TRANSACTIONS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

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WITH EIGHT PLATES.

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TRANSACTIONS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

VOL. XIV.

THE MAGNETIC ELEMENTS AT THE CAPE OF GOOD HOPE FROM 1605 TO 1900.

BY J. C. BEATTIE, D.Sc., AND J. T. MORRISON, M.A., B.Sc.

(Read May 29, 1901.)

§ 1. The first recorded observation of the declination at the Cape was made in 1605, the first measurement of intensity about 1841, the first observation of inclination or dip in 1751. Other observations have been made at irregular intervals till 1840. In 1841 a detachment of R.A. began observations at the Royal Observatory, Capetown, and carried them on till 1846. This observational work was continued at the permanent magnetical observatory established in connection with the Royal Observatory of the Cape of Good Hope; the magnetic work seems to have been discontinued after 1869.

In recent years observations have been taken by the magnetic observers attached to various expeditions. In addition to these, yearly observations are taken at the Royal Observatory, Capetown, by Messrs. Beattie and Morrison with a set of field-instruments (Kew pattern) obtained by Sir David Gill in 1894.

§ 2. *Inclination.*

The following is a list of the determinations of inclination at the Cape:—

Date.	Observers.	Dip.	Authorities.	Remarks.
1751.	La Caille	–43° 0′	From Sabine's 'Magnetical and Meteorological Observations at the Cape of Good Hope,' vol. i. Magnetism.	
1770.	Ekeberg	–44 25		
1774.	Bayley	–45 37		
1774.	Ekeberg	–44 29		
1775.	Wales	–45 19		
1775.	Abercrombie	–46 21		
1776.	Bayley	–46 31		
1780.	Bayley	–46 46		
1791.	Vancouver	–48 30		
1792.	Dentrecasteaux ..	–47 25		
1818.	Freycinet	–50 47		
1836.	Fitzroy	–52 35		
1839.	Du Petit Thouars..	–53 06		
1840.	Ross	–53 08		
1841.	R.A. Detachment..	–53 09		The results for 1841 to 1846 inclusive are the mean of observations taken as a rule twice weekly, four hours before and four hours after noon.
1842.	R.A. ,, ..	–53 12		
1843.	R.A. ,, ..	–53 19		
1844.	R.A. ,, ..	–53 36		
1845.	R.A. ,, ..	–53 31		
1846.	R.A. ,, ..	–53 33		
1847.	....	–53 41	Admiralty hydrographic records.	
1848.	....	–53 47		
1849.	....	–53 52		
1850.	....	–53 58		
Feb. 6, 1851.	Sir Thomas Maclear	–54 02	Sabine.	
1852.	....	–54 04	Dip-book Royal Observ. C. of G. Hope.	The results for 1852–1857 inclusive are the mean of observations taken twice weekly, morning and afternoon.
1853.	....	–54 09		
1854.	....	–54 19·6		
1855.	....	–54 24·5		
1856.	....	–54 23·9		
Jan. 1857.	....	–54 23·0		
Oct. 1857.	....	–54 36·4	Reise der Novara.	
March 1858.	....	–54 29·3	Dip-book R. O., C. of G. Hope.	
Aug. 1871.	Stone	–55 45·4		
Sept. 1871.	Stone	–55 34·9		
Nov. 1873.	....	–55 56·3	*Challenger* Report, Narrative ii.	
Sept. 30, 1874.	....	–56 6·0	Voyage of the *Gazelle*	
Jan. 31, 1890.	Preston	–57 15·2	U.S. Coast and Geodetic Survey, Bull. 23.	
Dec. 29, 1894.	Combe	–57 50·0	R. O. Records, C. of G. Hope.	With Dip Circle 9, by Dover.
Jan. 11, 1895.	Finlay	–57 52·0		
Oct. 23, 1897.	Finlay	–58 07·0		
Oct. 2, 1899.	Beattie & Morrison	–58 31·0	R. O. Records, C. of G. Hope.	
Aug. 19, 1900.	Beattie & Morrison	–58 38·9		
Dec. 1900.	Beattie & Morrison	–58 39·7		
Dec. 1900.	Beattie & Morrison	–58 41·1	....	With Dip Circle 142, by Dover.

From the above results the secular variation of inclination is as follows:—

Period.	Secular Variation.
1751 to 1840	6·94′ annual increase of south inclination.
1841 ,, 1846	5·45 ,, ,, ,,
1843 ,, 1854	5·10 ,, ,, ,,
1854 ,, 1873	2·20 ,, ,, ,,
1873 ,, 1890	4·90 ,, ,, ,,
1890 ,, 1900	7·80 ,, ,, ,,

§ 3. *Declination.*

The following list contains all the records of declination determination at the Cape of Good Hope which have come under our observation.

Date.	Observers.	Declination.	Authorities.	Remarks.
1605.	Davis	0° 30′ E. of N.		
1609.	Keeling	0 12 W. of N.		
1614.	Pring	1 30 ,,		
1614.	Daunton	1 45 ,,		
1622.		2 0 ,,		
1675.		8 0 ,,		
1675.	Leydeker	8 28 ,,		
1691.		11 0 ,,		
1721.	Mathews	16 25 ,,		
1754.	Mathews	16 23 ,,		
1751.	La Caille	19 15 ,,		
1753.	La Caille	19 00 ,,		
1768.	Wallis	19 30 ,,		
1768.	Carteret	19 30 ,,	Taken from Sabine's 'Magnetical and Meteorological Observations at the Cape of Good Hope,' vol. i. Magnetism.	
1770.	Ekeberg	19 10 ,,		
1771.	Cook	20 30 ,,		
1772.	Wales	20 26 ,,		
1774.	Ekeberg	21 39 ,,		
1774.	Bayley	21 36 ,,		
1775.	Wales	21 14 ,,		
1780.	Cook	22 16 ,,		
1783.	Lodberg	22 23 ,,		
1788.	Bligh	24 4 ,,		
1791.	Vancouver	25 40 ,,		
1792.	Dentrecasteaux	24 31 ,,		
1818.	Freycinet	26 31 ,,		
1836.	Fitzroy	28 30 ,,		
1839.	Du Petit-Thouars	29 9 ,,		From April, 1841, to July, 1846, inclusive the declination was observed hourly. The declination given for each year is the mean of all the observations for that year.
1841.	R.A. Detachment	29 0·2 ,,		
1842.	R.A. ,,	29 6·0 ,,		
1843.	R.A. ,,	29 5·0 ,,		
1844.	R.A. ,,	29 6·2 ,,		
1845.	R.A. ,,	29 7·4 ,,		From Sept., 1846, to Aug., 1850, the declination was observed five times daily. The declination given for the year is the mean of all the observations for that year.
1846.	R.A. ,,	29 9·2 ,,		
1847.		29 12·4 ,,		
1848.		29 14·0 ,,		
1849.		29 16·4 ,,		
1850.		29 18·8 ,,		From Sept., 1850, to Mar., 1852, the declination was observed five times daily.
1851.		29 20·9 ,,	R. Obs. C. of G. Hope Magnetic Records.	
1852.		29 22·9 ,,		
Oct. 11, 1857.		29 34·4 ,,	Reise der 'Novara.'	
1860.		29 41·8 ,,		
1861.		29 44·8 ,,		
1862.		29 50·3 ,,		
1863.		29 52·1 ,,		From October, 1860, to January, 1869, the declination was observed twice daily.
1864.		29 53·9 ,,	Magnetic Records, R. Obs. C. of G. Hope.	
1865.		30 0·1 ,,		
1866.		30 2·0 ,,		
1867.		30 1·7 ,,		
1868.		30 1·9 ,,		
Jan. 1869.		30 1·5 ,,		
Nov. 1873.		30 4·0 ,,	*Challenger* Reports, Narrative, vol. ii.	
Jan. 1890.	Preston	29 36·0 ,,	U.S. Coast and Geodetic Survey, Bull. 23.	
Jan. 1895.	Finlay	29 18·0 ,,	Magnetic Records, R. Obs. C. of G. Hope.	
Nov. 1897.	Finlay	29 2·0 ,,		
Dec. 1900.	Beattie & Morrison	28 53·0 ,,		

From the above results the secular variation of declination is as follows :—

Period.	Secular Variation.
1605 to 1839	7′·56 increase of westerly declination.
1841 ,, 1850	1·30 ,, ,, ,,
1843 ,, 1866	2·30 ,, ,, ,,
1866 ,, 1869	Very nearly constant.
1870 ,, 1890	2·80 decrease of westerly declination.
1890 ,, 1900	3·91 ,, ,, ,,

§ 4. The observations for intensity are fewer. The first recorded trustworthy observation was made in 1843. So far as is known to us, the results of all observations made since that date are contained in the following list. The results are given in c.g.s. units.

Date.	Observer.	Horizontal Intensity. c.g.s.units.	Total Intensity. c.g.s. units.	Authorities.
1843.	R.A. Detachment..	·2089	·3498	Sabine, 'Magnetical and Meteorological Observations at Cape of Good Hope,' vol. i.
1844.	,, ,, ..	·2069	·3470	
1845.	,, ,, ..	·2082	·3495	
1846.	Smalley..........	·2080		
1847.	,, ...	·2077		
1848.	,, ...	·2072		
1850.	,, ...	·2066		
1852.	Maclear..........	·2059	·3506	Magnetic Records, R. Obs. Cape of Good Hope.
1853.	,, ...	·2056	·3511	
1854.	,, ...	·2050	·3516	
1855.	,, ...	·2048	·3517	
1856.	,, ...	·2044	·3511	
1857.	,, ...	·2041	·3507	
Sept. 1857.	....	·2056	·3684	Reise der Novara.
Nov. 1873.	....	·1989	·3551	*Challenger* Report, Narrative, vol. ii.
Jan. 1890.	Preston	·1916	·3542	U.S. Coast and Geodetic Survey, Bull. 23.
Jan. 1895.	Finlay	·1900	·3572	Magnetic Records, R. Obs. Cape of Good Hope.
Aug. 1897.	Finlay	·18835	·3566	
Jan. 1901.	Beattie & Morrison	·1851	·3559	

Secular Variation.

	Horizontal Intensity. c.g.s.units.	Total Intensity. c.g.s. units.
1843 to 1855	·00035 annual decrease.	·00016 annual increase.
1855 ,, 1901	·00043 ,, ,,	·00009 ,, ,,
1890–1 ,, 1901	·00059 ,, ,,	?

APPENDIX I.

The following results of observations of declination were carried out at the Magnetic Observatory, at one time established at the Royal Observatory, Cape Town. The observations for 1850–51–52 were a continuation of those recorded in 'Sabine's Magnetical and Meteorological Observations, Cape of Good Hope,' vol. i. The declination was observed five times daily, viz., at 1h. 34m. p.m., 5h. 34m. p.m., 9h. 34m. p.m., 5h. 34m. a.m., 9h. 34m. a.m., Cape time.

The monthly means given on page 1*b*, are the average of all the values obtained during that month.

The declination results for the period October, 1860, to January, 1869, were observed twice daily—Sundays and public holidays excepted—at 10h. 34m. a.m., and 3h. 34m. p.m., Cape time.

The results given under the headings 10h. 34m. a.m., and 3h. 34m. p.m. are the means of the observations made at these hours for the periods given. The results of these years are of considerable interest, as it was at this time that the magnetic declination for a number of years was practically steady.

DECLINATION.

Month.	Mean, 1850.	Declination, 1851.	1852.
Jan.		29° 19′·3 W. of N.	29° 22′·2 W. of N.
Feb.		29 20·6 ,,	29 23·4 ,,
March		29 20·7 ,,	29 23·2 (first ten days only)
April		29 20·7 ,,	
May		29 20·7 ,,	
June		29 20·6 ,,	
July		29 20·9 ,,	
Aug.		29 21·0 ,,	
Sept.	29° 20·0′ W. of N.	29 22·4 ,,	
Oct.	29 19·3 ,,	29 22·1 ,,	
Nov.	29 19·1 ,,	29 21·6 ,,	
Dec.	29 18·8 ,,	29 19·9 ,,	

DECLINATION RESULTS, 1860–1869.

Date.	10h. 34m. a.m.	3h. 34m. p.m.	Mean.		Yearly Mean.
1860. Oct. 8–Oct. 17	29° 45′·7	29° 37′·9	29° 41′·8	W. of N.	29° 41′·8 W. of N.
Oct. 18–Oct. 27.	29 46·1	29 37·1	29 41·7	,,	
Oct. 28–Nov. 6.	29 49·0	29 38·3	29 43·7	,,	
Nov. 7–Nov. 16.	29 45·4	29 37·5	29 41·5	,,	
Nov. 17–Nov. 26.	29 45·4	29 37·0	29 41·2	,,	
Nov. 27–Dec. 6.	29 45·6	29 37·5	29 41·6	,,	
Dec. 7–Dec. 16.	29 45·2	29 38·1	29 41·7	,,	
Dec. 17–Dec. 26.	29 44·1	29 37·6	29 40·9	,,	
1861. Dec. 27–Jan. 5.	29 47·1	29 37·4	29 42·3	,,	29° 44′·8 W. of N.
Jan. 6–Jan. 15.	29 46·9	29 38·5	29 42·7	,,	
Jan. 16–Jan. 25.	29 46·6	29 39·1	29 42·9	,,	
Jan. 26–Feb. 4.	29 47·8	29 41·6	29 44·7	,,	
Feb. 5–Feb. 14.	29 48·8	29 39·5	22 44·2	,,	
Feb. 15–Feb. 24.	29 48·9	29 42·1	29 45·5	,,	
Feb. 25–Mar. 6.	29 50·1	29 40·1	29 45·1	,,	
Mar. 7–Mar. 16.	29 52·8	29 40·9	29 46·9	,,	
Mar. 17–Mar. 26.	29 50·3	29 40·1	29 45·2	,,	
Mar. 27–April 5.	29 52·1	29 39·8	29 46·0	,,	
April 6–April 15.	29 50·1	29 42·1	29 46·1	,,	
April 16–April 25.	29 50·2	29 42·2	29 46·2	,,	
April 26–May 5.	29 49·9	29 41·1	29 45·5	,,	
May 6–May 15.	29 47·1	29 41·6	29 44·4	,,	
May 16–May 25.	29 46·7	29 42·5	29 44·6	,,	

Date.	10h. 34m. a.m.	3h. 34m. p.m.	Mean.		Yearly Mean.
1861. May 26–June 4.	29° 44′·9	29° 42′·8	29° 43′·9	W. of N.	29° 44′·8 W. of N.
June 5–June 14.	29 44·5	29 41·5	29 43·0	,,	
June 15–June 24.	29 44·3	29 40·6	29 42·5	,,	
June 25–July 4.	29 43·4	29 40·0	29 41·7	,,	
July 5–July 14.	29 45·2	29 41·1	29 43·2	,,	
July 15–July 24.	29 44·4	29 42·8	29 43·6	,,	
July 25–Aug. 3.	29 45·1	29 41·4	29 43·3	,,	
Aug. 4–Aug. 13.	29 44·6	29 41·4	29 43·0	,,	
Aug. 14–Aug. 23.	29 45·3	29 42·0	29 43·7	,,	
Aug. 24–Sept. 2.	22 45·8	29 42·1	29 44·0	,,	
Sept. 3–Sept. 12.	29 46·7	29 42·2	29 44·5	,,	
Sept. 13–Sept. 22.	29 48·6	29 42·1	29 45·4	,,	
Sept. 23–Oct. 2.	29 49·0	29 40·2	29 44·6	,,	
Oct. 3–Oct. 12.	29 47·8	29 41·1	29 44·5	,,	
Oct. 13–Oct. 22.	29 49·2	29 41·7	29 45·5	,,	
Oct. 23–Nov. 1.	29 49·6	29 41·9	29 45·8	,,	
Nov. 2–Nov. 11.	29 50·1	29 43·0	29 46·6	,,	
Nov. 12–Nov. 21.	29 48·1	29 43·3	29 45·7	,,	
Nov. 22–Dec. 1.	29 49·6	29 44·0	29 46·8	,,	
Dec. 2–Dec. 11.	29 50·4	29 44·2	29 47·3	,,	
Dec. 12–Dec. 21.	29 50·9	29 44·0	29 47·5	,,	
Dec. 22–Dec. 31.	29 50·2	29 45·0	29 47·6	,,	
1862. Jan. 1–Jan. 10.	29 52·8	29 44·3	29 48·6	,,	29° 50′·3 W. of N.
Jan. 11–Jan. 20.	29 52·4	29 46·4	29 49·4	,,	
Jan. 21–Jan. 30.	29 50·9	29 47·4	29 49·2	,,	
Jan. 31–Feb. 9.	29 52·6	29 44·3	29 48·5	,,	
Feb. 10–Feb. 19.	29 54·6	29 45·7	29 50·2	,,	
Feb. 20–Feb. 29.	29 55·6	29 44·8	29 50·2	,,	
Mar. 2–Mar. 11.	29 57·3	29 45·8	29 51·6	,,	
Mar. 12–Mar. 21.	29 55·5	29 46·0	29 50·8	,,	
Mar. 22–Mar. 31.	29 55·4	29 45·7	29 50·6	,,	
April 1–April 10.	29 54·8	29 46·8	29 50·8	,,	
April 11–April 20.	29 55·0	29 47·3	29 51·2	,,	
April 21–April 30.	29 53·7	29 48·0	29 50·9	,,	
May 1–May 10.	29 53·5	29 47·2	29 50·4	,,	
May 11–May 20.	29 52·1	29 46·7	29 49·4	,,	
May 21–May 30.	29 52·4	29 47·7	29 50·1	,,	
June 1–June 9.	29 52·9	29 48·8	29 50·9	,,	
June 10–June 19.	29 49·9	29 46·8	29 48·3	,,	
June 20–June 29.	29 49·6	29 45·5	59 47·6	,,	
July 1–July 9.	29 49·9	29 46·7	29 48·3	,,	
July 30–Aug. 8.	29 53·8	29 48·5	29 51·2	,,	
Aug. 9–Aug. 18.	29 53·2	29 48·0	29 50·6	,,	
Aug. 19–Aug. 28.	29 54·0	29 48·4	29 51·2	,,	
Aug. 29–Sept. 7.	29 53·1	29 49·2	29 51·2	,,	
Sept. 8–Sept. 17.	29 53·9	29 47·7	29 50·8	,,	
Sept. 18–Sept. 27.	29 53·5	29 47·1	29 50·3	,,	
Sept. 28–Oct. 7.	29 55·1	29 47·7	29 51·4	,,	
Oct. 8–Oct. 17.	29 53·2	29 47·5	29 50·4	,,	
Oct. 18–Oct. 27.	29 52·5	26 47·4	29 50·0	,,	
Oct. 28–Nov. 6.	29 52·4	29 47·0	29 49·7	,,	
Nov. 7–Nov. 16.	29 53·9	29 46·6	29 50·2	,,	
Nov. 17–Nov. 26.	29 54·7	29 46·7	29 50·7	,,	
Nov. 27–Dec. 6.	29 51·1	29 49·1	29 51·6	,,	
Dec. 7–Dec. 16.	29 53·9	29 49·4	29 51·6	,,	
Dec. 17–Dec. 26.	29 53·9	29 50·3	29 52·1	,,	
1863. Dec. 27–Jan. 5.	29 54.6	29 49·4	29 52·0	,,	29° 52′·1 W. of N.
Jan. 6–Jan. 15.	29 56·0	29 48·7	29 52·3	,,	
Jan. 16–Jan. 25.	29 54·4	29 49·8	29 52·1	,,	
Jan. 26–Feb. 4.	29 54·2	29 50·6	29 52·4	,,	
Feb. 5–Feb. 14.	29 56·3	29 49·2	29 52·8	,,	
Feb. 15–Feb. 24.	29 57·1	29 49·3	29 53·2	,,	
Feb. 25–Mar. 6.	29 58·0	29 51·0	29 54·5	,,	

