spines, III with 2 outer spines as well. Femora with spines and spiniform setæ above. Scopulæ as in *H. lanata*, except that in metatarsus I the broad part of the scopula occupies at least $\frac{2}{3}$ of the length of the segment, while metatarsus III is thinly scopular in the distal third. Claws as in *H. lanata*.

Measurements.—Total length 14; length of carapace $5\frac{1}{2}$, width 4.

Closely related to the previous species, but easily distinguishable by the longer spinners, the more numerously spined legs and, especially, by the group of spines on the tarsus of the pedipalps.

3. Hermacha curvipes n. sp.

Types: 2 ♂ (No. 6011) collected by me under stones in a ravine on the mountainside at Simonstown, Cape Peninsula.

♂. *Colour.*—Carapace brown, with some dark radiating lines, rather thinly clothed with long, appressed, pale yellowish, silky hairs, the margins with erect black hairs and bristles; cheliceræ reddish brown, with pale yellowish hairs and black bristles; pedipalps ochraceous to pale yellowish; legs pale ochraceous, more or less faintly infuscated, especially on the femora, the 3 distal segments of the first leg dark reddish; under side of coxæ and sternum pale ochraceous; abdomen pale yellowish, the upper side with a median longitudinal and several obliquely transverse black stripes and a number of smaller irregular black markings, the under surface with a small black spot in front of each posterior spinner and a more anterior transverse row of 4 spots; posterior spinners infuscated below.

Carapace about as long as the metatarsus and $\frac{2}{5}$–$\frac{1}{2}$ of the tarsus of fourth leg but equal to or longer than the metatarsus and tarsus and equal to the tibia and $\frac{3}{4}$–$\frac{4}{5}$ of the metatarsus of first leg. Fovea transverse or subrotund.

Ocular area.—Anterior row of eyes transverse, the posterior margins of the eyes (when seen from above) forming a very distinctly recurved line, the lateral eyes large, twice or nearly twice as long as the median eyes, their distance from the anterior margin equal to or slightly less than the diameter of the median eyes; posterior row of eyes lightly recurved, the median eyes oval, slightly exceeding the anterior medians in length but smaller than and almost touching the posterior lateral eyes; the latter large, but smaller than the anterior laterals and almost touching them.

Labium muticous. *Coxæ* of pedipalps with numerous teeth at the base, the more distal ones much more scattered than the proximal ones.

Posterior spinners very long, considerably longer than the sternum and labium together and about $\frac{2}{3}$ or $\frac{3}{4}$ as long as the abdomen, the slender distal segment subequal to or slightly longer than the stoutish basal segment but much longer than the second segment. Anterior spinners 2½–3½ times their diameter (in the latter case more than their own length) apart.

Chelicerœ with 9–11 teeth in the inner row below; rastellum composed of long, fine and moderately stout bristles.

Pedipalps.—Bulb elongate pear-shaped, composed of a subglobular basal portion and a narrowed distal portion of about equal lengths, the distal portion truncated at the apex and provided there with a short, spirally curved, slender, claw-like process, reaching a little beyond the middle of the tibia. Tarsus not spined. Tibia somewhat swollen, the excavation for the reception of the bulb extending over almost the whole length of the under surface, the outer edge bordering the excavation produced near the middle into a conical tooth; the inner surface with 4–5 spines in the distal half, and often also with an additional one near the base, the outer surface with 1 spine near the apex. Patella and femur spined at the apex above.

Legs.—Metatarsus I with the proximal half or more strongly bowed, the concave side below, the under surface with a pair of spines at the apex, an outer spine a little beyond the middle and a small inner spine (absent in one specimen) near the base, the inner surface with a strong straight spine in the middle; II with 2 apical, 2 (sometimes 1) mesial and 2 basal spines below, also 1–2 on the inner, 1–2 on the dorsal, and 0–1 on the outer surfaces; III and IV numerously spined. Tibia I stout, not incrassated distally, the under surface with 2 apical, 1 basal and sometimes 1 mesial spine along the inner, and a row of 4 spines along the outer margin, the basal outer spine small and sometimes absent, the 2 outer middle ones long and stout, the outer apical one short but equally stout, spur-like, stronger than the inner apical spines; the inner surface with 3 superior spines; II with similarly arranged but slenderer spines, the small basal outer spine below absent, the inner surface with only two superior spines; III with 3 apical, 1–2 mesial and 2 basal spines below, also 2 on outer, 2 on dorsal and 3 (sometimes 2 or 4) on inner surfaces; IV with 3 apical, 2 mesial and 2 basal spines below, also 2 on the outer and 3 on the inner surfaces. Patellæ with 1–2 internal spines, III also with 2 spines on the anterior surface. Femora spined above. Scopulæ as in *H. lanata*, except that in tarsus III the dividing band of setæ is obsolete and in metatarsus I the broad part of the scopula is confined to the distal third of the segment. Inferior claw of anterior legs minute but more easily distinguishable than in the 2 preceding species.

Measurements.—Total length 17; length of carapace 7, width 5½.

Gen. LEPTHERCUS nov.

Closely allied to *Hermacha* Sim., but differing in having the inferior claws of the anterior legs larger and very distinct, the ocular area wider, twice as wide as long, the coxæ of the pedipalps muticous, and the tibia of the first pair of legs in the ♂ provided with a long, spine-tipped, spur-like, apical tubercle at the inner inferior edge. Other characters as in *Hermacha.* The rastellum is composed entirely of slender and moderately stout setæ. The outer row of teeth on the under side of the cheliceræ is composed, as in *Hermacha*, of a short posterior series of minute denticles. The posterior spinners are long and slender.

Type: *L. dregei* n. sp.

Lepthercus dregei n. sp.

Type: 1 ♂ (No. 5692) from Doornnek in the Zuurbergen, Alexandria Div., Cape Colony, discovered by Mr. J. L. Drège.

♂. *Colour.*—Carapace pale ochraceous, black-edged, with long, appressed, yellowish and pale olivaceous, silky hairs, the margins, especially behind, also with black bristles; cheliceræ pale ochraceous, with bands of pale yellowish hairs above; legs pale ochraceous, the femora very pale below but lightly infuscated above, the tarsi whitish on the under surface and on the sides, except at the apex and base; coxæ below and the sternum pale yellowish; abdomen pale yellowish, the under surface with some black spots posteriorly, the upper surface with a broad median mark, half a dozen pairs of obliquely transverse stripes and several other spots black.

Carapace as long as the metatarsus and $\frac{1}{6}$–$\frac{1}{7}$ of the tarsus of fourth leg, subequal to the tibia and $\frac{1}{2}$ the metatarsus and to the metatarsus and about $\frac{3}{5}$ of the tarsus of the first leg. Fovea wide, the bottom transverse.

Ocular area.—Anterior row of eyes scarcely procurved (seen from above), the lateral eyes about $\frac{1}{3}$ longer than the medians and distant from the anterior margin nearly twice the length of the median eyes; posterior row of eyes scarcely recurved, the median eyes oval, about as long as the anterior medians, the posterior lateral eyes as long as the anterior laterals and separated from them by about $\frac{1}{3}$ or $\frac{1}{4}$ of their length and narrowly separated from the posterior median eyes.

Labium and *coxæ* of pedipalps muticous.

Posterior spinners long and slender, a little longer than the sternum and labium together and about $\frac{2}{3}$ as long as the abdomen, the apical segment subequal to the basal segment but considerably longer than the mesial segment. Anterior spinners short and stoutish, about their own diameter apart.

Chelicerœ with 6 teeth in the inner row below.

Pedipalps.—Femur with several setiform spines above. Patella with an apical inner spine above. Tibia with an apical spine and 3 slender, spiniform setæ on the distal half of the inner surface, the under surface with numerous, long, fine setæ, the outer surface with a single distal spine. Tarsus not spined. Bulb subspherical, the process curved, almost as long as the bulb, somewhat flattened and rather thick in the proximal three-fourths of its length but very fine and slender distally and finely pointed.

Legs.—Metatarsus I almost straight, slightly but noticeably swollen on the infero-internal side at the end of the basal fourth, the under side with 3 spines along the outer but none along the inner edge, the inner surface with 1 mesial spine; II with 1 inner and 2 outer apical, 2 mesial and 2 basal spines below, besides 1–2 spines on the inner surface; III and IV numerously spined. Tibia I robust, slightly incrassated towards the apex below, and provided at the inner inferior edge with a long, cylindrical, tubercular spur, which curves slightly outwards and is tipped with a stout, slightly curved spine, this spine being shorter than the tubercle; under surface also with 3 outer and 2 inner spines, inner surface with 2 spines and outer surface with 1 spine; II with 3 apical, 1 mesial and 2 basal spines below, and 2 spines on the inner surface; III with 3 apical, 2 mesial and 2 basal spines below, also 2 on the outer, 2 on the dorsal and 2 on the inner surfaces; IV with 3 pairs of spines below, also 2 spines on the inner and 2 on the outer surfaces. Patellæ with 1–2 internal spines, III also with 2 spines on the outer surface. Femora spined above. All the tarsi scopulate below, the scopulæ less dense than in *Hermacha*, entire in I–III but divided in IV by a band of setæ, this band comparatively narrow. Metatarsus I scopulate on both sides below in the distal half or more, the scopula almost obsolete along the middle line below, II thinly scopulate in the distal third, III and IV not scopulate.

Measurements.—Total length $9\frac{1}{2}$; length of carapace $4\frac{1}{4}$, width 3·1.

Gen. PIONOTHELE nov.

Closely allied to *Hermacha* Sim., but differing in having the ocular area more than twice as wide as long and close to the anterior margin of the carapace. In the ♂ the tarsus of the first pair of legs is somewhat swollen in the middle, appearing convex lengthways below and more attenuated distally, when seen from the side, while the tibia is rather slender and only very slightly thicker than the metatarsus (in *Hermacha* the tarsus is cylindrical and not attenuated distally). The rastellum is composed of a number of slender and moderately stout setæ. The inferior claw of the anterior legs is very minute and only with difficulty distinguishable; the superior claws are long, with numerous teeth in 2 series, the superior claws of the posterior legs slender. The posterior spinners are very stout. The tarsi of the fourth legs are spined.

Type : *P. straminea* n. sp.

Pionothele straminea n. sp.

Type : 1 ♂ (No. 3586) found by Mr. C. L. Leipoldt, near Rondegat, about 5 miles south of Clanwilliam.

♂. *Colour* very pale ochraceous; the abdomen still paler, with about a dozen black spots above; the carapace with numerous, fine, black bristles near the margins, especially posteriorly, and some very fine, long, yellowish, silky hairs, the surface otherwise almost glabrous.

Carapace about as long as the metatarsus of the fourth leg and equal to the metatarsus and about $\frac{3}{4}$ of the tarsus of first leg.

Ocular area.—Anterior row of eyes (seen from above) scarcely procurved, the eyes subequal in size, the laterals about $\frac{1}{2}$ their diameter from the anterior margin; posterior row somewhat recurved, the eyes subequal (or the medians smaller), very much smaller than the anterior eyes, the lateral eyes distant about $\frac{1}{2}$ their diameter from the anterior lateral eyes and narrowly separated from the posterior median eyes.

Labium muticous. *Coxæ* of pedipalps with a small toothed area of about 15 teeth at the base.

Posterior spinners very thick, the apical segment short, scarcely longer than wide and almost as long as the second segment, the 2 distal segments together slightly shorter than the basal segment. Anterior spinners very short, nearly twice their diameter apart.

Cheliceræ short, with about 6 teeth below in the inner row.

Pedipalps.—Femur with some spiniform setæ (and spines ?) above. Patella with a spine above. Tibia with 2–3 distal spines on the inner, 0–1 on the dorsal and 1 on the outer surfaces. Bulb globoso-turbinate, the process slightly longer, very fine and straight, reaching backwards beyond the middle of the tibia.

Legs.—Tarsi I–III unspined, IV with a single long spine near the middle of the upper outer edge. Metatarsus I straight, scarcely slenderer than the tibia, with 2 outer and 2 inner spines (including an apical pair) below, also 1 on the outer and 2 on the dorsal surface, and 2 along the inner upper edge; II with 3 outer and 2 inner spines (including 3 apical spines) below, 1–2 on outer surface, 1–2 on the dorsal surface, and 3 along upper inner edge; III and IV numerously spined. Tibia I not robust, the under surface with a row of 3 outer but no inner spines, the apical outer spine strong, spur-like and slightly curved at the apex, the outer surface besides with 2 inferior spines and the inner surface with 2 superior spines; II with 2 outer apical and an inner row of 3 spines below, besides 2 spines along the upper inner edge; III with paired spines below, and with 2 anterior, 1 dorsal and 2 posterior spines besides; IV with spines and spiniform setæ below, also 2 spines on the outer and 2–3 on the inner surface. Patellæ with 1–2 internal spines, III also with 3 external spines. Femora numerously spined above. Tarsi I and II imperfectly scopulate but thickly hairy below, III and IV not scopulate. Metatarsi I and II with a thin distal patch of hairs similar to those on the tarsi below.

Measurements.—Total length 9; length of carapace, $3\frac{3}{4}$; width 3.

SUMMARIES OF SOME RECENT BOTANICAL AND ZOOLOGICAL PAPERS REFERRING TO SOUTH AFRICA.

Durand et Schinz. Conspectus floræ Africæ. Vol. i., part 2. Bruxelles, 1898. Royal 8vo, pp. 268.

This part contains the orders Ranunculaceæ to Frankeniaceæ, while the fifth volume of the work, as mentioned in the previous Summary, contains the greater part of the Monocotyledons.

Engler, A. Monographieen Afrikanischer Pflanzen-Familien und Gattungen. Veröffentlicht mit Unterstützung der Kgl. Preuss. Akademie der Wissenschaften. Leipzig.

Part II. *Melastomataceæ*, von A. Gilg. Pp. 52, with 10 plates. 1898.

Contains the descriptions of several species of *Dissotis* from Natal.

Part III. *Combretum*, von A. Engler und L. Diels. Pp. 116, with 30 plates. 1899.

This most exhaustive work contains a list of publications referring to the order *Combretaceæ*, a review of its genera, and the descriptions of all the species of the genus *Combretum*. Among them are seventeen species occurring in South Africa, while the "Flora Capensis," vol. ii., published in 1862, mentions only 10 species. The species are arranged in 55 groups, of which the distribution, &c., is discussed.

Wood, J. Medley, and Evans, Maurice S. Descriptions and figures of Natal indigenous plants, with notes on their distribution, economical value, native names, &c. Vol. i., part 2, large 4to, pp. 43–81, with 50 plates. Durban, 1899.

The complete volume contains the figures and descriptions of 100 plants, and forms a most valuable addition to the literature on South African botany.

Flora Capensis, edited by W. T. Thiselton-Dyer. Vol. vii., parts 2 and 3. London, 1898–99.

These two parts contain the concluding portion of the *Cyperaceæ* by Clarke, and the greater portion of the *Gramineæ* by Stapf.

Icones Plantarum, edited by Sir J. D. Hooker. Vol. vi., part iii. London, 1898.

Contains two remarkable South African plants :—

Tab. 2555. *Rigiophyllum squarrosum* Hochst. This plant had not been found since 1840 [*Krauss*] until Mr. R. Schlechter rediscovered it lately in its original locality near Elim.

Tab. 2558. *Staavia Dodii* Bolus is a very showy plant from the neighbourhood of Simonstown, discovered quite recently by Captain Wolley-Dod.

Icones Plantarum. Vol. vii., part i. London, 1899.

Contains the diagnoses and figures of several species of grasses from Thunberg's collections. One of them [tab. 2601] is the "wild rye" (Dutch "rogge"), from which the "Roggeveld" is supposed to have received its name. The author, Stapf, considers it as an indigenous species, and names it *Secale africanum* Stapf.

Wood, J. Medley and Evans, Maurice S. New Natal plants. Decade I., pp. 7. In Journal of Botany, 1897.

Britten, James, and Baker, E. G. Notes on *Crassula.* In Journal of Botany, December, 1897, pp. 10.

Contains the revision of several species originally described by Thunberg.

Schönland, S., and Baker, E. G. New species of *Crassula* in Journal of Botany, October, 1898, pp. 13.

Contains 26 new species from the collections of Bolus, Flanagan, Marloth, Schönland, Scully, Wolley-Dod, Wood.

SCHINZ, HANS. Die Pflanzenwelt Deutsch Süd-West Afrika's mit Einschluss der westlichen Kalihari, No. I. Bulletin de l'Herbier Boissier, vol. iv. Genève, 1896, pp. 1–57.

SCHINZ, HANS. Die Pflanzenwelt Deutsch Süd-West Afrika's, &c., No. II. Bull. de l'Herb. Boiss., vol. v., 1897, pp. 59–101.

Beginning with the Cryptogams these articles contain an enumeration of the known species of plants forming the vegetation of that part of Africa mentioned in the title. There are also a number of new species described.

SCHINZ, HANS. Beiträge zur Kenntniss der Afrikanischen Flora No. V. In Bulletin de l'Herbier Boissier, vol. v., No. 12. Genève, 1896, pp. 809–846.

Contains contributions from Cogniaux, Gürke, Hackel, Heimerl, Klatt, and Schinz, with the diagnoses of 48 new species, almost all South African, from the collections of Bachmann, Fenchel, Fleck, Galpin, Höpfner, Junod, Rehmann, Schlechter.

SCHÖNLAND, S. Crassulaceæ in Bulletin de l'Herbier Boissier, vol. v., No. 10. Genève, 1897, pp. 859–864.

Contains the diagnoses of 8 new species of *Crassula* and one of *Dinacria* from the collections of Haygarth, Schlechter, and Wood.

GÜRKE, M. Labiatæ in Bull. de l'Herb. Boiss., vol. vi., No 7. 1898.

Contains 11 new species from the collections of Belck, Fleck, Rehmann, Tyson.

HALLIER, H. Convolvulaceæ in Bull. de l'Herb. Boiss., vol. vi., No. 7, 1898, pp. 529–548, and vol. vii., No. 1, 1899, pp. 41–63.

This is a revision of a number of species from South Africa, and Central Africa, with a few new diagnoses.

Schinz, Hans. Beiträge zur Kenntniss der Afrikanischen Flora, No. 8. In Bull. de l'Herb. Boiss., vol. vi., No, 9. Genève, 1898, pp. 729–751.

Contains contributions from Hoffmann, Koehne, and Pax, with the diagnoses of 29 new species from the collections of Dinter, Fleck, Galpin, Rautanen, Rehmann, Schenck, Schinz, Schlechter.

Schinz, Hans. Beiträge zur Kenntniss der Afrikanischen Flora, No. 10. In Bull. de l'Herbier Boiss., vol. vii., No 1. Genève, 1899, pp. 23–65.

Contains contributions from Hackel, Hallier, Schinz, Schlechter, describing 28 new species from the collections of Bachmann, Dinter, Fleck, Galpin, Junod, Rehmann, Schinz, Schlechter, Wood.

A new genus of Leguminosæ is named *Neorautanenia.*

Pestalozzi, Anton. Die Gattung *Boscia.* In Bull. de l'Herb. Boiss., vol. vi., app. iii., Genève, 1898, pp. 152, tab. i. to xiv.

The species of this genus (Capparidaceæ) are shrubs or small trees occurring in the tropical and sub-tropical regions of Northern, Central, and Southern Africa. The author recognises 27 species, several of them being established by himself. The most important part of the work is devoted to the histology of the plants. The results are highly interesting, as the structure of the leaves of those species which grow in dry regions like the Kalihari, Griqualand West, and the Western Transvaal possess very elaborate means of protection against drought, the mechanical part of the tissues being specially well developed. This investigation also shows that the anatomical characters of plants are often very useful in determining the identity or non-identity of species.

Schlechter, R. Orchidaceæ africanæ novæ vel minus cognitæ. Engler's Jahrbücher für systematische Botanik, vol. xxiv., pp. 418–433. Leipzig, 1897.

Contains the descriptions of 10 new species from the collections of Baur, Bolus, Flanagan, Glass, Krook, Penther, Schlechter, Thode, Trimen, Zeyher.

SCHLECHTER, R. Plantæ Schlechterianæ novæ vel minus cognitæ. Part i. Engler's Jahrbücher, vol. xxiv., pp. 434–459. Leipzig, 1897.

Contains the descriptions of two new genera by H. Bolus, viz., *Schlechteria* [Cruciferæ] and *Phyllosma* [Rutaceæ], of 40 new species by R. Schlechter, of 7 new species of Leguminosæ and Compositæ by H. Bolus, and 1 new species of Juncaceæ by Buchenau.

GÜRKE, M. Ebenaceæ africanæ. Engler's Jahrbücher, vol. xxv., pp. 60–73. 1898.

Contains the descriptions of 2 new South African species of *Royena* collected by Wilms and Junod.

GÜRKE, M. Labiatæ africanæ. Part iv. Engler's Jahrbücher, vol. xxv., pp. 74–85. 1898.

Contains the descriptions of 16 new South African species from the collections of Bachmann, Galpin, Kuntze, Schlechter, Tyson, Wood.

GILG, E. Gentianaceæ africanæ. Engl. Jahrb., vol. xxv., pp. 86–110. 1898.

Contains the descriptions of 26 new South African species of Belmontia, Chironia, and Sebæa collected by Bachmann, Baur, Burchell, Drège, Ecklon, Glass, Meyer, Scott Elliott, Thode, Tyson, Wilms, Wood, Zeyher.

DIELS, L. Campanulaceæ africanæ. Engler's Jahrb., vol. xxv., pp. 111–119. 1898.

Contains the descriptions of 8 new South African species from the collections of Bachmann, Tyson, Wilms.

RUHLAND, W. Kritische Revision der afrikanischen Arten der Gattung *Eriocaulon*. Engl. Jahrb., vol. xxvii. Leipzig, 1899.

Diels, L. Beiträge zur Kenntniss der Scrophulariaceen Afrika's. Part ii. Engler's Jahrb., vol. xxv., pp. 120–123. 1898.

Contains the descriptions of 5 new South African species collected by Dr. Wilms.

Schlechter, R. Die Drège'schen Asclepiadaceen im E. Meyer'-schen Herbar. Engl. Bot. Jahrb. Beiblatt, No. 54, pp. 14.

Contains a critical revision of the collection of Asclepiadaceæ on which E. Meyer based the descriptions published in 1835 in his Com. pl. Afr.-austr. This collection is at present in the possession of Dr. Brehmer at Lübeck.

Marloth, R. Die Blattscheiden von *Watsonia Meriana* als Wasser absorbirende Organe. In Festschrift zum 70 Geburtstage Schwendener's, pp. 421–424, with two figures. Berlin, 1899.

The absorption of water by aërial organs of plants is—apart from the epiphytes—of rare occurrence. *Watsonia Meriana*, a gorgeous iridaceous plant, which flowers in summer on the south-western mountains, possesses inflated leaf sheaths which often contain water. This water is derived from the south-east clouds, and serves, as proved by a series of experiments, to feed the sheaths which surround the young tissue at the internodes, but cannot be utilised by the flowers themselves.

MacOwan, P. Herbarium Austro-Africanum, Cent. XX. Capetown, 1898.

The total number of plants distributed amounts to 30,000. It is not the intention of the author to continue this distribution in the same way. Rare plants coming in will be sent out from time to time.

R. M.

ZOOLOGY.

MAMMALIA.

Bryden, H. A. (edited by). Great and Small Game of Africa. Pp. 1–612, pls. i.–xv. London, Rowland Ward. 4to.

A large and important work on the Game Animals of Africa by various contributors, among whom are the Editor (Mr. Bryden), Messrs. F. Vaughan Kirby, R. Lydekker, A. H. Neumann, Percy Rendall, and F. C. Selous. All the Ungulata and the larger Carnivora are dealt with, and in addition to coloured illustrations of the heads of the various animals arranged on a series of 15 plates, there are various woodcuts and photogravure reproductions of photographs of great beauty and value.

Jentink, F. A. The species of the Antelope—Genus Pediotragus. Notes Leyd. Mus. xxii., p. 33. 1900.

Dr. Jentink recognises four, or perhaps five, distinct species of the genus Pediotragus containing the Steenbok; these are *P. kelleni* (sp. nov.) from Southern Angola, *P. tragulus*, and *P. horstockii* (*R. campestris* auct.), the common form from the Colony, *P. rufescens* (H. Smith.) from Natal, and *P. neumanni*, Matchie from German East Africa.

Kirby, F. V. Field-notes on the Blue Duiker of the Cape Colony (*Cephalophus monticola*). Proc. Zool. Soc., 1899, pp. 830–833.