Date.	10h. 34m. a.m.	3h. 34m. p.m.	Mean.	Yearly Mean.
1863. Mar. 7–Mar. 16.	29° 59′·1	29° 48′·5	29° 53′·8 W. of N.	29° 52′·1 W. of N.
Mar. 17–Mar. 26.	29 58·4	29 49·7	29 54·1 ,,	
Mar. 27–April 5.	29 57·5	29 49·2	29 53·4 ,,	
April 6–April 15.	29 55·1	29 48·5	29 51·8 ,,	
April 16–April 25.	29 56·4	29 50·3	29 53·4 ,,	
April 26–May 5.	29 53·9	29 50·1	29 52·0 ,,	
May 6–May 15.	29 54·4	29 49·4	29 51·9 ,,	
May 16–May 25.	29 53·0	29 49·7	29 51·4 ,,	
May 26–June 4.	29 52·9	29 48·7	29 50·8 ,,	
June 5–June 14.	29 50·8	29 49·3	29 50·1 ,,	
June 15–June 24.	29 51·3	29 49·4	29 50·4 ,,	
June 25–July 4.	29 51·3	29 48·8	29 50·1 ,,	
July 5–July 14.	29 51·0	29 48·6	29 49·8 ,,	
July 15–July 24.	29 50·1	29 49·4	29 49·8 ,,	
July 25–Aug. 4.	29 52·1	29 49·4	29 50·8 ,,	
Aug. 5–Aug. 14.	29 52·3	29 49·3	29 50·8 ,,	
Aug. 15–Aug. 24.	29 51·9	29 49·8	29 50·9 ,,	
Aug. 25–Sept. 3.	29 53·7	29 50·2	29 55·0 ,,	
Sept. 4–Sept. 13.	29 54·0	29 50·7	29 52·4 ,,	
Sept. 14–Sept. 23.	29 54·6	29 50·1	29 52·4 ,,	
Sept. 24–Oct. 3.	29 55·0	29 49·7	29 52·4 ,,	
Oct. 4–Oct. 13.	29 54·4	29 48·9	29 51·7 ,,	
Oct. 14–Oct. 23.	29 54·8	29 48·2	29 51·5 ,,	
Oct. 24–Nov. 2.	29 54·7	29 48·0	29 51·4 ,,	
Nov. 3–Nov. 12.	29 53·7	29 49·6	29 51·7 ,,	
Nov. 13–Nov. 22.	29 56·2	29 50·1	29 53·2 ,,	
Nov. 23–Dec. 2.	29 58·0	29 50·2	29 54·1 ,,	
Dec. 3–Dec. 12.	29 56·9	29 50·5	29 53·7 ,,	
Dec. 13–Dec. 22.	29 56·0	29 52·1	29 54·1 ,,	
1864. Dec 23–Jan. 1.	29 55·3	29 52·1	29 53·7 ,,	29° 53′·9 W. of N.
Jan. 2–Jan. 11.	29 56·8	29 53·8	29 55·3 ,,	
Jan. 12–Jan. 21.	29 58·2	29 53·4	29 55·8 ,,	
Jan. 22–Jan. 31.	29 57·3	29 51·1	29 54·2 ,,	
Feb. 1–Feb. 10.	29 56·6	29 53·9	29 55·2 ,,	
Feb. 11–Feb. 20.	29 57·8	29 52·9	29 55·4 ,,	
Feb. 21–Mar. 1.	30 1·6	29 51·7	29 56·7 ,,	
Mar. 2–Mar. 11.	30 2·5	29 54·0	29 58·3 ,,	
Mar. 12–Mar. 21.	30 1·7	29 53·1	29 57·4 ,,	
Mar. 22–Mar. 31.	30 2·4	29 55·2	29 58·8 ,,	
April 1–April 10.	30 0·5	29 55·4	29 58·0 ,,	
April 11–April 20.	30 0·3	29 54·6	29 57·5 ,,	
April 21–April 30.	30 0·5	29 56·0	29 58·3 ,,	
May 1–May 10.	29 59·1	29 55·4	29 57·3 ,,	
May 11–May 20.	29 57·2	29 54·8	29 56·0 ,,	
May 21–May 30.	29 57·3	29 56·3	29 56·8 ,,	
May 31–June 9.	29 56·0	29 55·5	29 55·8 ,,	
June 10–June 19.	29 56·8	29 55·5	29 56·2 ,,	
June 20–June 29.	29 56·7	29 55·0	29 55·9 ,,	
June 30–July 9.	29 55·7	29 53·2	29 54·5 ,,	
July 10–July 20.	29 57·2	29 53·7	29 55·5 ,,	
July 20–July 29.	29 57·0	29 54·8	29 55·9 ,,	
July 30–Aug. 8.	29 57·7	29 54·7	29 55·9 ,,	
Aug. 9–Aug. 18.	29 58·2	29 54·7	29 56·5 ,,	
Aug. 19–Aug. 28.	29 56·9	29 55·0	29 56·0 ,,	
Aug. 29–Sept. 7.	29 58·0	29 55·1	29 56·6 ,,	
Sept. 8–Sept. 17.	29 58·6	29 54·6	29 56.6 ,,	
Sept. 18–Sept. 27.	29 59·2	29 55·4	29 57·3 ,,	
Sept. 28–Oct. 7.	29 59·9	29 53·4	29 56·7 ,,	
Oct. 8–Oct. 17.	30 1·1	29 54·7	29 57·9 ,,	
Oct. 18–Oct. 27.	30 0·8	29 55·0	29 57·9 ,,	
Oct. 28–Nov. 6.	30 0·7	29 54·9	29 57·8 ,,	
Nov. 7–Nov. 16.	30 1·2	29 54·5	29 57·9 ,,	
Nov. 17–Nov. 26.	29 58·6	29 54·9	29 56·8 ,,	

Date.	10h. 34m. a.m.	3h. 34m. p.m.	Mean.		Yearly Mean.
1864. Nov. 27–Dec. 6.	29° 59′·4	29° 54′·6	29° 57′·0	W. of N.	29° 53′·9 W. of N.
Dec. 7–Dec. 16.	29 59·3	29 55·7	29 57·5	,,	
Dec. 17–Dec. 26.	29 59·7	29 54·2	29 57·0	,,	
1865. Dec. 27–Jan. 5.	30 0·2	29 53·4	29 56·8	,,	30° 0′·1 W. of N.
Jan. 6–Jan. 15.	30 2·3	29 54·1	29 58·2	,,	
Jan. 16–Jan. 25.	30 3·8	29 55·1	29 59·5	,,	
Jan. 26–Feb. 4.	30 4·4	29 54·5	29 59·5	,,	
Feb. 5–Feb. 14.	30 5·9	29 54·5	29 55·2	,,	
Feb. 15–Feb. 24.	30 4·3	29 57·6	30 1·0	,,	
Feb. 25–Mar. 6.	30 5·4	29 55·9	30 0·7	,,	
Mar. 7–Mar. 16.	30 4·6	29 57·0	30 0·8	,,	
Mar. 17–Mar. 26.	30 3·6	29 58·1	30 0·9	,,	
Mar. 27–April 5.	30 6·1	29 57·5	30 1·8	,,	
April 6–April 15.	30 4·0	29 58·9	30 1·5	,,	
April 16–April 25.	30 2·2	29 59·1	30 0·7	,,	
April 26–May 5.	30 2·9	29 58·2	30 0·6	,,	
May 6–May 15.	30 1·1	29 58·9	30 0·0	,,	
May 16–May 25.	30 0·4	29 55·9	29 58·2	,,	
May 26–June 4.	30 0·7	29 57·6	29 59·2	,,	
June 5–June 14.	30 0·9	29 59·1	30 0·0	,,	
June 15–June 24.	30 0·0	29 58·5	29 59·3	,,	
June 25–July 4.	30 0·7	29 58·4	29 59·6	,,	
July 5–July 14.	29 59·3	29 58·0	29 58·7	,,	
July 15–July 24.	29 58·9	29 58·2	29 58·6	,,	
July 25–Aug. 3.	30 1·1	29 57·6	29 59·4	,,	
Aug. 4–Aug. 13.	30 0·4	30 0·2	30 0·3	,,	
Aug. 14–Aug. 23.	30 0·9	29 58·4	29 59·7	,,	
Aug. 24–Sept. 2.	30 2·7	29 59·7	30 1·2	,,	
Sept. 3–Sept. 12.	30 2·2	29 59·3	30 0·8	,,	
Sept. 13–Sept. 22.	30 2·4	29 59·1	30 0·8	,,	
Sept. 23–Oct. 2.	30 2·4	29 58·5	30 0·5	,,	
Oct. 3–Oct. 12.	30 4·6	29 57·6	30 1·1	,,	
Oct. 13–Oct. 22.	30 4·4	29 57·5	30 1·0	,,	
Oct. 23–Nov. 1.	30 2·6	29 56·5	29 59·6	,,	
Nov. 2–Nov. 11.	30 3·5	29 58·6	30 1·1	,,	
Nov. 12–Nov. 21.	30 3·0	29 59·1	30 1·1	,,	
Nov. 22–Dec. 1.	30 3·3	29 59·4	30 1·4	,,	
Dec. 2–Dec. 11.	30 3·1	29 59·0	30 1·1	,,	
Dec. 12–Dec. 21.	30 2·8	29 58·7	30 0·8	,,	
Dec. 22–Dec. 31.	30 2·4	30 0·3	30 1·4	,,	
1866. Jan. 1–Jan. 10.	30 3·5	30 0·5	30 2·0	,,	30° 2′·0 W. of N.
Jan. 11–Jan. 20.	30 5·1	30 1·4	30 3·3	,,	
Jan. 21–Jan. 30.	30 4·3	30 2·0	30 3·2	,,	
Jan. 31–Feb. 9.	30 4·7	30 0·9	30 2·8	,,	
Feb. 10–Feb. 19.	30 3·9	29 59·3	30 1·6	,,	
Feb. 20–Mar. 1.	30 6·6	30 0·3	30 3·5	,,	
Mar. 2–Mar. 11.	30 7·8	29 59·4	30 3·6	,,	
Mar. 12–Mar. 21.	30 10·0	30 0·1	30 5·1	,,	
Mar. 22–Mar. 31.	30 6·1	30 0·4	30 3·3	,,	
April 1–April 10.	30 6·8	30 2·7	30 4·8	,,	
April 11–April 20.	30 6·1	37 1·3	30 3·7	,,	
April 21–April 30.	30 5·5	30 0·5	30 3·0	,,	
May 1–May 10.	30 4·6	30 0·6	30 2·6	,,	
May 11–May 20.	30 4·0	30 0·5	30 2·3	,,	
May 21–May 30.	30 3·5	30 0·6	30 2·1	,,	
May 31–June 9.	30 0·1	29 59·4	29 59·8	,,	
July 20–July 29.	30 3·0	30 0·9	30 2·0	,,	
July 30–Aug. 8.	30 3·4	30 0·3	30 1·9	,,	
Aug. 9–Aug. 18.	30 2·7	30 59·8	30 1·3	,,	
Aug. 19–Aug. 28.	30 1·8	30 0.2	30 1·0	,,	
Aug. 29–Sept. 7.	30 0·2	29 58·2	29 59·2	,,	
Sept. 8–Sept. 17.	30 0·3	29 58·7	29 59·5	,,	
Sept. 18–Sept. 27.	30 3·6	29 59·2	30 1·4	,,	

Date.	10h. 34m. a.m.	3h. 34m. p.m.	Mean.	Yearly Mean.
1866. Sept. 28–Oct. 7.	30° 2′·7	29° 58′·4	30° 0′·6 W. of N.	30° 2′·0 W. of N.
Oct. 8–Oct. 17.	30 3·0	29 57·5	30 0·3 ,,	
Oct. 18–Oct. 27.	30 3·2	29 58·1	30 0·7 ,,	
Oct. 28–Nov. 6.	30 3·5	29 58·1	30 0·8 ,,	
Nov. 7–Nov. 16.	30 2·3	29 59·1	30 0·7 ,,	
Nov. 17–Nov. 26.	30 4·0	29 59·9	30 2·0 ,,	
Nov. 27–Dec. 6.	30 3·7	30 0·0	30 1·9 ,,	
Dec. 7–Dec. 16.	30 5·4	29 59·1	30 2·3 ,,	
Dec. 17–Dec. 26.	30 3·5	30 0·2	30 1·9 ,,	
1867. Dec. 27–Jan. 5.	30 4·6	30 0·0	30 2·3 ,,	30° 1′·7 W. of N.
Jan. 6–Jan. 15.	30 5·6	30 0·3	30 3·0 ,,	
Jan. 16–Jan. 25.	30 5·1	30 0·5	30 2·8 ,,	
Jan. 26–Feb. 4.	30 3·3	30 0·5	30 1·9 ,,	
Feb. 5–Feb. 14.	30 5·0	30 0·6	30 2·8 ,,	
Feb. 15–Feb. 24.	30 4·8	30 1·3	30 3·1 ,,	
Feb. 25–Mar. 6.	30 6·1	30 0·0	30 3·1 ,,	
Mar. 7–Mar. 16.	30 7·3	30 1·6	30 4·5 ,,	
Mar. 17–Mar. 26.	30 5·6	29 59·1	30 2·4 ,,	
Mar. 27–April 5.	30 5·5	30 0·0	30 2·8 ,,	
April 6–April 15.	30 5·8	30 1·4	30 3·6 ,,	
April 16–April 25.	30 4·2	30 1·0	30 2·6 ,,	
April 26–May 5.	30 4·2	30 1·5	30 2·9 ,,	
May 6–May 15.	30 3·4	30 0·5	30 2·0 ,,	
May 16–May 25.	30 3·0	30 0·1	30 1·6 ,,	
May 26–June 4.	30 3·8	30 2·2	30 3·0 ,,	
June 5–June 14.	30 2·0	30 0·2	30 1·1 ,,	
June 15–June 24.	30 2·2	30 0·6	30 1·4 ,,	
June 25–July 4.	30 0·6	30 0·0	30 0·3 ,,	
July 5–July 14.	30 0·3	29 59·0	29 59·7 ,,	
July 15–July 24.	30 1·3	29 58·8	30 0·1 ,,	
July 25–Aug. 3.	30 0·5	29 58·3	29 59·4 ,,	
Aug. 4–Aug. 13.	29 59·9	29 58·6	29 59·3 ,,	
Aug. 14–Aug. 23.	30 1·6	29 59·4	30 0·5 ,,	
Aug. 24–Sept. 2.	30 1·6	29 59·8	30 0·7 ,,	
Sept. 3–Sept. 12.	30 2·9	29 52·8	30 1·4 ,,	
Sept. 13–Sept. 22.	30 4·7	29 59·8	30 2·2 ,,	
Sept. 23–Oct. 2.	30 3·7	29 59·0	30 1·4 ,,	
Oct. 3–Oct. 12.	30 3·2	29 58·5	30 0·9 ,,	
Oct. 13–Oct. 22.	30 4·6	29 57·0	30 0·8 ,,	
Oct. 23–Nov. 1.	30 3·4	29 58·0	30 0·7 ,,	
Nov. 2–Nov. 11.	30 2·5	29 57·9	30 0·2 ,,	
Nov. 12–Nov. 21.	30 3·5	29 57·8	30 0·7 ,,	
Nov. 22–Dec. 1.	30 3·7	29 59·1	30 1·4 ,,	
Dec. 2–Dec. 11.	30 2·8	29 59·3	30 1·1 ,,	
Dec. 12–Dec. 21.	30 4·2	29 58·3	30 1·3 ,,	
Dec. 22–Dec. 31.	30 4·7	29 58·3	30 1·5 ,,	
1868. Jan. 1–Jan. 10.	30 4·2	29 59·4	30 1·8 ,,	30° 1′·9 W. of N.
Jan. 11–Jan. 20.	30 3·4	29 58·0	30 0·7 ,,	
Jan. 21–Jan. 30.	30 3·8	30 0·1	30 2·0 ,,	
Jan. 31–Feb. 9.	30 3·5	29 59·9	30 1·7 ,,	
Feb. 10–Feb. 19.	30 3·8	29 58·6	30 1·2 ,,	
Feb. 20–Feb. 29.	30 5·7	30 0·7	30 3·2 ,,	
Mar. 1–Mar. 10.	30 7·2	30 0·5	30 3·9 ,,	
Mar. 11–Mar. 20.	30 8·0	30 0·1	30 4·1 ,,	
Mar. 21–Mar. 30.	30 7·1	30 1·6	30 4·4 ,,	
Mar. 31–April 9.	30 7·8	30 1·0	30 4·4 ,,	
April 10–April 19.	30 5·3	30 1·9	30 3·6 ,,	
April 20–April 29.	30 6·2	30 2·9	30 4·6 ,,	
April 30–May 9.	30 4·7	30 1·2	30 3·0 ,,	
May 10–May 19.	30 4·5	30 1·6	30 3·1 ,,	
May 30–June 8.	30 1·9	29 59·3	30 0·6 ,,	
June 9–June 18.	30 1·2	30 0·2	30 0·7 ,,	
June 19–June 28.	30 0·8	29 58·5	29 59·7 ,,	

Date.	10h. 34m. a.m.	3h. 34m. p.m.	Mean.	Yearly Mean.
1868. June 29–July 8.	30° 1′·1	29° 58′·8	30° 0′·0 W. of N.	30° 1′·9 W. of N.
July 9–July 18.	30 1·1	30 1·1	30 1·1	,,
July 19–July 28.	30 3·2	30 0·8	30 2·0	,,
July 29–Aug. 7.	30 2·9	30 0·2	30 1·6	,,
Aug. 8–Aug. 17.	30 2·6	30 0·3	30 1·5	,,
Aug. 18–Aug. 27.	30 2·3	29 59·8	30 1·1	,,
Aug. 28–Sept. 6.	30 2·1	29 59·3	30 0·7	,,
Sept. 7–Sept. 16.	30 3·6	29 58·7	30 1·2	,,
Sept. 17–Sept. 26.	30 2·1	29 57·4	29 59·8	,,
Sept. 27–Oct. 6.	30 4·5	29 57·5	30 1·0	,,
Oct. 7–Oct. 16.	30 4·4	29 57·4	30 0·9	,,
Oct. 17–Oct. 26.	29 6·3	29 58·5	30 2·4	,,
Oct. 27–Nov. 5.	30 6·4	29 58·4	30 2·4	,,
Nov. 6–Nov. 15.	30 4·9	29 57·9	30 1·4	,,
Nov. 16–Nov. 25.	30 4·1	29 57·8	30 1·0	,,
Nov. 26–Dec. 5.	30 4·5	29 57·6	30 1·1	,,
Dec. 6–Dec. 15.	30 5·0	29 59·3	30 2·2	,,
Dec. 16–Dec. 25.	30 4·5	29 59·2	30 1·9	,,
1869. Dec. 26–Jan. 4.	30 5·0	29 57·9	30 1·5	,,

APPENDIX II.

The appended results of observations of inclination taken at the Royal Observatory, Cape of Good Hope, have not hitherto been published. So far as we have been able to find the observations were carried out with a dip-circle obtained from Woolwich by Mr. Maclear—afterwards Sir Thomas Maclear. The needles used were marked 1, 2, respectively. In 1854 needle 1 was broken. A new pair—marked 1, 2 new pair—were afterwards used.

It is evident from the results that the needles did not agree amongst themselves.

Inclination.

Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1852.	May 4	12.0	1	53° 56′·4	
	,, 4	4.0 p.m.	1	54 5·6	
	,, 11	10.30 a.m.	1	53 58·0	
	,, 11	10.30 a.m.	1	54 7·2	
	,, 11	4.0 p.m.	1	54 19·8	54° 6′·0
	,, 18	11.50 a.m.	1	54 7·2	
	,, 18	3.10 p.m.	1	54 8·1	
	,, 26	11.35 a.m.	1	54 12·5	
	,, 26	3.22 p.m.	1	54 1·9	
1852.	June 2	11.22 a.m.	1	54 2·2	
	,, 2	3.42 p.m.	1	54 6·9	
	,, 8	11.15 a.m.	1	54 3·2	
	,, 8	3.15 p.m.	—	54 7·3	
	,, 15	11·2 a.m.	1	54 0·4	54° 5′·4
	,, 15	3.42 p.m.	1	54 8·4	
	,, 21	2.30 ,,	1	54 2·3	
	,, 21	4.10 ,,	1	54 8·7	
	,, 22	10.52 a.m.	1	54 6·3	

Date.			Cape Time.	Needle.	Inclination.	Monthly Mean.
1852.	June	22	2.2 p.m.	1	54° 4′·0	50° 5′·4
	,,	22	3.59 ,,	1	54 4·1	
	,,	30	12.37½ ,,	1	54 4·3	
	,,	30	3.58 ,,	1	54 9·2	
1852.	July	6	11.2½ a.m.	1	54 3·6	54° 1′·9
	,,	6	3.49 p.m.	1	54 6·1	
	,,	13	11.55 a.m.	1	54 5·4	
	,,	13	3.50 p.m.	1	54 3·9	
	,,	21	10.7 a.m.	—	54 3·3	
	,,	21	4.7 p.m.	1	53 56·0	
	,,	27	11.30 a.m.	1	53 53·4	
	,,	27	3.40 p.m.	1	54 3·3	
1852.	Aug.	5	9.30 a.m.	1	53 59·0	54° 2′·8
	,,	5	4.22 p.m.	1	54 2·1	
	,,	10	9.40 a.m.	1	54 1·0	
	,,	10	3.56 p.m.	1	54 4·3	
	,,	17	9.40 a.m.	1	54 2·4	
	,,	17	4.10 p.m.	1	54 9·3	
	,,	24	10.52 a.m.	1	54 0·6	
	,,	24	3.32 p.m.	1	54 6·8	
	,,	31	10.22 a.m.	1	53 38·7	
	,,	31	3.35 p.m.	1	54 2·1	
1852.	Sept.	1	11.5 a.m.	1	53 59·8	54° 4′·5
	,,	1	3.30 p.m.	1	54 0·5	
	,,	7	9.5 a.m.	1	54 8·8	
	,,	7	3.55 p.m.	1	54 10·1	
	,,	14	10.7 a.m.	1	54 4·4	
	,,	14	3.27 p.m.	1	54 6·3	
	,,	21	10.35 a.m.	1	54 1·7	
	,,	21	3.30 p.m.	1	54 4·4	
	,,	28	10.42 a.m.	1	54 4·5	
	,,	28	3.37 p.m.	1	54 4·3	
1852.	Oct.	5	10.37 a.m.	1	54 6·8	54° 5′·3
	,,	5	3.37 p.m.	1	54 10·4	
	,,	12	10.22 a.m.	1	54 5·0	
	,,	12	3.37 p.m.	1	54 5·7	
	,,	19	9.38 a.m.	1	54 3·2	
	,,	19	3.15 p.m.	1	54 53·9	
	,,	26	10.10 a.m.	1	54 8·2	
	,,	26	3.17 p.m.	1	54 6·0	
1852.	Nov.	2	9.40 a.m.	1	54 7·5	54° 4′·1
	,,	2	3.32 p.m.	1	54 6·2	
	,,	9	10.22 a.m.	1	54 6·6	
	,,	9	3.37 p.m.	1	54 5·8	
	,,	16	10.15 a.m.	1	54 4·0	
	,,	16	3.45 p.m.	1	54 4·8	
	,,	23	10.10 a.m.	1	54 4·7	
	,,	23	4.12 p.m.	1	54 15·6	
	,,	26	10.32 a.m.	2	54 1·8	
	,,	26	3·25 p.m.	2	54 4·8	
	,,	30	10.15 a.m.	2	54 2·0	
	,,	30	4.10 p.m.	2	53 54·4	
	,,	30	10.18 a.m.	1	54 2·1	
	,,	30	4.15 p.m.	1	53 57·4	

	Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1852.	Dec.	7	10.12 a.m.	1	54° 2′·3	54° 4′·7 (Yearly Mean, 1852, 54° 4′·3)
	,,	7	4.3 p.m.	1	54 7·3	
	,,	7	10.6 a.m.	2	54 1·6	
	,,	7	4.53 p.m.	2	54 15·4	
	,,	10	10.15 a.m.	1	54 2·7	
	,,	10	4.15 p.m.	1	54 1·9	
	,,	11	9.27 a.m.	1	54 3·0	
	,,	11	3.57 p.m.	1	54 3·7	
	,,	14	9.40 a.m.	1	54 9·8	
	,,	14	3.38 p.m.	1	54 4·5	
	,,	15	10.15 a.m.	1	54 2·1	
	,,	15	3.56 p.m.	1	54 5·6	
	,,	16	10·11 a.m.	1	53 58·0	
	,,	16	3.30 p.m.	1	54 3·7	
	,,	17	9.12 a.m.	1	53 59·3	
	,,	17	3.30 p.m.	1	54 3·3	
	,,	21	9.38 a.m.	1	54 2·2	
	,,	21	3·21 p.m.	1	54 2·6	
	,,	22	10.25 a.m.	1	54 2·5	
	,,	22	3.25 p.m.	1	54 2·8	
	,,	24	10.27 a.m.	1	54 4·8	
	,,	24	3.20 p.m.	1	54 4·2	
	,,	28	9.35 a.m.	1	54 3·2	
	,,	28	3.35 p.m.	1	54 9·3	
	,,	29	9.50 a.m.	1	54 4·6	
	,,	29	3.37 p.m.	1	54 6·0	
	,,	31	9.10 a.m.	1	54 7·5	
	,,	31	3.25 p.m.	1	54 16·7	
1853.	Jan.	4	10.7 a.m.	1	54 7·9	54° 8′·9
	,,	4	3.30 p.m.	1	54 6·2	
	,,	11	3.36 ,,	1	54 11·5	
	,,	12	10.32 a.m.	1	54 5·7	
	,,	12	3.26 p.m.	1	54 7·7	
	,,	25	10.40 a.m.	1	54 7·1	
	,,	25	3.45 p.m.	1	54 11·4	
1853.	Feb.	1	10.16 a.m.	1	54 5·5	54° 7′·1
	,,	1	3.49 p.m.	1	54 12·6	
	,,	4	3.31 ,,	1	54 6·2	
	,,	5	10.34 a.m.	1	54 11·0	
	,,	8	10.55 ,,	1	54 5·0	
	,,	8	3.27 p.m.	1	54 5·9	
	,,	12	10.20 a.m.	1	54 5·6	
	,,	12	3.51 p.m.	1	54 7·0	
	,,	15	7.55 a.m.	1	54 5·2	
	,,	15	3.55 p.m.	1	54 8·7	
	,,	16	10.15 a.m.	1	54 3·2	
	,,	16	4.30 p.m.	1	54 9·9	
	,,	18	10.35 a.m.	1	54 4·6	
	,,	18	4.0 p.m.	1	54 8·8	
	,,	19	10.20 a.m.	1	54 6·3	
	,,	19	4.9 p.m.	1	54 6·5	
	,,	21	9.38 a.m.	1	54 7·8	
	,,	21	2·40 p.m.	1	54 11·4	
	,,	22	8.0 a.m.	1	54 9·6	
	,,	22	4·17 p.m.	1	54 10·6	
	,,	23	9.30 a.m.	1	54 7·9	
	,,	23	4.54 p.m.	1	54 9·7	
	,,	24	10.16 a.m.	1	54 4·6	
	,,	24	3.10 p.m.	1	54 5·6	

	Date.			Cape Time.	Needle.	Inclination.	Monthly Mean.
1853.	Feb.	25	......	10.15 a.m.	1	54° 5′·6	54° 7′·1
	,,	25	......	4.35 p.m.	1	54 4·7	
	,,	26	......	10·19 a.m.	1	54 3·6	
	,,	26	......	3.41 p.m.	1	54 5·0	
1854.	March	1	......	10.27 a.m.	1	54 7·2	54° 6′·4
	,,	1	......	4.0 p.m.	1	54 7·7	
	,,	2	......	10.23 a.m.	1	54 4·7	
	,,	2	......	3.50 p.m.	1	54 4·4	
	,,	4	......	10.52 a.m.	1	54 3·3	
	,,	4	......	3.25 p.m.	1	54 5·7	
	,,	5	......	10.32 a.m.	1	54 2·6	
	,,	5	......	3.42 p.m.	1	54 4·8	
	,,	8	......	10.20 a.m.	1	54 7·7	
	,,	8	......	3.35 p.m.	1	54 10·8	
	,,	9	......	10.25 a.m.	1	54 8·7	
	,,	9	......	3.39 p.m.	1	54 11·7	
	,,	11	......	10.30 a.m.	1	54 7·2	
	,,	11	......	3·45 p.m.	1	54 11·3	
	,,	12	......	9·4 a.m.	1	54 6·1	
	,,	12	......	4·2 p.m.	1	54 9·6	
	,,	15	......	10·25 a.m.	1	54 5·6	
	,,	15	......	4.0 p.m.	1	54 8·1	
	,,	16	......	10.17 a.m.	1	54 5·3	
	,,	16	......	4.0 p.m.	1	54 6·0	
	,,	18	......	10.21 a.m.	1	54 5·0	
	,,	18	......	4.5 p.m.	1	54 9·5	
	,,	19	......	10.32 a.m.	1	54 5·1	
	,,	19	......	4.1 p.m.	1	54 7·3	
	,,	22	......	10.25 a.m.	1	54 2·6	
	,,	22	......	3.35 p.m.	1	54 4·2	
	,,	23	......	10.35 a.m.	1	54 3·2	
	,,	23	......	4.2 p.m.	1	54 5·2	
	,,	26	......	10.35 a.m.	1	54 3·1	
	,,	26	......	5.7 p.m.	1	54 8·1	
	,,	29	......	10.35 a.m.	1	54 5·3	
	,,	29	......	3.35 p.m.	1	54 7·6	
1853.	April	1	......	10.50 a.m.	1	54 6·7	54° 6′·5
	,,	1	......	3.50 p.m.	1	54 6·6	
	,,	5	......	9.32 a.m.	1	54 2·6	
	,,	5	......	3.22 p.m.	1	54 7·6	
	,,	8	......	10.34 a.m.	1	54 5·9	
	,,	8	......	4.5 p.m.	1	54 11·1	
	,,	12	......	11.30 a.m.	1	54 7·3	
	,,	12	......	3.25 p.m.	1	54 9·6	
	,,	15	......	10.16 a.m.	1	54 5·8	
	,,	15	......	3.27 p.m.	1	54 5·5	
	,,	19	......	10.37 a.m.	1	54 2·5	
	,,	19	......	3.30 p.m.	1	54 7·0	
	,,	23	......	9.7 a.m.	1	54 4·2	
	,,	23	......	3.59 p.m.	1	54 6·4	
	,,	26	......	7.47 a.m.	1	54 4·5	
	,,	26	......	3.37 p.m.	1	54 9·9	
	,,	29	......	10.15 a.m.	1	54 5·4	
	,,	29	......	3.52 p.m.	1	54 7·3	
1853.	May	3	......	10.20 a.m.	1	54 8·7	54° 9′·0
	,,	3	......	3.35 p.m.	1	54 14·9	
	,,	6	......	10.12 a.m.	1	54 8·3	
	,,	6	......	3.43 p.m.	1	54 11·5	

	Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1853.	May 10	......	10.20 a.m.	1	54° 9′·0	
	,, 10	......	3.25 p.m.	1	54 7·5	
	,, 13	......	10.10 a.m.	1	54 4·5	
	,, 13	......	3.10 p.m.	1	54 6·5	
	,, 17	......	9·45 a.m.	1	54 6·3	
	,, 17	......	4.4 p.m.	1	54 9·2	
	,, 20	......	9.42 a.m.	1	54 8·6	
	,, 20	......	3.57 p.m.	1	54 9·8	54° 9′·0
	,, 24	......	10.15 a.m.	1	54 8·0	
	,, 24	......	3.40 p.m.	1	54 8·6	
	,, 27	......	10.37 a.m.	1	54 10·0	
	,, 27	......	3.25 p.m.	1	54 11·0	
	,, 31	......	9.10 a.m.	1	54 9·8	
	,, 31	......	4.2 p.m.	1	54 8·4	
1853.	June 3	......	10.30 a.m.	1	54 6·8	
	,, 3	......	3.52 p.m.	1	54 11·2	
	,, 7	......	10.15 a.m.	1	54 9·8	
	,, 7	......	3.23 p.m.	1	54 11·8	
	,, 10	......	10.42 a.m.	1	54 8·1	
	,, 10	......	3.42 p.m.	1	54 9·3	
	,, 14	......	9.47 a.m.	1	54 7·9	
	,, 14	......	3.30 p.m.	1	54 12·4	54° 9′·3
	,, 17	......	9.45 a.m.	—	54 7·7	
	,, 17	......	3.20 p.m.	—	54 8·2	
	,, 21	......	10.10 a.m.	1	54 8·5	
	,, 21	......	3.20 p.m.	1	54 6·8	
	,, 24	......	9.40 a.m.	1	54 8·9	
	,, 24	......	3.52 p.m.	1	54 11·3	
	,, 28	......	10.12 a.m.	1	54 8·7	
	,, 28	......	4.15 p.m.	1	54 10·4	
1853.	July 1	......	10.45 a.m.	1	54 8·3	
	,, 1	......	3.25 p.m.	1	54 9·5	
	,, 5	......	10.17 a.m.	1	54 8·2	
	,, 5	......	3.52 p.m.	1	54 10·4	
	,, 8	......	10.17 a.m.	1	54 6·2	
	,, 8	......	4.25 p.m.	1	54 11·5	
	,, 12	......	10.42 a.m.	—	54 12·0	
	,, 12	......	3.51 p.m.	—	54 14·0	
	,, 15	......	10.25 a.m.	1	54 12·5	
	,, 15	......	4.37 p.m.	1	54 14·2	54° 10′·2
	,, 19	......	10.35 a.m.	1	54 10·4	
	,, 19	......	3.47 p.m.	1	54 10·9	
	,, 22	......	10.42 a.m.	1	54 7·6	
	,, 22	......	4.7 p.m.	1	54 12·5	
	,, 26	......	10.20 a.m.	1	54 7·1	
	,, 26	......	3.52 p.m.	—	54 10·6	
	,, 29	......	10.20 a.m.	1	54 8·6	
	,, 29	......	3.57 p.m.	1	54 9·5	
1853.	Aug. 2	......	10.12 a.m.	1	54 10·3	
	,, 2	......	3.25 p.m.	1	54 9·6	
	,, 5	......	10.25 a.m.	1	54 10·2	
	,, 5	......	3.50 p.m.	1	54 7·3	
	,, 9	......	10.17 a.m.	1	54 10·3	
	,, 9	......	4.10 p.m.	1	54 10·2	54° 9′·2
	,, 12	......	10.39 a.m.	1	54 8·1	
	,, 12	......	4.7 p.m.	1	54 9·8	
	,, 16	......	9.12 a.m.	1	54 5·8	
	,, 16	......	4.51 p.m.	1	54 7·4	

	Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1853.	Aug. 19	......	10.12 a.m.	1	54° 4′·3	
	,, 19	......	4.20 p.m.	1	54 11·1	
	,, 23	......	10.15 a.m.	1	54 9·8	
	,, 23	......	4.7 p.m.	1	54 10·4	54° 9′·2
	,, 26	......	10.10 a.m.	1	54 8·1	
	,, 26	......	4.22 p.m.	1	54 12 0	
	,, 31	......	10.7 a.m.	1	54 9·3	
	,, 31	......	4.55 p.m.	1	54 10·7	
1853.	Sept. 2	......	10.15 a.m.	1	54 13·8	
	,, 2	......	4.35 p.m.	1	54 21·1	
	,, 6	......	10.35 a.m.	1	54 7·5	
	,, 6	......	4·58 p.m.	1	54 17·1	
	,, 9	......	10.27 a.m.	1	54 7·3	
	,, 9	......	4.37 p.m.	1	54 10·3	
	,, 13	......	10.12 a.m.	1	54 8·7	
	,, 20	......	11.25 ,,	1	54 7·9	
	,, 21	......	10.12 ,,	1	54 10·1	
	,, 21	......	4.35 p.m.	1	54 11·8	54° 11′·7
	,, 23	......	10.37 a.m.	1	54 9·2	
	,, 23	......	4.40 p.m.	1	54 11·9	
	,, 26	......	12.15 a.m.	1	54 11·8	
	,, 26	......	3.52 p.m.	1	54 14·1	
	,, 28	......	11.10 a.m.	1	54 16·8	
	,, 28	......	4.20 p.m.	1	54 16·5	
	,, 30	......	10.15 a.m.	1	54 11·7	
	,, 30	......	4.11 p.m.	1	54 12·0	
1853.	Oct. 3	......	7.17 a.m.	1	54 10·2	
	,, 3	......	4.10 p.m.	1	54 11·5	
	,, 5	......	9.17 a.m.	1	54 8·9	
	,, 5	......	4.31 p.m.	1	54 11·8	
	,, 7	......	9.35 a.m.	1	54 8·8	
	,, 7	......	4.40 p.m.	1	54 11·5	
	,, 10	......	4.31 ,,	1	54 10·5	
	,, 11	......	10.24 a.m.	1	54 9·6	
	,, 11	......	1.19 p.m.	1	54 9·4	
	,, 11	......	4·52 ,,	1	54 11·2	
	,, 12	......	8.57 a.m.	1	54 9·2	
	,, 12	......	1.18 p.m.	1	54 11·0	
	,, 12	......	4.41 ,,	1	54 10 0	
	,, 13	......	10.14 a.m.	1	54 9·0	
	,, 13	......	1.19 p.m.	1	54 9·6	
	,, 13	......	4.56 ,,	1	54 10·6	
	,, 14	......	10.12 a.m.	1	54 8·1	
	,, 14	......	1.19 p.m.	1	54 8·1	54° 10′·1
	,, 14	......	4.25 ,,	1	54 11·4	
	,, 15	......	10.12 a.m.	1	54 7·9	
	,, 15	......	1.23 p.m.	1	54 8·4	
	,, 15	......	5.3 ,,	1	54 12·0	
	,, 17	......	8.57 a.m.	1	54 10·4	
	,, 17	......	1.32 p.m.	1	54 10·2	
	,, 17	......	4 51 ,,	1	54 10·1	
	,, 18	......	10.19 a.m.	1	54 8·5	
	,, 18	......	1.35 p.m.	1	54 7·3	
	,, 18	......	5.9 ,,	1	54 10·8	
	,, 19	......	10.5 a.m.	1	54 8·5	
	,, 19	......	1.26 p.m.	1	54 8·8	
	,, 19	......	4.57 ,,	1	54 10·5	
	,, 20	......	9.40 a.m.	1	54 11·3	
	,, 20	......	1.26 p.m.	1	54 11·0	
	,, 20	......	5.15 ,,	1	54 12·8	

	Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1853.	Oct.	21	10.11 a.m.	1	54° 11′·3	
	,,	21	1.32 p.m.	1	54 13·5	
	,,	21	5.6 ,,	1	54 9·0	
	,,	22	6.40 ,,	1	54 10·8	
	,,	22	10.29 a.m.	1	54 9·5	
	,,	22	1.29 p.m.	1	54 9·0	
	,,	22	5.0 ,,	1	54 10·1	
	,,	24	6.43 a.m.	1	54 10·7	
	,,	24		1	54 10·6	
	,,	24	1.21 p.m.	1	54 12·1	
	,,	24	4.53 ,,	1	54 14·0	
	,,	25	6.6 a.m.	1	54 11·1	
	,,	25	10.18 ,,	1	54 11·0	
	,,	25	2.10 p.m.	1	54 13·0	
	,,	25	5.10 ,,	1	54 14·1	
	,,	26	6.19 a.m.	1	54 10·9	
	,,	26	10.4 ,,	1	54 10·5	
	,,	26	1.34 p.m.	1	54 10·5	54° 10′·1
	,,	26	5.0 ,,	1	54 12·4	
	,,	27	6.22 a.m.	1	54 10·2	
	,,	27	10.3 ,,	1	54 8·2	
	,,	27	1.34 p.m.	1	54 9·0	
	,,	27	5.18 ,,	1	54 11·8	
	,,	28	6.8 a.m.	1	54 9·3	
	,,	28	10.31 ,,	1	54 5·8	
	,,	28	1.56 p.m.	1	54 7·5	
	,,	28	4.27 ,,	1	54 10·4	
	,,	29	6.8 a.m.	1	54 8·3	
	,,	29	10.9 ,,	1	54 11·7	
	,,	29	2.11 p.m.	1	54 7·5	
	,,	29	6.10 ,,	1	54 8·8	
	,,	31	6.10 a.m.	1	54 10·6	
	,,	31	10.27 ,,	1	54 9·8	
	,,	31	1.35 p.m.	1	54 8·0	
	,,	31	4.58 ,,	1	54 17·3	
1853.	Nov.	1	6.7 a.m.	1	54 13·6	
	,,	1	10.20 ,,	1	54 12·6	
	,,	1	1.28 p.m.	1	54 13·4	
	,,	1	6.12 ,,	1	54 16·6	
	,,	1	10.30 ,,	1	54 17·4	
	,,	2	6.14 a.m.	1	54 12·9	
	,,	2	10.16 ,,	1	54 10·1	
	,,	2	1.30 p.m.	1	54 8·5	
	,,	2	5.27 ,,	1	54 10·1	
	,,	2	10.10 ,,	1	54 14·8	
	,,	3	6.21 a.m.	1	44 11·6	
	,,	3	10.23 ,,	1	54 11·1	
	,,	3	1.27 p.m.	1	54 7·3	
	,,	3	6.32 ,,	1	54 9·8	54° 10′·7
	,,	3	10.38 ,,	1	54 9·4	
	,,	4	6.26 a.m.	1	54 9·1	
	,,	4	10.34 ,,	1	54 8·5	
	,,	4	1.27 p.m.	1	54 7·4	
	,,	4	6.14 ,,	1	54 9·3	
	,,	4	10.25 ,,	1	54 9·9	
	,,	5	6.9 a.m.	1	54 10·4	
	,,	5	10.10 ,,	1	54 8·4	
	,,	5	1.40 p.m.	1	54 7·5	
	,,	5	6.37 ,,	1	54 10·1	
	,,	8	10.15 a.m.	1	54 4·7	
	,,	8	4.36 p.m.	—	54 11·4	