An interesting account of the habits of the little Bluebuck of Knysna and the Eastern Province of the Colony.

Matchie, P. Ueber die geographische Verbreitung der Tigerpferde und das Zebra des Kaoko-Feldes in Deutsch Süd-West Afrika. S. B. Gesell. Nat. Freunde. Berlin, 1898, p. 169.

An account of the geographical distribution of the various races and species of Zebra, followed by the description of a new species—*Equus hartmannæ*—from Kaoko-land in the north-west corner of German South-West Africa. The new species appears to be very closely allied to the mountain zebra of the Colony (*Equus zebra* Linn.).

Millar, A. D. Zoological Notes from Natal. Zoologist (4) iii., pp. 145–148, pl. i. 1899.

Notes on :—

(1) The occurrence of monster Ray or Devil-fish (*Dicerobatis* sp. inc.), measuring 14 ft. across the disk.

(2) The courage of a Reedbuck (*Cervicapra arundinum*) in defence of its young.

(3) The occurrence of nests of the Black Saw-winged Swallow (*Psalidoprocne holomelæna*) and a Natal Kingfisher (*Ispidina natalensis*) in the hole of an Ant-bear, still tenanted by its original owner.

Parsons, F. G. On the Anatomy of the African Jumping Hare (*Pedetes caffer*) compared with that of the *Dipodidæ*. Proc. Zool. Soc., 1898, pp. 858–890.

Very little has hitherto been known about the anatomy of this singular animal, commonly known in South Africa as the Spring-haas. In this memoir considerable attention is devoted to the muscular system; the general result is to confirm the position of this animal among the Hystricomorphine rather than among the Myomorphine Rodents.

Pocock, R. I. Descriptions of Three New Forms of *Tragelaphus*. Ann. Mag. N.H. (7), v., p. 94. 1900.

A subspecies of Bushbuck from Linyante, on the Chobe River, in Rhodesia, is described as new. It had before been considered identical with the West African typical subspecies *Tragelaphus scriptus typicus*.

Sclater, P. L., and Thomas, O. The Book of Antelopes, parts xi.–xvii. London, R. H. Porter, 1899–1900. 4to.

The previous parts have been noticed before. The work is now complete, and consists of four volumes, containing upwards of 800 pages of letterpress and 100 coloured plates. The South African species treated of in the present parts are the Bluebuck, Roan, Sable, Gemsbok, Bushbuck, Inyala, Sitatunga, Kudu, and Eland.

SCLATER, W. L. The Mammals of South Africa. Vol. i. Primates, Carnivora, and Ungulata, pp. 1–324, figs. 1–80. London, R. H. Porter, 1900. 8vo.

The present work contains the first half of an account of the Mammals of South Africa. The second volume completing the work has been published this year (1901).

SCLATER, W. L. Descriptive List of the Rodents of South Africa. Annals S.A. Mus., i., pp. 181–239. 1899.

The total number of species enumerated is 62, of which 44 are represented in the collections of the South African Museum; one new species is described, *Malacothrix pentonyx*.

THOMAS, O. On the Zululand Form of Livingstone's Antelope. Ann. Mag. N.H. (7), i., p. 317. 1898.

Mr. Thomas considers that the Zululand form of Livingstone's Antelope should be separated from the typical form found on the Zambezi, and proposes to call it *Nesotragus livingstonianus zuluensis*. It differs from the typical form in being of a generally grizzled fawn colour instead of deep rufous, while the fetlocks are only indistinctly blackish behind, instead of being prominently black all round.

DE WINTON, W. E. On the Species of *Canidæ* found on the Continent of Africa. Proc. Zool. Soc., 1899, pp. 533–552 [13 figs. of skulls].

A revision of the wild dogs, jackals, and foxes of Africa. From South Africa the author recognises 5 species, viz.:—*Canis mesomelas*, the Black-backed Jackal; *Canis lateralis*, the Quaha or Side-striped Jackal; *Canis chama*, the Chama fox; *Otocyon megalotis*, the long-eared Fox; and *Lycaon pictus*, the Wild Dog or Wilde Hond.

DE WINTON, W. E. Descriptions of Three New Rodents from Africa. Ann. Mag. N.H. (7), i., pp. 251–254. 1898.

Description of a new species of Blesmol (*Georychus lugardi*) obtained by Major Lugard, C.B., in the Kalihari Desert.

DE WINTON, W. E. On the Nomenclature and Distribution of some of the Rodents of South Africa, with descriptions of new Species, Ann. Mag. N.H. (7), ii., pp. 1–8. 1898.

Gerbillus lobengulæ is described as new; alterations are made in the names of some other species.

AVES.

ALEXANDER, B. An Ornithological Expedition to the Zambezi River. Ibis (7), v., pp. 459–583, pl. xi. (1899), vi., pp. 70–109. pl. i., and pp. 424–458. 1900.

Mr. Alexander during his expedition up the Zambezi from Chinde to the Kafue River in the Mashakolumbwe country, collected some 914 bird skins, which included 250 species; these are described in the present paper. In addition to several new species, a large number of birds are brought for the first time within the limits of the South African fauna, and the field-notes made by the collector himself make the paper a most valuable one to South African Ornithologists.

MARSHALL, G. A. K. Notes on Mashonaland Birds. Ibis (7), vi., pp. 221–270. 1900.

A complete list of 250 species of birds hitherto observed in Mashonaland, with a number of very interesting observations on their habits, and in some cases of their nidification.

NEUMANN, O. Beiträge zu einer Revision der Laniariden. Journ. f. Ornith, 1899, pp. 387–417.

Revision of the genera and species of bush-shrikes, a number of which are found in South Africa.

NEUMANN, O. Neue und wenig bekannte afrikanische Vögel. Ornith. Monatsb., vii., pp. 23–26. 1899.

Among new South African birds here described are *Poiocephalus meyeri transvaalensis*, and *Numida transvaalensis*, both from the Transvaal.

REICHENOW, A. Die Vögel Afrikas, vol. i., part 1, pp. 1–320. Neudamm, Neumann, 1900. Large 8vo.

The first half of the first volume of a new work on African birds; the present portion contains a long introduction and list of literature, followed by a systematic account of the species of Gulls, Waders, and Game birds.

SCLATER, W. L. On a Collection of Birds from Inhambane, Portuguese East Africa. With field-notes by H. F. Francis. Ibis (7), v., 1899, pp. 111–115, 283–268.

Out of 25 species mentioned, two, *Erythrocercus francisci* and *Xenocichla debilis* are believed to be new, and three, *Pternistes humboldti*, *Cossypha quadrivirgata* and *Sycobrotus stictifrons* are new to the South African fauna.

SHARPE, R. B. On a Collection of Birds obtained by Mr. H. S. H. Cavendish, in Mozambique. Ibis (7), vi., pp. 109–115. 1900.

Mr. Cavendish, the well-known African traveller, paid a short visit to Southern Mozambique in the autumn of 1898, and collected examples of 37 species of birds in the neighbourhood of Beira and in the Cheringoma district; one species, a roi bekje, is new to science, and several others to the South African fauna.

SHELLEY, G. E. The Birds of Africa. Vol. ii., part i., pp. 1–160, pls. i.–vii., part ii., pp. 161–348, pls. viii.–xiv. London, R. H. Porter, 1900, large 8vo.

The present volume of this work, the first volume of which was published in 1896, contains an account of the Pittas, Sunbirds, Long-tailed Sugar Birds, White-eyes, Hill-Tits, Tits, Creepers, and Wagtails.

Sowerby, T. L. On a collection of Birds from Fort Chiquaqua, Mashonaland, with notes by R. Bowdler Sharpe, LL.D. Ibis (7), iv., pp. 567–575, pl. xii., fig 1. 1898.

Fort Chiquaqua is about eighteen miles E.S.E. of Salisbury; 48 species of birds were obtained, and among them were two Angolan forms new to South Africa, viz.—*Melierax mechowi* and *Monticola angolensis*, as well as a new species of Barbet, *Smilorhis sowerbyi*, which is figured on the plate.

Stark, A. C. The Birds of South Africa. Vol. i., pp. 1–322. London, R. H. Porter, 1900. 8vo.

The present volume is the first of a series in which it is proposed to give an account of the Fauna of South Africa south of the Zambezi and Cunene Rivers; it contains on account of 182 species, about half the Passerine birds and about a quarter of the total number of species to be treated of. Owing to the lamented death of the author during the siege of Ladysmith, there will be some little delay before the work can be completed.

Woodward, R. B. and J. D. S. Natal Birds. Pp. 1–215. Pietermaritzburg. P. Davis & Sons. 1899.

A very useful little manual on the Birds of Natal, with descriptions of plumage and habits. 386 species are included in the work.

Woodward, R. B. and J. D. S. Further Notes on the Birds of Zululand. Ibis (7), iv., pp. 216–228. 1898. On the Birds of St. Lucia Lake in Zululand. Ibis (7), vi., pp. 517–525. 1900.

A further contribution to the history of the birds of Zululand, consisting of an account of two journeys through the country, with incidental remarks on many of the birds there met with.

REPTILIA AND AMPHIBIA.

Haagner, A. C. Notes on the Cape Monitor (*Varanus albigularis*). Zoologist (4), iii., p. 226. 1899.

Note on habits of captivity.

PERACCA, M. G. Rettili ed Anfibi raccolti a Kazungula e sulla strada da Kazungula a Buluwaio dal Rev. Luigi Jalla, Missionario Valdese nell' alto Zambese. Boll. Mus. Zool. Anat. Comp. Torino. Vol. xi., No. 225. 1896.

A list of 17 species of Reptiles and Amphibia from Matabeleland, including one new species of snake, *Psammophis jallæ.*

SCLATER, W. L. List of the Reptiles and Batrachians of South Africa, with descriptions of new species. Annals S. A. Mus., i., pp. 95–112, pl. v. 1898.

A complete list of Reptiles and Amphibia compiled from Boulenger's British Museum Catalogue, with descriptions of a new snake, *Grayia lubrica;* a new lizard, *Elasmodactylus namaquensis;* and a new frog, *Heleophryne purcelli.*

WERNER, F. Reptilien und Batrachier aus Süd-Afrika. Jahrb. Naturw. Vereins Magdeburg, 1896–7, pp. 137–148.

An annotated list of three small collections made near Grahamstown, in Natal, and in the Transvaal. No new species are described.

PISCES.

BOULENGER, G. A. A Revision of the African and Syrian Fishes of the Family *Cichlidæ.* Part i., Proc. Zool. Soc., 1898, pp. 132–152, pl. xix. Part ii., Proc. Zool. Soc., 1899, pp. 98–143, pls. xi. and xii.

A revision of a large and important family of fresh-water fishes. Only about eight out of 118 species described are South African. But as our knowledge of the fresh-water fishes of South Africa is still exceedingly imperfect, it is to be hoped that future workers may bring to light additional species in our area.

BOULENGER, G. A. Descriptions of two new Gobiiform Fishes from the Cape of Good Hope. Marine Investigations in South Africa, Dept. of Agricult., pp. 1–4. 1898.

Description of two new Fishes, viz.: *Gobius gilchristi,* from the estuary of the little Brak River in Mossel Bay, and *Callionymus costatus* from off Cape St. Blaize.

BOULENGER, G. A. Liste des Poissons recuellis par le R. P. Louis Jalla à Kàsungula ; haut Zambèse. Boll. Mus. Zool. Anat. comp. Torino. Vol. ii., No. 260, 2 pp.

Contains descriptions of new species of *Chromis* and *Hemichromis.*

BOULENGER, G. A. A Revision of the Genera and Species of the Family *Mormyridæ.* Proc. Zool. Soc., 1898, pp. 775–821, pl. li.

This is a considerable family of fresh-water Fishes, found only in the rivers of Africa. They are specially remarkable for an organ on either side of the tail, having an electrical function. The family is not of very great importance in South Africa ; out of 72 species distributed among 11 genera recognised by the author, four species are found in the Zambezi and one in the Cunene River.

BOULENGER, G. A. Description of a New Genus of Perciform Fishes from the Cape of Good Hope. Annals S. A. Mus. i., pp. 379–380, pl. ix. 1899.

This Fish, named by Mr. Boulanger *Atyposoma gurneyi,* is allied to *Parascorpis typus,* and is known to the fishermen as the " Melk fish." It is found in False Bay.

WEBER, M. Zur Kenntniss der Süsswasser Fauna von Süd-Afrika. 2. Süsswasserfische von Süd-Afrika. Zool. Jahrb. Abt. f. Syst., x., pp. 142–155. 1897.

A list of fresh-water Fishes obtained by the author when travelling through South Africa in 1894–5 ; among them some seven species are new to science ; a discussion of the zoogeographical provinces of South Africa precedes the systematic portion.

W. L. S.

INSECTA.

Hymenoptera.

André, E. Description de trois nouvelles espèces de Mutilles de l'Afrique orientale appurtenant au Musée Royal de Belgique. Bulletin de la Société Zoologique de France, 1897, pp. 17–22.

The three male *Mutillæ* therein described are from Delagoa Bay.

Les types des Mutillides de la collection Radoszkowski. Annales de la Société Entomologique de France, 1899, pp. 1–43.

The author criticises some of Radoszkowski's species and completes the descriptions of some of them. Two South African species, *Mutilla caffra* ♂, and *M. Godefredi* ♂, are treated in this manner, and the extremely close resemblance of *M. scabro-foveolata*, Sich Rad with *M. penicillata*, the former from western Africa, and the latter from Delagoa Bay, is referred to.

Hyménoptères du Delagoa—*Mutilles.* Bulletin de la Société Vaudoise des Sciences Naturelles, 1899, vol. 35, pp. 259–263.

Contains the descriptions of 3 new species.

Brauns, Dr. Hans. Zur Kenntniss der südafrikanischen Hymenopteren. Annalen des K. K. Naturhistorischen Hof-museums, Wien, 1899, pp. 382–423, 1 pl.

Contains the descriptions of 3 new genera and 22 species of South African Hymenopterous (Aculeate) insects, captured by the author, mostly in the neighbourhood of Port Elizabeth.

Dalla Torre, C. G. de. Catalogus Hymenopterorum hucusque detectorum systematicus et synonymicus. Vol. iv., Braconidæ, Lipsiæ, 1898, 8 maj. 8 and 323 pp.

Péringuey, L. A contribution to the Knowledge of South African *Mutillidæ* (order Hymenoptera). Annals South African Museum. Vol. i., pp. 352–378, 1 plate.

Contains the description of 32 species, 29 of which are new.

PÉRINGUEY, L. Description of twelve new species of the genus *Mutilla* (order Hymenoptera) in the South African Museum. Ann. S. Afric. Mus., vol. i., pp. 439–450.

SCHULTHESS-SCHINDLER, A. DE. La Faune Entomologique du Delagoa. *Hyménoptères* en collaboration avec M. M. E. André, F. F. Kohl, W. Konow. Extr. Bulletin Société Vaudoise des Sciences Naturelles, vol. xxxv., No. 133, 1899.

Contains a list of the Hymenoptera collected by the Rev. H. Junod, amounting to 160 species representing 50 genera; and the description of one new Tenthredinidæ and two Chalcididæ by Konow; three new Mutillidæ by André, and two new Vespidæ by Schulthess-Schindler.

VACHAL, J. Matériaux pour une révision des espèces africaines du genre *Xylocopa* Latr. Annales Société Entomologique de France, vol. 67, 1898, pp. 92–99.

Contains the description of four new South African species.

COLEOPTERA.

ABEILLE DE PERRIN, ELZ. Malachides recueillis par M. Eugène Simon au Cap de Bonne-Espérance. Revue d'Entomologie, vol. xix., 1900, pp. 163–177.

Mr. Simon collected 22 species, 21 of which have been found to be undescribed, and referable to 7 genera, 3 of which are also new.

ARROW, G. J. On Sexual Dimorphism in Beetles of the family *Rutelidæ*. Transactions Entomological Society, London, 1899, pp. 255–269.

This paper contains, among others, the description of five new species of South African *Anomala*.

ARROW, G. J. On the Rutelid Beetles of the Transvaal; an enumeration of a collection made by Mr. W. L. Distant. Annals and Magazine of Natural History, vol. iv., series 7, 1899, pp. 118–122.

An enumeration of the species collected by Mr. Distant, with descriptions of six new species, and some remarks on species of *Adoretus*.

BELON, RÉV. M. J. Contribution à l'étude des *Lathridiidæ.* Annales Société Entomologique de Belgique, 1898, pp. 439–449.

The paper contains the description of three new South African species.

BRAUNS, H. Ein neuer Dorylidengast des Mimicry-Typus. Wiener Entomologische Zeitung, 1898, pp. 224–227.

Is the description of a new genus and species of a South African Staphylinid Beetle, found by the author with a Dorylid ant, which it mimicks. Dr. Brauns gives a figure of this remarkable insect.

BRAUNS, H. Ein neuer termitophiler Aphodier aus dem Orange-Freistaat. Annalen K. K. Naturhistorischen Hofmuseums, vol. xv., Wien, 1900, pp. 164–168, 1 pl.

BRENSKE, E. Melolonthiden aus Afrika. Stettiner Entomol. Zeitung, 1898, pp, 333–394.

Contains the description of 2 genera and 12 species from South Africa.

DISTANT, W. L. On some South African Insects. Annals and Mag. Natural History, vol iii., series 7, 1899, pp. 178–179.

The paper contains the description of two new Longicorn Beetles, and two new Lepidoptera.

DISTANT, W. L. Some apparently undescribed Insects from the Transvaal. Annals and Mag. Natural History, vol. iii., series 7, 1899, pp. 461–465.

The paper consists of the description of one new species of Coleoptera and seven Lepidoptera.

GAHAN, C. J. Descriptions of new Longicorn Coleoptera from East Africa. Annals and Mag. Natural History, vol. ii., series 7, 1898, pp. 40–59.

Among the new species described in this paper is one, *Margites lineatus,* which occurs also in the Transvaal (Murchison Range).

GORHAM, THE REV. H. S. Descriptions of new Genera and Species of Coleoptera from South and West Africa of the section *Serricornia*, and of the Families *Erotylidæ*, *Endomychidæ*, and *Languriidæ*. Annals and Mag. of Natural History, vol. v., series 7, 1900, pp. 79–94.

Contains the description of 5 new genera and 21 new species collected by Mr. G. A. K. Marshall in Natal and Southern Rhodesia.

GROUVELLE, A. Description de Clavicornes d'Afrique et de la Région Malgache. Annales Société Entomologique de France, 1898, pp. 136–185.

Thirty-four South African species are described in this paper.

JACOBY, M. Further contributions to the Knowledge of the Phytophagous Coleoptera of Africa, including Madagascar. Part i. Proceedings of the Zoological Society of London, 1897, pp. 238–265, 1 pl.

The paper deals only with the *Criocerinæ*, *Cryptocephalinæ*, and *Clythrinæ*, and contains the descriptions of 26 new South African species, 7 of which are figured.

JACOBY, M. Further Contributions to the Knowledge of the Phytophagous Coleoptera of Africa, including Madagascar. Part ii. Proceedings of the Zoological Society of London, 1897, pp. 527–577, 1 pl.

The paper deals with the *Eumolpinæ*, *Halticinæ*, and *Galerucinæ*, and contains the descriptions of 6 new genera and 42 South African species, 3 of which are figured.

JACOBY, M. Additions to the Knowledge of the Phytophagous Coleoptera of Africa. Part i. Proceedings of the Zoological Society of London, 1898, pp. 212–242, 1 pl.

This paper contains descriptions of 36 new South African species and 1 genus belonging to the *Criocerinæ*, *Cryptocephalinæ*, *Clythrinæ*, *Eumolpinæ*, and *Chrysomelinæ*; 11 species are figured.

JACOBY, M. Additions to the Knowledge of the Phytophagous Coleoptera of Africa. Part ii. Proceedings of the Zoological Society of London, 1899, pp. 339–380.

Ths paper deals with the sub-Families *Halticinæ* and *Galerucinæ*, and in it are described 4 genera and 39 South African species, 9 of which are figured.

JACOBY, M. On new Genera and Species of Phytophagous Coleoptera from South and Central Africa. Proc. Zoolog. Soc. of London, 1900, pp. 203–266, with 1 plate.

This paper contains the descriptions of 100 new species referable to 56 genera, of which 3 genera and 69 species are South African and new; 12 species are figured. The material on which the paper is based has been collected principally by Mr. G. A. K. Marshall, in Mashonaland, and the Rev. O'Neil in the Cape Colony.

JUNOD, H. A. La Faune Entomologique du Delagoa. 1, *Coléoptères*, pp. 162–190, with 2 plates. Bulletin de la Société Vaudoise des Sciences Naturelles.

The paper contains a list of 479 species collected by the author, as well as some notes on the habits and localities of some of them. Eight new Tenebrionidæ have been described by Mons. L. Fairmaire, three of them, however, are undoubtedly synonymous with others previously described, *i.e.*, *Psammodes junodi*, *Psammodes cinctipennis*, and *Micrantereus externus*, which are synonymous with *P. junodi* Pér., *P. valens* Pér., and *M. devexus* Pér.

HORN, DR. W. Zwei neue Myrmecopteræ vom südlichen Africa. Entomologische Nachrichten. No. 22. Nov., 1898.

The author describes 2 species, *i.e.*, *M. gerstaekeri* from Nyassa, and *M. filicornis*, from the Transvaal (Komatipoort); the last named species is very closely allied to *M. limbata*.

HORN, DR. W. Ueber einige alte und neue Cicindeliden. *Loc. cit.*, 1899, p. 52.

Description of a subspecies, *Cicindela brevicollis*, var. *bertolonii*. Horn.

HORN, W. Neue afrikanische Cicindeliden. Deutsch. Entom. Zeitschr., 1899, pp. 381–382.

Contains the description of a new South African insect: *Myrmecoptera pentheri.*

HORN, W. De novis Cicindelidarum speciebus. Deutsch. Entomol. Zeitschr., 1900, pp. 193–212.

Contains the description of a new *Myrmecoptera* from the Transvaal: *M. micans.*

HORN, W. Zum Studium der Cicindeliden. Entomologische Nachrichten, 1900, pp. 214–218.

The author considers *Dromica immaculata* as a variety of *D. tuberculata Dej.*, and *Myrmecoptera umfuliana* as *M. mauchi*. Bates.

KERREMANS, CH. Buprestides de l'Afrique équatoriale et de Madagascar. Annales Société Entomologique de Belgique, vol. 43, 1900, pp. 256–298.

Contains the description of 6 South African species.

KERREMANS, CH. Buprestides nouveaux et remarques synonymiques. Annales Soc. Entom. de Belg., vol. 44, pp. 282–351.

Contains the description of 4 South African species.

KOLBE, H. Ueber einige Arten der Dynastidengattung *Heteronychus*. Entomologische Nachrichten, 1900, pp. 163–169, and pp. 324–335.

The author revises the species of the genus, includes in a new one, *Heteroligus*, *Heteronychus Claudius* which occurs also in South-West Africa, and describes four new South African species.

KRAATZ, G. *Psadacoptera bipunctata,* nov. spec. von Natal. Deutsche Entomologische Zeitschrift, 1898, p. 91.

Description of a new Coleopterous insect belonging to the sub-Family *Cetoninæ.*

KRAATZ, G. "*Pachnoda bella.* Description of" Deutsche Entomol. Zeitschr., 1898, pp. 14–15.

KRAATZ, G. Eine neue *Ceratogonia*-Art vom Transvaal. Deutsche Entomol. Zeitschr., 1898, pp. 141–142.

KRAATZ, G. Ueber die Gattung *Phonotænia*, Kraatz. Deutsch. Entom. Zeitschr., 1900, pp. 78–79.

Contains the description of a new species : *P. zambesiana.*

KRAATZ, G. *Cœlorrhina Grandyi* (Bates) and *Nyassica* (Kraatz). Deutsch. Entomol. Zeitschr., 1900, p. 336.

The last-named species occurs also in Mashonaland.

LEWIS, G. On new Species of *Histeridæ*, and Notices of others. Annals and Magazine of Natural History, vol. 20, series 7, 1897, pp. 179–196 and 356–364.

In these two papers 4 new species and 1 new genus are described from South Africa. Mr. G. A. K. Marshall's observations that the species of *Paratropus* seek their prey in fungi, and that species of *Pachycrærus* are found under bark and in rotten logs is here recorded.

LEWIS, G. On new Species of *Histeridæ* and Notices of others. Annals and Magaz. Natur. Hist., vol. iv., series 7, 1899, pp. 1–29.

Contains the description of only one South African species: *Hypocacus rubricatus*, Lewis, and records Mr. G. A. K. Marshall's observation that *Hister nigrita* Er. has been found in Mashonaland devouring *Onitis inuus*, a beetle of large size, and feeding also on *Aphodii* and small *Onthophagi.*

LEWIS, G. On new Species of *Histeridæ* and Notices of others. Annals and Magazine of Natural History, ser. 7, vol. ii., 1898.

The paper contains descriptions of 6 new South African species, 1 of which, *Saprinus beatulus*, is a remarkable species, similar to several Indian ones, and has been found by Mr. L.

Péringuey in the mounds of refuse formed outside the galleries of the underground termite. *Hodotermes viator*, Latr.; *Monoplius pinguis*, and *M. inflatus* occur also in the same mounds.

Lewis, G. On new Species of *Histeridæ* and Notices of others. Annals and Magazine of Natural History, vol. v., ser. 7, 1900, pp. 224–234 and 246–254.

One new species is described. *Hister Holubi* is noticed. According to Mr. Marshall this beetle lives on the larvæ of the large horn-destroying, microlepidopteron *Tinea vastella.*

Oertzen, E. V. Beitrag zur Kenntniss der Gattung *Anomalipus.* Deutsche Entomologische Zeitschrift, 1897, pp. 33–46.

The author describes 11 new species, and gives a key to the species of this South African genus which, according to him, number now 36. He does not seem to have been aware that a description of 4 new species had appeared in 1896, in the Transactions of the Entomological Society of London, pp. 168 *et sequitur*, nor of that of *A. expansicollis*, Fairm, in the Bull. Soc. Ent. Fr., 1891, p. cxciii.

Péringuey, L. Fifth Contribution to the South African Coleopterous Fauna. Description of new species of Coleoptera, chiefly in the collection of the South African Museum. Annals of the South African Museum, vol. i., 1899, pp. 240–330, with 2 pl.

Péringuey, L. Notes sur certaines Cétoines (Crémastochilides) rencontrées dans les fourmilières ou termitières, avec description d'espèces nouvelles. Annales Société Entomologique de France, 1900, pp. 66–72.

Contains descriptions of 1 new genus and 5 new species.

Pic, M. Description de deux *Caryoborus* africains nouveaux (Coléopt.). Bulletin Société Entomologique de France, 1898, pp. 371–372.

One of the new species, *C. albonotatus*, is from Natal.

Pic, M. Diagnoses de deux *Ptinus* de l'Afrique Australe, et sous genre *Eutaprimorphus*. Miscellanea entomologica. Vol. 6, pp. 54–55.

RAFFRAY, A. Diagnoses de Staphylinides myrmécophiles nouveaux. Bulletin Société Entomologique de France, 1898, pp. 351–352.

Two new species and 2 new genera: *Pygonostenus* and *Trilobotideus.*

RAFFRAY, A., and FAUVEL, A. Genres et espèces de Staphylinides nouveaux d'Afrique. Revue d'Entomologie, vol. 18, 1899, pp. 1–44, with 1 pl.

The paper deals with myrmecobious or termitobious insects, and contains the description of 4 new genera and 9 species from South Africa.

WASMANN, E. Ein neuer *Fustigerodes* aus der Capkolonie. Wiener Entomologische Zeitung, xvi., 1897, pp. 201–202.

Is the description of a new species found in the paper-nests of an ant, *Cremastogaster peringueyi*, and which, however, is synonymous with *Fustigerodes peringueyi.*

WASMANN, E. Ein neuer Dorylidengast aus Südafrika. Deutsche Entomologische Zeitschrift, 1897, p. 278.

The author describes and figures a Staphylinid beetle, *Pygostenus Raffrayi*, found among ants of the genus *Dorylus.*

WASMANN, E. Ueber *Novoclaviger* und *Fustigerodes.* Wiener Entomolog. Zeit., xvii., 1898, pp. 96–99, with 3 figures.

Contains the description of a new myrmecophilous Clavigerid beetle, found in the nests of an ant, *Rhoplaomyrmex spec.*

WASMANN, E. Eine neue dorylophite Tachyporinen Gattung aus Südafrika. Eine neue *Philusina* vom Cap. Wien. Ent. Zeit. Jahr. 17, 1898, pp. 101–103, with 4 figs.

Description of a new génus and a new species, *Doryloxenus*, allied to *Pygostenus*; also of *Philusina braunsi.*

WASMANN, E. Ein neues myrmecophiles Curculionidengenus aus der Kapkolonie. Deutsch. Entomol. Zeitschr., 1899, pp. 170–171.

Is the description of a weevil beetle, of the sub-Family

Cossoninæ, found in the nests made of a substance resembling paper by the ant *Cremastogaster peringueyi*, Emer.

WASMANN, E. Ein neues physogastres Aleocharinengenus aus der Kapkolonie, loc. cit., 1899, pp. 178–179.

The author describes and figures a Staphylinid beetle found in the nest of a small Termite, *Termes unidentatus*, Wasm.

WASMANN, E. Eine neue dorylophile *Myrmedonia* aus der Kapkolonie, mit einigen anderen Notizen über Dorylinengäste. Deutsch. Entom. Zeitschr., 1899, pp. 174–177.

The paper contains a description of a new Coleopterous insect of the family Staphylinidæ living with a Dorylid ant, and a note on the Staphylini found with these ants.

WASMANN, E. Ein neues physogastres Aleocharinengenus aus der Kapkolonie. Deutsch. Entom. Zeitschr., 1899, pp. 178–179, 1 pl.

Termitotropha O'Neili, fig., new gen. and new species, is found with the white ant *Termes unidentatus*.

WASMANN, E. Ein neuer *Termitodiscus* aus Natal. Deutsch. Entom. Zeitschr., 1900, pp. 401–402.

WASMANN, E. Zwei neue *Lobopelta*-Gäste aus Süd-Afrika. Deutsch. Entom. Zeitschr., 1899, pp. 403–404, 1 fig.

WASMANN, E. Zwei neue myrmecophile *Philusina*-Arten aus Süd-afrika. Deutsch. Entom. Zeitschr., 1899, pp. 405–406.

One of these two species of Staphylinid beetles, *P. aterrima*, lives with the ant *Solenopsis punctaticeps*, the other, *P. incola*, with *Pheidole megacephala*.

WASMANN, E. "G. D. Haviland's Beobachtungen über die Termitophilie von *Rhopalomelus angusticollis*, Boh." Verhandlungen der K.K. zoologisch-botanischen Gesellschaft in Wien., 1899, pp. 245–249.

WASMANN, E. Zur Kenntnis der termitophilen und myrmekophilen Cetoniden Süd-Afrikas. Illustrierte Zeitschrift für Entomologie, 1900, pp. 65–67 and 81–84, with 1 pl.

Contains the description of five, and the figures of four, South African species referable to four genera, two of which are new.

WASMANN, E. Neue Dorylinengäste aus dem neotropischen und dem äthiopischen Faunengebiet. Zoologische Jahrbücher, vol. 14, pl. 3, Jena, 1900, 75 pp., with 2 pl.

The author in the second part of the paper treats of the guests of the African Driver ants (*Anomma* and *Dorylus*), and describes a new genus and 2 new species.

WASMANN, E. Neue Paussiden, mit einer biologischen Nachtrag. Notes from the Leyden Museum, vol. xxi., 1900, pp. 33–52, with 2 pl.

Contains the description of a new South African species, *Paussus semilineatus*.

WEISE, J. Cassidinen und Hispinen aus Deutsch-Ostafrika. Arch. Naturg. Jahrg., 65, Bd. 1, pp. 241–267.

The paper contains the description of one species of *Aspidomorpha* from the Zambesi.

LEPIDOPTERA.

AURIVILIUS, CHR. Rhopalocera Æthiopica. Die Tagfalter des Æthiopischen Faunengebietes. Eine systematisch-geographische Studie, pp. 1–561, Mit. O. Tafeln. Kongl-Svenska. Vetenskaps-Akademiens Handlingar. Band. 31, No. 5. Stockholm, 1899.

A synopsis of the butterflies of the whole of Æthiopic Africa, and also of Madagascar, numbering 1,612 species, to which has been added a list of 142 works on African Lepidoptera. The Hesperiidæ, however, are not included in this work, owing to their being regarded by the author as a separate group.

Butler, A. G. On a Collection of Lepidoptera made by Mr. F. V. Kirby, chiefly in Portuguese East Africa. Proceedings Zoological Society, 1898, pp. 49–58.

Ninety-two species, of which 2 are new, are here recorded from the Eastern Transvaal and Portuguese East Africa, presumably south of the Zambezi.

Butler, A. G. A Revision of the species of Butterflies belonging to the genus *Teracolus*, Swains. Annals and Magazine of Natural History, vol. 20, series 7, 1897, pp. 385–399, 451–472, and 495–507.

The author claims to have devoted special care on studying the sexes and seasonal forms, and lays great stress on the variations of the dry and wet season forms. Many names of species are therefore sunk into synonymous ones. He criticises also some of Mr. Marshall's suppositions regarding the identity of some of these forms.

Butler, A. G. On the Lepidopterous Insects collected by Mr. G. A. K. Marshall in Natal and Mashonaland in 1895 and 1897. Proc. Zoolog. Soc., 1898, pp. 186–201, with 1 plate.

The author enumerates and notices 119 species, describes and figures 3 new ones, and figures 2 others.

Butler, A. G. On a Collection of Butterflies almost entirely made at Salisbury, Mashonaland, by Mr. Guy A. K. Marshall in 1898. Proc. Zoolog. Soc., 1898, pp. 902–912.

The paper contains the description of 2 new genera allied to *Leptoneura*, and 1 new species.

Distant, W. L. On a Collection of Heterocera made in the Transvaal. Annals and Magazine of Natural History, vol. 20, series 7, 1897, pp. 15–17.

Contains the description of 3 new *Zygænidæ* and 1 *Pyralid;* 1 *Arctiid*, 2 *Lithosiidæ;* 11 *Lymantriidæ;* 2 *Eupterotidæ;* 7 *Lasiocampidæ;* 1 *Arbelid*, 1 *Cossid*, and 1 *Hepialid*.

DISTANT, W. L. Heterocera from the Transvaal. Ann. and Magaz. Nat. Hist., vol. 1, series 7, 1898, pp. 116–118.

Is the description of 1 new *Arctiid*, 2 *Lymantriidæ*, 1 *Limacosid*, and 1 *Lasiocampid*, all from Johannesburg.

DISTANT, W. L. Some apparently undescribed species of Heterocera from the Transvaal. Annals and Magazine Natural History, vol. iv., series 7, 1899, pp. 359–362.

Contains the description of 4 new species of *Lymantriid* moths, 1 *Europterid ;* 1 *Notodontid*, 1 *Lasiocampid*, and 1 *Chrysopolomid*.

DRUCE, H. Descriptions of some new species of Heterocera. Annals and Magazine of Natural History, vol. 1, series 7, 1898, pp. 146–149 and 207–215.

Contains the description of a new *Syntomid*, 1 *Liparid*, and 1 *Arctiid* moth.

DRUCE, H. Descriptions of some new species of Heterocera from Tropical America, Africa, and the Eastern Islands. Annals and Magaz. Nat. Hist., vol. 3, series 7, 1899, pp. 228–236, 465–474, and 200–205.

Contains the description of 2 new *Zygænidæ*, 1 *Liparid*, 1 *Lasiocampid*, and 8 *Ægeriidæ* from South Africa.

HAMPSON, SIR G. F. On a Collection of Heterocera made in the Transvaal. Ann. Nat. Hist., vol. 1, series 7, 1898, pp. 158–164.

The paper contains an enumeration of the *Pyralidæ* collected by Mr. W. L. Distant, almost all taken at Pretoria; six of them are described for the first time.

HAMPSON, SIR G. F. The Moths of South Africa (Part i.). Annals of the South African Museum, vol. ii., pt. iii., 1900, pp. 33–66.

The author deals in this first paper with the *Syntomidæ*, *Arctiadæ*, and *Agaristidæ*, which number 139 species referable to 58 genera. Two genera and 10 species are described for the first time.

KARSCH, F. Neue harmoncopode Lepidopteren des Berliner Museums aus Afrika. Entomologische Nachrichten, 1898, pp. 330–336.

Contains the description of a new genus and a new species of Agaristid moth, *Mitrophrys meraca*, from South-West Africa.

MABILLE, P. Lepidoptera nova malgassica et africana. Annales Société Entomologique de France, 1900, vol. 68, pp. 723–753.

Contains short diagnoses of two South African Insects: *Phalera lignitea* and *Macroplectra tripunctata.*

MABILLE, P. Description de Lepidoptères nouveaux. Annales Société Entomologique de France, vol. 66, 1898, pp. 182–231.

Contains the description of 2 South African species.

MARSHALL, G. A. K. On the Synonymy of the Butterflies of the Genus *Teracolus.* Proceedings Zoological Society, 1897, pp. 3–36.

The author does not see any necessity for naming seasonal forms, not more than for the naming of sexual ones, and suggests the adoption of three standard signs or letters to signify wet, dry, and intermediate forms respectively.

MARSHALL, G. A. K. Seasonal Dimorphism in Butterflies of the Genus *Precis*. Doubled. Annals and Mag. Natur. Hist., vol. 2, 7th series, No. 7, July, 1898, pp. 30–40.

Two years before this the author recorded his conviction (Trans. Ent. Soc., 1896) that seasonal dimorphism of a singularly marked character existed among certain African species of the genus *Precis.* He has at last, and after not a few disappointments, succeeded in breeding typical *Precis sesamus* Trim. from eggs laid by three separate females of *P. octavia* subsp. *natalensis*. Staud., "thereby establishing beyond doubt what is certainly the most remarkable instance of seasonal variation as yet known among the Lepidoptera."

One of his pupæ, however, produced, curiously enough, a pure *P. natalensis.* The colouring of the larva, judging by the few examples examined, is not affected by season, but the pupa presents two forms of colouration. During the moist summer months the withered leaves of the food plant turn dark-brown or black, instead of yellow as in the winter, so that the gilded form or the dull brownish black one is well adapted to its surroundings, looking like a bit of shrivelled leaf. In one case, the wet season form was bred from a golden pupa, but no typical *P. sesamus* has as yet been reared from the dark form. The differences between the seasonal forms of the imago are not confined to shape and colour alone, but there is likewise a very appreciable divergence in habits, of which Mr. Marshall gives an interesting account.

In considering the reasons for seasonal dimorphism, the author concludes that the climatic one is the directly exciting cause; but while in Europe the dimorphic tendency seems to be brought into action by heat and cold, and humidity has no part in it, so far as South Africa is concerned, the author is strongly of opinion that the exact converse is the case, and that there is "strong *primâ facie* evidence that humidity and not temperature is the exciting agent of dimorphism in this part of the world."

WARREN, W. New *Drepanulidæ, Thyrididæ*, and *Geometridæ* from the Æthiopian Region. Novitates Zoologicæ, vol. 6, 1899, pp. 287–313.

Contains the description of 6 new South African Species.

WARREN, W. New Genera and Species of *Thyrididæ* and *Geometridæ* from Africa. Novit. Zoolog., vol. 7, 1900, pp. 90–98.

Contains the description of 9 South African Geometrid Moths.

DIPTERA.

RICARDO, MISS GERTRUDE. Notes on the *Pangoninæ* of the Family *Tabanidæ* of the British Museum Collection. Annals and Magazine of Natural History, vol. v., 7th series, 1900, pp. 97–121 and 167–182, with 1 plate.

The paper embodies the results of an attempt to rearrange the specimens of *Pangoninæ* in the British Museum, dealing, so far, with *Pangonia*, Latreille and its allied genera. Several South African species are noticed, and 2 new ones described and figured.

RICARDO, MISS GERTRUDE. Notes on *Diptera* from South Africa (*Tabanidæ* and *Asilidæ*). Ann. Mag. Nat. Hist., vol. vi., series 7, 1900, pp. 161–178.

The flies treated in this paper are those collected by Mr. Distant, chiefly from the Transvaal, 10 of which are new species.

TASCHENBERG, OTTO. Die Verbreitung des Sandflohes in Afrika (*Sarcopsyla penetrans*). Die Natur, Jahrg. 1897, p. 46, pp. 310–311.

HEMIPTERA-HOMOPTERA.

COCKERELL, T. D. A. A new Genus of *Coccidæ*, *Cryptinglisia lounsburyi*, injuring the roots of the grape-vine in South Africa. Entomologist, vol. 33, 1900, pp. 173–174.

COOLEY, R. A. New Species of *Chionaspis* and Notes on previously known Species. Canadian Entomologist, vol. 30, pp. 85–90.

Contains description of one species from Cape Colony.

DISTANT, W. L. Descriptions of new Species of Hemiptera-Heteroptera. Annals and Magazine Natural History, vol. ii., series 7, 1898, pp. 133–135.

In this short paper is the description of one species from Delagoa Bay, *Storthogaster Junodi*, belonging to the *Phyllocephalinæ*.

DISTANT, W. L. Rhynchota from the Transvaal, Mashonaland, and British Nyassaland (Pt. i.). Annals and Mag. Nat. Hist., vol. ii., series 7, 1898, pp. 294–316.

The paper refers to the Heteropterous Family *Pentatomidæ* and is based on the author's collection, and others acquired in the Transvaal, one made near Salisbury, Mashonaland, by Mr. G. A. K. Marshall, and another received from Dr. Percy

Rendall, made in Nyassaland. In this first family *Pentatomidæ*, the following species are enumerated for the three localities:—

	Species.	Sp. nov.	Gen. nov.
Transvaal	120 ...	... 16 ...	... 2
Mashonaland	36 ...	... 5 ...	... 1
Nyassaland	45 ...	... 8 ...	... 2

The author states that all the new species will be figured in his forthcoming "Insecta Transvaaliensia."

Distant, W. L. On two undescribed Cicadas from the Transvaal. (*Platypleura silvia*, and *Tibicen Sirius*). Annals and Magaz. Nat. Hist., vol. 3, ser. 7, 1899, pp. 81–82.

Distant, W. L. On some South African Homoptera. Ann. and Mag. Nat. Hist., vol. iv. series 7, 1899, pp. 113–115.

Contains the descriptions of two new species from South Africa referable to two new genera of *Fulgoridæ*.

Kirkaldy, G. W. On *Ægaleus bechuana*, a new species of *Cimicidæ*, reported to injure coffee-berries in British Central Africa. Entomologist, vol. 33, 1900, pp. 77–78.

Montandon, A. L. La Faune Entomologique du Delagoa—*Hémiptères*. Bulletin de la Société Vaudoise des Science Naturelles, vol. xxxv., No. 132, 1899, pp. 216-220.

A list of the Hemiptera collected by Rev. H. Junod, amounting to 52 species, referable to 37 genera.

Neuroptera.

Forster, F. Odonaten des Transvaalstaates. Entom. Nachr., 24, 1898, pp. 166–172.

Description of two new species of *Onychogomphus* and *Orthetrum*.

Forster, F. Odonaten des Transvaalstaates. Entomologische Nachrichten, 23, 1897, pp. 215–220.

KARSCH, F. Neue Odonaten aus Ost-und Süd-Afrika mit Einschluss des Seengebietes. Entomologische Nachrichten, 1899, pp. 369.

The paper deals mainly with insects from South-East Africa, beyond the South African limit, but one species, *Æschna dolabrata,* from the Cape of Good Hope, is also described.

KIRBY, W. F. On a Collection of Dragon-flies from the Transvaal and Nyassaland. Annals and Magazine Natural History, vol. ii., series 7, 1898, pp. 229–245.

This collection was found to consist of upwards of forty species, among which one will form the type of a new genus, and eight are new. Many of the species enumerated are found to occur in other parts of Africa, Madagascar, India, Central and Western Asia, and Europe.

MACLACHLAN, ROBERT. Description de deux espèces nouvelles de Névroptères du genre *Croce* McLach. Bulletin Société Entomologique de France, 1898, pp. 169–171.

One species, *C. damaræ,* is from Damaraland.

SJÖSTED, Y. Neue afrikanische Termiten. Entomologische Nachrichten, 1899, pp. 33–39.

Includes the description of one species, *Termes tumulicola,* ranging, according to the author, from Togoland to Natal.

ORTHOPTERA.

KARSCH, F. Vorarbeiten zu einer Orthopterologie Ostafrika's. Entomologische Nachrichten, 1900, pp. 274–287.

The paper contains a synopsis of the species of the genus *Catantops* (*Caloptenidæ*), and in which four South African species, including a new one, are noticed.

KIRBY, W. F. On a Collection of *Mantidæ* from the Transvaal, &c., formed by Mr. W. L. Distant. Ann. Mag. Nat. Hist., vol. iv., series 7, 1899, pp. 344–353.

The collection contained 30 South African species, one of which, *Solygia distanti,* is described as new.

KIRBY, W. F. Notes on a Collection of *Gryllidæ, Stenopelmatidæ, Gryllacridæ*, and *Hetrodidæ* formed by Mr. W. L. Distant in the Transvaal and other South and East African localities. Annals Mag. Nat. Hist., vol. iii., series 7, 1899, pp. 475–480.

A preliminary list to Mr. Distant's comprehensive work on the Insects of the Transvaal, and contains the description of 2 new *Stenopelmatidæ*.

KIRBY, W. F. Notes on a Collection of African *Blattidæ*, chiefly from the Transvaal, formed by Mr. W. L. Distant. Ann. and Mag. Nat. Hist., vol. v., ser. 7, 1900, pp. 277–294.

Forty-six species referred to 24 genera are enumerated; 13 species and 1 genus are described for the first time.

KIRBY, W. F. Order *Orthoptera* in Distant's Insecta Transvaaliensia, pp. 1–24 and 2 coloured pl. London, 4to, 1900.

SAUSSURE, H. DE. Voeltzkow, Wissenschaftliche Ergebnisse der Reisen in Madagascar and Ost-Afrika in den Jahren, 1889–1895 — *Orthoptera*. Abhandl. d. Senckenb. naturforschenden Gesellsch., vol. xxi., 1899, part iv., pp. 569-664, with 2 plates.

Although dealing mainly with Madagascar and East African species, the paper contains descriptions of 22 new South African species referable to 19 genera, 5 of which are new, and 5 figured with details.

SCHULTHESS-SCHINDLER, Dr. O. DE. La Faune Entomologique du Delagoa. *Orthoptères*. Extr. Bulletin de le Société Vaudoise des Sciences Naturelles. Vol. xxxv., No. 132, 1899, pp. 191–222, with 2 plates and figs. in the text.

The number of species of this order collected by Rev. H. Junod is 56. Two new genera and 10 new species are described, and 8 species figured. The author includes also in this paper the description of a new species from Senegambia.

L. P.

Arachnida.

Simon, E. Description d'une Araignée myrmécophile du cap de Bonne-Espérance (*Andromma raffrayi*, n. sp.). Bull. Soc. Ent. Fr., No. 10, pp. 179–181. 1899.

This is one of the *Drassidæ*, and was found in the Cape Peninsula by M. A. Raffray, along with the beetle *Pentaplatarthrus paussoides* in the nests of the ant *Plagiolepis fallax*.

Loman, J. C. C. Beiträge zur Kenntnis der Fauna von Süd-Africa. Ergebnisse einer Reise von Prof. Max Weber im Jahre 1894. IV. Neue Opilioniden von Süd-Africa und Madagascar. Zoolog. Jahrb. Syst. xi., pp. 515–530, pl. xxxi. 1898.

Contains descriptions of about 8 new South African species, chiefly from Knysna and Natal, and collected by Prof. Weber.

Pocock, R. I. The *Arachnida* from the Province of Natal, South Africa, contained in the collection of the British Museum. Ann. Mag. Nat. Hist. (7), ii., pp. 197–225, pl. viii. 1898.

The list includes 2 *Solifugæ*, 6 Scorpions (1 new *Hadogenes*), 1 Pedipalp, and 52 Spiders (including 18 new species belonging to the genera *Harpactira*, *Stegodyphus*, *Dresserus*, *Dinopis*, *Araneus*, *Hersilia*, *Spencerella* n.g., *Palpimanus*, *Cydrella*, *Platyoides*, *Corinna*, *Sparassus*, *Thomisus*).

Pocock, R. I. Descriptions of three new species of Spiders of the genus *Selenops*, Latr. Ann. Mag. N. H. (7), ii., 1898, pp. 348–351.

One new species (*S. kraussi*) from Cape Colony.