Date.				Cape Time.	Needle.	Inclination.	Monthly Mean.
1853.	Nov.	9	......	10·53 a.m.	1	54° 7·2′	54° 10′·7
	,,	9	......	5.5 p.m.	1	54 14·5	
	,,	10	......	10.17 a.m.	1	54 11·2	
	,,	10	......	4.59 p.m.	1	54 19·5	
	,,	11	......	10.33 a.m.	1	54 13·1	
	,,	11	......	5.50 p.m.	1	54 12·4	
	,,	12	......	6.7 a.m.	1	54 10·1	
	,,	12	......	10.6 ,,	1	54 8·5	
	,,	12	......	1.29 p.m.	1	54 10·8	
	,,	12	......	5.36 ,,	1	54 11·6	
	,,	14	......	9.38 a.m.	1	54 12·6	
	,,	14	......	5.11 p.m.	1	54 10·1	
	,,	17	......	9.34 a.m.	1	54 8·5	
	,,	17	......	4.38 p.m.	1	54 10·5	
	,,	21	......	10.20 a.m.	1	54 9·9	
	,,	21	......	4.34 p.m.	1	54 10·5	
	,,	24	......	10.25 a.m.	1	54 9·6	
	,,	27	......	4.57 p.m.	1	54 6·0	
	,,	29	......	10.37 a.m.	1	54 10·1	
	,,	29	......	4.55 p.m.	1	54 10·2	
1853.	Dec.	3	......	10.42 a.m.	1	54 7·7	54° 11′·4 (Yearly Mean for 1853, 54° 9′·2)
	,,	3	......	4.39 p.m.	1	54 10·7	
	,,	6	......	10.16 a.m.	1	54 6·5	
	,,	6	......	5.5 p.m.	1	54 25·1	
	,,	9	......	10.25 a.m.	1	54 8·9	
	,,	9	......	5.23 p.m.	1	54 10·6	
	,,	13	......	10.19 a.m.	1	54 7·9	
	,,	13	......	5.35 p.m.	1	54 16·1	
	,,	16	......	10.41 a.m.	1	54 11·1	
	,,	16	......	4.55 p.m.	1	54 12·2	
	,,	21	......	11.9 a.m.	1	54 6·2	
	,,	21	......	5.6 p.m.	1	54 17·3	
	,,	27	......	10.55 a.m.	1	54 7·8	
	,,	27	......	—	1	54 11·2	
	,,	30	......	7.3 a.m.	1	54 8·7	
	,,	30	......	6.19 p.m.	1	54 11·9	
1854.	Jan.	3	......	10.17 a.m.	1	54 13·5	54° 12′·9
	,,	3	......	5.31 p.m.	1	54 15·8	
	,,	6	......	10.37 a.m.	1	54 10·9	
	,,	6	......	4.59 p.m.	1	54 11·9	
	,,	10	......	10.27 a.m.	1	54 11·2	
	,,	10	......	4 50 p.m.	1	54 10·7	
	,,	14	......	10.55 a.m.	1	54 10·9	
	,,	14	......	4.45 p.m.	1	54 12·3	
	,,	17	......	10.17 a.m.	1	54 12·6	
	,,	17	......	5.13 p.m.	1	54 12·3	
	,,	21	......	10.23 a.m.	1	54 11·2	
	,,	21	......	5.10 p.m.	1	54 15·6	
	,,	25	......	10.6 a.m.	1	54 9·7	
	,,	25	......	5.50 p.m.	2	54 15·3	
	,,	27	......	10.21 a.m.	2	54 16·5	
	,,	27	......	4.31 p.m.	2	54 15·9	
	,,	31	......	10.42 a.m.	2	54 15·3	
	,,	31	......	4.44 p.m.	2	54 11·8	
1854.	Feb.	3	......	10.22 a.m.	2	54 12·4	54° 5′·6
	,,	3	......	4.50 p.m.	2	54 20·7	
	,,	7	......	10.13 a.m.	2	54 11·7	
	,,	7	......	4.56 p.m.	2	54 13·3	
	,,	28	......	10.0 a.m.	2	54 18·5	

Date.	Cape Time.	Needle.	Inclination.	Monthly Mean.
1854. March 3	10.21 a.m.	2	54° 16′·4	
,, 3	4.41 p.m.	2	54 21·7	
,, 10	9.14 a.m.	2	54 22·7	
,, 10	4.54 p.m.	2	54 23·2	
,, 14	10.36 a.m.	2	54 19·5	
,, 14	4.56 p.m.	2	54 23·7	54° 22′·0
,, 22	10.22 a.m.	2	54 18·3	
,, 22	4.42 p.m.	2	54 20·1	
,, 28	10.29 a.m.	2	54 25·6	
,, 28	4.37 p.m.	—	54 33·4	
,, 31	10.30 a.m.	2	54 23·1	
,, 31	5.21 p.m.	2	54 15·7	
1854. April 4	10.17 a.m.	2	54 15·3	
,, 4	5.24 p.m.	2	54 17·3	
,, 8	10.45 a.m.	2	54 17·1	
,, 8	5.6 p.m.	2	54 20·0	
,, 11	10.39 a.m.	2	54 32·5	
,, 11	4.42 p.m.	2	54 30·3	
,, 18	10.18 a.m.	2	54 18·0	54° 21′·3
,, 18	4.42 p.m.	2	54 19·0	
,, 21	10.43 a.m.	2	54 16·7	
,, 21	4.36 p.m.	2	54 28·9	
,, 25	10.26 a.m.	—	54 19·6	
,, 25	4.39 p.m.	2	54 22·8	
,, 28	10.26 a.m.	2	54 17·3	
,, 28	4.10 p.m.	2	54 23·5	
1854. May 2	9.47 a.m.	2	54 29·3	
,, 2	4.42 p.m.	2	54 32·0	
,, 5	10.26 a.m.	2	54 22·0	
,, 5	4.0 p.m.	2	54 27·2	
,, 9	10.35 a.m.	2	54 20·2	
,, 9	4.40 p.m.	2	54 18·3	
,, 12	10.31 a.m.	2	54 21·5	
,, 12	4.28 p.m.	2	54 26·7	
,, 17	10.25 a.m.	2	54 8·6	
,, 17	4.8 p.m.	2	54 17·4	54° 21′·3
,, 20	10.16 a.m.	2	54 18·8	
,, 20	4.34 p.m.	2	54 21·0	
,, 23	10.16 a.m.	2	54 18·3	
,, 23	5.18 p.m.	2	54 22·4	
,, 26	10.25 a.m.	—	54 19·0	
,, 26	4.32 p.m.	2	54 21·6	
,, 30	10.6 a.m.	—	54 14·4	
,, 30	3.33 p.m.	2	54 24·9	
1854. June 2	10.15 a.m.	2	54 22·6	
,, 2	4.51 p.m.	2	54 16·9	
,, 6	10.30 a.m.	2	54 14·0	
,, 6	5.49 p.m.	2	54 16·2	
,, 9	10.15 a.m.	2	54 22·3	
,, 9	4.23 p.m.	2	54 31·9	
,, 13	10.9 a.m.	2	54 21·6	54° 19′·4
,, 13	4.17 p.m.	2	54 31·8	
,, 17	11.15 a.m.	2	54 31·7	
,, 17	4·41 p.m.	2	54 20·0	
,, 20	9.51 a.m.	2	54 13·9	
,, 20	3.18 p.m.	2	54 13·8	
,, 23	10.27 a.m.	2	54 7·7	

	Date.		Cape Time.	Needle.		Inclination.	Monthly Mean.
1854.	June 23	......	4.21 p.m.	2		54° 11′·6	50° 19′·4
	,, 27	......	10.37 a.m.	2		54 26·4	
	,, 27	......	4.41 p.m.	—		54 17·1	
	,, 30	......	10.25 a.m.	2		54 9·0	
1854.	Dec. 7	......	10.51 a.m.	2	(new pair)	54 19·1	54° 24′·8 (Yearly Mean for 1854, 54° 19′·6)
	,, 7	......	6.12 p.m.	2	,,	54 25·8	
	,, 8	......	10.10 a.m.	2	,,	54 13·1	
	,, 8	......	5.8 p.m.	2	,,	54 32·2	
	,, 9	......	11.42 a.m.	2	,,	54 29·4	
	,, 9	......	6.7 p.m.	2	,,	54 25·2	
	,, 12	......	10.12 a.m.	2	,,	54 23·2	
	,, 12	......	5.0 p.m.	2	,,	54 30·7	
	,, 15	......	10.40 a.m.	2	,,	54 20·1	
	,, 15	......	4.55 p.m.	2	,,	54 33·4	
	,, 19	......	10.16 a.m.	2	,,	54 23·7	
	,, 19	......	6.11 p.m.	2	,,	54 28·1	
	,, 22	......	10.30 a.m.	2	,,	54 17·6	
	,, 22	......	5.25 p.m.	2	,,	54 30·6	
	,, 26	......	12.42 a.m.	2	,,	54 18·1	
	,, 29	......	6.5 p.m.	2	,,	54 26·6	
1855.	Jan. 2	......	10.20 a.m.	2	(new pair)	54 22·0	54° 5′·7
	,, 2	......	5.27 p.m.	2	,,	54 27·1	
	,, 5	......	5.45 ,,	1	,,	54 17·4	
	,, 6	......	10.20 a.m.	1	,,	54 4·9	
	,, 6	......	6.4 p.m.	1	,,	54 4·7	
	,, 9	......	11.0 a.m.	1	,,	53 50·0	
	,, 9	......	2.27 p.m.	1	,,	54 14·2	
	,, 12	......	10.17 a.m.	1	,,	54 2·2	
	,, 12	......	5.32 p.m.	1	,,	54 18·9	
	,, 16	......	10.15 a.m.	1	,,	53 52·6	
	,, 16	......	5.18 p.m.	1	,,	54 13·5	
	,, 19	......	9.32 a.m.	1	,,	53 54·4	
	,, 19	......	5.45 p.m.	1	,,	54 3·8	
	,, 23	......	11.10 a.m.	1	,,	53 46·2	
	,, 23	......	5.22 p.m.	1	,,	54 1·2	
	,, 27	......	11.28 a.m.	1	,,	53 54·7	
	,, 27	......	11.28 ,,	1	,,	53 56·9	
	,, 30	......	11.2 ,,	1	,,	54 3·1	
1855.	Feb. 2	......	10.15 a.m.	1	(new pair)	54 2·5	54° 24′·2
	,, 6	......	10.35 ,,	2	,,	54 21·9	
	,, 6	......	5.15 p.m.	2	,,	54 27·9	
	,, 10	......	9.38 a.m.	2	,,	54 23·5	
	,, 10	......	5.42 p.m.	2	,,	54 27·4	
	,, 13	......	10.16 a.m.	2	,,	54 19·2	
	,, 13	......	5.34 p.m.	2	,,	54 31·0	
	,, 15	......	10.22 a.m.	2	,,	54 22·9	
	,, 15	......	5.25 p.m.	2	,,	54 27·3	
	,, 20	......	9.0 a.m.	2	,,	54 28·5	
	,, 20	......	5.5 p.m.	2	,,	54 25·7	
	,, 23	......	9.6 a.m.	2	,,	54 23·6	
	,, 23	......	5.0 p.m.	2	,,	54 27·2	
	,, 27	......	9.0 a.m.	2	,,	54 25·2	
	,, 27	......	5.5 p.m.	2	,,	54 23·1	
1855.	March 2	......	9.7 a.m.	2	(new pair)	54 25·3	54° 27′·0
	,, 2	......	4.32 p.m.	2	,,	54 32·0	
	,, 6	......	9.15 a.m.	2	,,	54 32·9	

	Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1855.	March 6	......	5.4 p.m.	2 (new pair)	54° 28′·8	
	,, 9	......	9.38 a.m.	2 ,,	54 23·1	
	,, 9	......	5.55 p.m.	2 ,,	54 31·5	
	,, 13	......	10.7 a.m.	2 ,,	54 22·6	
	,, 13	......	5.20 p.m.	2 ,,	54 27·2	
	,, 16	......	10.36 a.m.	2 ,,	54 20·3	
	,, 16	......	5.32 p.m.	2 ,,	54 23·5	
	,, 20	......	10.5 a.m.	2 ,,	54 26·2	54° 27′·0
	,, 20	......	5.27 p.m.	2 ,,	54 29·9	
	,, 23	......	10.10 a.m.	2 ,,	54 26·1	
	,, 24	......	4.52 p.m.	2 ,,	54 29·7	
	,, 27	......	9.30 a.m.	2 ,,	54 25·4	
	,, 27	......	4.41 p.m.	2 ,,	54 26·3	
	,, 30	......	10.15 a.m.	2 ,,	54 25·8	
	,, 30	......	4.35 p.m.	2 ,,	54 29·7	
1855.	April 3	......	12.52 a.m.	2 (new pair)	54 27·4	
	,, 3	......	4.37 p.m.	2 ,,	54 24·3	
	,, 5	......	11.52 a.m.	2 ,,	54 23·9	
	,, 5	......	5.27 p.m.	2 ,,	54 30·7	
	,, 10	......	10.15 a.m.	2 ,,	54 29·8	
	,, 13	......	11.15 ,,	2 ,,	54 29·5	
	,, 17	......	11.5 ,,	2 ,,	54 25·6	54° 26′·8
	,, 20	......	12.0	2 ,,	54 24·1	
	,, 25	......	11.40 ,,	2 ,,	54 26·0	
	,, 25	......	5.0 p.m.	2 ,,	54 24·4	
	,, 27	......	10.30 a.m.	2 ,,	54 22·7	
	,, 27	......	4.48 p.m.	2 ,,	54 31·7	
1855.	May 1	......	11.22 a.m.	2 (new pair)	54 21·5	
	,, 1	......	5.21 p.m.	2 ,,	54 32·0	
	,, 4	......	10.25 a.m.	2 ,,	54 31·8	
	,, 8	......	10.32 ,,	2 ,,	54 24·1	
	,, 8	......	4.37 p.m.	2 ,,	54 35·2	
	,, 11	......	10.25 a.m.	2 ,,	54 25·4	
	,, 11	......	3.45 p.m.	2 ,,	54 23·4	
	,, 15	......	10·55 a.m.	2 ,,	54 22·9	
	,, 15	......	4.49 p.m.	2 ,,	54 27·1	54° 26′·7
	,, 18	......	11.36 a.m.	2 ,,	54 28·3	
	,, 18	......	4.36 p.m.	2 ,,	54 26·7	
	,, 22	......	10.55 a.m.	2 ,,	54 24·5	
	,, 22	......	4.20 p.m.	2 ,,	54 23·9	
	,, 25	......	11.5 a.m.	2 ,,	54 26·7	
	,, 25	......	4.15 p.m.	2 ,,	54 31·1	
	,, 29	......	10.40 a.m.	2 ,,	54 23·2	
	,, 29	......	4.15 p.m.	2 ,,	54 24·4	
1855.	June 1	......	11.30 a.m.	2 (new pair)	54 22·0	
	,, 1	......	4.17 p.m.	2 ,,	54 24·6	
	,, 5	......	11.27 a.m.	2 ,,	54 19·3	
	,, 5	......	5.5 p.m.	2 ,,	54 16·8	
	,, 8	......	11.22 a.m.	2 ,,	54 25·5	
	,, 8	......	4.30 p.m.	2 ,,	54 34·5	
	,, 12	......	10.55 a.m.	2 ,,	54 23·7	54° 22′·1
	,, 12	......	4.22 p.m.	2 ,,	54 21·1	
	,, 15	......	10.35 a.m.	2 ,,	54 21·2	
	,, 15	......	5.7 p.m.	2 ,,	54 22·4	
	,, 19	......	11.25 a.m.	2 ,,	54 19·8	
	,, 19	......	4.7 p.m.	2 ,,	54 26·6	
	,, 22	......	10.15 a.m.	2 ,,	54 15·3	

	Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1855.	June 22	......	3.55 p.m.	2 (new pair)	54° 15′·7	54° 22′·1
	,, 26	......	11.25 a.m.	2 ,,	54 24·2	
	,, 26	......	4.25 p.m.	2 ,,	54 24·3	
	,, 29	......	10.37 a.m.	2 ,,	54 18·5	
	,, 29	......	4.55 p.m.	2 ,,	54 23·1	
1855.	July 3	......	11.22 a.m.	2 (new pair)	54 23·7	54° 24′·5
	,, 3	......	4.7 p.m.	2 ,,	54 26·5	
	,, 6	......	10.12 a.m.	2 ,,	54 26·0	
	,, 6	......	5.20 p.m.	2 ,,	54 27·9	
	,, 10	......	10.25 a.m.	2 ,,	54 26·3	
	,, 10	......	4.22 p.m.	2 ,,	54 25·9	
	,, 13	......	11.25 a.m.	2 ,,	54 28·7	
	,, 13	......	4.55 p.m.	2 ,,	54 18·5	
	,, 17	......	10.50 a.m.	2 ,,	54 23·2	
	,, 17	......	3.55 p.m.	2 ,,	54 24·4	
	,, 20	......	10.25 a.m.	2 ,,	54 18·0	
	,, 20	......	4.16 p.m.	2 ,,	54 23·7	
	,, 24	......	10.27 a.m.	2 ,,	54 23·5	
	,, 24	......	4.32 p.m.	2 ,,	54 22·6	
	,, 27	......	10.22 a.m.	2 ,,	54 21·4	
	,, 27	......	4.25 p.m.	2 ,,	54 30·3	
	,, 31	......	10.37 a.m.	2 ,,	54 26·1	
	,, 31	......	4.47 p.m.	2 ,,	54 24·8	
1855.	Aug. 3	......	10.20 a.m.	2 (new pair)	54 23·9	54° 23′·6
	,, 3	......	4.42 p.m.	2 ,,	54 31·7	
	,, 7	......	10.22 a.m.	2 ,,	54 20·0	
	,, 7	......	4.22 p.m.	2 ,,	54 25·2	
	,, 10	......	10.17 a.m.	2 ,,	54 18·8	
	,, 14	......	9.12 ,,	2 ,,	54 22·3	
	,, 14	......	4.37 p.m.	2 ,,	54 19·9	
	,, 17	......	9.5 a.m.	2 ,,	54 19·2	
	,, 17	......	4.25 p.m.	2 ,,	54 27·9	
	,, 21	......	11.49 a.m.	2 ,,	54 19·3	
	,, 21	......	4.40 p.m.	2 ,,	54 25·2	
	,, 24	......	9.10 a.m.	2 ,,	54 23·9	
	,, 24	......	5.7 p.m.	2 ,,	54 24·7	
	,, 29	......	9.7 a.m.	2 ,,	54 18·7	
	,, 29	......	4.37 p.m.	2 ,,	54 27·2	
1855.	Sept. 1	......	11.7 a.m.	2 (new pair)	54 18·4	54° 23′·6
	,, 1	......	4.52 p.m.	2 ,,	54 23·8	
	,, 4	......	11.52 a.m.	2 ,,	54 20·1	
	,, 4	......	4.57 p.m.	2 ,,	54 25·4	
	,, 6	......	10.22 a.m.	2 ,,	54 17·1	
	,, 6	......	4.22 p.m.	2 ,,	54 30·7	
	,, 8	......	10.22 a.m.	2 ,,	54 23·3	
	,, 8	......	4·47 p.m.	2 ,,	54 29·8	
	,, 11	......	9.40 a.m.	2 ,,	54 19·4	
	,, 11	......	4.54 p.m.	2 ,,	54 35·8	
	,, 13	......	10.32 a.m.	2 ,,	54 24·6	
	,, 13	......	4.52 p.m.	2 ,,	54 26·6	
	,, 15	......	9.47 a.m.	2 ,,	54 27·4	
	,, 15	......	4.59 p.m.	2 ,,	54 26·4	
	,, 18	......	9.35 a.m.	2 ,,	54 21·9	
	,, 18	......	4.57 p.m.	2 ,,	54 26·1	
	,, 20	......	10.15 a.m.	2 ,,	54 23·3	
	,, 20	......	5.8 p.m.	2 ,,	54 22·9	
	,, 22	......	10.2 a.m.	2 ,,	54 17·5	
	,, 22	......	4.56 p.m.	2 ,,	54 24·6	

	Date.		Cape Time.	Needle.		Inclination.	Monthly Mean.
1855.	Sept. 25	......	9.2 a.m.	2	(new pair)	54° 22′·8	
	,, 25	......	4.47 p.m.	2	,,	54 23·9	
	,, 27	......	9.2 a.m.	2	,,	54 19·6	54° 23′·6
	,, 27	......	4.52 p.m.	2	,,	54 19·0	
	,, 29	......	9.37 a.m.	2	,,	54 21·4	
	,, 29	......	4.52 p.m.	2	,,	54 22·5	
1855.	Oct. 2	......	9.11 a.m.	2	(new pair)	54 19·9	
	,, 2	......	5.9 p.m.	2	,,	54 23·2	
	,, 4	......	9.32 a.m.	2	,,	54 21·0	
	,, 4	......	5.3 p.m.	2	,,	54 25·0	
	,, 6	......	9.26 a.m.	2	,,	54 25·1	
	,, 6	......	5.5 p.m.	2	,,	54 25·2	
	,, 9	......	10.5 a.m.	2	,,	54 19·5	
	,, 9	......	5.25 p.m.	2	,,	54 19·1	
	,, 11	......	10.15 a.m.	2	,,	54 22·6	
	,, 11	......	4.55 p.m.	2	,,	54 22·7	
	,, 13	......	10.5 a.m.	2	,,	54 23·1	
	,, 13	......	5.2 p.m.	2	,,	54 21·4	
	,, 16	......	9.2 a.m.	2	,,	54 22·6	54° 22′·1
	,, 16	......	5.22 p.m.	2	,,	54 26·5	
	,, 18	......	10.12 a.m.	2	,,	54 18·9	
	,, 18	......	5.0 p.m.	2	,,	54 21·3	
	,, 20	......	8.35 a.m.	2	,,	54 18·1	
	,, 20	......	—	2	,,	54 19·5	
	,, 23	......	9.20 ,,	2	,,	54 25·1	
	,, 23	......	5.12 p.m.	2	,,	54 22·9	
	,, 25	......	9.41 a.m.	2	,,	54 19·9	
	,, 25	......	5.5 p.m.	2	,,	54 20·2	
	,, 27	......	9.36 a.m.	2	,,	54 23·0	
	,, 27	......	5.8 p.m.	2	,,	54 24·2	
1855.	Dec. 11	......	9.37 a.m.	2	(new pair)	54 19·7	
	,, 11	......	5.12 p.m.	2	,,	54 23·8	
	,, 14	......	9.12 a.m.	2	,,	54 21·9	
	,, 14	......	6.5 p.m.	2	,,	54 25·7	
	,, 18	......	9.25 a.m.	2	,,	54 22·2	
	,, 18	......	5.20 p.m.	2	,,	54 27·5	54° 23′·3
	,, 21	......	9.57 a.m.	2	,,	54 23·7	(Yearly Mean, 1855,
	,, 21	......	4.37 p.m.	2	,,	54 27·1	54° 24′·5)
	,, 26	......	8.52 a.m.	2	,,	54 18·5	
	,, 26	......	5.20 p.m.	2	,,	54 24·6	
	,, 28	......	8.50 a.m.	2	,,	54 20·2	
	,, 28	......	4.35 p.m.	2	,,	54 25·0	
1856.	Jan. 1	......	9.32 a.m.	2	(new pair)	54 20·3	
	,, 1	......	4.53 p.m.	2	,,	54 27·2	
	,, 4	......	10.25 a.m.	2	,,	54 18·4	
	,, 4	......	5.25 p.m.	2	,,	54 24·4	
	,, 8	......	8.37 a.m.	2	,,	54 19·9	
	,, 8	......	5.20 p.m.	2	,,	54 25·0	
	,, 11	......	9.5 a.m.	2	,,	54 21·8	
	,, 11	......	5.9 p.m.	2	,,	54 23·0	
	,, 15	......	9.40 a.m.	2	,,	54 22·5	
	,, 15	......	5.42 p.m.	2	,,	54 25·9	54° 23′·2
	,, 18	......	9.8 a.m.	2	,,	54 20·0	
	,, 18	......	5.20 p.m.	2	,,	54 24·8	
	,, 22	......	9.30 a.m.	2	,,	54 24·6	
	,, 22	......	5.30 p.m.	2	,,	54 26·8	
	,, 25	......	9.30 a.m.	2	,,	54 25·1	
	,, 25	......	5·8 p.m.	2	,,	54 25·5	
	,, 29	......	9.15 a.m.	2	,,	54 25·6	
	,, 29	......	5.6 p.m.	2	,,	54 25·6	

	Date.			Cape Time.	Needle.		Inclination.	Monthly Mean.
1856.	Feb.	1	......	8.52 a.m.	2	(new pair)	54° 23′·1	54° 26′·2
	,,	1	......	5.5 p.m.	2	,,	54 27·0	
	,,	5	......	9.5 a.m.	2	,,	54 24·1	
	,,	5	......	5.2 p.m.	2	,,	54 27·2	
	,,	8	......	9.12 a.m.	2	,,	54 25·8	
	,,	8	......	5.9 p.m.	2	,,	54 28·7	
	,,	12	......	9.30 a.m.	2	,,	54 25·8	
	,,	12	......	5.15 p.m.	2	,,	54 27·3	
	,,	15	......	10.5 a.m.	2	,,	54 21·9	
	,,	15	......	5.25 p.m.	2	,,	54 24·2	
	,,	19	......	9.22 a.m.	2	,,	54 23·0	
	,,	19	......	5.0 p.m.	2	,,	54 25·3	
	,,	22	......	9.5 a.m.	2	,,	54 27·4	
	,,	22	......	5.9 p.m.	2	,,	54 30·0	
	,,	26	......	9.20 a.m.	2	,,	54 27·0	
	,,	26	......	4.59 p.m.	2	,,	54 28·3	
	,,	29	......	9.9 a.m.	2	,,	54 26·5	
	,,	29	......	5.22 p.m.	2	,,	54 28·9	
1856.	March	4	......	9.12 a.m.	2	(new pair)	54 24·0	54° 23′·5
	,,	4	......	4.55 p.m.	2	,,	54 21·0	
	,,	7	......	9.5 a.m.	2	,,	54 24·1	
	,,	7	......	5.15 p.m.	2	,,	54 19·7	
	,,	11	......	10.1 a.m.	2	,,	54 23·2	
	,,	11	......	5.1 p.m.	2	,,	54 26·6	
	,,	14	......	10.2 a.m.	2	,,	54 22·0	
	,,	14	......	4.52 p.m.	2	,,	54 22·5	
	,,	18	......	10.5 a.m.	2	,,	54 21·5	
	,,	18	......	5.25 p.m.	2	,,	54 26·7	
	,,	22	......	10.7 a.m.	2	,,	54 22·0	
	,,	22	......	5.6 p.m.	2	,,	54 21·8	
	,,	25	......	10.5 a.m.	2	,,	54 23·6	
	,,	25	......	5.5 p.m.	2	,,	54 23·0	
	,,	28	......	9.0 a.m.	2	,,	54 26·8	
	,,	28	......	5.1 p.m.	2	,,	54 27·6	
1856.	April	1	......	9.2 a.m.	2	(new pair)	54 24·5	54° 27′·3
	,,	1	......	5.5 p.m.	2	,,	54 28·2	
	,,	5	......	9.5 a.m.	2	,,	54 25·2	
	,,	5	......	4.45 p.m.	2	,,	54 26·8	
	,,	8	......	9.17 a.m.	2	,,	54 23·3	
	,,	8	......	5.0 p.m.	2	,,	54 25·9	
	,,	11	......	9.27 a.m.	2	,,	54 25·1	
	,,	11	......	4.55 p.m.	2	,,	54 29·6	
	,,	15	......	8.59 a.m.	2	,,	54 24·2	
	,,	15	......	5.5 p.m.	2	,,	54 30·4	
	,,	18	......	8.55 a.m.	2	,,	54 28·3	
	,,	18	......	4.40 p.m.	2	,,	54 26·1	
	,,	23	......	9.2 a.m.	2	,,	54 31·8	
	,,	23	......	5.2 p.m.	2	,,	54 29·0	
	,,	26	......	9.15 a.m.	2	,,	54 28·8	
	,,	26	......	4.55 p.m.	2	,,	54 25·9	
	,,	30	......	8.56 a.m.	2	,,	54 29·8	
	,,	30	......	4.55 p.m.	2	,,	54 28·5	
1856.	May	2	......	9.7 a.m.	2	(new pair)	54 25·1	54° 24′·7
	,,	2	......	5.2 p.m.	2	,,	54 27·5	
	,,	7	......	8.57 a.m.	2	,,	54 18·5	
	,,	7	......	5.11 p.m.	2	,,	54 23·2	
	,,	10	......	10.7 a.m.	2	,,	54 25·3	
	,,	10	......	4.47 p.m.	2	,,	54 26·9	

	Date.	Cape Time.	Needle.		Inclination.	Monthly Mean.
1856.	May 13	10.2 a.m.	2	(new pair)	54° 25′·0	
	,, 13	4.47 p.m.	2	,,	54 25·3	
	,, 16	10.7 a.m.	2	,,	54 23·0	
	,, 16	4.40 p.m.	2	,,	54 28·7	
	,, 21	10.7 a.m.	2	,,	54 22·4	
	,, 21	5.2 p.m.	2	,,	54 26·5	
	,, 24	10.7 a.m.	2	,,	54 21·8	54° 24′·7
	,, 24	4.42 p.m.	2	,,	54 21·6	
	,, 27	10.10 a.m.	2	,,	54 26·5	
	,, 27	4.30 p.m.	2	,,	54 29·1	
	,, 27	10.20 a.m.	2	,,	54 26·5	
	,, 27	4.30 p.m.	2	,,	54 29·1	
	,, 30	10.35 a.m.	2	,,	54 20·9	
	,, 30	4.25 p.m.	2	,,	54 26·6	
1856.	June 3	10.20 a.m.	2	(new pair)	54 20·7	
	,, 6	10.17 ,,	2	,,	54 24·9	
	,, 6	4.40 p.m.	2	,,	54 28·0	
	,, 7	4.40 ,,	2	,,	54 20·6	
	,, 10	10.25 a.m.	2	,,	54 22·3	
	,, 10	4.37 p.m.	2	,,	54 22·4	
	,, 13	10.25 a.m.	2	,,	54 23·4	
	,, 13	4.30 p.m.	2	,,	54 28·6	54° 24′·0
	,, 17	10.30 a.m.	2	,,	54 20·8	
	,, 17	4.45 p.m.	2	,,	54 27·6	
	,, 20	10.25 a.m.	2	,,	54 19·3	
	,, 20	4.15 p.m.	2	,,	54 31·8	
	,, 24	10.20 a.m.	2	,,	54 24·0	
	,, 24	4.5 p.m.	2	,,	54 21·6	
	,, 27	10.57 a.m.	2	,,	54 21·2	
	,, 27	4.12 p.m.	2	,,	54 26·6	
1856.	July 1	11.0 a.m.	2	(new pair)	54 22·2	
	,, 1	4.40 p.m.	2	,,	54 27·1	
	,, 5	10.42 a.m.	2	,,	54 27·5	
	,, 5	4.10 p.m.	2	,,	54 23·1	
	,, 9	11.40 a.m.	2	,,	54 15·2	
	,, 9	4.25 p.m.	2	,,	54 18·2	
	,, 11	11.0 a.m.	2	,,	54 17·4	54° 21′·9
	,, 14	4.12 p.m.	2	,,	54 26·4	
	,, 16	11.15 a.m.	2	,,	54 25·8	
	,, 16	4.7 p.m.	2	,,	54 24·8	
	,, 25	10.22 a.m.	2	,,	54 22·4	
	,, 25	4.5 p.m.	2	,,	54 16·9	
	,, 30	10.25 a.m.	2	,,	54 20·0	
	,, 30	4.7 p.m.	2	,,	54 19·6	
1856.	Aug. 1	11.30 a.m.	2	(new pair)	54 23·4	
	,, 1	5.2 p.m.	2	,,	54 24·4	
	,, 5	12.37 a.m.	2	,,	54 26·2	
	,, 6	4.15 p.m.	2	,,	54 25·7	
	,, 8	10.37 a.m.	2	,,	54 22·8	
	,, 8	4.22 p.m.	2	,,	54 23·2	
	,, 12	11.2 a.m.	2	,,	54 21·1	54° 22′·9
	,, 12	4.40 p.m.	2	,,	54 23.2	
	,, 15	11.2 a.m.	2	,,	54 22·1	
	,, 15	4.5 p.m.	2	,,	54 24·0	
	,, 22	10.7 a.m.	2	,,	54 14·5	
	,, 22	4.2 p.m.	2	,,	54 22·7	
	,, 26	10.7 a.m.	2	,,	54 25·1	
	,, 26	3.57 p.m.	2	,,	54 24·7	

	Date.		Cape Time.	Needle.	Inclination.	Monthly Mean.
1856.	Sept. 5	......	10.37 a.m.	2 (new pair)	54° 26′·3	
	,, 5	......	4.50 p.m.	2 ,,	54 25·6	
	,, 12	......	10.55 a.m.	2 ,,	54 14·6	
	,, 12	......	4.42 p.m.	2 ,,	54 16·3	
	,, 17	......	11.25 a.m.	2 ,,	54 25·0	
	,, 17	......	4.35 p.m.	2 ,,	54 23·8	
	,, 23	......	10.22 a.m.	2 ,,	54 21·0	54° 22′·0
	,, 23	......	4.25 p.m.	2 ,,	54 20·0	
	,, 27	......	9.6 a.m.	2 ,,	54 18·5	
	,, 27	......	4.17 p.m.	2 ,,	54 26·2	
	,, 29	......	11.19 a.m.	2 ,,	54 22·7	
	,, 30	......	4.5 p.m.	2 ,,	54 23·8	
1856.	Oct. 3	......	11.25 a.m.	2 (new pair)	54 27·2	
	,, 3	......	4.5 p.m.	2 ,,	54 21·0	
	,, 7	......	11.25 a.m.	2 ,,	54 21·6	
	,, 7	......	4·40 p.m.	2 ,,	54 22·1	
	,, 10	......	10·55 a.m.	2 ,,	54 24·2	
	,, 10	......	4.2 p.m.	2 ,,	54 22·6	
	,, 14	......	11.2 a.m.	2 ,,	54 22·8	
	,, 14	......	4.50 p.m.	2 ,,	54 20·9	
	,, 18	......	11.0 a.m.	2 ,,	54 21·0	
	,, 18	......	4.27 p.m.	2 ,,	54 22·8	54° 23′·8
	,, 21	......	10.12 a.m.	2 ,,	54 22·4	
	,, 21	......	4.0 p.m.	2 ,,	54 29·8	
	,, 25	......	10.8 a.m.	2 ,,	54 26·7	
	,, 25	......	4.42 p.m.	2 ,,	54 25·9	
	,, 28	......	10.52 a.m.	2 ,,	54 25·6	
	,, 28	......	3.52 p.m.	2 ,,	54 26·7	
	,, 31	......	10.8 a.m.	2 ,,	54 24·0	
	,, 31	......	4.55 p.m.	2 ,,	54 20·9	
1856.	Nov. 4	......	10.8 a.m.	2 (new pair)	54 23·7	
	,, 4	......	4.23 p.m.	2 ,,	54 22·2	
	,, 7	......	10.12 a.m.	2 ,,	54 21·7	
	,, 7	......	5.5 p.m.	2 ,,	54 24·1	
	,, 11	......	10.58 a.m.	2 ,,	54 22·1	
	,, 11	......	4.2 p.m.	2 ,,	54 27·5	
	,, 14	......	10.8 a.m.	2 ,,	54 23·1	
	,, 14	......	5.22 p.m.	2 ,,	54 19·8	54° 23′·6
	,, 18	......	10.5 a.m.	2 ,,	54 23·7	
	,, 18	......	4.55 p.m.	2 ,,	54 26·7	
	,, 21	......	10.12 a.m.	2 ,,	54 26·1	
	,, 22	......	4.2 p.m.	2 ,,	54 23·0	
	,, 25	......	10.5 a.m.	2 ,,	54 21·1	
	,, 25	......	4.37 p.m.	2 ,,	54 23·2	
	,, 29	......	10.12 a.m.	2 ,,	54 24·0	
	,, 29	......	4.0 p.m.	2 ,,	54 25·0	
1856.	Dec. 2	......	10.8 a.m.	2 (new pair)	54 20·1	
	,, 2	......	4.30 p.m.	2 ,,	54 18·0	
	,, 5	......	10.8 a.m.	2 ,,	54 18·9	
	,, 5	......	4.8 p.m.	2 ,,	54 25·5	
	,, 9	......	10.8 a.m.	2 ,,	54 22·2	
	,, 9	......	4.32 p.m.	2 ,,	54 26·7	54° 23′·7
	,, 12	......	10.20 a.m.	2 ,,	54 25·5	(Mean for year 1856,
	,, 12	......	4.30 p.m.	2 ,,	54 30·4	54° 23′·9)
	,, 15	......	9·23 a.m.	2 ,,	54 23·6	
	,, 15	......	4.35 p.m.	2 ,,	54 24·3	
	,, 24	......	10.12 a.m.	2 ,,	54 24·2	
	,, 30	......	10.10 p.m.	2 ,,	54 23·5	

	Date.	Cape Time.	Needle.	Inclination.	Monthly Mean.
1857.	Jan. 9	10.10 a.m.	2 (new pair)	54° 25′·7	
	,, 13	10.8 ,,	2 ,,	54 19·9	
	,, 16	10.8 ,,	2 ,,	54 25·5	54° 23′·0
	,, 20	10.8 ,,	2 ,,	54 21·9	
	,, 31	10.8 ,,	2 ,,	54 22·0	
1857.	Feb. 3	10.28 ,,	2 (new pair)	54 18·9	54° 19′·4
	,, 6	10.12 ,,	2 ,,	54 19·9	
1858.	Mar. 16	10.30 ,,	2 (new pair)	54 29·3	
1871.	Aug. 16	about noon	2	55 46·5	
	,, 30	about noon	1	55 44·2	
1871.	Sept. 28	noon	1	55 34·9	

APPENDIX III.

The following results are the monthly means of the horizontal intensity obtained by experiment at the Royal Observatory, Cape of Good Hope, at the dates given. The total intensity is calculated from the observed values of dip and of horizontal intensity.

Cape Town.