Pocock, R. I. Descriptions of some new Scorpions. Ann. Mag. N. H. (7), iii., pp. 411–420. May, 1899.

One *Opisthophthalmus* from the Transvaal, 1 *Opisthacanthus* from Basutoland, 1 *Cheloctonus* from Griqualand West, and 1 *Parabuthus* from Bechuanaland are described as new.

Pocock, R. I. Some new *Arachnida* from Cape Colony. Ann. Mag. N. H., ser. 7, vol. 6, pp. 316–333. 1900.

Descriptions of 2 new species of *Solifugæ* and 35 of *Araneæ*.

Pocock, R, I. Diagnoses of some new species of Spiders from Mashonaland. Ann. Mag. N. H., ser. 7, vol. 7, pp. 337–340. 1901.

Descriptions of 9 new spiders.

Pocock, R. I. Descriptions of some new African *Arachnida*. Ann. Mag. N. H., ser. 7, vol. 7, pp. 384–388.

Six new South African spiders are described.

Pickard-Cambridge, O. On some new exotic Spiders collected by Messrs. G. A. K. Marshall and R. Shelford. Proc. Zool. Soc., London, 1901, pp. 11–16, pl. 5.

Two new spiders from Mashonaland described.

Pickard-Cambridge, O. On some new species of exotic *Araneida*. Proc. Zool. Soc., London, 1899, pp. 518–532, pl. 29–30.

One new Argiopid from Natal is described.

Purcell, W. F. On the species of *Opisthopthalmus* in the collection of the South African Museum, with descriptions of some new forms. Ann. S. Afr. Mus., i., part ii., pp. 131–180. 1899.

Treats of the distribution of the species, the characteristics of their numerous local races, and the systematic characters. Three new species from Bushmanland and Clanwilliam are described, and a general synoptic table for the genus is given.

Purcell, W. F. New and little-known South African *Solifugæ* in the collection of the South African Museum. Ann. S. Afr. Mus., vol. 1, part 3, pp. 381-432. 1889.

Purcell, W. F. New South African Scorpions in the collection of the South African Museum. Ann. S. Afr. Mus., vol. 1, part 3, pp. 433–438. 1899.

New species of *Parabuthus* (3), and *Hadogenes* (4).

Onychophora.

Purcell, W. F. On the South African species of *Peripatidæ* in the collection of the South African Museum. Ann. S. Afr. Mus., vol. i., part ii., pp. 331–351. 1899.

The external systematic characters of the South African species of *Peripatopsis* are given in detail, and three new species are described. Further, a new South African genus (*Opisthopatus*) is established, represented by a single species (*O. cinctipes* n. sp.) from the Uitenhage Division. A synoptic table for all the named South African forms is given.

Purcell, W. F. On the anatomy of *Opisthopatus cinctipes*, Purc., with notes on other, principally South African, Onychophora. Ann. S. Afr. Mus., vol. 2, part 4, pp. 67–116, pl. 10–12. 1900.

The first part of this paper deals with the anatomy of *Opisthopatus*, while the second part forms a supplement to the previous paper.

Bouvier, E. L. Observations biologiques sur le *Peripatus capensis*, Grube. C.R. Acad. Sc., Paris, t. 129, pp. 971–973. 1899.

Bouvier, E. L. Quelques observations sur les Onychophores (*Peripatus*) de la collection du Musée Britannique. Quart. Journ. Micr. Sc. (n.s.), vol. 43, pp. 367–373. 1900.

Makes a new variety *natalensis* of the Natal form of *Opisthopatus cinctipes* Purc.

Bouvier, E. L. Observations sur le *Peripatopsis moseleyi*. Bull. Soc. Ent. Fr., 1900, pp. 119–121.

Bouvier, E. L. A propos des Onychophores du Cap, désignés sous les noms de *Peripatus capensis*, Grube, et de *P. brevis*, Blain. Bull. S. E. Fr., 1901, p. 74.

Proves that *P. capensis* and *P. brevis* are identical, but prefers to retain the former name, as it is so well established.

W. F. P.

PROCEEDINGS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

ORDINARY MONTHLY MEETING,

held at the conclusion of the Annual General Meeting.

August 31, 1898.

THOMAS STEWART, F.G.S., M.I.C.E., President, in the Chair.

Messrs. C. F. JURITZ, J. C. WATERMEYER, C. L. W. MANSERGH, and C. T. HOLLAND were elected ordinary members of the Society.

Messrs. HAROLD A. FRY, of Johannesburg, HENRY RIX-TROTT, of Port Elizabeth, and LANGHAM DALE, of Cape Town, were nominated for election as ordinary members.

Mr. W. L. SCLATER's motion, "That the Council takes into consideration the holding of the ordinary meetings at 4.15 p.m. instead of 8 p.m. on such afternoons as they shall decide," was carried.

The list of additions to the Library was read.

Mr. D. E. HUTCHINS read a paper on "National Forests."

ORDINARY MONTHLY MEETING.

September 29, 1898.

THOMAS STEWART, F.G.S., M.I.C.E., President, in the Chair. Sixteen members present.

Messrs. HAROLD A. FRY, HENRY RIX-TROTT, and LANGHAM DALE were elected ordinary members of the Society.

Dr. W. KOLLE, Dr. C. E. PIERS, and Messrs. G. LEITH and C. A. LEDOUX were nominated for election as ordinary members.

Mr. PÉRINGUEY's motion "That the Council be instructed to take the steps necessary for the incorporation by Royal Charter of the Society under the name of 'Royal Society of South Africa'" was discussed, and after discussion the meeting adopted Dr. GILL's amendment "That the question of incorporation of this Society by Royal Charter be referred to the Council for consideration and report."

The list of additions by exchange and donation to the Library was read.

Dr. MARLOTH read a paper entitled "Notes on the Mode of Growth of *Tubicinella* on the Right Whale."

Ordinary Monthly Meeting.

October 27, 1898.

Thomas Stewart, F.G.S., M.I.C.E., President, in the Chair. Twelve members present.

Dr. W. Kolle, Dr. C. E. Piers, and Messrs. G. Leith and C. A. Ledoux were elected ordinary members of the Society.

Messrs. W. A. Oakley, R. E. Brounger, T. S. MacEwan, O. F. Monier-Williams, and C. Fuller were nominated for election as ordinary members.

Miss Wilman exhibited an interesting photograph taken by Dr. Molengraaff on the farm Doornpan, near Mooiklip, Vryheid District. It shows Dwyka Conglomerate lying upon shales of the Barberton Formation (Swazieland Schists), and the latter exhibit undoubted glacial striations.

Mr. F. Treleaven exhibited some Australian butterflies, the property of Mr. C. Fuller.

Mr. W. L. Sclater exhibited bird skins collected for the South African Museum by Messrs. W. and H. F. Francis, including those of *Guttera edouardi*, *Herodias rufiventris*, and *Pternistes humboldti*, the latter new to the South African fauna.

Mr. A. P. Trotter directed the attention of members to a sun-spot which was visible at the time, and with the help of a telescope enabled them to view the phenomenon.

Mr. J. R. Sutton's paper, "Do the Mining Operations affect the Climate of Kimberley?" was read.

The list of book and papers received was read.

Ordinary Monthly Meeting.

January 26, 1899.

Thomas Stewart, F.G.S., M.I.C.E., President, in the Chair. Nine members and seven visitors present.

Messrs. W. A. Oakley, R. E. Brounger, T. S. MacEwan, O. F. Monier-Williams, and C. Fuller were elected ordinary members of the Society.

Mr. H. L. L. Feltham and Dr. W. W. Stoney were nominated for election.

A list of books and papers received was laid upon the table.

Mr. J. C. Watermeyer's paper, entitled "Notes on a Journey in German South-West Africa," was read.

Ordinary Monthly Meeting.

March 27, 1899.

T. Stewart, F.G.S., M.I.C.E., President, in the Chair.

M. F. Rohden, Esq., was nominated for election as an ordinary member.

H. L. L. Feltham, Esq., and Dr. W. W. Stoney were elected ordinary members.

Mr. W. L. Sclater exhibited copies of Bushman paintings found on a krantz at Schoombie, and of others from Basutoland representing scenes of battle and the chase.

Dr. T. Muir showed certain herbaria, the outcome of prizes he offered to schools and children a year ago to encourage a practical interest in botany.

Mr. H. P. Saunders read a paper on "Boring for Water in the Colony." Mr. Saunders said there were few districts in the Colony in which careful and competent selection would not discover sites where, within 200 feet of the surface, considerable supplies of water would be found, an average of 10,000 gallons per diem being easily obtainable by use of a wind pump from a three-inch bore. Increasing the diameter of the hole on the more favourable sites would often give 50,000 gallons per diem by pumping. During six years' experience in boring for the Government Mr. Saunders had never failed in striking water either in the Malmesbury Beds or in the Dwyka Conglomerate. It was futile to expect large supplies from deep boring in the Colony.

Mr. G. Alston said that his measurements, taken over many years, showed that the subterranean water-level was gradually sinking. He suggested that the Government should repair the loss by making a double or treble line of large dams in the upper portions of the country, from which water could be forced into the porous strata to make good the loss caused by tapping at lower levels.

Dr. Piers corroborated the sinking of the water-level, and agreed that it was due to excessive tapping of the underground supplies.

Mr. McEwen called attention to the boring at Matjesfontein and Tweedside, where water had been struck at a depth of 400 feet to the amount of 50,000 gallons a day.

Mr. Westhofen said that last year the Government had nineteen drills in use; 367 holes were bored, with an aggregate depth of over 26,000 feet; in 325 of the holes water was found, and of these 258 yielded more than 1,000 gallons per diem. The Government was spending £16,000 to £18,000 a year on this work, and all they got in return from the farmers was perhaps not more than £3,000.

The CHAIRMAN suggested that it would be well if systematic observations could be made of the quantity of water flowing in the Orange River at a given point, and then a comparison of this with the amount that reached the sea. The difference would give some idea of the amount finding its way underground.

Mr. WESTHOFEN said they did that on a small scale by observations taken on a few rivers, where notes were made of the rainfall, and gaugings taken of the volume of water in the river. It had been found that the latter was only about one-sixth of the total quantity received on the drainage area.

The CHAIRMAN said that in the case of the Orange River the proportion must be even smaller, as he understood observations showed that the water at the railway bridge was only a fraction per cent. of the total rainfall. It would be an interesting and valuable study if some regular work in this direction were undertaken.

ORDINARY MONTHLY MEETING.

March 30, 1899.

T. MUIR, LL.D., M.A., Vice-President, in the Chair.

Dr. G. S. CORSTORPHINE gave notice of motion that the Society return to the former day and hour of meeting, viz., Wednesdays at 8 p.m.

M. F. ROHDEN, Esq., Oudtshoorn, was elected an ordinary member.

Dr. GILCHRIST exhibited several specimens obtained by the Government trawler, the *Pieter Faure*. These included (1) several species of Veritillum from the east coast, Table Bay, and St. Helena Bay; (2) other species of Alcyonarians; (3) several species of fish, one of which, a small flat fish allied to the genus *Rhombus*, was found on the Agulhas Bank, though its adult form was not yet known.

Dr. MARLOTH mentioned that he had heard that the German Deep-sea Expedition on the *S.S. Valdivia* had rediscovered one of the Bouvet Islands.

Mr. L. PÉRINGUEY showed some stone implements found at Stellenbosch and Paarl, which he considered the oldest types yet found in South Africa. He intended to lay an exhaustive account of these implements before the Society at a future date.

The list of books and papers recently received was laid on the table.

Ordinary Monthly Meeting.

April 27, 1899.

T. Stewart, F.G.S., M.I.C.E., President, in the Chair.

L. Crawford, Esq., D.Sc., Professor of Mathematics, South African College, and Thomas Quentrall, Esq., Inspector of Mines, Kimberley, were nominated for election as ordinary members.

After discussion of Dr. Corstorphine's motion to return to the former day and hour of meeting, it was agreed that the Secretary should obtain the opinion of all the town members.

Mr. W. Westhofen exhibited a piece of granite found many years ago in one of the quarries in the gardens, showing a perfect cross formed by felspar crystals.

The following paper was read: "Notes on the Occurrence of Alpine Types in the Vegetation of the Higher Peaks of the South-Western Region of the Cape," by R. Marloth, Ph.D.

Ordinary Monthly Meeting.

May 31, 1899.

T. Stewart, F.G.S., M.I.C.E., President, in the Chair.

A. D. Millar, Esq., Durban, and Dr. J. Hanau, Carnarvon, were nominated for election as ordinary members.

L. Crawford, Esq., D.Sc., Professor of Mathematics, South African College, and T. Quentrall, Esq., Inspector of Mines, Kimberley, were elected ordinary members.

The President announced that a majority of the town and suburban members had voted for the meetings being again held on Wednesdays and in the evening.

Professor Van der Riet exhibited (1) bituminous shale from Ermelo, Z.A.R., containing 43 per cent. volatile matter; (2) a fine specimen of Apophyllite from Kimberley; and (3) a Theriodont skull from Groot Vlaakte on the Karroo.

Mr. E. J. Dunn, F.G.S., read a paper entitled "Notes on the Dwyka Coal Measures at Vereeniging, Transvaal."

Ordinary Monthly Meeting.

July 12, 1899.

T. Stewart, F.G.S., M.I.C.E., President, in the Chair.

The following gentlemen were nominated as ordinary members: S. S. Hough, Esq., M.A., Royal Observatory; A. Struben, Esq., Cape Town; Hon. Dr. W. Berry, The Speaker, House of Assembly; J. A. Masson, Esq., Surveyor-General, Natal; W. Osborn, Esq., Public Library, Durban; J. A. Francis, Esq., Durban; D. Don, Esq., Durban.

A suggestion was made by the Secretary that each member reading a paper before the Society should write a summary for the press, so that country members might get better information of the Meetings.

The Chairman thought this a subject with which the Council might deal.

Dr. Gill described the work which was being done in spectroscopy at the Royal Observatory. He gave an account of the new spectroscope which had been designed by himself and erected by the liberality of Mr. Maclean.

Mr. Sclater gave an account of the discovery of an ancient stone in excavations carried on in Adderley Street. He had deciphered the inscription as follows:—

"Charles Cle chiefe command of *Palsgrave Elizabeth* and *Hope* arrived ye XXIIII. June and dep. for Bantam ye XX. July 1619. Thomas Brockendon, Cape merchant of the *Palsgrave.*"

He had communicated with Mr. Ravenstein on the subject, who had referred the matter to Mr. W. Foster, of the India Office, from whom he had received a letter stating that on looking through the records of the East India Company he found that the fleet in question sailed from the Thames in March, 1619. The *Hope* had made several previous voyages, but the *Palsgrave* (1,083 tons) and *Elizabeth* (978 tons) were new ships built by the Company in the previous year. The chief was Commander Charles Clevenger (Cle of the inscription), who hoisted his flag in the *Palsgrave*. At the Cape they seemed to have met the *Lesser James*, homeward bound. It was customary for the Company's sailors (as also the Dutch) to cut such inscriptions for the information of succeeding ships, and the particulars thus obtained were continually repeated in the letters home. At times letters were buried and inscriptions engraved near at hand giving intelligence where they might be found. Sir Thomas Roe, on his way to India in 1615, had an inscription cut recording his embassy, and indeed there must be many such buried stones in Cape Town and its vicinity.

Mr. Sclater also exhibited the photograph of the skull of a gigantic lemur which had been sent to him from Madagascar. For the skull itself the price of £8,500 was asked.

The Chairman gave a short account of underground water in the Transvaal. Very little had been done in South Africa with regard to underground water, and the geological conditions of this Colony did not show that we could look to any great supply in future from underground sources. But it was quite a different matter with the Transvaal, where dolomitic limestone covered large areas.

Ordinary Monthly Meeting.

August 9, 1899.

T. Stewart, F.G.S., M.I.C.E., President, in the Chair.

The Minutes of last meeting were read and confirmed.

The list of books presented to the Library was laid on the table.

The following gentlemen were nominated for election as ordinary members at the next meeting: Chas. T. Gray, Esq., Commissioner of Mines, Natal; J. B. Moffat, Esq., Native Affairs Office, Cape Town; H. Beard, Esq., B.A. (Cantab), Cape Town; W. Tyson, Esq., F.L.S., Department of Agriculture, Cape Town.

The following gentlemen were elected ordinary members of the Society: Hon. Dr. Berry, Messrs. S. S. Hough, Esq., M.A., J. A. Masson, Esq., W. Osborn, Esq., J. A. Francis, Esq., D. Don, Esq.

The meeting then resolved itself into the

Annual General Meeting.

The Hon. Secretary read the Annual Report :—

The number of Ordinary Meetings held has been eight, at which eight papers were read. Six of these papers are now being printed, and will form Part I. of Volume XI. of the Transactions. During the year Parts II. and III. of Volume X. were issued. These two Parts contain 372 pp. and 6 plates.

The Books and Pamphlets belonging to the Society's Library have been catalogued, and are now arranged in the gallery of the reading-room of the Public Library, where they may be consulted. The Catalogue is in duplicate, one set of slips being in the Library, the other with the Secretary.

The Society's Transactions have been sent to 110 Societies and Institutions, and in return 251 publications were received during the year.

There are 132 ordinary members and 2 honorary members now on the roll; 23 were elected during the year, 1 died, and 7 resigned.

(Signed) L. Péringuey, *Hon. Secretary.*

The Hon. Treasurer read the statement of Receipts and Expenditure as follows :—

THE HON. TREASURER IN ACCOUNT WITH THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY, JULY 1, 1898, TO JUNE 30, 1899.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
To Balance in Bank, June 30, 1898	408	8	1	By Printing Transactions..	243	14	0
,, Subscriptions	174	14	0	,, Preparing and Reproducing Plates for Transactions	49	2	8
,, Sale of Publications ..	23	8	6	,, Freight	4	3	6
,, Subscriptions for *Valdivia* Dinner	39	18	0	,, Preparing Card Catalogues of Library ..	10	17	5
,, Repayment by South African Museum for Plates..	18	19	6	,, Stationery and Printing	11	4	0
				,, Attendant at Meetings	5	0	0
				,, *Valdivia* Dinner	39	18	0
				,, Petty Cash (chiefly Postages, Carriage, and Bank Charges	23	5	0
				,, Advance (to be repaid) ..	30	0	0
				,, Balance at Bank, June 30, 1899	248	12	11
	£665	18	1		£665	18	1

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

Audited and found correct.

(Signed) W. F. PURCELL, M. WILMAN, } *Auditors.*

The voting for President and four members of Council resulted as under :—

President : L. PÉRINGUEY, F.Z.S., F.E.S., &c.

Council : G. S. CORSTORPHINE, B.Sc., Ph.D., T. MUIR, M.A., LL.D., W. L. SCLATER, M.A., T. STEWART, F.G.S., M.I.C.E.

ORDINARY MONTHLY MEETING.

September 27, 1899.

L. PÉRINGUEY, President, in the Chair.

DR. GILCHRIST showed a series of flat fish ova in different stages of development.

The following gentlemen were nominated for election as ordinary members at next meeting : J. F. QUEKET, Esq., F.Z.S., Natal ; G. M. CLARK, Esq., M.A., Government Electrician, Cape Town ; W. G. MASON, Esq., B.Sc., Principal of Agricultural School, Elsenberg.

The following gentlemen were elected ordinary members: Messrs. Chas. T. Gray, J. B. Moffat, H. Beard, and W. Tyson.

Dr. Gill gave a summary of Mr. J. R. Sutton's paper, "The Winds of Kimberley."

Mr. P. L. Sclater, Sec. Z.S. Lond., on the invitation of the President, addressed the Society on the subject of a Zoological Garden for Cape Town.

Mr. Sclater, on bringing the subject before the Society, said he was naturally much interested in it, seeing that for the past forty years he had had the honour of occupying the position of Secretary to the Zoological Society of London. It was naturally, on that account, his endeavour on every opportune occasion to interest others in this particular branch of science. In bringing the subject before them, he proposed to divide his remarks into three parts. In the first place, he would say a few words about the value of zoological gardens generally; secondly, he would refer to the special value of such an institution to Cape Town; and thirdly, he would suggest one or two ideas with respect to the most practical method of promoting such an interesting and instructive scheme.

In so progressive a city as Cape Town it was hardly necessary for him to labour upon the point of the educational importance of such an institution. As a means of scientific study of various animals, it offered advantages to the student and observer which could not otherwise be obtainable without long and tedious journeys into the remote parts of the country. Every foremost nation of Europe had its "Zoo," and France deserved the prime order of merit for having, in the beginning of the present century, taken the initiative in this branch of natural history by laying the foundations of the world-famed Jardin des Plantes. In Holland also there were excellent Zoological Gardens, particularly at Amsterdam, Rotterdam, and the Hague; while at Berlin, Cologne, Frankfort, Vienna, and other cities, the same method of combining instruction with innocent amusement was carried out. All the large cities of America, such as Washington, Philadelphia, and New York, were likewise provided with such institutions. In Australia, Melbourne, Sydney, and Perth had their Zoological Gardens, and other important and growing communities in that part of the globe were following suit.

At the present moment the only Zoological Garden on the continent of Africa was the small but well-kept enclosure at Cairo, under the direction of Mr. Stanley Flower, the talented son of the late Sir William Flower, formerly Director of the British Museum. Mr. Sclater was also aware that Pretoria, in the Transvaal Republic, wanted to have its Zoological Garden, and he had been much pleased to confer on the subject with Dr. Gunning, the Director of the State Museum at Pretoria, when he was here a few days ago. Cape Town seemed to Mr. Sclater to offer many advantages for the establishment of an efficiently directed Zoological Garden. It was a most delightful place of residence, the climate was all that could be desired, and the facilities of communication with other parts of the world were beyond comparison, taking geographical conditions into account. They all knew better than he could tell them that the energies and forces of civilisation had practically driven the large game of South Africa into the wilds. They could not see an antbear, nor feast their eyes upon a lion in its native lair. They had to visit that excellent institution, the South African Museum, in order to view them, beautifully stuffed, and enclosed in glass cases. But surely a live lion was a better creature to look at than a dead one! It was a curious fact that of all the different species of antelopes 110 or 120 belonged to Africa, but they were all being gradually destroyed as civilisation advanced; and it ought to be one of the privileges of Cape Town to show to its own population and to visitors, living specimens of the graceful animals which in years gone by used to roam freely over the valleys, plains, and slopes of South Africa in their thousands.

Mr. Sclater admitted that the most difficult part of his subject was the solution of the problem—how to establish in this city a Zoological Garden under the most practical economic conditions. But after discussing various plans, he was disposed to recommend the formation of a Cape Zoological Society, the subscriptions of members to go towards forming the nucleus of a fund for its establishment. He expressed a hope that not only the Government, when funds were available, but the City Corporation would contribute towards the encouragement of so deserving an institution, and he suggested that, by way of a beginning, the vacant ground at the back of the Museum might be set apart for the initiatory "cradle-space" of a Zoological Garden.

A discussion followed Mr. Sclater's address, and opinions were expressed by several members as to the relative desirability of a Zoological Garden in or near Cape Town, or a large reserve area being shut off to allow native animals being preserved. A proposal had formerly been made that the peninsula south of Simon's Town should be so utilised. Dr. E. B. Fuller gave notice that he would move at next meeting "That the Council of the Society be instructed to take up the question of the founding of a Zoological Garden in Cape Town."

Dr. Muir proposed a vote of thanks to Mr. Sclater for his interesting and stimulating address.

Ordinary Monthly Meeting.

November 1, 1899.

L. Péringuey, President, in the Chair.

The Minutes of the last meeting were read and confirmed.

Dr. E. B. Fuller's motion, "That the Council of the Society be instructed to take up the question of the founding of a Zoological Garden in Cape Town," was carried unanimously.

Captain A. E. Pakeman, East London, was nominated for election as an ordinary member.

The following gentlemen were elected ordinary members: Messrs. J. F. Queket, G. M. Clark, and W. G. Mason.

Dr. Marloth exhibited various Diptera, Hemiptera, and Coleoptera which he had caught in the snow near the summit of the Matroosberg in October. He had also found diatoms, and the eggs and larvæ of insects. So far he had no proof, however, that any insects were confined to such regions.

The President said that true Alpine forms of insects had been found by M. Raffray in Abyssinia, and that they were known on Kilima Njaro, but not further south.

The President exhibited a clay pot of native manufacture recently presented to the South African Museum by Mr. Wood, of East London. The pot is not of Kaffir make, but might be referred to those natives who have left their traces in the "Kitchen-middens."