Date.		H. c.g.s. units.	Total Intensity. c.g.s. units.	
1843.	July	·2084	·3489	
	Oct.	·2093	·3506	
1844.	Jan.	·2070	·3467	
	Apr.	·2067	·3471	
	July	·2069	·3473	
1845.	Feb.	·2085	·3500	Wilmot & Clerk.
	Mar.	·2083	·3496	
	Apr.	·2077	·3488	
	May	·2084	·3496	
	June	·2082	·3493	
1846.	Apr.	·2080		
	Dec.	·2080		
1847.	Jan.	·2080		
	Feb.	·2078		
	Mar.	·2077		
	Apr.	·2076		
	May	·2077		
	June	·2079		
	July	·2078		Smalley.
	Aug.	·2078		
	Sept.	·2076		
	Oct.	·2074		
	Nov.	·2073		
	Dec.	·2073		
1848.	Jan.	·2073		
	Feb.	·2071		
	Mar.	·2072		

Date.		H. c.g.s. units.	Total Intensity. c.g.s. units.	
1853.	June	·2056	·3510	
	July	·2056	·3513	
	Aug.	·2057	·3512	
	Sept.	·2054	·3513	
	Oct.	·2055	·3511	
	Nov.	·2055	·3511	
	Dec.	·2055	·3511	
1854.	Jan.	·2054	·3513	
	Feb.	·2048	·3507	
	Mar.	·2050	·3519	
	Apr.	·2050	·3519	
	May	·2050	·3517	
	June	·2050	·3515	
	July	·2049		Maclear.
	Aug.	·2050		
	Sept.	·2049		
	Oct.	·2048		
	Nov.	·2049		
	Dec.	·2050	·3523	
1855.	Jan.	·2050		
	Feb.	·2048	·3519	
	Mar.	·2047	·3521	
	Apr.	·2049	·3523	
	May	·2047	·3521	
	June	·2047	·3514	
	July	·2047	·3518	
	Aug.	·2048	·3518	

Date.		H. c.g.s. units.	Total Intensity. c.g.s. units.	
1848.	Apr.	·2072		Smalley.
	May	·2073		
	June	·2074		
	July	·2072		
	Aug.	·2074		
	Sept.	·2073		
	Oct.	·2070		
	Nov.	·2068		
	Dec.	·2069		
1850.	Jan.	·2066		
1852.	Sept.	·2058	·3507	Maclear.
	Nov.	·2060	·3503	
	Dec.	·2058	·3509	
1853.	Jan.	·2060	·3512	
	Feb.	·2059	·3513	
	Mar.	·2058	·3510	
	Apr.	·2056	·3508	
	May	·2056	·3510	

Date.		H. c.g.s. units.	Total Intensity. c.g.s. units.	
1855.	Sept.	·2047	·3516	Maclear.
	Oct.	·2046	·3512	
	Dec.	·2047	·3516	
1856.	Jan.	·2047	·3515	
	Feb.	·2046	·3518	
	Mar.	·2045	·3512	
	Apr.	·2044	·3517	
	May	·2045	·3514	
	June	·2044	·3512	
	July	·2043	·3507	
	Aug.	·2043	·3507	
	Sept.	·2042	·3505	
	Oct.	·2041	·3505	
	Nov.	·2042	·3507	
	Dec.	·2042	·3508	
1857.	Jan.	·2042	·3506	
	Feb.	·2042	3502	
	Oct.	·2039	·3513	

Date.		H.	T.	
1873–9		·1989 c.g.s. units.	·3551 c.g.s. units.	Challenger
1890–1		·1916 ,, ,,	·3542 ,, ,,	Pensacola
1895–05		·1900 ,, ,,	·3572 ,, ,,	Finlay
1897–8		·18835 ,, ,,	·3566 ,, ,,	Finlay
1901–0		·1851 ,, ,,	·3559 ,, ,,	B. & M.
1857	Oct.	*·2060* ,, ,,	*·3557* ,, ,,	(Novara)

ON A STEREOSCOPIC METHOD OF PHOTOGRAPHIC SURVEYING.

By H. G. Fourcade.

(Read October 2, 1901.)

In the method proposed in this paper, photographs are taken, with a surveying camera, at a pair of points, the plates being exposed in the vertical plane passing through both stations. A *réseau*, or a graduated back frame, gives the means of measuring the coordinates of any point on the plates with reference to the optical axis of the camera. After development and fixing, the negatives, or positives from them, are viewed in a stereoscopic measuring machine, which, by combining the pictures, renders possible the instant identification of any point common to the pair of plates. Movable micrometer wires traverse each field, and pointings may be made simultaneously with both eyes. The readings of the micrometers, referred to the *réseau*, give the three co-ordinates of the point by direct multiplication by, or division from, constants for the plates which depend only on the focal length of the camera lens and the length of the base. When a sufficient number of points have been plotted from their co-ordinates, contour lines may be drawn.

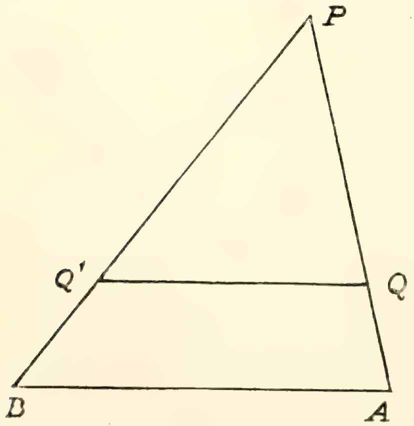


Fig. 1.

Theory of the Method.—Let A and B (Fig. 1) be the ends of the base and Q and Q' the positions on the photographs of any point P.

Take A as origin and $A\,B$ as positive direction of x-axis.

Let (X, Y, Z) be the co-ordinates of P; $(x_a, f, z_a)(x_b, f, z_b)$ the co-ordinates of Q and Q'.

The equation of $A\,P$ is

$$\frac{x}{X}=\frac{y}{Y}=\frac{z}{Z},$$

and if we put $y=f$, we get

$$x_a=\frac{f}{Y}X$$

$$z_a=\frac{f}{Y}Z$$

Similarly the equation of $B\ P$ is

$$\frac{x-b}{X-b}=\frac{y}{Y}=\frac{z-h}{Z-h},$$

where b and h are the x and z co-ordinates of B.

Whence

$$x_b=\frac{f}{Y}(X-b)+b$$

$$z_b=\frac{f}{Y}(Z-h)+h.$$

From these equations we find

$$x_a-x_b+b=\frac{bf}{Y}=e.$$

e is the *stereoscopic difference*, constant for points in any plane perpendicular to $A\ y$ and vanishing for points at infinity.

The values of the co-ordinates of P follow

$$Y=\frac{b}{e}f$$

$$X=\frac{b}{e}x_a$$

$$Z=\frac{b}{e}z_a.$$

A check is afforded by the values of X and Z derived from $B\,P$.

$$X=\frac{b}{e}x'_b-b$$

$$Z=\frac{b}{e}z'_b-h,$$

x'_b and z'_b denoting here the co-ordinates of Q' referred to B.

The measurement of the co-ordinates of a point being made independently on each plate, although simultaneously, it will be a sufficient condition for the viewing apparatus to make corresponding portions of the two pictures combine with or without change of perspective.

Using a magnifying optical system to view the pair of plates, the condition for distinct vision is that the two images of any point appear in a *corresponding plane of vision*, so that the visual rays meet in space. This condition evidently remains satisfied when the images are magnified, or when they are brought nearer together along a line parallel to that joining the nodal points of the two eyes, and for different distances between the viewing lenses or the eyes, since in all these cases the lines joining the two images of a point remain parallel to the eyes.

Surveying Camera.—The essential features are a camera on a theodolite base, and a telescope with its line of collimation at right angles to the optical axis of the camera, so that by changing pivots the orientation of the pair of plates is not affected by errors of inclination, collimation, or graduation.

The photographic plate is pressed, during exposure, against a back frame in the focal plane of the camera lens by a spring contrivance similar to those used in other surveying cameras, which permits the shutter of the dark slide to be drawn and replaced. The *réseau* is hinged in front of the plate, its correct register being determined by

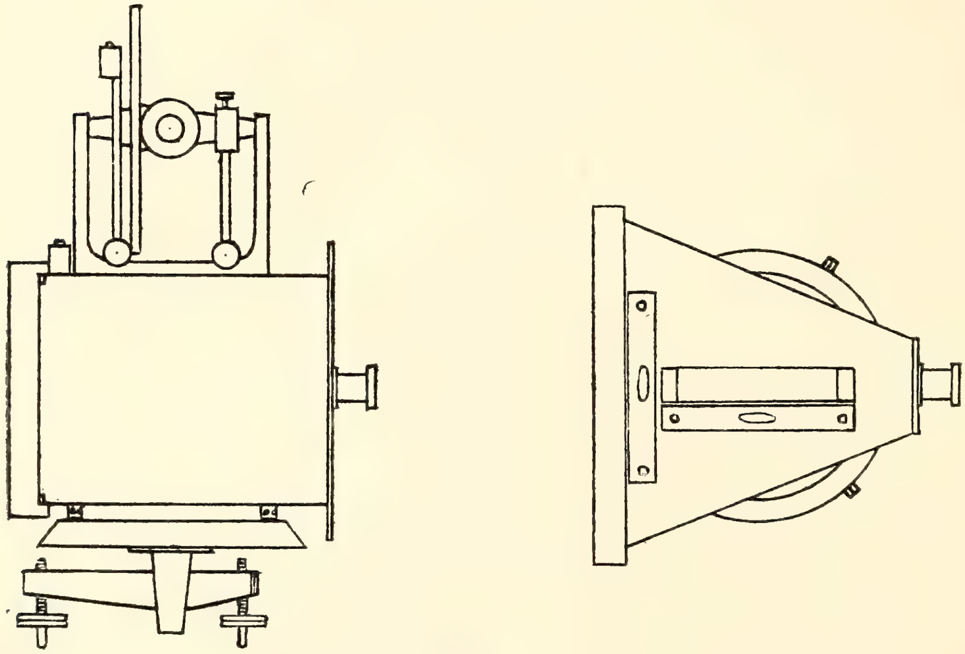


Fig. 2.

geometrical contacts. It is impressed upon the plate by exposure to sky-light reflected through the camera lens, and then moved out of the way for the exposure of the picture itself. A graduated front slide is used to displace the horizon line by moving the lens, but in normal circumstances it is set at the zero of its scale. Fig. 2 shows the general arrangement of the instrument.

Conditions to be satisfied.—One instrumental condition, sufficiently satisfied in construction, is that the front slide be parallel to the vertical *réseau* lines. Any defect in this respect is eliminated by determining the origin of the *réseau* co-ordinates and the focal length for different readings of the front scale.

The camera adjustments are: (1) *Plane of réseau to be vertical.* (2) *Horizon line of réseau to be horizontal.* These adjustments are made with the aid of a level, fitted with a Bohnenberger eyepiece.

The auxiliary level having been placed directly in front of the camera, and its line of collimation made horizontal, the vertical axis of the camera is set vertical by reference to the level of the vertical circle. Then (1) is effected by turning the camera in altitude with the foot-screws, and in azimuth, until the cross-wires of the level coincide with their image reflected from the silvered back surface of the *réseau*, when the bubble of the longitudinal level on the camera is adjusted to the centre of its run. Replace the front slide and lens and set again the vertical axis vertical. (2) is now effected by making the ends of the horizon line of the *réseau* coincide with the cross-wires of the level in two positions, using for the purpose the side capstan-headed screw in the base. The transverse level on the camera is then adjusted, and the longitudinal level made perpendicular to the vertical axis by means of the front capstan-headed screw under the camera.

The theodolite adjustments, effected by ordinary methods, are: (3) *Horizontal axis made perpendicular to vertical axis.* (4) *For collimation.* (5) *Horizontal axis made parallel with optical axis of camera.* An approximate adjustment of (5) is sufficient.

Instrumental Constants.—These are: (1) The *zero of the front scale;* (2) the *zero of the réseau* and co-ordinates of the R-points, and (3) the *focal length.* They may be determined in the usual manner, but it is convenient to first make the centre R-point coincide with the zero of the *réseau* co-ordinates, by collimating directly upon the *réseau* plate when adjusting the camera with the help of an auxiliary level, as already explained. In that case, the lens requires to be adjustable horizontally as well as vertically.

The focal length f is found from the measurement of exposed plates containing the images of well-defined points of which the angular distances are known. Call α the angle between two points of which the horizontal co-ordinates are a and b. Then—

$$f = \frac{a-b}{2\tan\alpha} + \sqrt{\frac{(a-b)^2}{4\tan^2\alpha} - ab}.$$

Measurement of the Plates.—It is unnecessary in a preliminary note such as this is, to enter into the construction of the measuring apparatus in much detail, as a description of actual instruments with examples of their use may fitly be given in a subsequent paper. A suitable machine would generally resemble those which have been used for the measurement of celestial photographs, and like such may be of various types.

In the type now considered, the plates are set side by side at an inclination corresponding to that of the base line and at heights such that corresponding R-points are horizontal. Both plate-carriers can slide about in a horizontal direction on a stage formed of a sheet of plate glass *g* (Fig. 3), which itself can be moved vertically by a double rack and pinion. Any small error in the setting of the plates and in the fitting of the slides will be automatically corrected by the position of the eyes in front of the eyepieces of the viewing microscopes, and by their power of accommodation, and does not affect the accuracy of the measurements.

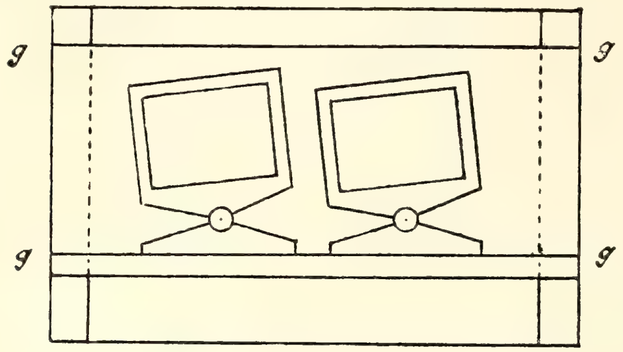


Fig. 3.

The measuring microscopes are of low power, and include in their field at least one clear R-square of 1 centimetre side. Their distance apart is adjustable to suit the eyes of the observer. One is fitted with a pair of micrometers at right angles capable of rotation in order to bring the horizontal and vertical wires parallel to the R-lines. The other is similarly fitted with the exception that one horizontal micrometer is sufficient. The runs are adjusted on a scale.

The centres of the plates are separated to a sufficient distance by

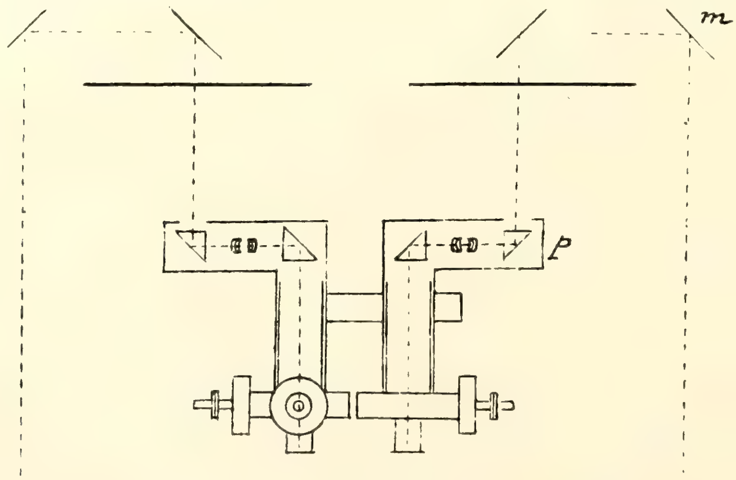


Fig. 4.

introducing in each microscope a pair of prisms of total reflection *p* (Fig. 4).

The micrometers might also be used in the position of the plates, giving more room for the screws and greater facility in the reading of their heads, and the plates themselves set further back, behind an additional lens, as in the Cambridge measuring machine recently described by Mr. Hincks (*Monthly Notices*, lxi. p. 444).

The zero wires form a frame fitting an R-square, as in Sir David Gill's machine used at the Cape Observatory (*Monthly Notices*, lix. p. 61).

For convenience, the whole arrangement is tilted at an angle of 45°, and the light illuminating the plates reflected by mirrors m from a window at the back of the observer.

The setting of the plates may be effected by turning a micrometer to the inclination of the base by means of a graduated circle, and making both sets of R-lines agree in inclination and height with the micrometer wires. The second micrometer is then set by making its wires parallel to the vertical R-lines on either plate.

The vertical R-lines are combined by the microscopes, but the horizontal lines only when the distance between the centres of the pictures is equal to that between the microscope object-glasses.* In making a measurement the plates are moved by the slow motion screws on the slides of their carriers and of the stage until the zero square of one microscope fits an R-square of the corresponding plate, and the zero wires of the other microscope coincide with a pair of vertical R-lines on the second plate. The points in the field of view may then be bisected without disturbing the zero settings.

The co-ordinates of any point on the plates are given by the direct readings of the micrometer heads added to the value of the R-lines considered. The stereoscopic difference results from the difference of the x's on the two plates.

Range of the Method.—In practice, the range of the method would be limited by the blurring of distant detail by light diffused in the atmosphere. This "aerial perspective" is reduced by the use of orthochromatic plates and an orange screen cutting off the rays of shorter wave-length which form the blue haze, but even then the effective range would probably not exceed some 5 miles or 8 kilometres.

On the other hand, the difference in phase of the objects would prevent their ready combination at distances less than three to four times the length of the base. The view would then correspond to that of a model seen with the eyes at a distance of 10 inches from the nearer edge.

* [Should be "between the lower optical axes of the microscopes."]

Let $2b$ be the length of the base and a the angle subtended by it at a distance y. Then—

$$y = b \cot \frac{a}{2}$$

$$\frac{dy}{y} = -\frac{b}{y} \cdot \frac{da}{2 \sin^2 \frac{a}{2}}$$

$$= -\frac{da}{\sin a}.$$

Let $\frac{1}{100}$th of an inch or 0·25 mm. be the admissible error on the plan, 8 kilometres the limiting value of y, and $\Delta a = 20''$. On the scale of the Canadian photographic surveys, $\frac{1}{40000}$, the maximum error allowable will be 10 metres at 8 kilometres, or $\frac{\Delta y}{y} = \frac{1}{800}$. Then $a = 4° \ 27'$ and $2b = 620$ metres.

By increasing the base to 2 kilometres a maximum possible accuracy at 8 kilometers of $\frac{1}{2500}$ of the distance or 3 metres, would be attained, but the area mapped would be reduced to a narrow strip.

With the base of 620 metres, the area mapped with a plate of diameter equal to the focal length of the lens would be contained between the limiting circles at 8 and 2·5 kilometres shown at d and n (Fig. 5) and would amount to 22 square kilometres on either side of the base, or, more correctly, to that portion not masked by the nearer topographical features.

The error in x will be due to that in y and that of the x co-ordinate on the plate. We may write—

$$(\Delta x)^2 = \left(\frac{y}{f}\Delta l\right)^2 + \left(\frac{x}{y}\Delta y\right)^2.$$

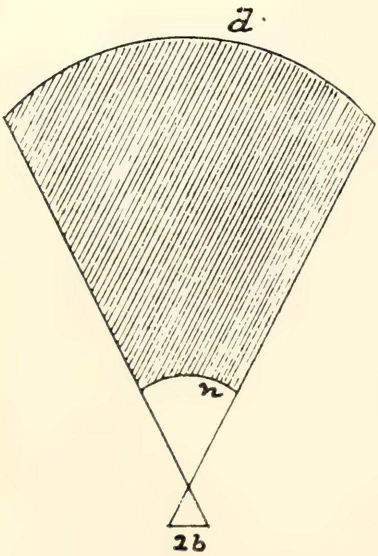


Fig. 5.

With a lens of 150 mm. focal length and an error of ·025 mm. in the plate x's, the maximum error is, for the base and the scale of plan considered, 5 metres, or on the plan 0·12 mm.

The error in height is given by the same expression. At the maximum distance the second term cannot exceed $\left(\frac{1}{4}\Delta y\right)^2$ if the difference in height between the base and the distant points does not exceed 2,000 metres. In absolute amount the total error for points at extreme distances would be $\pm$ 2·75 metres.

The contour lines should then, in the case already considered, be accurate to 0·25 mm. on slopes greater than 15°, but the actual accuracy will be reduced to some extent by the uncertainty of the correction for refraction. This correction, combined with that for curvature, can be applied at sight from a small table with y-argument.

By reducing the base, pairs of photographs may be taken within a confined space, as when mapping hidden valleys. The method can also be combined to any extent with the ordinary methods of photographic surveying. It would be of particular advantage in the mapping of large areas of mountainous country.

VARIATION OF THE STAR C.P.D. – 41°·4511.

By A. W. Roberts, D.Sc.

(Read October 2, 1901.)

The star C.P.D. – 41°·4511
R.A. 10h. 16m. 44s. (1875)
Dec. 41° 43′·8

has recently been discovered, through the assiduous and fruitful industry of Mr. R. T. A. Innes, of the Royal Observatory, to be an Algol variable of a very interesting type.

I purpose in the present paper stating very briefly what this type of variation is, and indicating the physical conditions of orbital movement that have produced the light changes observed.

The star came under observation at Lovedale in July of this year. A few nights' observation was sufficient to establish the fact that the star was an Algol variable.

By the end of the month sufficient measures had been secured to yield a full light curve.

It was matter of some regret that the western position of the star in the evening sky prevented an extended series of observations from being taken every evening. Still, as stated, enough observations were obtained to indicate unmistakably the complete form of the light curve.

Mr. Innes was good enough to send me some of his earlier measures, and these, combined with my own, yield as the full period of variation—

1d. 20h. 30m. 3s.

With this period all the observations made were reduced to the mean light curve of 1901, July 1 and 2. These reduced observations are as follows :—

	Reduced Date.	Mag.		Reduced Date.	Mag.		Reduced Date.	Mag.
	1901. d. h. m.	m.		1901. d. h. m.	m.		1901. d. h. m.	m.
1.	July 1 1 12	10·00	33.	July 1 20 50	10·00	64.	July 2 13 45	10·00
2.	2 3	10·00	34.	21 14	9·90	65.	13 48	10·05
3.	2 15	10·00	35.	22 10	9·90	66.	14 50	10·25
4.	2 33	10 00	36.	22 57	10·00	67.	15 5	10·35
5.	2 45	10·00	37.	23 10	10·00	68.	15 5	10·40
6.	2 45	9·90	38.	1 23 20	10·00	69.	15 12	10·45
7.	4 6	10·00	39.	2 1 0	10·00	70.	15 15	10·40
8.	5 25	10·00	40.	1 50	9·90	71.	15 20	10·55
9.	5 55	10·00	41.	2 45	10·00	72.	15 25	10·60
10.	6 25	10·00	42.	3 0	10·00	73.	15 35	10·60
11.	6 30	10·00	43.	4 15	10·00	74.	15 35	10·75
12.	7 0	10·00	44.	4 52	10·00	75.	15 40	10·60
13.	7 44	10·00	45.	5 25	10·00	76.	15 50	10·70
14.	9 36	10·00	46.	6 25	10·00	77.	15 50	10·85
15.	9 45	10·00	47.	6 30	10·00	78.	15 55	10·75
16.	10 0	10·10	48.	7 5	10·00	79.	16 0	10·85
17.	10 0	10·00	49.	7 26	10·00	80.	16 5	10·75
18.	10 58	10·00	50.	7 30	10·00	81.	16 15	10·95
19.	13 30	10·00	51.	8 15	10·00	82.	16 30	10·90
20.	13 45	10·00	52.	8 42	10·05	83.	16 30	10·85
21.	14 30	10·10	53.	9 15	10·05	84.	16 45	10·80
22.	15 0	10·00	54.	9 30	9·90	85.	16 48	10·95
23.	15 58	10·00	55.	10 15	10·00	86.	17 0	10·65
24.	16 0	10·00	56.	10 30	10·00	87.	17 0	10·60
25.	17 0	10·15	57.	11 30	10·00	88.	17 15	10·45
26.	18 0	10·15	58.	11 42	9·90	89.	17 15	10·68
27.	18 30	10·00	59.	12 15	10·00	90.	17 30	10·30
28.	19 0	10·05	60.	12 48	10·10	91.	17 45	10·25
29.	19 0	10·00	61.	13 10	9·90	92.	18 0	10·15
30.	20 0	10·00	62.	13 20	10·20	93.	18 15	10·15
31.	20 0	10·10	63.	2 13 40	10·10	94.	2 19 30	10·05
32.	1 20 44	10·00						

From these observations the following elements of light variation can be readily determined :—

Full period of variation	1d. 20h. 30m. 3s.
Epoch of prin. min.	1901. July 2d. 16h. 17m.
Epoch of second. min.	July 1d. 17h. 30m.
Magnitude at max.	10·00m.
Magnitude at prin. min.	10·90m.
Magnitude at second. min.......	10·15m.
Duration of prin. mid.	4h. 30m.
Duration of increasing phase...	2h. 15m.
Duration of decreasing phase...	2h. 15m.

The explanation of Algol variation which has commended itself to astronomers generally, is that every Algol variable is a binary star, the components of which move in an orbit almost coincident with the line of sight. In the case of three Algol stars this theory is supported by spectroscopic evidence. It may be remarked that these three cases are the only ones where such confirmation is possible, at least in the present limitations of spectroscopic research.

Now in a binary system whose orbit is situated in the plane of sight, it is evident that eclipse, partial or total, will take place every revolution. The amount, duration, and chief features of this eclipse will depend upon the form and position of the orbit in which the stars move, as well as on their relative size and brightness. Further, it is possible to express in set terms and definite relations the connection which exists between the elements of light variation and the orbital elements on which the elements of light variation depend.

It is beyond the purpose of this paper to deal with these relations. Sufficient to say that the variation of C.P.D. – 41°·4511, was rigorously subjected to analysis in order to ascertain the form and dimensions of the orbit in which it moved.

Subsequent observations may, to a very limited extent, modify the results thus determined, but the following conclusions will not be essentially altered by any new data :—

(1) The Algol variable C.P.D. – 41°·4511 is an Algol close binary star, whose period of revolution is equal to its full light cycle, viz. :—

1d. 20h. 30m. 3s.

(2) The epoch when the two component stars move into the line of sight is—

1901, July 2d. 16h. 17m. (C.M.T.)

(3) The orbit is practically circular and inclined 6° to the plane of sight.

(4) The two stars are equal in size, the diameter of any one of them being equal to one-third the radius of the orbit.

(5) The two stars are unequal in brightness, one being 6·14 times brighter than the other.

(6) The density of the system is a little less than half that of the un.

In order to test the dependence which can be placed on these results we invert the problem, and from the conditions of orbital movement and dimensions, compute a theoretical light curve.

Assuming that C.P.D. – 45°·4511 moves in an orbit of which the foregoing is a numerical description, then three equations are sufficient to set forth the magnitude of the star at any instant.

These three equations are:—

(1) $\text{Cos}\,\phi = 3{\cdot}077\ \sqrt{1 - 0{\cdot}991\ \text{Cos}^2\,(0{\cdot}135\text{T})^\circ}$

(2) $\text{L} \quad = 1 - 0{\cdot}274\,(2\,\phi - \sin 2\,\phi)$

(3) $\text{Mag.} = 2{\cdot}5\,(10 - \text{Log L}) + 10{\cdot}05\text{m}.$

In Fig. (1) is given the light curve of C.P.D. – 45°·4511 as determined from observation. The thick dotted line represents the mean *observed* light curve.

In the same Figure the *theoretical* light curve as determined from equations (1), (2), and (3), is indicated by a fine dotted line.

The two light curves are practically identical. This accordance between theory and observation is remarkable. It is testimony to the validity and accuracy of the conclusions come to as explanatory of the star's variation.

It is also, I think, strong presumptive evidence against the meteoric theory of stellar variation—at least as an explanation of the variation of C.P.D. – 41°·4511.

The value of the density obtained also bears directly on this question.

It is true that the density of C.P.D. – 41°·4511 is considerably greater than the mean density of stars of this type or class. In the *Astrophysical Journal*, vol. x., No. 5, I pointed out that the average density of close binary stars is—

0·13.

A more recent investigation (not yet quite completed) based on my own observations of eight southern Algol stars confirms this value.

In the case of C.P.D. – 41°·4511 we have a value of the density equal to three times this mean value, and the pertinent question arises, Is it possible to have a globular mass of meteors, the density of which is—

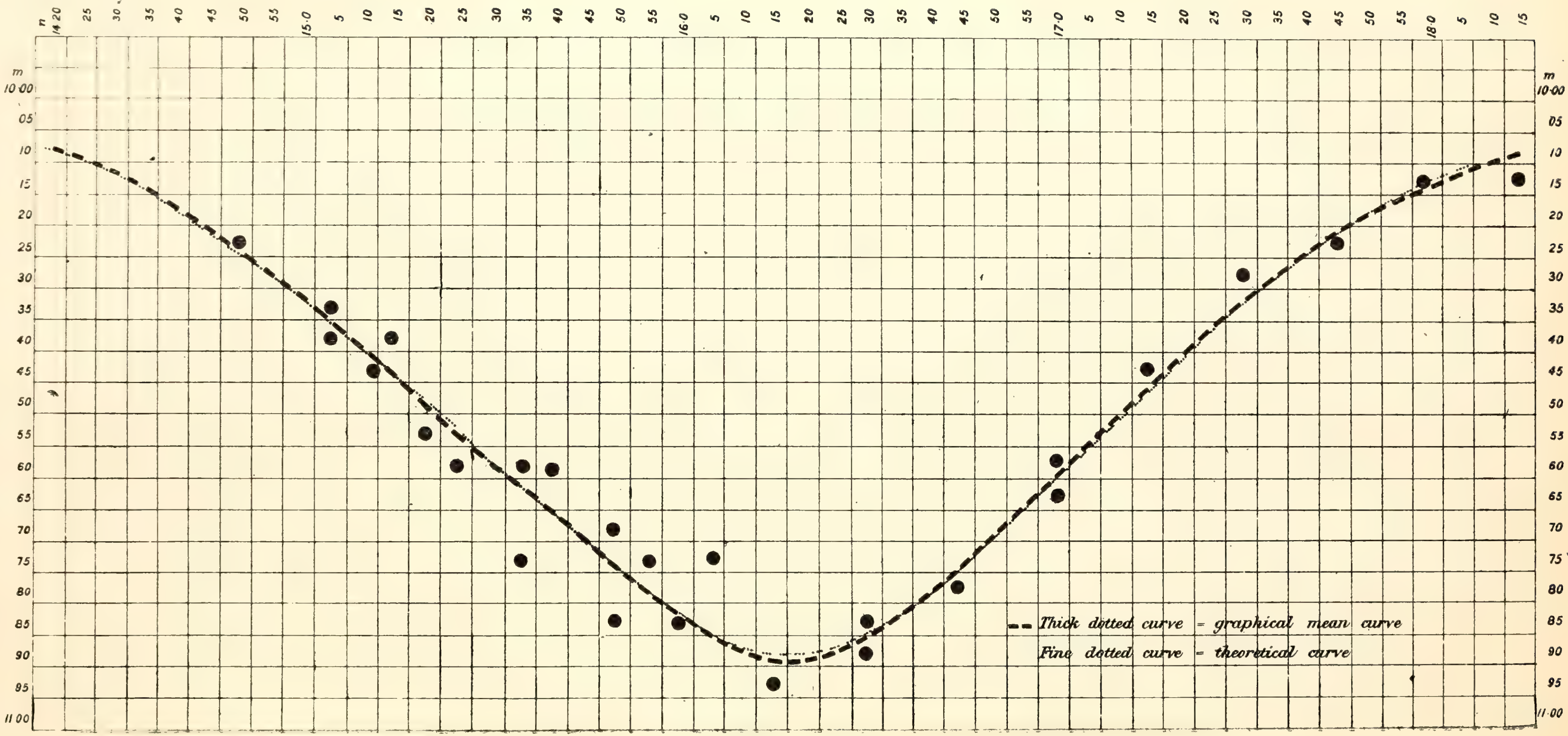
0·4

or one-half that of the sun ?

It is possible if the meteors be solid bodies, of the specific gravity of iron, and each meteor separated from its fellow by less than its own diameter; but under no other conditions. Against this assumption we postulate a luminous body revolving on its axis in less than two days, and consequently subjected to great tidal stress and strain.

In a boundless universe there are no doubt boundless possibilities of structural divergence; but in our explanation of such phenomena

Light curve of C.P.D. -41°. 4511
1901 July 2.



as observation makes us acquainted with, we are limited in two directions.

(1) We must apply to all facts that come within the range of our knowledge only such explanations as are rational and intelligible, and which are warranted by our experience of that which is more immediate.

(2) The explanations preferred must be applicable to, and sufficient for, all the phenomena of a well-defined class or type.

If the theory fails in any one single instance it is inferior, as an explanation, to that which meets every case.

Judged by these criteria, the meteoric theory of stellar variation fails.

Far more sufficient, valid, and intelligible is the theory which regards variable stars as the first stage in that long spiral evolution of stellar systems which, starting with contiguous homogeneous gaseous bodies, ends in such binary systems as Alpha, Centauri, and Castor.

The successive stages of stellar development thus form a unified, orderly, related sequence.

In the early stages we have contiguous bodies of gaseous density and of apiodal figure revolving round one another in a few hours. When these contiguous stars move in orbits the plane of which passes through the earth, their movement is made evident as Algol variation. The orbits of stars in this stage of development are nearly all circular.

As the component stars move further and further apart, their orbits take to themselves a greater eccentricity; the influence of this eccentric motion is made evident as short period variation.

And then in the process of ages the star becomes a visual binary.

There is nothing in this statement of cosmic evolution to offend either our sense of the necessity to make observation and theory agree, or our appreciation of that unity and order which compasses the heavens as a garment.

Mr. R. T. A. Innes adds:—

This star was first suspected to be variable by Professor J. C. Kapteyn, of Groningen, from his examination of the plates taken for the Cape Photographic Divichmusterung. Four plates, covering the region of the sky where this star is situated, were sent him from the Royal Observatory; on three, the star appeared of the 9·6 magnitude, but on the fourth plate it was only of the 10·5 magnitude. Lest this might be due to some photographic defect, Professor Kapteyn examined the image with a microscope; it was perfectly normal, making the variability of the star highly probable. Professor Kapteyn communicated these facts to Sir David Gill, who kindly gave me the matter for further investigation. As this star falls within the Cape zone of the *Carte du Ciel*, there were a number of plates available for a further examination without recourse to the sky. I examined these, twelve in number, but found no certain difference of magnitude. But my first telescopic observation on Feb. 20, 1899, caught the star at a low magnitude (10·5); this was fortunate, as I did not secure another minimum for sixteen months. Had my first observation not happened as it did, the confirmation of variability and Dr. Roberts's interesting paper might have been delayed many years, as both the *Carte du Ciel* plates and my other visual observations extending over sixteen months offered no evidence of change of magnitude.

At the Cape Observatory we have now secured in all nine observed minima covering 2,202 periods in 4,083 days, yielding a period of—

1d. 20h. 30m. 2·9s.,

a difference from Dr. Roberts's result of only one-tenth of a second—a quantity far smaller than the probable error to which such determinations are liable.

RESULTS OF SOME EXPERIMENTS UPON THE RATE OF EVAPORATION.

By J. R. Sutton, M.A. (Cantab.).

(Read November 27, 1901.)

Of the dozens of patterns of evaporators designed (and sometimes used) by different inventors, not one has hitherto been unreservedly accepted as a standard. Consequently, in the absence of any authoritative pronouncement, observers have used so-called gauges of all sorts of sizes and all sorts of mountings. Naturally the results differ as widely as the methods, some showing a rate of evaporation fully twice as great as others. Mr. Baldwin Latham, for example, showed that his fine evaporation gauge made of copper, 1 foot in diameter, containing 1 foot in depth of water, and floated by means of a hollow copper ring, placed 6 inches distant from the body of the gauge—to which it was attached by radial arms—on a tank 4 feet in diameter and 30 inches deep, gave an annual average evaporation of 19·95 inches; whereas a copper pan, 5 inches in diameter and 12 inches deep, standing in air, lost 38·19 inches.* In the Strathfield Turgiss experiments, again, the indicated evaporation for the six months April to September, 1870, varied between 20·64 inches from a large iron tank 6 feet square and 2 feet deep, sunk in the ground, to a trifle under 47 inches from a tin can 12 inches deep and 5 inches in diameter, standing upon the ground; some small pans under cover giving an annual average of about 14 inches at the same time.† "Dr. Brownrigg fixes the evaporation of some parts of England at

* Presidential Address to the Royal Meteorological Society. *Quarterly Journal Roy. Met. Soc.*, vol. xviii. p. 55.

† *British Rainfall*, 1889.

73·8 inches during the four summer months, May, June, July, and August, and the evaporation of the whole year at upwards of 140 inches." * This is probably the largest estimate for England ever seriously made.

Symons claimed that the different rates at which the water evaporated from different gauges "could not fail to convince any one that the key to the whole question was to be found in one item, the temperature of the water." Latham argued, however, that the greatest deviations arise as much, or more, from capillarity, "the water rising on the sides of the gauge and thus inordinately increasing the amount of evaporation. Consequently a small gauge, having a larger amount of side area, in proportion, than a large gauge, indicates a very much larger amount of evaporation. . . . In a 5-inch evaporating gauge this capillarity adds nearly 40 per cent. to the water area of the gauge, whereas in a gauge 1 foot in diameter the influence of capillarity is less than half that of a 5-inch gauge, whilst in a gauge 6 feet in diameter (or 6 feet square) the influence of capillarity is only one-sixth part of that of a 1-foot gauge." † The same authority showed, moreover, that if any given gauge were coated with some dressing, or pigment, which would lessen the capillary attraction between the walls of the gauge and its water, then the rate of evaporation would become notably decreased. For example, three 5-inch gauges, one plain copper, one enamelled white, and another enamelled black, but otherwise equal and similarly situated, standing in a tank of water up to the level of the evaporating surface, gave the following comparative annual average loss :—

	Inches.
Copper gauge	27·90
Black ,,	22·97
White ,,	21·74

while a copper gauge of the same dimensions, freely exposed in air, gave in the same period an average of 36·96 inches, and the 1-foot floating gauge 19·40 inches. Thus a given unprotected and unsheltered gauge lowered its indications by nearly 25 per cent. when relegated to the somewhat cooler and more humid (and presumably less windy) environment of the tank ; whereas

* Dr. Dobson in some "Observations on the Annual Evaporation at Liverpool in Lancashire." *Phil. Trans.*, vol. lxvii.

† Many authors agree with Latham in making evaporation proportional to the surface area. But see Preston, who cites Stefan, making evaporation proportional to diameter. *Theory of Heat.*

under given climatic conditions a restricted capillarity reduced the rate of evaporation by 22 per cent.

Without claiming that capillarity is responsible for all the increase of evaporation shown by an unpainted, as compared with a painted gauge, it seems likely that some of the high numbers indicated by the small gauges at Strathfield Turgiss were due, in great part, to this source of error.

At Camden Square, London, Symons tried three gauges :—

I. A cylinder (material not stated), 5 inches in diameter and $5\frac{1}{2}$ inches long, resting on the neck of a stone bottle, part of the body of which was sunk in the ground so that the rim of the evaporator was a foot above the surface of the ground. It is described as "an excellent arrangement for enabling the sun to heat the water as much as possible."

II. A black japanned tin cylinder, 5 inches in diameter, 1 foot long, buried 9 inches in the earth. "The cheapest possible evaporator, partly protected against heating, but too small and unduly affected by the sides, which must be high to prevent out-splashing and overflow."

III. A glass vessel, 5 inches in diameter and 9 inches deep, placed inside a tub of water—15 inches in diameter and also 9 inches deep—so that that inside the cylinder was always surrounded by water up to the same level. The rim of the tub was just above, and the surface of the water approximately flush with, the ground line. "A repetition of Major Phillips's, insplashing and outsplashing nearly balance, but it breaks at the first frost."

From July 22 to November 19, 1869, the results were :—

Gauge.	Water Evaporated.	Ratio Evaporated.
I.	15·75 inches	162
II.	13·57 ,,	140
III.	9·72 ,,	100

From July 22nd to August 12th the results were :—

Gauge.	Water Evaporated.	Ratio Evaporated.	Average Excess of Temperature above 65°.	Temperature Ratio.
I.	2·46 inches	178	15·7°	178
II.	3·13 ,,	127	10·8	123
III.	4·37 ,,	100	8·8	100

Of course the period is far too short from which to derive certain conclusions. And while some of the observed differences in the quantities were conceivably due to differences of temperature, it is not at all unlikely that a part were due to differences in capillarity, and a great part also to the wind. For it is clear enough that the surface of No. I. must have been more wind swept than II., and still more than III.

My own experiments upon the evaporation of water have not lacked variety, albeit not always complete or necessarily convincing. In none of them have I been able to detect the excessive perturbing influence that has been claimed for the temperature of the water. On the contrary, it seems to occupy a comparatively unimportant place in the list of acknowledged agencies.