The Secretary read a paper by the Hon. J. D. Hugo, of Worcester, on "Vitalism."

Drs. Marloth and Hutcheon expressed their interest in Mr. Hugo's paper.

Ordinary Monthly Meeting.

November 29, 1899.

L. Péringuey, President, in the Chair.

The Minutes of the last meeting were read and confirmed.

J. H. C. Krapohl, Esq., B.A., Concordia, and R. Broom, Esq., M.D., B.Sc., Port Elizabeth, were nominated for election as ordinary members.

Captain A. E. Pakeman, East London, was elected an ordinary member.

Dr. J. D. F. Gilchrist exhibited a number of marine specimens, including a new species of Hippocampus from Knysna, a new Anchovy from Zwartkops River and Saldanha Bay, and a new Crustacean.

The President recorded the deciphering by Mr. Donald Ferguson of the inscription on an old stone which has been in the South African Museum since 1855. (See *Transactions*, XI., Part 2, pp. 196–201.)

Dr. J. D. F. Gilchrist read a paper on "The Genus *Paraplysia*, with Description of a New Species."

Mr. Rogers read a paper by himself and Mr. E. H. L. Schwarz on "The Orange River Ground Moraine."

Ordinary Monthly Meeting.

January 31, 1900.

L. Péringuey, President, in the Chair.

Messrs. Wm. Anderson, Government Geologist, Natal; J. M. Orpen, Surveyor-General, Rhodesia; G. Watermeyer, Interpreter Supreme Court; and B. R. MacMillan, Department of Agriculture, Cape Town, were nominated for election as ordinary members.

Dr. R. Broom, Port Elizabeth, and Mr. J. H. C. Krapohl, Concordia, were elected ordinary members.

The Secretary stated that the Royal Geographical Society, the Geological Society, and the Royal Astronomical Society, London, had intimated that their publications would in future be sent to the Society's Library. The Cambridge Philosophical Society had presented a complete set of its Proceedings, and had promised to forward future numbers.

Mr. Chas. F. Juritz, M.A., Cape Town, read a paper entitled, "The Soils of the South-Western Districts of the Cape Colony."

Ordinary Monthly Meeting.

March 28, 1900.

P. Ryan in the Chair.

His Excellency Sir Alfred Milner, K.C.B., G.C.M.G., was nominated for election as an ordinary member by the President and Secretary.

Messrs. Wm. Anderson, Natal; J. M. Orpen, Rhodesia; G. Watermeyer, and B. R. MacMillan, Cape Town, were elected ordinary members of the Society.

Mr. E. H. L. Schwarz exhibited portions of a fossil reptile which had recently been discovered in the course of the geological survey of the Uitenhage District.

The SECRETARY read a note on "Ocean Currents, Sand-dunes, and the Wreck of the *Ismore*," by Mr. Garwood Alston.

Mr. C. STEWART communicated a paper on "River Bars and Ocean Currents," by Captain A. E. Pakeman of East London.

ORDINARY MONTHLY MEETING.

May 2, 1900.

L. PÉRINGUEY, President, in the Chair.

The Minutes of the last meeting were read and confirmed.

Prof. H. E. S. FREMANTLE, B.A. (Oxon.), South African College, was nominated for election as an ordinary member by Messrs. CORSTORPHINE and PÉRINGUEY.

His Excellency Sir ALFRED MILNER, K.C.B., G.C.M.G., was elected as an ordinary member.

Mr. SCLATER exhibited a portion of a bone found at a considerable depth below the surface in Grave Street, and presented to the Museum by Colonel Feilden. The bone was obviously the upper portion of the radius and ulna of a large ungulate animal; it appeared to be too large for an ox, and Mr. Sclater suggested that it might perhaps be that of a hippopotamus. If this was so, it was interesting as confirming the statement in Van Riebeek's diary, that hippopotami were in the habit of wallowing in the marsh which formerly existed on the site of what is now Church Square.

The Rev. Dr. F. C. KOLBE read a paper entitled, "Ultimate Analysis of Our Concept of Matter."

The lecturer first briefly stated the four prevailing views on the subject—the mechanical, the dynamic, the vortical, and the Scholastic or Aristotelian. The first analyses the world into separately existing atoms, and accounts for all diversity of phenomena by their relative motions. The second reduces the universe to centres of force. The third analyses matter into an almost entirely indeterminate substratum, absolutely homogeneous, into which variety of form is introduced by energy alone. The fourth admits no differentiation at all in the substratum, takes account rather of the combinations of particles than of the particles combined, and analyses the world into an indeterminate matter placed in existence by a hierarchy of forms. The first two theories being for various reasons rejected, the lecturer stated that the purpose of this paper was to reconcile the third and the fourth. This he did by showing how slight a change Lord Kelvin would have to make to identify his substratum with that of Aristotle, and how desirable it was to make that change.

The question of energy and form was somewhat more complex, but by two illustrations Dr. Kolbe showed how it was likely or possible that vortices singly were very different from vortices in combination, and that therefore scientists might very well admit that Aristotle was right in fixing his analysis on the forms rather than on the elements. Thus a *modus vivendi* might be set up, in which scientists would gain the benefit of more accurate psychology and philosophy, while Aristotelians would be able to enlarge their bounds by the whole progress of modern science.

Ordinary Monthly Meeting.

June 6, 1900.

L. Péringuey, President, in the Chair.

The Minutes of the last meeting were read and confirmed.

On the motion of the President, it was resolved that the Society congratulate Sir David Gill on the honour which Her Majesty the Queen had conferred upon him; and that Dr. Thomas Muir be congratulated on his election as a Fellow of the Royal Society, London.

Prof. H. E. S. Fremantle, South African College, was elected an ordinary member.

Dr. G. H. Clifton, Knysna, was nominated by Miss Wilman and Dr. Corstorphine, and Prof. W. Ritchie, South African College, by Drs. Beattie and Corstorphine, for election as ordinary members.

The list of books received since last meeting was laid on the table.

The President intimated that Part I. of Vol. XI. of the *Transactions* had been issued to members.

Mr. W. L. Sclater exhibited a curious relic of Napoleon's sojourn at St. Helena, in the form of a steel cross-bow, provided by the English Government for their Imperial captive's pastime. Annexed to the old-time weapon was a certificate by John Desfontein of the H.E.I.C. service, then in charge of the stores depôt on the island, worded thus: "This patent steel cross-bow, made by A. Forsyth & Co., patent gunmakers, No. 8, Leicester Square, Leicester Street, London, sent to St. Helena, for General Buonaparte—£24. Cleaning, etc., etc. (since), with additional new silk strings, apparatus, etc.—£8. Total, £32." It was presented to the South African Museum in 1875 by Mr. John Broadway.

Mr. Sclater also exhibited a series of photographs of birds and their nests taken by Mr. R. H. Ivy, in the neighbourhood of Graham's Town. Among them were the following: *Cossypha bicolor* the Piet-mijn-vrouw—*Monticola rupestris*, the nest of which contained an egg of the solitary cuckoo (*Cuculus solitarius*) distinctly visible in the photograph owing to its darker colour—*Dryoscopus cubla*, the Puff-back Shrike, showing the bird with its powder-puff-like feathers of the back erected—*Tockus melanoleucus*, the Horn-bill—*Pratincola torquata*, the South African Stonechat—*Cestropus natalensis*, the Lark-heeled Cuckoo, which differs from most of its relatives, in building its own nest and hatching its own young.

Dr. J. D. F. Gilchrist exhibited:

(1) A Gadoid fish, belonging to the genus *Haloporphyrus* and probably a new species, found by the Government steamer in trawling about 40 miles off Cape Town, in over 100 fathoms.

(2) Four fishes showing luminous organs, viz.: a *Monocentris* from shallow water, Mossel Bay; an *Argyropelecus*, a *Paraliparis*, and a *Scopelus* from over 100 fathoms off the Cape Peninsula, probably all new species.

(3) A number of new Alcyonarians which had been procured by the Government steamer and described by Prof. Hickson, F.R.S. These included the new genus, *Acrophytum claviger*, and three new species—*Heteroxeina capensis*, *Sarcophytum trochiforme*, *Gorgonia capensis*.

(4) Specimens of *Veritillum* illustrating the difference in size of the fauna of the east and west coasts of Africa, the eastern forms being larger than those from the west coast.

(5) A specimen of *Agriopus torvus*.

(6) A new species of Anchovy from East London, this being the second species of the genus *Engraulis* discovered in South African waters.

Dr. F. Purcell exhibited specimens of all the known South African species of "Peripatus," including, in addition to the three previously described forms, four others recently described by himself in the "Annals of the South African Museum," making seven in all, viz.:—

Peripatopsis capensis (Grube), with 17 pairs of legs. P. balfouri (Sedg.), with 18 pairs of legs. P. leonina, Purc., with 21–22 ,, ,,	from the Cape Peninsula.
P. Sedgwicki, Purc., with 20 ,, ,, P. clavigera, Purc., ,, 17 ,, ,,	from Knysna.
P. moseleyi (Wood-m.), with 20–22 pairs of legs. Opisthopatus cinctipes, Purc., with 16 ,, ,,	from Natal and the Eastern parts of Cape Colony.

Of these the last-named form is the most interesting, as it differs so much from all the others that a new genus had to be created for its reception. It was discovered by the Rev. J. A. O'Neil at Dunbrody, Uitenhage Division. It resembles the Australian forms in several respects.

Dr. Purcell maintained that the supposed great antiquity of "Peripatus" was very doubtful, depending as it did on the supposition that the tracheæ of the tracheate Arthropods could only have originated once, for it is now known that true tracheæ have originated independently in at least three different ways, for instance in two ways in spiders and in a third way in insects. It would be reasonable to suppose, therefore, that "Peripatus" may also have acquired its tracheæ independently of those of the insects.

In the discussion which followed, Dr. Corstorphine stated that the peculiar distribution of Peripatus had some bearing on the question of its antiquity. Dr. Gilchrist thought that the presence of tracheæ could not be overlooked, and, if not conclusive, was at least some evidence of the close relationship of Peripatus to the ancestral insect.

In reply Dr. Purcell mentioned that the distribution of Peripatus might be accounted for by the drifting of the animal on logs, as the creature could easily live for at least six months without food.

Ordinary Monthly Meeting.

June 27, 1900.

L. Péringuey, President, in the Chair.

The Minutes of the last meeting were confirmed.

The following gentlemen were nominated for election as ordinary members: Messrs. William Craig, A.M.I.C.E. and William Robertson, M.R.C.V.S., by Messrs. B. R. MacMillan and L. Péringuey; Mr. C. W. Mally, Assistant Entomologist, by Messrs. Péringuey and Corstorphine; Major W. E. M. Stanford, C.M.G., by Messrs. Corstorphine and Sclater.

Prof. W. Ritchie and Dr. G. H. Clifton were elected ordinary members.

The Secretary read a letter of thanks for the Society's congratulations from Dr. T. Muir.

Mr. E. H. L. Schwarz exhibited copies of some Bushman drawings which he had found near Nieuwoudtville.

Along with the usual reproductions of men and animals, there are certain puzzling figures which have not been recorded from other localities. One of these consists of a rude slipper-like form with seven bars across it; another is a circle with seven peripheral radiating bars, and a third shows three concentric circles, from the outer of which there extend twenty-one bars. Mr. Schwarz thought that the first-mentioned figure might be a tally.

Mr. McEwen suggested that the recurrence of seven and its multiple, might indicate that the other two were also reckonings of some sort.

Dr. Piers mentioned that there were many scratched drawings at Wagenaars Kraal, in the Nieuwveld, where some of the older drawings had been copied by subsequent natives.

Dr. Corstorphine exhibited a piece of limestone showing very typical cone-in-cone structure. It had been found on a *débris* heap at Kimberley and forwarded to the Museum by Mr. Gardner Williams.

Dr. Corstorphine gave a short note on an old beach deposit on the site of the South African Brewery at Woodstock, which had been brought to his notice by Mr. A. W. Ackermann, Architect, Cape Town.

Immediately adjacent to the railway, excavations for foundations have been made down to the underlying Malmesbury slate. The sections nearest town show a layer of shells and water-worn boulders, some 3 feet thick, resting on the slate and covered by about 3 feet of sand and soil, but within 30 yards the deposit entirely thins out. The shells all belong to species found on the present beach, viz.: *Lutraria oblonga, Bullia rhodostoma, B. Lævigata, Patella argenvilli, Crepidula hepatica, Turritella knysnæensis.*

A copy of a report on a submarine disturbance, from the Magistrate at Walfish Bay, forwarded by Mr. Stanford, was read by the Secretary. The Magistrate stated that on May 31st or June 1st last, a new island appeared about 100 yards N.E. of Pelican Point. The island was about 150 feet long by 30 feet wide, and stood 12 feet above high water. It was composed of a tenacious clay; soundings gave 7–10 fathoms around it; steam was observed rising from the clay, and an intense smell of sulphuretted hydrogen was perceptible, even at a distance of 5 miles.

Mr. W. L. Sclater read a paper entitled, "Notes on the so called 'Post Office Stone,' and other inscribed stones preserved in the South African Museum and elsewhere."

Annual General Meeting.

August 1, 1900.

L. Péringuey, President, in the Chair.

The Report of the Council and the Treasurer's statement were adopted.

Mr. L. Péringuey was unanimously re-elected President.

Mr. H. Bolus, Dr. J. D. F. Gilchrist, Sir David Gill, K.C.B., and Dr. Marloth were re-elected Members of Council for the ensuing two years.

Report of Council for Year ending June 30, 1900.

During the past year eight ordinary meetings have been held, at which, in addition to various short notes and exhibitions of specimens, eight papers were read.

Part 1 of Vol. XI. of the *Transactions* containing seven papers and nine plates was issued to members early in June, while the first proof of Part 2 was returned to the printer during the same month.

The number of Institutions to which the *Transactions* are sent is 110, and the Society's Library has been increased by donations of 180 volumes and papers during the year.

The cataloguing of the Library is being continued on the plan mentioned in last year's report.

The membership of the Society is still increasing, the members at June 30 being: Honorary Members 2, Ordinary Members 148.

The Council has to record with regret the deaths of four members: Mrs. Barber, Prof. F. Guthrie, Rev. Mr. Muller, and Dr. A. C. Stark.

The financial position of the Society is extremely gratifying, as will be seen by reference to the balance-sheet annexed. The Treasurer further reports that out of the 148 Ordinary Members, 87 are town members paying an annual subscription of £2, and 61 are country members paying an annual subscription of £1, so that the Society as at present constituted should from this source obtain an annual income of £235. It will be seen that during the present year only £202 16s. 0d. has been received. This is to a great extent owing to the war and the fact that many of our members are resident in the Transvaal. The arrears due to the Society in the matter of subscriptions amount to £76, of which the greater portion may be regarded as a safe asset.

During the year £109 15s. 2d. was received from sale of *Transactions*.

Owing to the fact that during the last year we have not paid for the printing of Part 1 of Vol. XI. of the *Transactions* there is a large balance amounting to £480 10s. 11d. in hand as against £248 12s. 11d. at the commencement of the year. As it appeared to be bad finance to have so large a sum lying idle at the bank, the Council has placed a sum of £300 on fixed deposit with the Standard Bank, bearing interest at the rate of $3\frac{1}{2}$ per cent. per annum.

Signed for the Council,

L. Péringuey, *President.*

Geo. S. Corstorphine, *Secretary.*

The Hon. Treasurer's Account with the South African Philosophical Society, July 1, 1899, to June 30, 1900.

Receipts.	£	s.	d.	Expenditure.	£	s.	d
To Balance at Bank, June 30, 1899	241	12	11	By Preparation and Reproduction of Plates for Transactions	51	6	6
,, Repayment of advance (see last year's statement)	30	0	0	,, Printing Notices of Meetings, &c., &c.	12	10	0
,, Subscriptions..	202	16	0	,, Purchase of Stationery	7	6	6
,, Sale of Publications ..	109	15	3	,, Typewriting of MSS. ..	2	15	6
				,, Freight of Books and Transactions from Europe	4	9	9
				,, Payments for attendance at meetings and clerical assistance	7	0	0
				,, Petty expenses (chiefly postage)	23	0	0
				,, Repayment to S. African Museum for Annals..	1	10	0
				,, Bank Charges	0	15	0
					£110	13	3
				Balance as per Bank Book	480	10	11
	£591	4	2		£591	4	2

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.

W. F. Purcell,
M. Wilman, } *Auditors.*

LIST OF COUNCIL AND MEMBERS,

For year ending June 30, 1900.

COUNCIL.

L. Péringuey, *President.*

W. L. Sclater, *Treasurer.*
G. S. Corstorphine, *Secretary.*
H. Bolus.
J. D. F. Gilchrist.
Sir David Gill.
R. Marloth.
T. Muir.
T. Stewart.

HONORARY MEMBERS.

1897 Fisk, *Rev.* G. H. R., *C.M.Z.S.* Church House (ordinary member from 1877).

1897 Trimen, R., *F.R.S.*, *F.L.S.*, *Hon. F.Z.S.*, Entomological Society, London (ordinary member from 1887).

CORRESPONDING MEMBER.

Prof. E. Cohen, Greifswald.

ORDINARY MEMBERS.

1897 Alston, E. G., Van Wijks Vlei.
1895 Alston, G., 1, Lilian Villas, Wandel St.
1890 Amphlett, G. T., Standard Bank, Cape Town.
1896 Anderson, G. E. C., *M.D.*, Church Street.
1886 Anderson, T. J., *M.L.A.*, Kenilworth.
1900 Anderson, Wm., Geol. Survey Office, Maritzburg.
1877 Arderne, H. M., The Hill, Claremont.
1895 Baker, H., Castle Co. Chambers, Cape Town.
1897 Barker, C. N., Rownham, Malvern, Durban.
1899 Beard, Herbert R., *B.A.* (*Cantab.*), Woodside, Wynberg.
1897 Beattie, J. C., *D.Sc.*, *F.R.S.E.*, South African College.
1882 Beck, J. H. M., *M.D.*, Rondebosch.
1899 Berry, *Hon. Sir* W. Bisset, *M.D.*, Cape Town.
1897 Black, R. Sinclair, *M.D.*, Robben Island.
1883 Bodkin, A. A., *M.A.*, Diocesan College.
1877 Bolus, H., *F.L.S.*, Kenilworth.
1897 Brauns, H., *M.D.*, *Ph.D.*, Willowmore.
1898 Breyer, H. G., *M.D.*, Gymnasium, Pretoria.
1900 Broom, R., *M.D.*, *B.Sc.*, Pearston.
1899 Brounger, R.E., *M.I.C.E.*, Bloemfontein.
1897 Brown, F. N. Dimock, *M.R.C.S.E.*, Hilton College, Maritzburg.
1877 Buchanan, *Hon. Mr. Justice* E. J., Claremont.
1898 Churchill, F. O. F., Chalfont, Gillets, Natal.
1899 Clark, G. M., *M.A.* (*Cantab.*), *A.M.I.C.E.*, General Post Office.
1900 Clifton, G. H., *M.D.* (*Edin.*), *M.R.C.S.*, and *L.S.A.* (*Lond.*), Knysna.
1896 Cooper, A., Richmond, Natal.
1895 Corstorphine, Geo. S., *B.Sc.*, *Ph.D.*, South African College.
1896 Cowper, Sydney, Claremont.
1899 Crawford, Lawrence, *M.A.*, *D.Sc.*, South African College.
1895 Cregoe, J. P., P.O. Box 1420, Johannesburg.
1895 Crowhurst, J. W., *F.R.C.V.S.*, Cape Times Buildings.

1898 Dale, Langham, Colonial Office.
1890 Dodds, W. J., *M.D.*, Valkenberg, Mowbray.
1899 Don, David, The Maze, Berea, Durban.
1898 Drege, J. L., Port Elizabeth.
1877 Ebden, *Hon.* A., Rondebosch.
1897 Edington, A., *M.B.*, Graham's Town.
1895 Evans, M. S., *F.Z.S.*, Durban.
1890 Fairbridge, W. G., 133, Long-market Street, Cape Town.
1899 Feltham, H. L. L., Stellenberg, Kenilworth.
1892 Fletcher, W., P.O. Box 670, Cape Town.
1899 Francis, J. A., Durban.
1900 Fremantle, H. E. S., *M.A.* (*Oxon.*), South African College.
1898 Fry, Harold A., Wagenhuiskrantz, Bredasdorp.
1899 Fuller, C., *F.E.S.*, Maritzburg.
1895 Fuller, E. B., *M.B.*, *C.M.*, *F.R.C.S.E.*, Church Square, Cape Town.
1877 Fuller, T. E., *M.L.A.*, Bollihope, Mowbray.
1896 Gilchrist, J. D. F., *M.A.*, *B.Sc.*, *Ph.D.*, South African Museum.
1879 Gill, *Sir* David, *K.C.B.*, *LL.D.*, *F.R.S.*, *Hon. F.R.A.S.*, Royal Observatory.
1897 Graham, F. G. C., Somerset East.
1899 Gray, Chas. J., Dept. of Mines, Maritzburg.
1895 Gregory, A. J., *M.D.*, Colonial Office.
1897 Gunning, J. W. B., *Ph.D.*, The Museum, Pretoria.
1898 Hamilton, T. H., Engineer's Dept., C.G.R., Cape Town.
1899 Hanau, J., *M.D.*, Carnarvon.
1891 Heenan, R. W. Hammersley, *M.I.C.E.*, Table Bay Harbour Works.
1898 Holland, C. T., P.O. Box 200, Bulawayo.
1899 Hough, S. S., *M.A.* (*Cantab.*), Royal Observatory.
1889 Howard, R. N., *M.R.C.S.*, *F.R.Met.S.*, Port Nolloth.
1897 Hugo, D. de Vos, *M.B.*, Worcester.
1896 Hugo, Hon. J. D., Worcester.
1891 Hutcheon, D., *M.R.C.V.S.*, Cape Town.
1897 Hutchins, D. E., *F.R.Met.S.*, Kenilworth.
1895 Impey, S. P., *M.D.*, Overbeek Square, Cape Town.
1883 Janisch, N., Colonial Office.
1898 Juritz, C. F., *M.A.* (*Cape*), Govt. Laboratory, Cape Town.
1892 Kannemeyer, D. R., *M.B.*, Burghersdorp.
1896 Kitching, C. McGowan, *M.D.*, Church Street, Cape Town.
1896 Kolbe, *Rev.* F. C., *B.A.*, *D.D.*, St. Mary's Presbytery, Cape Town.
1900 Krapohl, J. H. C., *B.A.* (*Cape*), Concordia.
1899 Ledoux, C. A., *F.L.S.*, *F.E.S.* (*Lond.*), Bacteriological Inst., Graham's Town.
1898 Leith, G., P.O. Box 8, Pretoria.
1877 Lightfoot, The *Ven. Archdeacon*, Cape Town.
1888 Lindley, J. B., *M.A.*, *LL.B.*, Claremont.
1892 Lithman, K. V., Dock Road, Cape Town.
1896 Littlewood, E. T., *M.A.*, *B.Sc.*, High School, Wynberg.
1895 Lounsbury, C. P., *B.Sc.*, Dept. of Agriculture.
1899 McEwen, T. S., *A.M.I.C.E.*, Resident Engineer's Office, C.G.R., Cape Town.
1900 MacMillan, B. R., Department of Agriculture.
1897 Macpherson, J. W. C., *M.B.*, Stellenbosch.
1894 Mally, L., 8, Shortmarket Street, Cape Town.
1898 Mansergh, C. L. W., Public Works Department.
1887 Marchand, *Rev.* B. P., *B.A.*, Rondebosch.
1885 Marloth, R., *Ph.D.*, *M.A.*, Church Street, Cape Town.
1897 Marshall, G. A. K., *F.E.S.*, *F.Z.S.*, P.O. Box 56, Salisbury.
1899 Mason, W. G., *B.Sc.* (*Edin.*), *F.H.A.S.*, Elsenberg, Mulders Vlei.
1899 Masson, J. L., Maritzburg.
1896 Mayer, C., Stellenbosch.
1897 Meiring, I. P. v. H., Worcester.
1899 Millar, A. D., 298, Smith Street, Durban.

1900 Milner, *H. E. Sir* Alfred, *K.C.B.*, *G.C.M.G.*, *M.A.* (*Oxon.*).
1899 Moffat, J. B., Native Affairs Office, Cape Town.
1898 Molengraaff, G. A. F., *Ph.D.*, Pretoria.
1899 Monier-Williams, O. F., St. George's Chambers, Cape Town.
1896 Morrison, J. T., *M.A.*, *B.Sc.* *F.R.S.E.*, Victoria College, Stellenbosch.
1892 Muir, T., *LL.D.*, *M.A.*, *F.R.S.*, *F.R.S.E.*, Dept. of Education.
1899 Oakley, H. M., Arderne's Bldgs., Cape Town.
1900 Orpen, J. M., Salisbury.
1899 Osborn, W., Durban.
1899 Pakeman, *Capt.* A. E., East London.
1885 Péringuey, L., *F.E.S.*, *F.Z.S.*, South African Museum.
899 Piers, C. E., *M.D.*, Rheede Street, Cape Town.
1895 Purcell, W. F., *Ph.D.*, *M.A.*, South African Museum.
1899 Queket, J. F., *F.Z.S.*, Museum, Durban.
1899 Quentrall, Thos., Kimberley.
1894 Raffray, A., *Chev. de la Legion d'Honneur*, Cape Town.
1895 v. d. Riet, B., *Ph.D.*, *M.A.*, Victoria College, Stellenbosch.
1900 Ritchie, W., *M.A.* (*Oxon.*), South African College.
1898 Rix-Trott, H., *C.E.*, Pt. Elizabeth.
1892 Roberts, A. W., *F.R.A.S.*, *Hon. D.Sc.* (*Cape*), Lovedale.
1896 Rogers, A. W., *M.A.* (*Cantab.*), *F.G.S.*, South African Museum.
1899 Rohden, M. F., Oudtshoorn.
1882 Rose, J. E. B., Sea Point.
1897 Ross, A., *F.Z.S.*
1890 Ryan, P., Rosebank.
1878 St. Leger, F. Y., *B.A.*, *M.L.A.*, Newlands.
1895 Saunders, H. P., Arderne's Bldgs., Cape Town.
1890 Schönland, S., *Ph.D.*, *M.A.*, AlbanyMuseum, Graham'sTown.
1896 Schreiner, *Hon.* W. P., *Q.C.*, *M.L.A.*, Lyndale, Newlands.
1878 Schunke-Hollway, H. C., *F.R.G.S.*, Plaisir de Merle, Paarl.
1895 Schwarz, E. H. L., *A.R.C.S.*, South African Museum.
1896 Sclater, W. L., *M.A.* (*Oxon.*), *F.Z.S.*, South African Museum.
1877 Silberbauer, C. F., 4, Liesbeek Villas, Rondebosch.
1896 de Smidt, H., *B.A.*, Treasury, Cape Town.
1877 Smith, *Hon.* C. Abercrombie, *M.A.* (*Cantab.*), Audit Office.
1877 Southey, *Hon. Sir* R., *K.C.M.G.*, Wynberg.
1897 Stewart, C., *B.Sc.*, Meteorological Dept., Cape Town.
1883 Stewart, T., *F.G.S.*, *M.I.C.E.*, St. George's Chambers, Cape Town.
1895 Stoney, W. W., *M.D.*, Kimberley.
1899 Struben, A., Westoe, Mowbray.
1897 Sutton, J. R., *B.A.* (*Cantab.*), Kimberley.
1898 Tennant, David, 102, Wale Street, Cape Town.
1895 Thomson, W., *M.A.*, *B.Sc.*, *F.R.S.E.*, University Chambers, Cape Town.
1882 Tooke, W. Hammond, Dept. of Agriculture.
1896 Tredgold, C. H., *B.A.*, *LL.B.*, P.O. Box 306, Bulawayo.
1896 Treleaven, F., Plein Street, Cape Town.
1898 Trotter, *Col.* J. K., *R.A.*, The Castle, Cape Town.
1896 Turner, G., *M.D.*, Colonial Office, Cape Town.
1899 Tyson, W., *F.L.S.*, For. Fell. Roy. Bot. Soc., Edin., Dept. of Agriculture.
1896 Veale, H. B., *M.B.*, Pretoria.
1897 Versfeld, J. J., *L.R.C.S.*, Stellenbosch.
1877 de Villiers, *The Right Hon. Sir* J. H., *K.C.M.G.*, *P.C.*, Wynberg.
1900 Watermeyer, G., Supreme Court.
1898 Watermeyer, J. C., *B.A.*, Windhoek, German S.W. Africa.
1893 Westhofen, W., *M.I.C.E.*, Public Works Dept.
1878 Wiener, L., Newlands.
1898 Wilman, M., Kenilworth.
1897 Wood, J. Medley, Berea, Durban.

ORDINARY MONTHLY MEETING.

August 1, 1900.

L. PÉRINGUEY, President, in the Chair.

The SECRETARY read a letter from Sir David Gill thanking the Society for its congratulations.

Mr. WALDRON, Public Works Department, was nominated for election as an ordinary member by Drs. CORSTORPHINE and GILCHRIST.

Messrs. WM. CRAIG, C. W. MALLY, WM. ROBERTSON, and W. E. M. STANFORD, C.M.G., were elected ordinary members.

The SECRETARY read a second report on the mud island which appeared off Pelican Point at the beginning of June, from Mr. Cleverly, R.M., Walfish Bay, and showed the photographs taken by Mr. Waldron, Public Works Department. The report and photographs were forwarded to the Society by Mr. Stanford.

Mr. CLEVERLY reported that the island no longer existed on June 7th, it having then entirely subsided, as, on steaming over the site, soundings of six and seven fathoms were obtained. The sea was much discoloured and a distinct odour of sulphur was still to be distinguished. Small quantities of dead fish were found on Pelican Point, but this is a not unusual occurrence. About the time of the island's appearance heavy rollers set in along the coast, and though these did not affect Walfish Bay, thirty yards of the new breakwater at Swakop Mouth were totally destroyed, a derrick carried away, and two men drowned. Though these rollers are usually experienced on this coast in the winter months, Mr. Cleverly understands that the engineer in charge at Swakop Mouth had set up a theory that the damage to his works resulted from an earthquake wave, and that he pointed to the appearance of the mud island at Walfish Bay in support of his theory, but in Mr. Cleverly's opinion the cause of the upheaval must have been extremely local, as no disturbance whatsoever was felt at the settlement or in the confined waters of Walfish Bay.

Mr. WALDRON, on the invitation of the President, gave an account of his visits to the island. It was visited on June 1st, 2nd, and 4th. At next visit on June 7th there was no island. On June 1st one member of the party landed and noticed a small basin-shaped hollow containing water and emitting gas bubbles. The odour was distinctly that of sulphuretted hydrogen.

In reply to a question Mr. WALDRON stated that sulphur was found on the shore in certain holes.

Dr. MARLOTH, who had formerly visited Walfish Bay, stated that he came to the conclusion that the sulphur found there was artificial, and he could not but think due to a wreck. He considered that the island was probably upheaved by the formation of gas—in connection with which the sulphur might have played a part.

Dr. Corstorphine agreed with Dr. Marloth as to there being no need for volcanic activity to explain the phenomenon; nor was there any evidence of such. He compared the appearance of the island at Walfish Bay with the "mud lumps" known to arise in the Gulf of Mexico, and quoted Sir Charles Lyell's account of these. The Walfish Bay island was evidently a quite similar phenomenon. As to the gas, the Gulf of Mexico "mud lumps" usually gave off marsh-gas, and the sulphuretted hydrogen perceived as being emitted at Walfish Bay, was probably due to the decomposition of animal as against plant material. The fine mud from Walfish Bay, under the microscope, was found to contain diatoms, fish scales, bones, and other remnants of animal matter. On this view, there was no need to call in the shipwrecked sulphur as an agent in the formation of the Walfish Bay "mud-lump."

Mr. L. Péringuey gave a summary of his paper entitled, "Notes on Stone Implements of Palæolithic type found at Stellenbosch and the Vicinity."

Mr. Péringuey described the discovery of stone implements of a particularly ancient type at Bosman's Crossing, Paarl, and Malmesbury. From the rude character of the chipped stones, he was disposed to regard them as being equal in age to the palæolithic implements of Europe, but Dr. Corstorphine had shown him the difficulty of accepting this theory owing to the geological deposits in or on which the stones are found. So far no implements have been found in any deposit that can be regarded as of great antiquity. In the Stellenbosch district the implements are found imbedded either in the rain-wash of weathered granite or in the laterite, or simply on the surface, so that no geological evidence has yet been discovered as to the presumable antiquity of the implements.

One feature of this occurrence, which Dr. Corstorphine pointed out, is that as yet no implements have been found on the recent alluvial terraces of the Eerste River, but only on the hill-slopes round about. The implements are formed from water-worn boulders of Table Mountain Sandstone, and often retain a considerable portion of the water-worn surface.

Colonel Feilden expressed the pleasure with which he had listened to Mr. Péringuey's account of the stones, as he had given considerable attention to this subject for twenty years past. The amazing feature, to his mind, was the abundance of most heterogeneous types of chipped stones all over South Africa. He quite agreed as to the geological difficulty in assigning the Stellenbosch implements to any great antiquity, though most of them were of an extremely rude type.

ORDINARY MONTHLY MEETING.

August 29, 1900.

L. PÉRINGUEY, President, in the Chair.

The following gentlemen were nominated for election as ordinary members: Mr. J. W. HONEY, Cape Town, by Messrs. SCLATER and PÉRINGUEY; Dr. R. JAMES, Cape Town, Prof. J. G. LAWN, Kimberley, Messrs. A. WALSH, Pt. Elizabeth, by Messrs. CORSTORPHINE and PÉRINGUEY, and F. MASEY, Cape Town, by Messrs. PÉRINGUEY and CORSTORPHINE.

Mr. F. W. WALDRON was elected an ordinary member.

The SECRETARY exhibited an inscribed stone showing *Phola* borings found on the site of the new brewery at Woodstock and presented to the Museum by Mr. A. W. ACKERMANN.

A paper "On the Structure of the Palate in *Dicynodon* and its Allies," by Dr. R. BROOM, was read by the SECRETARY.

Dr. R. MARLOTH read the following note explanatory of the Walfish Bay mud island, described by Mr. F. W. Waldron at the last meeting: "The formation of the mud island is probably quite independent from the patches of sulphur known to exist in the neighbourhood of Walfish Bay. From the fact that the gas was seen bubbling through the water it seems hardly likely that it was pure sulphuretted hydrogen, which is very soluble in water. Unfortunately, no sample of the gas was collected. I think it very probable that the gas was marsh gas mixed with some sulphuretted hydrogen. Both these gases are formed when seaweed is decaying at the exclusion of air, hence there would be nothing else required to account for the whole phenomenon than to suppose that quantities of seaweed were buried in the locality under a very thick layer of mud—conditions which may be taken to exist along that coast."

ORDINARY MONTHLY MEETING.

October 3, 1900.

L. PÉRINGUEY, President, in the Chair.

Mr. J. W. HONEY, Dr. R. JAMES, Messrs. F. MASEY, and A. WALSH were elected ordinary members of the Society.

Mr. PÉRINGUEY read his Presidential Address (postponed from the Annual General Meeting).

ANNUAL ADDRESS TO THE MEMBERS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY,

ON OCTOBER 3, 1900.

BY THE PRESIDENT, L. PÉRINGUEY, F.E.S.

SOME PHASES OF INSECT LIFE IN SOUTH AFRICA.

I.—*Protective Colouration.*

The colouration of invertebrate animals is in many instances due to the presence of certain organic pigments which absorb particular light vibrations, and transmit or reflect others in greater or lesser degree.

The utility of colouration and markings in animals and especially in insects is very great, and in the present address I shall deal with protective colouration, which is of two main sorts, viz. :—

I. Assimilation to the tint of the inanimate surroundings securing—
   (*a*) Resemblance as an aid to aggression in addition to simple protective resemblance,
   (*b*) Protective resemblance pure and simple.

II. Display of brilliant colours :
   (*a*) Indicating that the species is unpalatable, or
   (*b*) Imitation by a perfectly palatable species of one that had better not be touched.

But no one of these protective resemblances is absolutely restricted to a single use, nor is it attained by a single means. For instance, in the case of the Mantidous insect *Phyllocrania insignis*, the colouration is brown with lighter or darker tints imitating those of a withering or withered leaf, while at the same time this protective resemblance is increased by the development of foliated appendages reproducing the very shape of the leaf. In all cases of aggressive and protective resemblance occurring in South Africa it will be found that colour and modification of shape go together, and that in cases of simple protective resemblance a modification of shape, or gait, or flight completes the deception.

I shall deal first with protective colouration as an aid to aggression as well as a protection from enemies, and this for shortness I shall term *aggressive resemblance* in opposition to *resemblance pure and simple.*

(*a*) Resemblance as an aid to aggression in addition to simple protective resemblance.

The number of genera and species of carnivorous insects, *i.e.*, insects which prey on others, is small in proportion to that of non-carnivorous ones.

Taking first the order ORTHOPTERA (*i.e.*, the Cockroaches, Stick-Insects, Locusts, Grasshoppers, Praying-Mantis, &c.), in which protective colouration is carried to a point of efficiency as high, if not higher, than in the Lepidoptera, while modification in shape is most varied, the *Mantidæ* and *Sagidæ* alone are of raptorial habit; both are very voracious.

Among the South African species of the former I find that of those contained in the Cabinet of the South African Museum, 19 are green or yellow, and 48 are brown, greyish, or dusky. *Mantis natalensis*, which belongs to the green or greenish series is, however, occasionally drab-coloured, and it is quite possible that more of the green species may also occasionally be greyer. "Wolves in sheep's clothing," most of them, they are difficult to detect; some are almost exact reproductions of the rod-like, harmless *Phasmidæ*, or Stick-Insects (*Parathespia macra, Danuria thunbergi*). One (*Fisheria sulcatifrons*) goes a step further, and actually has a long anal process in imitation of some of these harmless *Phasmidæ*. It must be remembered, however, that the female, in the adult stage, simulates better than the male, while the young of either sex are even better adapted to their surroundings than the adults.

Some of the South African *Empusinæ* have greenish wing-covers (tegmina) relieved by whitish or yellow markings. One of them, *Harpax tricolor*, is fairly common in the neighbourhood of Cape Town, but it is only found on the flowers of the wild carrot. The scattered greenish and white patches on the body of the insect harmonise so well with the flowerets of the plant that the resemblance is very great indeed—so great that it is usually some time before one detects its presence. Removed from the flower the animal is distinct enough: replaced again he becomes so inconspicuous that one actually wonders where he is. The young insect is even better adapted. The abdomen is recurved on the back, and kept expanded there like a flower, while the powerful raptorial claws are ready to seize the unsuspecting visitor.

Cases of attracting colours are rare here, but in India there is a *Mantis* which feeds upon the insects attracted to it by its flower-like shape and pink colour—the apparent petals being the flattened legs of the insect. The South African Mantis, *Pseudocreobotra ocellata*, is quite as singular as the Indian *Hymenopus bicornis*. In the larval stage it is pink, and the recurved abdomen, owing to the expansion of the foliated sides and the presence of a median row of spines, produces the illusion of a flower-bud ready to burst. It is in the adult stage, however, that the attractive colouration reaches probably its highest point. The overlapping wing-covers have centrally a large, yellow, round patch, partly encircling a round, black patch, and encircled in turn by a black band. The arrangement of these colours makes the illusion complete. I remember seeing some live examples of this *Pseudocreobotra* sent here *en route* to London. Distinct enough when in the empty cage, they became almost invisible, except for the ocellus, when green vegetation was introduced. Not satisfied, moreover, with this protective resemblance, many, if not all, the species of the group have, when on the watch, a swaying motion, as of a leaf moved by the breeze.

In both of these instances the insects are comparatively brightly coloured, but there are, in South Africa, especially numerous instances of *Mantidæ* adapted to dingy surroundings, and clothed therefore in a sober and dingy garb as an aid to aggression, and thus hidden in as effective a manner as the bright kinds just mentioned. In the leaf-headed Mantis (*Phyllocrania insignis*) there is not a part of the limb or body, even to the powerful raptorial legs, which is not compressed, foliated, or banded, so as to resemble the indented parts of a dry leaf, withering or partly crumbled; the female of *Oxypilus annulatus* is not winged as are both sexes in the examples cited above. Her colour is grey, verging on drab, or fuscous, and relieved here and there by whitish and black patches or specks. She is far from uncommon on the sandy parts of the Cape Flats, and, unlike the other three *Mantidæ* mentioned, she is found only on the ground, with which she harmonises so well that, even for the entomologist, she is extremely difficult to detect, and then only when in motion. *Popa undata*, which closely imitates a dry twig, is also found only in dusky grey surroundings.

It is not yet proven that the browns, greys, yellows, or similar hues, undergo a modification in accordance with the variation of the tints of the environment, though there is good reason to think that the greens are affected by the greater or less intensity of light. It is difficult to believe that such protected insects are compelled to remain in one locality, as would be their fate were the colours unchangeable. That it is not so is to some extent indicated by the variation in the colours of different individuals found in different and diverse localities.

In the larval stage, variation in colour is comprehensible as indicating one of the several moulting periods, during which the outer integument undergoes a desiccation preparatory to casting, but this explanation does not apply to the adult forms. Certainly in South Africa, the *Mantidæ* show colours harmonising with their surroundings, and the brownish, dead-wood-like *Popa* will not be captured in a green bower, any more than *Pseüdocreobotra* will be met with on the reddish soil of the Karroo.

Such protective resemblance is not, however, limited to the young or adult Mantis. It is equally conspicuous in the shape of the ootheca, or egg-containing cocoon, made by the females. Some of these are marvellous imitations of seed-pods attached to blades of grass. They have, in fact, little appearance of their real character. I have purposely said "made" by the female, because she shapes and fashions the foam-like matter, of which the cocoon is formed, with her hind legs and the apical part of her abdomen.

It is difficult to discover if the increase in number of *Mantidæ* or *Sagidæ* is in the ratio of their highly protective resemblance. In South Africa, however, the *Mantidæ* cannot be said to be more numerous in number and species than orthopterous insects of other families; the *Sagidæ* are, however, certainly much rarer than the *Mantidæ*, and very difficult to procure.

The Hemipterous family *Reduviidæ*, which either have no odorific apparatus, or at all events do not emit a pungent smell, also contains many examples of predacious species showing aggressive resemblance. The wings and legs of some are so altered by dilatation, or excision, of parts that the assimilation to surroundings becomes perfect. The Cape species, *Pephricus capicola*, *P. paradoxus*, *Craspedum phylomorphum* might easily be pitted against the best protected Mantis or Stick-Insect for effectiveness of imitative colour and pattern. *Pephricus capicola* was first described by the traveller and naturalist, Sparrman, who relates, as quoted by Westwood,* that "when at the Cape in 1772, he observed this insect at noontide as he sought shelter from the intolerable heat of the sun among the branches of a shrub. Though the air was so extremely still and calm as hardly to have shaken an aspen-leaf, he yet thought he saw a little, withered, pale, crumpled leaf eaten as it were by caterpillars, fluttering from the tree. This appeared to him so extraordinary that he suddenly left his bower to examine it. He could scarcely believe his eyes when he saw creeping on the ground a live insect in shape and colour resembling the fragment of a withered prickly leaf with

* 'Arcana Entomologica,' vol. i., p. 7.

the edges turned up and having the appearance of having been eaten by caterpillars."

In the other Orders of insects I know of no case in which protective resemblance may be of use for predacious purposes, except in the genus *Graphipterus* of the Order COLEOPTERA. The upper side is clothed with short hairs, varying in colour from pale grey to buff, and relieved by black patches or stripes. These insects harmonise singularly well with the different tints of the soil of the plains on which they live, and move with great rapidity. Still, I believe that in this instance the colouration is more for protection than for aggression.

(*b*) Protective resemblance pure and simple.

Protective colouration pure and simple is met with among non-carnivorous species in all the Orders. These non-carnivorous species, as has been stated, form the great majority of the class. To give in detail all the instances found in South Africa would be impossible within the limits of this address, and I shall therefore restrict myself to a few.

As in various instances of aggressive resemblance, this type of protective colouration is very frequently associated with a modification of the shape, or form, and I do not see that the two can well be separated, because colouration alone would, in many cases, be insufficient for concealment.

Let us take the Orders seriatim.

ORTHOPTERA.—The *Gryllidæ* are mainly nocturnal, or burrow-dwellers, and are mostly dun-coloured or black; some, however, are green, but these are only met with on green twigs or on blades of grass.

In the *Phaneropteridæ*, or Leaf-like Locusts, the colouration is of two sorts, brown and green, the latter being predominant. *Horastophaga*, *Tylopsis*, *Plangia*, *Pseudophylus*, *Arantia* are as a rule green, but a few are fulvous or brown. In these genera not only is the colour absolutely similar to that of the insect's surroundings, but the shape, mode of carriage, and even the neuration of the upper wings have been modified. For example, in *Arantia spinulosa* the dividing vein of the upper wing appears as a highly developed mid-rib, the mediastine veins are obsolete, those in the discoidal parts are no longer longitudinal, and the fuscate ones are broadly reticulate, thus producing a close imitation of the venation of a leaf.

In South Africa the *Phasmidæ*, or Stick-Insects, seem to be numerous neither in species nor in individuals, in spite of their wonderful assimilation in shape and colour to their surroundings. So perfect is their adaptation that one very rarely can detect the individual insect. Personally I have never captured them except by artificial means. The number of green species in the collection of the South African Museum is the same as that of the grey or brown ones. Examples of one or two species are either greenish or greyish. These *Phasmidæ*, like the *Mantidæ*, which so often mimic them, are green when found on green grass (*Phasmus stellenboschus*), but fuscous or grey when living among dry vegetation or other brown surroundings (*Phalces coccyx*, *Palophus haworthi*, &c.). It is now known that the food, especially the chlorophyll of plants, plays an important part in the colouration of the adult insect, so that no great importance can be attached to the frequent occurrence of green individuals. The Stick-Insects that I have been able to observe do not make an ootheca, but the eggs are wonderful objects, and resemble elongate ribbed seeds or seed-cases; the eggs of *Palophus* resemble the excrements of the insect.

The *Pneumoridæ* (*Blas op*) are exclusively South African. One species is pink, the others green; silvery patches are an occasional adornment. The two species found in this neighbourhood hide in the daytime in grass or among green leaves, and begin their courting at night.

Where green vegetation is of short duration and evergreens are rare, as is the case for the greater part of the South African area, green orthopterous insects should theoretically be in the minority, and I find that the facts bear out the theory. Out of 510 species of South African orthopterous insects in the Museum Cabinet only 103, *i.e.*, one-fifth, are green. Among these I do not include 9 species in which green is only a warning colour. Greys and buffs relieved by whitish, maroon, or flavous patches prevail; even as patches, greenish shades are rare.

The *Pamphagidæ* represented by numerous species of the South African genera, *Xiphocera*, *Akocera*, *Haplolopha*, &c., all have those neutral tints harmonising entirely with their surroundings and varying in shade merely with the change in the colour of the soil of different areas throughout the country, as the Karroo, Griqualand West, Bushmanland, Paarl, or Graham's Town. In *Porthetis carinata* from Namaqualand pure grey is the colour, whereas the same species on the Cape Flats shows streaks of green. In all the species of this group, save one, the male alone has wings. In the exception alluded to, however, the wings of the female are partly atrophied.

Protective also is the dull brown colour of the wing-covers of the Ædipodidous *Cosmorhysa*, *Caloptenus*, *Acrotylus*, and *Sphingonotus*, which, so long as they do not move, are hardly distinguishable from the ground on which they squat at full length. If alarmed, however, they display in their short, very jerky flight most gorgeous pink, crimson, cerulean, yellow, or partly black under-wings. Such brilliant display should not be attributed to love-making, for it is not, as in birds, connected with a more sumptuous livery in the male. The brilliant colour of the lower wings, which is hidden by the upper ones when the insect is at rest, is nearly the same in both sexes. Incredible as it may seem, the sudden flash of these gorgeous colours in connection with the jerky flight of the insect is a most perfect method of baffling a pursuing enemy.

I have no reason to believe that these insects are unpalatable and that the colour of the under-wings is a warning colour, because the South African orthopterous insects which display warning colours do not assimilate to their surroundings, whereas resemblance to the soil can hardly be carried further than in the case of these crickets. Even in an extremely small area, where the ground varies in tint, a similar variation is noticeable in insects found only a few yards apart. Such colour is very delicate, and often fades after death. I may also mention that, in spite of frequent attempts, I have never succeeded in driving the lighter-coloured species to the darker-coloured soil and keeping them there in order to find out if their colour could be affected by the new surroundings. If I returned to the spot either an hour or a day after, the hue of the insects I met corresponded to the colour of the ground on which I found them. It is, however, not unreasonable to suppose that the insects I had driven there had most probably gone back to their first haunt.

Peculiar to South Africa are the extraordinary genera *Batrachornis*, *Batrachotettix*, and *Methone*. Difficult to surpass as are those I have already mentioned for harmonising with their resting or hiding-places, nevertheless they must give place to these so-called toad-locusts. Some of them, as *Methone*, are as much as 3 inches long and 2 inches wide; but, in spite of this bulk, they assimilate so well with the soil that they are invisible, even to the experienced eye, so long as they do not move, and this they very seldom do in the daytime. Of some species both sexes are winged, of others the male only, while of others both sexes are wingless. Even the winged individuals have a very limited power of flight.

This limitation of flying power, reduction or total abortion of the wings would seem to imply that, owing to favourable conditions obtaining in the part of the country where these insects are found, the protective resemblance to surroundings is to be still enhanced by the elimination of the organs of flight to add to the illusion. The absorption or disappearance of these organs will be compensated by an increase in size of other organs useful for protective purposes, such as a still better adaptation to the squatting habit by the development of broader femora, &c.

This is well proved in the case of *Methone*, the most perfectly protected of all these insects. It is wingless and has only a rudimentary wing-cover in both sexes. The enormous development of the thighs (femora), which are held, when the insect squats, against the side of the abdomen, certainly helps considerably to bring the shape of the body into harmony with the relief or contour of the ground.

In the NEUROPTERA, all of which are carnivorous, I know of only one possible case of adaptive colouring, the myrmeleonidous *Glenurus excentrus*, in which the position of the wings when the insect is at rest, enhances the protection obtained by their colouration. This manner of carrying the wings when in repose differs from that of the other *Myrmeleonidæ*.

In the HEMIPTERA-HOMOPTERA, to which Order belong the Bugs, Cicadæ, and Scale-Insects, protective colouring seems to be restricted among the *Pentatomidæ* to the ubiquitous green *Nezara* and *Cyclogaster* (*N. capensis*, *N. pallido-conspersa*, *C. pallidus*, &c.), which are found on green plants, and to the mottled *Cœnomorpha nervosa* and *Atelocera stictica*, found here on the oak-tree, but in most instances the markings, often very brilliant and highly conspicuous, are of the warning sort. Most of them dispense a most pungent and generally offensive smell, which is notorious.

Nothing can be more like the bark of the trees to which they cling than the mottled South African *Cicadæ* (Singertjies). It would seem easy for any one to locate our common species, *Platypleura striata*, for its ear-piercing noise guides one easily enough to the trunk of the willow-tree on which it rests; but when one draws near, its music ceases, and then it is well-nigh impossible to perceive the insect. Three species of this genus, which are not inhabitants of our neighbourhood, display a greenish colour on the surface, and in one, *P. divisa*, the upper side is clothed with fine, silky hairs conspicuously imitating fine moss or minute lichens. *Pyrops tenebrosus* imitates a stump of wood. On the other hand, the brightly coloured *Eddasa euchroma*, *Rhinorta guttata*, *Ptyelus grossus*, do not seem to imitate anything, and yet they are almost entirely invisible on the tree-trunks where they stand. They are surrounded by a broad patch consisting of a white, somewhat flocculent substance exuded by themselves. So much lost are they on that white surface that during a journey to the Transkei I found great difficulty at first in detecting these insects. I suspect that we have here a case of indirect protective resemblance combined with warning colour; in spite of which, however, these insects are easily scared by the presence of an intruder, and rapidly take to flight.

In the Order DIPTERA (or two-winged Flies) the colouration for adaptation to surroundings does not play a very important rôle so far as the South African species are concerned. In the genus *Bombylius*, however, the body of which is clothed with long white or pale yellowish hairs, and whose wings are either transparent or veined with a slightly fuscous or brown tinge, the South African forms, *Bombylius servillei*, *B. stylicornis*, *B. argentifer*, *Systoecus rubricosus*, &c., harmonise wonderfully with the soil on which they stand while in the act of depositing their egg or eggs beside those of other insects on which the young will eventually prey. The species with lighter, almost white, hairs are only met with on whitish sandy patches or spots. They can be observed along the seashore or not far inland, from Salt River to Namaqualand.

From the Flies we pass to the Butterflies and Moths (LEPIDOPTERA). This is *par excellence* the Order in which, throughout all the stages of growth of the insect, protective colours are in the ascendant. The brilliant colours with which most of the diurnal butterflies are adorned are, of course, well known. But what is perhaps not so well known is that of the 415 species occurring in South Africa only 22 can be said to have the under side of the wings brighter or more conspicuously coloured than the upper. The very large proportion of butterflies with a more dingy or less conspicuously coloured under side, is explained by the fact that most of them when at rest or in their hiding-place have the wings folded, and the under side of the wings only is exposed to view. Were the under side adorned with bright colours the presence of the insect would be immediately detected, and it would fall so much more easily a prey to its enemies. To assume, however, that those species, the under side of whose wings is more conspicuous or more brilliantly coloured than the upper side, would be more easily preyed upon on account of their detection being made easier would be a mistake, as will be seen later on, because this very brilliant pattern contributes in many cases to the concealment of the insect by producing an illusion.

In a series of the "Brown" (*Melanitis leda*), which frequents underwood, and the upper side of the wings of which is modestly coloured, we find on the under side a series of dull tints, infinitely variable yet harmonising constantly with the tints of the environment. *Charaxes varanes*, which is probably the handsomest butterfly found in the Cape Colony, and almost excels *Melanitis leda* in the resemblance of its under surface to a faded leaf, sits, according to Trimen, on the stems and among the branches of trees, where, the wings being folded, it becomes invisible. *Precis archesia*, *P. natalica*, *P. elgiva* are models of assimilation. The colouration of these species is not that of withered leaves, and any one who remembers the pattern and colour of their under side is not surprised to learn that the first species delights to repose on rocks and large stones, and that the second often settles on the ground, because of the similarity of their markings to the colour of the places on which each kind rests.

Frequently described is the fixed resemblance to environment which is found in the Kallima butterfly, in which not only is the under side of the wings exactly like a dead or brown leaf with a very apparent mid-rib, but the apices of the hind wing are so produced as to resemble the leaf-stalk, while the creature rests or stands in such a way that its tail appendices touch a branch, thus better simulating a stalk.

The South African *Precis tugela* affords as good an example of protective resemblance. *Precis cuamia*, another South African species, is also very leaf-like, but does not quite reach the perfection of the other.

Among the Moths, we find protective resemblance due to colouration still more intensified. This group of butterflies has mostly sombre hues, but there are some which have brilliant colours, and these examples are mostly diurnal forms. When present, as in some of the diurnal *Zygænidæ* and *Agaristidæ*, &c. (*Païs decora*, *Ægocera fervida*), they are danger signals, and do not come into the category of protective colours. Of course there are exceptions, but brilliant colours for protection by harmonising with the surroundings are rare. Among those I doubt if there is a more striking object than the Silver Moth (*Leto venus*), with its crimson body and fore-wings covered with brilliant silvery lamellæ, thus resembling the Orthopterous *Cystocœlia guttata* and *Pneumora variolosa*, which, like *Leto*, are also nocturnal.

No one not an entomologist can realise the extraordinary keenness of scent developed in the male insect for mating purposes. The unfortunate female, especially among Lepidoptera, is often mobbed by her suitors. Numbers of examples of many moths are caught by the simple device of enclosing a captured female in a small muslin bag. Males will flock to it from all parts of the neighbourhood. It would thus be quite unsafe to consider these glittering, silvery patches as beacons of light for the species to attract one another. The olfactory power of the male is sufficient for that purpose, and he needs no other guide. As a proof, the young of *Cystocœlia*, which becomes adult only after several moults, and in which sexual attraction could not be of any use or value at its early stage, is as much splashed and banded with silver in both sexes as the adult female, which latter is in several species much more brightly decorated than the male.

The true explanation is that the silvery bands and patches break the general outline of the insect at rest, or hidden in the foliage. This is also the case for 12 of the 22 South African butterflies alluded to before, in which the under side of the wings is brighter than the upper. In 7 of them (*Charaxes jahlussa, pollux, druceanus pelias, saturnus, castor, brutus*) this brightness is mostly due to a longitudinal central band of silver; when the insect is at rest or asleep, this band, by its brilliance, naturally throws the lateral parts of the wing in the shade, and the real outline of the closed wing disappears. The same result is obtained by 5 others, in which, however, the silvery band is replaced by silvery patches. I have made experiments in this direction, and if the power of sight of birds or insectivorous animals resembles ours, the arrangement of the colours will certainly prove baffling.

We have also in South Africa one case of Dimorphism connected with protective colouration in two species of the genus *Precis*, *i.e.*, *P. sesamus* and *P. natalensis.* In the colouration of the former, which delights in shady places, blue predominates, red being reduced to a mere supra-marginal narrow band, and the under side is mottled and protective: in the latter red predominates, blue being reduced to a mere marginal dotted band, and the predominant red of the under side is certainly not protective. This species, instead of shady places, frequents the "open, highest point of any neighbourhood." Now, our colleague, Mr. G. A. K. Marshall, of Salisbury, from eggs laid by *Precis natalensis* has bred *Precis sesamus:* from the red species he has reared the blue one, and the red also. Bearing in mind the different habits of what was until then considered as two different species, we are compelled to conclude that, if one of the progeny develops one colour, that colour immediately influences its habitat, as if by intuition of the value of its colouring as a protection.

Not only are the adults in the Lepidoptera protected in numberless instances, but the caterpillars are also similarly helped by a protective colouration brought about by a resemblance to their supports and surroundings. Geometrid larvæ everywhere appear to resemble twigs in a lesser or greater degree, but I doubt if the larva of *Boarmia acaciaria*, which has now taken here to the oak and even to the orange-tree, could be surpassed in such resemblance. Too little is, however, known of the habits and identity of the larvæ of South African moths for me to enlarge much on their colouration.

In the COLEOPTERA, or Beetles, probably the most numerous of all insects, colour-harmony with the surroundings is not greatly exemplified. This is not surprising, since in the early stages the larvæ of most species are hidden, or if they live in the open, they are often covered with prickles, or are slimy like some of the hymenopterous saw-flies. We have, however, some good instances in South Africa. Here, most of the cursorial *Tenebrionidæ* are black. They are covered, however, in life with a greyish or yellowish pulverulence easily lost on capture, it is true, and therefore seldom seen in the Cabinet specimens, but which helps them to harmonise so well with the tint of the soil as to make their detection very often impossible. Many of them (*Zophosis*, *Adesmia*) are extremely rapid runners. *Zophosis muricata*, with its easily rubbed coating, is in the veld, a very different insect from a Museum specimen. One of the most striking examples of change of colour is found in the case of some of the very agile *Adesmia* (*Onymachris*), found on the south-west coast of Africa. From 20° N. lat. southwards to Blaauwberg there extends along the coast a series of sand dunes, ever shifting and often extending very far inland, as in Damaraland. On these dunes are found black insects of somewhat large size and provided with long legs which enable them to run with extreme rapidity on the sand. When pursued or fearing attack they bury themselves head foremost. They are, like many other members of this family, covered with a greyish or yellowish pulverulence; however, in *Onymachris langi*, *marginipennis*, *palgravei*, the wing-covers are of a straw colour, with whiter or slightly pinkish lines, or in the case of *O. candidipennis* and of *Stenocara eburnea* ivory-white. Until I observed near Port Nolloth the singular habit of the kindred species occurring there, I could not understand why this white colouration was restricted to the hind part of the body, but it is easily explained. However rapid in its movements, it takes a little time for the insect to disappear head foremost into the sand, and while the animal is burying itself, the hind part which is considerably longer than the anterior, is almost invisible owing to the close resemblance to the sand produced by the straw or white colour of the hind part of the body.

All the cursorial species of *Trachynotus*, and they are very numerous in South Africa, have also this pulverulent covering, which in the case of *T. bohemani* is even sulphureous, and is arranged in longitudinal bands or patterns. It may in truth be said of all the terricolous South African *Tenebrionidæ* that, with the exception of the *Moluridæ* and species living under stones, in the imago state they all have a more or less distinct terrenous covering.

In *Eurychora* this pulverulence has become almost lanuginose, by means of which the insect is so well disguised that his gait has been affected, and it is now a very slow-moving insect, trusting evidently to its disguise to be taken for what he is not.

Most of the ground weevils, which are extremely numerous in South Africa, are wonderfully imitative of their surroundings, and often the scales of which the patterns consist, are so arranged that if the animal feigns death it is hard for the entomologist to find it again. Plant weevils are also very imitative, but some are so conspicuous owing to their colouring that it is difficult to believe that the colouration is not intended as a warning: *Polycleis equestris*, *P. prasina*, *Hypomeces barbicauda*, *Sciobius wahlbergi*, are cases in point. Many of these ground weevils have an extremely hard covering—one that must task an insectivorous animal's ability to the utmost, yet the ground spiders of the genus *Harpactira* pierce their armour.

Species of the genus *Larinus*, which is very numerously represented in South Africa, have a yellowish, whitish, or mottled pulverulent coating; they exude a new pulverulence if the old one is rubbed off, so as to maintain the protective colouration.

The assimilation of *Anthribidæ*, which are xylophagous, to the colour of the wood or bark of trees is almost marvellous, and this assimilation is shared by many of the *Lamiid Longicorns* which are also living on dead, sometimes on healthy trees. *Paristernia analis* and *Callidium longicolle* seem to me to be mimickers, but of which species it is not yet clear.

In the Coleoptera it cannot be said that brilliancy is always connected merely with warning colours. Yet whole families, like the *Buprestidæ*, are simply rutilant, and are only equalled by the livery of some *Cetoninæ*. The *Buprestidæ*, however, when at rest, do not show in nature the brilliancy of integument which characterises them so much in the Cabinet. All the South African species, even the most brilliant, have a fine whitish, or slightly yellowish, pulverulent coating which subdues the sheen. They are all extremely alert, and drop on the ground, mostly on their back, and simulate death at the least appearance of danger, or they take speedily to flight. Were these bright colours warning colours it is most probable that they would trust to them more, and not try to escape seizure in the way they do. In South Africa several of them, belonging to the genus *Julodis*, have on the upper and under sides a mass of yellow or reddish tufts, giving them a most peculiar appearance, and reminding one at once of the yellow clusters of the "Doornbosch" (*Acacia horrida*). If the resemblance of these insects (the congeners of which elsewhere have bands and not tufts) to the yellow clusters of the acacia flowers was adduced as a proof of an assimilation to the surroundings, this would be but partially true, because only two species are found on the acacia in bloom. Others, as often as not, are found on graminaceous plants, or on bushes not always in flower at the time of their appearance, which lasts at most one month. The time of their appearance in Namaqualand, and in the south-west of the Cape Colony, where the species are most numerous, does not coincide with the flowering of the acacia. It is, however, quite possible that, at some remoter period, acacias were more numerous, and that the insect has adapted itself to other conditions of life, retaining still his acquired characters.

II.—*Display of brilliant colours.*

(*a*) Indicating that the species is unpalatable.

I have dealt so far only with colouration, which, combined with other modifications, is useful for aggressive resemblance in the case of carnivorous insects, or for protective purposes in the case of non-carnivorous insects. But there is another kind of protective colouring differing from the two mentioned, inasmuch as it consists in the display of bright colours to show the enemy that the bearers of the same are unpalatable. These colours are only displayed by non-carnivorous insects, and warn insectivorous animals that the individual is to be avoided.

In the examples found in South Africa, such warning colours occur in species which have a special gait, or a comparatively slow, lazy mode of flight, possibly acquired through the consciousness of the efficacy of the colours.

It is in the Orders Orthoptera, Hemiptera, and Lepidoptera that the most striking instances of this kind of protection are found.

In the Orthoptera, the huge species of *Phymateus* (*P. verrucosus, leprosus, morbillosus*) with red or green thorax, blue and green upper wings, and roseate or purple under wings are conspicuous enough objects in the landscape. *Ochrophlebia carinata, ligneola*, &c., never lose the chance of taking a short flight to show their purple or magenta under wings. The same portion of *Zonocerus elegans* is pink, and of *Poecilocera Stali* and *P. calliparea* orange. *Poetasia rubro-ornata* is not so conspicuously marked, but there are vermilion bars on the sides of the legs and abdomen which proclaim *urbi et orbi* its unpalatableness to would-be devourers. As for *Petasia spumans*, an obese species very often met with around Cape Town, it is so well protected that it has lost the use of its wings: seize it and you will be greeted with such a volume of ill-smelling foam that you will regret having interfered with the animal. Among these locusts, protection is secured by an evil smell and an evil taste. The young are still better protected; for, although they have no wings to display as danger signals, they are streaked and banded in the most conspicuous manner.

Among the bugs (HEMIPTERA) the scutellaridous *Callidea natalensis* and *C. dregei* are azure blue, and have crimson bands above, and crimson spots laterally; *Graptornis aulicus* is a most conspicuous object. No one could fail to see *Roscius illustris*, or *Odontopus sexpunctatus*. Here again the species are unpalatable, and emit a very pungent scent as a means of defence. But in addition to these, we have in the carnivorous series such brilliantly coloured species as the purple *Cleptnia aculata*, *Glymmatophora submetallica*, the dark blue *Centraspis petersi*, &c., which are certainly very conspicuous and yet do not emit any scent. Unless used for a lure, one wonders at the utility of this colouration.

It is, however, probably in the LEPIDOPTERA that warning colours are most numerous. In this Order, perhaps more than in the others, two quite different types of insects present such colours:

(1) Insects which are genuinely unpalatable. These generally have a slow, lazy flight.

(2) Insects which are not themselves unpalatable, but which mimic the colours of some one or other of the nauseous varieties.

In our neighbourhood we have a very common butterfly, *Acræa horta*, which is probably the slowest flier among all her South African congeners, also very slow fliers. So lazy, indeed, is her flight that while on the wing she can, with a little care, be captured by the hand. This species belongs to an unpalatable race. *Acræa rahira*, which mostly frequents damp places where mint grows, is not a very much better flier. It is also a nauseous prey; experiments have been made by me with fowls and cage-birds, which went to prove it. Among the "Clear Wings," *Syntomis cerbera*, conspicuous enough in our neighbourhood owing to the colour of its body and wings, hardly flutters at all, and is caught by hand without difficulty. The sumptuous *Euchromia lethe* and *E. africana* seem to have nothing else to do, but to display their brilliant colouring. All these are unpalatable. These are extreme cases where the power of flight is almost reduced to *nil* as a consequence of useful warning colours. On the other hand, many so protected species will display great agility when endeavouring to escape capture.

In the Order COLEOPTERA the *Lycidæ* have bright yellow elytra sometimes broadly edged with black. Some of them have long spines in the centre of the back (*Lycus hamatus ; kolbei*). They are at times very little conspicuous, in spite of their colouration. On yellow flowers they are hardly visible, but they are so sluggish on a plant, or when flying, that on that account alone I suspect them to be unedible.

The *Cantharidæ*, a family represented by a very considerable number of species in South Africa, have most conspicuous colours, generally consisting of broad, red or yellow transverse bands on a black or brown background. They are found at times in incredible numbers feeding on flowers. They simulate death when danger is near, and drop to the ground, but they are not so alert as the *Buprestidæ*. When seized they exude a yellowish fluid through the joints of their legs which is not only nauseous, but is nothing else than cantharidin. The colour of these insects is sometimes uniform, but it is always conspicuous, and at times most gorgeous.

In the *Longicornia* there is a sub-family, the *Callichrominæ*, in which, as far as South Africa is concerned, most of the species possess bright metallic blues or greens, azure or gold hues, or when not brightly metallic, they have a black background relieved by very conspicuous yellow or red bands. They are mostly floricolous, and extremely showy. Correlated with these brilliant warning colours is the power to emit a musky scent, extremely pungent in some species. This they emit, not only when danger threatens, but often also in their flight when not apparently alarmed. The slender, graceful long-horn called *Promeces longipes*, known here under the wrong name of Spanish Fly, is a representative of this sub-family.

Among the *Lamiinæ* there is a group of insects belonging to the genus *Tragocephala*, in which the black velvety colour of the body is relieved by broad bands or patches of most beautiful orange or chrome-yellow. The conspicuousness of these markings is extreme ; but the purpose it serves has not yet been satisfactorily ascertained.

Lastly, I have met in the family *Chrysomelidæ*, in which bright metallic colours predominate, two cases in which the metallic hues were undoubtedly warning colours.

In the HYMENOPTERA I have found no example of these warning colours ; even the gorgeousness of the ruby-tailed flies (*Chrysidæ*) cannot be said to be connected with either of the types of such colours.

(*b*) Imitation by a palatable species of one that had better be not touched.

If warning colours have the effect of protecting their owners by showing the enemy that they had better be left alone, it follows that a species, however palatable it may be, which, accidentally or otherwise, happens to resemble in colouration or in general appearance the protected one, will also derive from that accident or from the causes from which this likeness originated a certain amount of protection. Such cases are not common however, and they are mostly found in the LEPIDOPTERA. The palatable species is then said to mimic the unpalatable one.

Among the Danaïnæ there is, here, a genus (*Pseudacræa*) containing four South African palatable species, of which two are now known to imitate the colouration of *Planema aganice*, an unpalatable kind, not only when settled, but also on the wing. This in itself is the most remarkable feature *of the mimicking case*, but Trimen, however, says that *Aganice* is a higher flyer than most *Acræinæ*, to which it is most closely allied.

There occurs in our neighbourhood an unpalatable species, *Danais chrysippus*, the colouration of which is, in the words of Trimen, "very accurately mimicked by the female of *Diadema misippus*, an edible one; even its varieties *Alcippus* and *dorippus* being copied by corresponding varieties of the female *Diadema*. Less exact, but very obvious mimickers are the form of the female *Papilio cenea*, and of the female *Argynnis nipke*." Trimen adds, in speaking of *Danais chrysippus*, "that the flight is also very slow, and that the pupa is very conspicuous." This is quite correct, but the flight of the mimicking female *Diadema misippus* is more powerful than that of the mimickee *Danais chrysippus*, and I have it on the authority of good observers that the stray mimicker is conspicuous on that account when observed among the mimickees.

Among the clear wings, the female of *Trochilima caudescens* bears a striking resemblance to one of our wasps, *Eumenes caffra*, and the flight of the two is nearly similar. Examples of this kind might be quoted *ad infinitum*.

CONCLUSION.

From the facts brought to your notice to-night, I trust I have been able, with the aid also of the exhibits, to make it apparent to you that many insects are helped in perpetuating their race by means of protective colouration pure and simple, or protective resemblance as an aid to aggression.

This protective colouration must, however, be looked upon as relative. Were it perfect, it would follow that the insectivorous animals would have either disappeared entirely by this time, have become scarce, or have taken to another diet, as some of the present partly insectivorous, partly granivorous birds have done. But there is no evidence that the number of such animals is being reduced now, or that extinct forms have become extinct owing to the absence or want of protection afforded by colouration in so many insects, in connection with the various devices which I have endeavoured to explain.

Let us now look at the imperfection of the hypothesis. I have laid stress, in speaking of protective resemblance, on the fact that the insect is only protected when motionless.

Methone becomes quite a conspicuous object when in motion; *Precis tugela* is easily seen when flying; *Phasmus stellenboschus* from invisible becomes quite evident. It is in the adult stage, however, that flight and motion imperil the safety of the insect, and it is then that the majority of fatal cases occur, mostly owing to sexual attraction.

Were it otherwise, why should not the *Mantidæ* and *Phasmidæ* be more numerous than they are. The former are probably not attacked by Ichneumons, or other parasitic insects, of which they would make a mouthful, but there is evidence to show that their egg-pod does not escape the attention of these numberless parasites, which are really the main factor in checking the increase in the multiplication of the species.

If, from purely protective resemblance, we turn to warning colours, or to the assumption by edible insects of the colour of unpalatable ones, better known by the name of the theory of mimicry, I am fain to think that the conclusions arrived at by many entomologists who support this theory, are not warranted by a sufficient number of reliable observations.

Trimen, in his Presidential Address to the Entomological Society of London in 1897, formulates the theory of mimicry as being brought about by—

a. Persecution of insectivorous foes.

b. Possession of malodorous and distasteful juices of certain groups.

c. Rejection or avoidance by foes of the insect provided with offensive juices, and loss occasioned to distasteful species by the attack of young and inexperienced enemies.

And he adds that—

d. "In the co-operation of these factors the theory of mimicry depends."

Let us consider how Trimen's first proposition, *i.e.*, persecution by insectivorous foes, bears on this southern part of Africa.

In this South African area the number of insectivorous mammals is small in kinds, and, with the exception of bats, certainly in examples; lizards are plentiful, batrachians are not numerous. Of birds we have 775 species, and of these, Mr. W. L. Sclater informs me, 194 are wholly, and 120 are partly, insectivorous. The large number of insectivorous birds, as well as the great predominance of lizards, chameleons, &c., over other insectivorous animals certainly implies an immense destruction of insect life. But in so far as the mimicry of non-edible insects by edible ones is concerned, there is not a single well-authenticated record of attack by birds or lizards of the mimicker or mimickee. The only instances of butterflies captured on the wing recorded during many years by Trimen, who took a special interest in the test, are the observations of the late Mrs. Barber that various sun-birds caught and brought to their nestlings *Pyrameis cardui*, the "painted lady"; the statement made by Mr. Mansel Veale that *Tchitrea cristata* captures the male of *Papilio Cenea;* and Mr. T. Ayres notes that the Kingfisher, *Ispidina natalensis*, feeds almost entirely on butterflies. In addition to this record Mr. Trimen's observations are limited to the capture, in succession, by our common fiscal, *Lanius collaris*, of several newly emerged *Papilio lynceus* on the wing. This record is meagre, the more so that, as I have already said, butterflies of both sexes have a specially dangerous time during courtship and pairing. More important still is the fact that none of the species of butterflies mentioned by these observers is affected by the theory of mimicry.

We also find that cases of mimicry in Lepidoptera are comparatively scarce. But if the species is protected by that means, surely the number of its progeny should increase more than that of the non-protected ones. Notwithstanding that serious defect the latter are, however, considerably more numerous.

A mimicker may also suffer from the mimicry being too realistic. We have here a fairly common Eristalidous fly (*Erystalomya modesta*), which not only greatly resembles the bee, but even overdoes the well-known humming noise produced by the mimickee. On two occasions I have seen the wasp *Philanthus diadema*, which stores the nest for his young with honey bees, pounce upon and carry away this fly, mistaking, with fatal effect, the mimicker for the mimickee.

Let us now consider the second proposition, *i.e.*, the possession of malodorous and distasteful juices of certain groups.

This possession by certain groups of insects does not seem to materially increase the number of *Cantharidæ*, *Lycidæ*, or *Cerambycidæ* in the COLEOPTERA, or *Pentatomidæ* in the HEMIPTERA. In the LEPIDOPTERA, the protected *Acræa horta* or *A. rahira*, even *Danaïs chrysippus*, are not excessively abundant. The latter is far from having attained the great range of distribution of the comparatively non-protected *Vanessa cardui*. The orthopterous species of *Phymatideus*, made so conspicuous by their warning colours, are never abundant like so many of their congeners. It is not that they are not prolific. On the contrary, the abdomen of the gravid female is so distended that she can hardly drag it, and I found that the egg-pod of *Phymateus leprosus* contains as many, even more eggs than that of the peregrine and of the migratory locusts. These two last-named species have certainly not warning colours in the adult stage, yet the young of the migratory one, *Pachytilus migratorius*, are so gaily coloured as to have earned for them the local name of "rooi-batjes," or redcoats. Their smell is also repugnant. Yet they cannot be said to derive much profit on that account from depredations by enemies, and there is nothing to warrant the belief, except theoretically, that the adults have lost this warning colouring or that nauseous smell, because they have developed a power of flight and of sociability which has more than counterbalanced the loss of this protective colouration.

Lastly, as to the third proposition of rejection by foes of the insects provided with offensive juices, it must be admitted that many of the experiments have been made with domestic animals or animals kept in captivity, including my own with *Acræa rahira* and *Acræa horta*. These examples are not always convincing. My fowls last year would not touch, when thrown to them, the caterpillars of our common swallow-tail butterfly, *Papilio demoleus*, which were only too plentiful on my citrus-trees. My ducks, however, enjoyed them, although these gaily caparisoned caterpillars emit a most pungent scent when alarmed.

As for the loss occasioned to distasteful species by the attack of young and inexperienced enemies, the author of this part of the theory, Fritz Muller, and those who believe in it, do not seem to have taken into consideration the possibility of characters from the same source as that derived from the obtention and the retention of malodorous qualities, *i.e.*, natural selection, being equally well developed in the young of the enemy. Our attention is called to a few cases of butterflies with the wings partly eaten as if by a lizard or a bird, in order to prove that a young or foolish enemy had failed in catching the insect. But who is the observer who will affirm that a carnivorous animal never misses his intended quarry?

Some years ago, the whole of the garden at the back of the present Public Library was tenanted by numerous Epeirid spiders (*Argyope australis*), than which there was probably no more conspicuous animal in the landscape, with their silvery white cephalothorax and the broadly expanded, pale-yellow abdomen banded with silvery white. I happened to be in my greenhouse, recording some observations, when a Cape Bulbul (*Pycnonotus capensis*), whose plumage denoted its youth, swooped down on one of these spiders two yards from my window, but suddenly stopped and remained poised in the air for as long as thirty seconds, then flew away. He came back three times, but in the end he flew away for good, leaving the tempting but suspicious morsel untouched. Although an insectivorous bird, and in spite of its youth, he did not make a sudden attack on the conspicuous animal, to the partial or complete detriment of the latter. Evidence of this kind should be reckoned with, when attributing so much importance to the Mullerian theory of inexperienced enemies.

There are also, in addition, instances recorded of some of these unpalatable butterflies being preyed upon. Sir G. Hampson remarks that in South India the *Euplocœ* and *Danaidœ*, which are supposed to be protected by their evil taste, were caught by enemies as often as any other. Distant, in his "Naturalist in the Transvaal," mentions a *Danaïs chrysippus* being devoured by an orthopterous *Hemisaga*, &c., &c.

Until the conditions of life have been carefully followed and carefully observed, we cannot affirm that this protective resemblance, mimetism of unpalatable insects, and warning colours are due to one cause, although man's logical mind may be inclined to find a satisfactory explanation for these phenomena. They exist; they are patent; any observer can control them. But the explanation is not satisfactory, because we probably ascribe to some factors results not commensurate with their relative value. I shall not venture to add a new explanation to those already offered. But in summing up I may add that many cases have been now brought forward which cannot be reconciled with the theories accepted of late years, and it is not surprising, therefore, that some naturalists, entomologists especially, are not quite convinced of the truth of these hypotheses, although they have to recognise the phenomena.

ORDINARY MONTHLY MEETING.

October 31, 1900.

T. STEWART, Vice-President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were nominated for election as ordinary members: Messrs. F. N. R. FINDLAY, Pretoria, by Dr. F. W. PURCELL and Mr. L. PÉRINGUEY; W. A. Russell, M.A. (Cantab.), Cape Town, by Messrs. J. T. MORRISON and G. S. CORSTORPHINE; H. F. WILSON, M.A. (Cantab.), Colonial Office, by Messrs. E. G. ALSTON and G. S. CORSTORPHINE.

The Secretary communicated a paper by R. BROOM, M.D., B.Sc., "On *Ictidosuchus primævus*," nov. spec.

Professor J. T. MORRISON, M.A., B.Sc., Stellenbosch, read a paper "On Some Periodical Changes in the Rainfall at the Royal Observatory, Cape of Good Hope, since 1841."

ORDINARY MONTHLY MEETING.

November 28, 1900.

L. PÉRINGUEY, President, in the Chair.

The minutes of the last meeting were confirmed.

The following gentlemen were nominated for election as ordinary members: Mr. E. H. V. MELVILL, A.M.I.C.E., F.R.G.S., Johannesburg, by Messrs. CORSTORPHINE and PÉRINGUEY; Mr. E. PAYNE, Cape Town, by Messrs. MACMILLAN and CORSTORPHINE.

Messrs. F. N. R. FINDLAY, Pretoria, W. A. RUSSELL, M.A., Cape Town, and H. F. WILSON, M.A., Cape Town, were elected ordinary members of the Society.

The list of books presented to the Library during October and November was laid on the table.

The Secretary announced that Part 2 of Vol. XI. of the Society's Transactions, together with a list of the contents of the previously published volumes had been issued to members; Part 3 had been sent to the press, and a continuation of the President's Catalogue of South African Coleoptera was also in the press to form Volume XII.

The Secretary read a paper by Dr. R. BROOM, of Pearston, "On the leg and toe bones of *Ptychosiagum*."

Dr. J. D. F. GILCHRIST read a paper entitled, "The History of the Local Names of Cape Fishes."

Ordinary Monthly Meeting.

February 6, 1901.

T. Stewart, Vice-President, in the Chair.

It was unanimously resolved on the motion of the Vice-President that the Society express its condolence, through His Excellency the Governor, with His Majesty the King on the death of our late Gracious Sovereign, Queen Victoria.

The minutes of the last meeting were confirmed.

The following gentlemen were nominated for election as ordinary members at the next meeting: Messrs. R. O. Wynne Roberts, Cape Town, and T. N. Leslie, Vereeniging, by Messrs. Corstorphine and Péringuey.

The following gentlemen were elected ordinary members of the Society: Messrs. E. H. V. Melvill, A.M.I.C.E., F.R.G.S., Johannesburg, and E. Payne, Cape Town.

Mr. E. H. L. Schwarz exhibited some photographs and copies of interesting Bushman paintings from Groot Riet River, near the boundary of the Ceres and Clanwilliam districts, on the road from the Cold Bokkeveld to Whupperthal. The drawings have been made on the face of a cliff overhanging a tributary of the Groot Riet River. There is no cave properly speaking, but the river has cut slightly into the cliff at the base, so as to form a shallow recess. The floor of the recess is some 20 feet above the present river level, and a fine Bushman pot (exhibited) was obtained here. The paintings themselves are done in a great number of styles, by different people. They are in red paint, except for one brown and three black figures. One of the most important points is shown in the picture of a woman about to cut up a dead buck. The way she is holding the stone implement, namely, in the middle, confirms the evidence afforded by the drawings of Nieuwoudtville, which are in an entirely different style. Another interesting feature is the buck drive, where a number of buck are shown being driven into a pen, while two men are seen carrying a dead animal away. The tallies of those who drew in red paint were simple bars smeared in succession on the rock, sometimes over previous drawings, but those who drew in black used dots grouped into circles.

A pallet for grinding paint was also shown.

Mr. Sclater pointed out that one of the photographs evidently represented the drawing of a white rhinoceros, an animal of whose occurrence so far south no written record has been preserved.

The Chairman in thanking Mr. Schwarz on behalf of the Society for his interesting paper, hoped that he would soon give a detailed account of the various Bushman drawings which he had on several occasions brought to the notice of the Society.

Mr. A. W. ROGERS, M.A., F.G.S., read a paper entitled, "On a Glacial Conglomerate in the Table Mountain Sandstone."

Mr. SCLATER having taken the chair,

Mr. STEWART read a paper on "The Rainfall of the Cape Peninsula." He said:—

As the stations in the Cape Peninsula, at which rainfall observations have been made, have increased greatly during recent years, it has occurred to me that it would not be uninteresting to draw attention to some of the results.

In the year 1876 there were only three stations in the Cape Peninsular from which rainfall returns were received by the Meteorological Commission. These stations were the Royal Observatory, Wynberg, and Simon's Town.

Since then the number of stations has been added to from time to time, making in all thirty-two stations from which returns were received by the Meteorological Commission in 1900. In addition to these, there are seven stations on Table Mountain from which regular observations have been taken for use in connection with the supply of water to Cape Town and Wynberg, but the returns have not been forwarded for insertion in the annual reports of the Meteorological Commission.

Observations have been obtained from thirty-one stations in the Peninsula for five years or more, together with the yearly rainfall at each station. In cases where the observations have extended to seven years, the average has been worked out for these years; in a few cases the average rainfall for sixteen years has been given.

It will be seen how unequally distributed the rainfall is. The average for the last seven years at Signal Hill is 15·49 inches; at Rondebosch 41·22 inches; at Kenilworth 42·90 inches; at Disa Head (2,500 feet above the sea) on Table Mountain, 36·96 inches; and at Maclear's Beacon (3,478 feet above the sea) on Table Mountain, 86·81 inches. The heaviest rainfall in the Peninsula is registered at the last station.

The following is a comparison of the results obtained from the Disa Head gauge with those from Maclear's Beacon for the last seven years:—

	Disa Head.	Maclear's Beacon.
1894	35·10	74·08
1895	37·88	94·37
1896	38·68	73·34
1897	38·26	98·24
1898	43·08	92·67
1899	34·95	105·85
1900	30·02	69·14

The Disa Head gauge does not appear to give a correct idea of the rainfall in its immediate neighbourhood. This is clearly proved by the reading of the other gauges close by it being much in excess. For example, the Dam gauge, which is only about one hundred yards distant, and about 100 feet below the Disa Head gauge, registers about one-third more rain on an average. The difference is clearly due to the broken nature of the country.

The rainfall during last month (January) has been of an exceptional character, in fact there is no record of a previous rainfall during any of the summer months having approached the present amount, and in conclusion I draw attention to the results obtained at certain of the gauges on Table Mountain :—

	Disa Head.	Dam.	Maclear's Beacon.	Waai. Vlei.	Plantation.	Wynberg Reservoir.	Wynberg Watershed.
January 3rd	·01	·01	·03	.04	·03	·02	—
5th, 6th, 7th, 8th, 9th	1·05	2·78	4·0	3·46	3·15	1·97	1·94
12th	·05	·10	—	—	—	·10	·12
14th, 15th, and 16th..	1·37	3·33	3·90	4·00	4·12	3·19	3·65
18th, 19th, 20th......	2·05	3·16	4·31	3·75	3·48	3·14	3·44
23rd and 24th	·15	·27	·43	·23	·35	·42	·48
29th and 30th	·14	·32	·45	·27	·36	·23	·30
Totals	4·82	9·97	13·12	11·75	11·49	9·07	9·93

Ordinary Monthly Meeting.

April 24, 1901.

L. Péringuey, President, in the Chair.

The Minutes of the last meeting were confirmed.

A letter from His Excellency the High Commissioner was read, conveying the thanks of His Majesty the King to the Council and members of the Society for the message of sympathy passed at the last meeting.

The following gentlemen were nominated for election as ordinary members at the next meeting: Messrs. Pieter van Noorden, Willowmore, by Dr. Brauns and Mr. L. Péringuey; B. Cookson, M.A., Royal Observatory, and Major Tatham, Wynberg, by Messrs. Sclater and Péringuey; Messrs. F. L. Dwyer, and J. H. Cox, M.D., Cape Town, by Messrs. T. Stewart and G. M. Clark; J. E. Fitt, A.M.I.C.E., and T. W. Perry, C.E., Cape Town, by Mr. F. W. Waldron and Dr. G. S. Corstorphine; the Rev. Dr. Flint, Joint Library, Houses of Parliament, by Drs. T. Muir and G. S. Corstorphine; and Mr. J. Lyle, M.A., by Mr. W. A. Russell and Dr. G. S. Corstorphine.

Messrs. R. O. Wynne Roberts, Cape Town, and T. N Leslie, Vereeniging, were elected ordinary members of the Society.

Mr. Garwood Alston showed three photographs of stones standing erect about six miles south of Port Nolloth, near which Mr. R. Colson, of the Customs Department, found certain kitchen-middens, from which a skull and several native pots and grinding stones were obtained. The stones form enclosures of 4 feet by 2, running north and south. Two of the enclosures were dug into, but yielded nothing. The underlying indurated sand seemed to be quite undisturbed. Mr. Alston emphasised the absence of evidence as to the meaning of the enclosures, and said that the small size was against the view that old burial-places are indicated.

Professor J. T. Morrison communicated a paper on "Some Pressure and Temperature Results for the Great Plateau of South Africa," by J. R. Sutton, M.A. (Cantab).

Dr. J. C. Beattie referred to the assistance which work like that of Mr. Sutton afforded for weather forecasting—a matter which had not yet become possible in South Africa.

Mr. T. Stewart congratulated Mr. Sutton on the valuable work he had done, but pointed to the danger incurred in comparing Kimberley with Cordoba or Adelaide, unless the topography was also considered.

Mr. C. Stewart pointed out that the drawing of Isobars, or lines of equal pressure, from which forecasts could be made, depended on a knowledge of the rate of decrease of temperatures with increase of height above the sea. While this has been ascertained with considerable accuracy in regard to free air, from observations taken on mountains, and by means of kites and balloons, our knowledge of the similar decrease over plateaux such as constitute the main part of South Africa, was still very deficient. Mr. Stewart pointed out that the temperature curve of Port Nolloth showed in August a similar sudden rise to that given by Mr. Sutton for July at Kimberley. This he ascribes to the easterly winds then prevailing at Port Nolloth, being strongly heated when passing over the Kalahari.

Mr. Garwood Alston stated that along the north of the Colony the hot winds were N.W. at Kimberley, N. at Kenhardt and Prieska, and E. at Port Nolloth, and referred to this as being evidence in favour of the late Mr. Gamble's view that the Kalahari Desert was a centre of high pressure whence these winds spread outward.

Professor Morrison said that he had, with Mr. C. Stewart's help, made a comparison of the daily pressure at Cape Town with that at Kimberley and Durban as given by Mr. Sutton, and had found that while the several places showed the same changes, Cape Town was almost invariably a day earlier than Durban. This was contrary to Mr. Sutton's view as to the progression of the pressure wave.

On the motion of the PRESIDENT, a vote of thanks was passed to Mr. Sutton for his paper, and to Professor Morrison for the trouble he had taken in summarising and placing the results before the meeting.

ORDINARY MONTHLY MEETING.

May 29, 1901.

L. PÉRINGUEY, President, in the Chair.

The Minutes of the last meeting were confirmed.

The PRESIDENT intimated that since the last meeting one of the members of the Society had been the recipient of high honour—His Excellency the High Commissioner having been created a peer by His Majesty the King—and he proposed that the meeting send its congratulations to Lord Milner of St. James and Cape Town. This proposal was carried unanimously.

The following gentlemen were nominated for election as ordinary members at the next meeting: Mr. W. J. HORN, Cape Town, by Drs. BEATTIE and CORSTORPHINE; Rev. EDWIN W. SMITH, Aliwal North, by Dr. CORSTORPHINE and Mr. PÉRINGUEY; Mr. JOHN PROCTOR, Cape Town, by Drs. CRAWFORD and CORSTORPHINE; Mr. W. HIRST, Cape Central Railways, by Dr. CORSTORPHINE and Mr. PÉRINGUEY.

The following gentlemen were elected ordinary members of the Society: Mr. B. COOKSON, M.A., Royal Observatory; Dr. J. H. COX, Messrs. F. L. DWYER, J. E. FITT, A.M.I.C.E., Cape Town; Rev. WM. FLINT, D.D., Joint Library, Houses of Parliament; Messrs. J. LYLE, M.A., Cape Town; P. VAN NOORDEN, Willowmore; T. W. WESTON PERRY, C.E., Cape Town; and Major TATHAM, Wynberg.

Dr. J. D. F. GILCHRIST exhibited several specimens of flat fishes obtained by the *Pieter Faure*, in Natal waters, and drew special attention to their diminutive size as compared with the species on the coast of the Cape Colony.

Mr. B. MACMILLAN exhibited a specimen of the Moon-fish, or Bull's-eye (*Brama raii*), caught in False Bay—a somewhat unusual locality for the species.

Dr. J. D. F. GILCHRIST read a paper, entitled, "Observations on the Marine Currents, and on the Temperature and Salinity of the Sea around the Cape Peninsula."

The observations consist of (*a*) a series on the temperature and salinity of the water, chiefly off the Cape Peninsula, at the surface and at every ten fathoms; (*b*) temperature observations taken daily for the years 1898, 1899, and 1900, at Robben Island in Table Bay, and at Roman Rock in Simon's Bay; (*c*) a series of temperatures and salinities observed on a voyage between Table Bay and False Bay, and one between Table Bay and Cape Hangklip; (*d*) Current observations as shown by drift bottles; (*e*) Some evidences of the effect of great range of temperature on marine life near the Cape Peninsula.

It was found from a consideration of the data that there exists westward of the Cape a great body of water of a higher temperature and specific gravity than that closer inshore, one series of observations giving a temperature higher than any observed during the years 1898–1900, either at Simon's Bay or Table Bay. There was found to be also a great range in temperature and specific gravity at the same place at different times, and in neighbouring places at the same time.

The temperatures observed at Table Bay and Simon's Bay were compared and bearing on the currents gone into in detail.

The drift bottles afford confirmatory evidence of the conclusion arrived at as to the presence and course of a branch of the Agulhas current on the west coast, and afford also additional information as to the presence of various counter-currents, some of which may well be the cause of shipping disasters, and should, if for this reason alone, receive more minute investigation.

Finally the bearing of the observations on the conditions of animal life was discussed and illustrated by various deposits, obviously of marine organisms, found in abundance to the south and west of the Cape Peninsula.

Mr. E. T. Littlewood asked if any attempt had been made to obtain information as to the currents at different depths.

Dr. E. B. Fuller suggested that the marked change of temperature in the inshore waters might, when thoroughly known, as shown by Dr. Gilchrist's observations, be of use to warn the navigator approaching the land during fog, and so help to prevent such disasters as that of the *Tantallon Castle*.

Mr. Sydney Cowper trusted that the result of such careful observations would be a practical one, tending towards great piscatorial development in Cape waters, and asked Dr. Gilchrist if he could now give any information under this head.

Mr. Henry de Smidt said it was scarcely to be hoped that Dr. Gilchrist could already give definite information on this question of fish migration, though every one knew that during recent years there had been a great reduction in the numbers of snoek and other fishes caught in these waters.

Mr. B. MacMillan suggested that the relatively higher September temperatures of Table Bay might be due to the continuous north-west winds blowing some portion of the warmer current into the Bay.

In reply, Dr. Gilchrist stated that the ultimate object of the observations was of course the obtaining of a thorough knowledge of the conditions here prevailing and influencing the distribution of the marine fauna, but it meant going into a very large question to try to explain the full bearing of what was even now known, and this was hardly the intention of the present paper. Dr. Fuller's suggestion had already been tried by some of the Mail Company's officers and doubtless there was much practical utility in it. Weighted bottles had been thrown overboard, but up to the present none had been returned, and the prospect of obtaining information as to the deeper currents by this means did not appear a hopeful one.

Dr. J. C. Beattie read a paper by himself and Professor J. T. Morrison, of Stellenbosch, on "The Magnetic Elements of the Cape of Good Hope, from 1605 to 1901."

The paper has for its object the determination of the secular variation of the magnetic elements at Cape Town, from the year 1605 to the present time. The first observation made at the Cape was a determination of the declination by Davis, in 1605. From that time till 1841, observations of this element have been made at irregular intervals. It is interesting to note that Vancouver, Cook, Ross, La Caille are amongst those to whom we owe records. From 1841 to 1846 a detachment of R.A. was stationed at the Royal Observatory of the Cape of Good Hope, for the purpose of studying the magnetic elements there. Observations were taken once per hour throughout that period. The work thus started was continued by Sir Thomas Maclear and Mr. E. J. Stone. Observations of the declination were at first made five times daily; later twice per day. This continued till 1869. From that date to the present time there are only a few isolated observations, one set in 1873, taken by the magneticians of the *Challenger*, a second set by Mr. Preston, of the U.S. *Pensacola*, in 1890. About 1894 Sir David Gill obtained a set of field instruments for determining the elements. Observations with these instruments were made in 1894, by Commander Combe; in 1895 and 1897, by Mr. Finlay; and in 1900, by Messrs. Beattie and Morrison. It is a matter for regret that the Royal Observatory can no longer—owing to the disturbances arising from the electric tramway—be used as a station for magnetic observations.

The records show that the declination when first observed in 1605 was practically nothing. From that time till about 1866 the declination had values W. of N., reaching a maximum of 30° W. of N. about the latter year. The declination seems to have kept this value till about 1874, since then it has had decreasing west values. At the present time it is about 28° 53′ W. of N., with an annual secular decrease of 3′ or 4′.

The first observation of dip was made in 1751 by La Caille. The value then was about 43°. Since that date it has been increasing till at the present time, January 1, 1901, its value is 58° 40′; it is increasing at the rate of 7′ or 8′ annually.

South African Philosophical Society,

CAPE TOWN.

The Society was founded in 1877, for the purpose of "promoting original research and recording its results, especially as connected with the Natural History, Physical Condition, History, Geography, Statistics, Industrial Resources, Languages, and Traditions of South Africa."

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Cape Town: *July. 1900.*

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