Attention may be called here to some rather large numbers given by the Kimberley Waterworks Company from a "wrought-iron tank 4-feet cube sunk in the ground to within about an inch of the top, and kept nearly full of water."*

1891	86·68 inches.
1892	104·39 ,,
1893	101·32 ,,
1894	91·26 ,,
1895	101·84 ,,
Mean..	97·10

	Monthly Mean.
January	11·1 inches.
February	8·8 ,,
March	7·7 ,,
April	6·2 ,,
May	5·6 ,,
June	4·3 ,,
July	4·8 ,,
August	6·4 ,,
September........	8·3 ,,
October	10·8 ,,
November	11·0 ,,
December	12·1 ,,

The greatest evaporation numbers for any Kenilworth (Kimberley) gauge—which, as it happens, are considerably less than those for the Waterworks tank—are derived from the indications of a copper pan 8 inches in diameter and about 5 inches deep, kept nearly full of water. The outside of this gauge was protected from the sun's rays by a covering of water, sawdust, and wood. As originally received from the makers it had an inside coating of bath-enamel; but this got saturated and came off very soon. It always showed signs of having once been painted, however, and this may have reduced the capillarity effect. In July, 1897, the covering of the gauge was improved, but this necessitated raising the gauge some 20 inches higher than before. The change seems to have somewhat increased the evaporation, while it also seems to have decreased the range of

* R. H. Twigg, in the *Quarterly Journal of the Roy. Met. Soc.*, vol. xxii. p. 166.

temperature of the water. The results of seven years' observations are—

1894	77·93	inches.
1895	88·43	,,
1896	87·72	,,
1897	103·18	,,
1898	92·15	,,
1899	90·44	,,
1900	90·82	,,
Mean..	90·11	,,

	Monthly Mean.	
January	10·42	inches.
February	9·33	,,
March	7·22	,,
April............	4·80	,,
May	3·80	,,
June............	3·10	,,
July	3·58	,,
August	5·59	,,
September	8·18	,,
October	10·59	,,
November	11·73	,,
December	11·77	,,

I have not seen the Waterworks tank, but there is no doubt that it could not have attained a higher degree of temperature than the pan. The disagreement between the two is probably partially accounted for by the sheltered position of the pan; the wind being interfered with a great deal by the trees. For the years 1897–8 at Kenilworth a circular iron tank of about 130 gallons capacity, sunk in the ground, lost 81·75 inches and 68·92 inches respectively.

An analysis of some of the evaporation numbers derived from the different Kenilworth gauges during the year 1900, furnishes a number of details that are not without interest. A full account of the instruments and of the results has been published elsewhere,* so that it will only be necessary to repeat just such particulars as are essential for present purposes.

In addition to (1) the copper pan mentioned above there are:—(2) An iron tub, enamelled white inside and out, 20 inches high † and 14 inches in diameter, standing with its rim about 2 feet above the ground, and sheltered by a single-louvred screen.

(3) A circular steel tank slightly less than 4 feet in diameter and 30 inches deep, standing in a cemented brick cistern of about 7 feet square and rather more than 3 feet deep. Thus the level of the rim of the tank is some 8 inches below the top of the cistern wall. The tank is kept nearly full of water, and the cistern also contains water up to about the same level. The indications are recorded by suitable machinery upon a rotating drum.

(4) A Piche evaporating tube of the usual pattern.

(5) Pickering "evaporimeters."

* *Report of the Meteorological Commission* for the year 1900; Cape Town, 1901.

† Outside dimensions; the inside depth would be more than an inch less.

Of the last little need be said. They are troublesome to use as routine instruments, but they may be safely trusted to evaporate more water in a given time than any other evaporator in use.

Comparative monthly totals for the year 1900 are :—

	8-inch Copper Pan.	Screened Tub.	Tank.	Piche Tube.
	Inches.	Inches.	Inches.	Inches.
January	11·57	7·11	7·58	8·59
February	11·26	6·73	6·78	8·62
March	6·35	3·72	4·28	5·28
April	4·15	2·61	2·95	3·79
May	4·19	3·08	2·44	5·13
June	3·14	2·35	1·60	3·94
July	2·93	1·94	1·37	3·37
August	5·06	3·29	2·77	5·73
September	8·81	6·55	4·73	9·48
October	10·93	8·06	6·23	10·32
November	12·49	9·65	7·74	11·26
December	9·94	6·89	6·74	7·32
Year	90·82	61·98	55·21	82·83

The daily mean values are :—

	8-inch Copper Pan.	Screened Tub.	Tank.	Piche Tube.
	Inches.	Inches.	Inches.	Inches.
January	·373	·229	·244	·277
February	·402	·240	·242	·308
March	·205	·120	·138	·170
April	·138	·087	·098	·126
May	·135	·099	·079	·165
June	·105	·078	·053	·131
July	·095	·063	·044	·109
August	·153	·106	·089	·185
September	·294	·218	·158	·316
October	·353	·260	·201	·333
November	·416	·322	·258	·375
December	·321	·222	·217	·236
Year	·249	·170	·151	·227

Comparative daily extreme values chiefly, but not necessarily, occurring on the same day, are :—

	8-inch Copper Pan.	Screened Tub.	Tank.	Piche Tube.
	Inches.	Inches.	Inches.	Inches.
January	·52	·35	·37	·43
February	·60	·38	·38	·46
March	·35	·24	·22	·29
April	·25	·16	·16	·20
May	·17	·15	·09	·21
June	·18	·11	·08	·22
July	·17	·12	·08	·22
August	·27	·24	·16	·31
September	·45	·37	·26	·49
October	·55	·41	·31	·51
November	·58	·46	·36	·51
December	·52	·42	·35	·38

For the purpose of showing how these different values have been influenced by the elements of climate, we give below in six columns (1) the mean temperature, humidity, and wind movement, of the successive months, derived from hourly observations, and (2) the mean temperature, humidity, and wind movement of the day, upon those days which saw the maximum amount of evaporation from the tank in each month :—

	Mean Values.			Extreme Values.		
	Air Temp.	Humidity.	Wind. Miles per day.	Air Temp.	Humidity.	Wind. Miles per day.
1900	°	%		°	%	
January	75	50	134	74	45	161
February	77	46	146	80	38	18
March	71	64	123	74	47	136
April	65	69	86	66	62	135
May	58	56	78	63	55	38
June..........	51	62	118	56	55	142
July	50	68	116	53	58	152
August	53	53	128	56	36	163
September	65	39	138	73	28	283
October	67	41	168	77	28	130
November	72	39	175	78	32	176
December	72	56	159	71	46	196

We notice that the air is much dryer than the mean in each instance of maximum evaporation, and the wind a good deal stronger in nearly every instance. But, singularly, the air, which under assigned conditions as to the total quantity of contained moisture, would have a temperature curve vibrating in opposite phases to that of the humidity curve; and might therefore be antecedently expected to show high temperature numbers, shows no very great departure from the mean.

Such a fact is worth looking into somewhat more closely. So let us take in turn the highest mean temperature of the day during each month, the lowest mean humidity, and the greatest daily wind movement (each is obtained from hourly observations), and compare them separately with the respective evaporation on the same day from the different gauges. The results, in positive departures from the mean, are given below:—

	Temp. Excess.	8-inch Copper Pan.	Screened Tub.	Tank.	Piche Tube.
1900	°	Inches.	Inches.	Inches.	Inches.
January*	+ 5	+ ·147	+ ·121	+ ·129	+ ·033
January	+ 5	+ ·127	+ ·071	+ ·083	+ ·103
February	+ 6	+ ·038	+ ·030	— ·018	+ ·032
March	+ 4	+ ·065	·000	+ ·025	+ ·060
April	+ 9	+ ·112	+ ·063	+ ·053	+ ·064
May	+ 5	+ ·005	+ ·001	+ ·007	+ ·005
June	+ 9	+ ·035	+ ·032	+ ·012	+ ·059
July	+ 9	+ ·055	+ ·047	+ ·017	+ ·091
August	+ 8	— ·023	— ·036	— ·040	— ·005
September	+ 11	+ ·056	+ ·072	— ·001	+ ·114
October	+ 11	+ ·097	+ ·070	+ ·002	+ ·107
November	+ 7	+ ·164	+ ·128	+ ·064	+ ·125
December	+ 6	+ ·019	— ·022	+ ·013	— ·026

	Humidity Excess.	8-inch Copper Pan.	Screened Tub.	Tank.	Piche Tube.
1900	%	Inches.	Inches.	Inches.	Inches.
January	— 20	+ ·147	+ ·071	+ ·044	+ ·153
February	— 17	+ ·158	+ ·140	+ ·057	+ ·152
March	— 21	+ ·155	+ ·090	+ ·079	+ ·120
April	— 15	+ ·112	+ ·063	+ ·053	+ ·074
May	— 9	+ ·035	+ ·021	— ·002	+ ·045
June	— 14	+ ·045	+ ·032	+ ·016	+ ·089
July	— 19	+ ·065	+ ·027	+ ·012	+ ·111
August	— 17	+ ·117	+ ·064	+ ·069	+ ·105
September	— 11	+ ·156	+ ·152	+ ·097	+ ·174
October	— 13	+ ·157	+ ·140	+ ·111	+ ·147
November	— 14	+ ·074	+ ·098	+ ·083	+ ·135
December	— 22	+ ·179	+ ·128	+ ·102	+ ·144

* There chanced to be two days in January each with the highest mean temperature of the day for the month.

	Wind Excess.	8-inch Copper Pan.	Screened Tub.	Tank.	Piche Tube.
1900	M. per day.	Inches.	Inches.	Inches.	Inches.
January	+ 80	+ ·067	+ ·071	+ ·017	+ ·023
February	+ 113	— ·102	+ ·010	— ·043	+ ·012
March	+ 113	— ·055	— ·050	— ·030	+ ·020
April	+ 50	+ ·022	— ·013	— ·005	+ ·034
May	+ 95	— ·005	— ·019	— ·008	+ ·005
June	+ 71	+ ·025	+ ·002	+ ·008	+ ·059
July	+ 77	+ ·065	+ ·017	+ ·027	+ ·091
August	+ 198	+ ·067	+ ·044	+ ·035	+ ·105
September	+ 145	+ ·156	+ ·152	+ ·097	+ ·174
October............	+ 229	— ·023	+ ·020	— ·019	+ ·067
November..........	+ 93	— ·246	— ·222	— ·152	— ·235
December	+ 89	+ ·069	+ ·078	+ ·006	+ ·024

That is, if we average the monthly numbers :—

1. When the mean temperature of the day rises 7°·3 above the monthly mean, the respective increases of evaporation are :—

	Inches.
8-inch Copper pan	+ ·069
Screened Tub	+ ·044
Tank	+ ·027
Piche Tube	+ ·059

2. When the mean humidity of the day falls below the mean of the month by 16 per cent. the respective increases of evaporation are :—

	Inches.
8-inch Copper pan	+ ·117
Screened Tub	+ ·086
Tank	+ ·060
Piche Tube	+ ·121

3. When the velocity of the wind for the day rises above the mean daily velocity for the month by 113 miles per day, the respective increases of evaporation are :—

	Inches.
8-inch Copper pan	+ ·003
Screened Tub	+ ·007
Tank	— ·006
Piche Tube	+ ·032

These conclusions are not altogether satisfactory. The second would seem rational enough ; but the numbers suggest that the first is merely a sort of undercurrent of the second. And a hasty inference from the third would be that the wind has no effect at all upon the rate of evaporation, which, of course, is not in agreement with what all reason and observation have assented to for many years. As a matter of fact it happens that a very large proportion of our very windy days are also damper than usual: seven of the twelve of the days considered of maximum wind-velocity being also showery; and the humidity of one being as much as 37 per cent. above the mean of the month; the average excess very nearly 5 per cent.

It must not be forgotten that the above results are derived from the extreme cases. If we consider every day in the year 1900, for the tank only, we may arrange the results in the following way:—

1. First, assigned mean temperatures of the day; next, how many days there were of these; lastly, the average evaporation on these days:—

Temperature.	No. of Days.	Average Evaporation.
		Inches.
Under 50°	52	·057
50–55	25	·082
55–60	42	·098
60–65	56	·108
65–70	51	·156
70–75	78	·202
75–80	56	·268
80–85	5	·264

2. The same process for assigned percentages of saturation:—

Humidity.	No. of Days.	Average Evaporation.
		Inches.
Under 30 %	8	·296
30–40	75	·236
40–50	79	·185
50–60	88	·122
60–70	54	·101
70–80	42	·077
80–100	19	·057

3. The same process for assigned velocity of the wind:—

Wind.	No. of Days.	Average Evaporation.
		Inches.
Less than 100 m. per d.	126	·103
100–150 ,,	116	·160
More than 150 ,,	123	·191

Hence the rate of evaporation increases while the temperature rises, while the humidity ratio decreases, and while the wind increases in velocity. The temperature numbers make no very symmetrical curve, but the humidity numbers, within the observed limits, fall pretty evenly upon the parabola

$$(100 - H)^2 = 20{,}000\,(E - e)$$

where E is the total amount of evaporation from the tank when the observed mean humidity of the day is H;* e being the average evaporation when the mean humidity of the day is between 80 and 100 per cent. That is, since e is not very great, the depth of water evaporated will vary approximately as the square of the number representing the dryness of the air. Also the rate of evaporation and the velocity of the wind increase together, and in pretty much the same ratio. This last, however, is quite an accidental result, and owes its existence perhaps more to the fact that during the most humid months of the year—*i.e.*, April, May, and June—the wind is lightest, whereas the air is dryest—in October, November, and December—when the strongest winds occur.

It would appear that the station is too sheltered to allow the wind to exert its maximum influence upon gauges on or near the ground. Indeed, if we consider all the observed daily amounts of evaporation occurring in a moderately dry air, say for mean daily humidity ratios lying between 30 and 40 per cent., during the year 1900, in all 75 occasions, we get 36 days with a wind-velocity below 140 miles per day,† and a concomitant average evaporation of ·234 inch per day; and 39 days with a wind-velocity greater than 140 miles per day, and a concomitant average evaporation of ·239 inch per day. There were, moreover, eleven of these occasions when the wind-velocity was less than 100 miles per day, and the average evaporation about one-fifth of an inch; and eleven other occasions when the wind-velocity was greater than 200 miles per day, and the average evaporation about one-quarter of an inch per day. Thus the Kenilworth experiments upon evaporation are not definite enough to reveal a wind factor anything like so influential as might have been anticipated, or at any rate to isolate it from amidst the variety of other contributing agencies.

Returning again to the question of the dryness of the air, we get the following average quantities of evaporation for assigned moisture conditions, from the pan, the tub, and the Piche gauge respectively:—

* Computed by the aid of the Greenwich factors.

† As recorded by a Robinson anemometer whose cups are 45 feet above the ground.

Humidity.	No. of Days.	8-inch Copper Pan.	Screened Tub.	Piche Tube.
		Inches.	Inches.	Inches.
Under 30 %	8	·515	·403	·49
30–40	75	·400	·291	·37
40–50	79	·303	·203	·27
50–60	88	·205	·134	·20
60–70	54	·160	·104	·14
70–80	42	·114	·069	·10
80–100	19	·053	·036	·05

The above formula applies to these results fairly well also, the numerical coefficient becoming respectively 10,500, 14,000, and 11,000 approximately. But the value of e is uncertain in the pan results because the evaporation from that source is greatly interfered with by rain when the air is very damp. It should be remarked also that while the humidity refers to the mean of hourly observations taken during the civil day, and the tank evaporation to civil day totals, the evaporation from the other gauges is measured at XX., and therefore the day begins four hours earlier for the latter than for the humidity.

In comparing the evaporation from the tank with the temperature of the air it has been tacitly assumed that the temperature of the water would follow that of the air pretty closely, and hence that for the one given we could roughly read the other. Now it was Symons's contention that a small gauge becoming heated to a very much greater degree by the sun's rays, thereby, for that chief reason, lost more than a large gauge. Hitherto I have not been able to make regular routine observations of the temperature of the water in my several gauges; but the following table giving some casual measurements during the winter and spring of 1901 has some points of interest. It contains (1) the hour of observation, (2) the temperature of the tank, (3) of the screened tub, (4) of a number of 5-inch copper pans, and (5) of the air:—

Hour.	Tank.	Screened Tub.	Copper Pans. Mean.	Air.
XXI.	55·4°	58.5°	—	—
XI.	57·2	51·4	60·9°	69·2°
XXIII.	51·8	53·9	48·5	50·0
XI.	55·5	46·2	54·2	57·0
XXIII.	55·0	58·4	54·8	53·0
XI.	60·6	55·6	64·4	70·3
XI.	65·4	64·8	74·8	82·0 (Strong Wind)
XI.	58·8	47·9	55·2	56·1
XI.	67·2	57·5	68·6	68·0
XXII.	70·8	68·6	—	65·4 (Cloudy)
XXIII.	69·0	66·5	—	60·0 (Do.)

With the exception of the last two rows all the observations were taken when the sky was clear. It will be seen that the tendency is for the tank to cool faster than the screened tub during the night, and to become warm much more quickly by day. We should expect then that the tank would lose more by day and less by night than the tub, and should not be blessèd. The following are some comparative means and totals by night (XX.–VIII.) and by day (VIII.–XX.), during the year 1900.

	Night.	Day.
Air Temperature	56·7°	72·0°
Wind-Velocity, m. per h.	4·4	6·5
Humidity %	64·2	42·8
Tank Evaporation, inches	19·6	35·6
Screened Tub do do	21·1	40·9
Piche Tube do do	22·7	60·1
Tank Evaporation ratio	35·5	64·5
Screen Tub do do	34·1	65·9
Piche Tube do do	27·5	72·5

Thus, while the tank did lose a little less than the tub by night, it lost a great deal less by day, the ratios taking the relative positions they would take if temperature instead of accelerating actually retarded evaporation. The rapid evaporation from the Piche Tube during the day is remarkable, considering that it is suspended in the shade. No observations of its temperature are available, but in virtue of its slender stem this is not likely to depart greatly from that of the air. Various tests suggest, if they do not prove, that this instrument is the most susceptible of all to the strength of the wind.

So far as the experiments made during 1900 go, they seem to justify at the most the following conclusions: (1) The most potent agency regulating the rate of evaporation from the different gauges was the humidity of the air; (2) A wind factor is suggested; (3) The great perturbing influence attributed to the temperature of the water has not been exactly confirmed. The same experiments do not, therefore, furnish sufficiently precise data out of which a general evaporation formula, with accurate indices and coefficients, could be constructed.* The main difficulty lies in the fact that it is in general

* Even if it were sought, which is not my object. Professor Abbe quotes approvingly the formula proposed by D. FitzGerald:—

$$E = 0{\cdot}0166\ (V - v)\ (1 + \tfrac{1}{2}W),$$

in which V is the vapour pressure in inches at the temperature of the water, v the vapour pressure at the temperature of the dew-point, and W the velocity of the wind. (See *Meteorological Apparatus and Methods*, 1888, p. 377.)

not possible to vary either of the conditions without introducing variations into the others. As Tyndall truly remarked, "the essence of good experimenting consists in the exclusion of circumstances which would render the pure and simple questions which we intend to put to Nature, impure and composite ones;"* and for an illustration we have the case cited above of the rate of evaporation varying in its annual march with the velocity of the wind—the latter, as it will be remembered, also varying with the annual variation in the dryness of the air. No doubt the complexity of the meteorological law governing the rate of evaporation from a water surface must be accounted responsible for the illusory shape it has assumed in the hands of some theorists.

Occasional experimentalists have resorted to laboratory practice in order to surmount some of the inherent difficulties of the native problem. A typical instance may be quoted: "In my first experiments out of doors," says Mr. J. R. Mann, "I found that the amount of error in measuring the small variations of short periods prevented me obtaining any accurate idea of the fluctuations, in the amount of evaporation, that followed the constant and incessant alteration in the state of the atmosphere and the temperature of the water. I therefore looked to artificial means for obtaining a greater amount of evaporation under more fixed conditions; and having obtained some certain basis, I endeavoured therefrom to devise a rule by which the amount of evaporation going on under natural conditions might be arrived at. After many failures, I adopted an arrangement which I think gave satisfactory results. An ordinary evaporating vessel, about 8 inches in diameter and $1\frac{1}{4}$ inches deep, containing a measured quantity of water, was floated in a larger vessel of water; the large vessel was placed upon an ordinary gas stove, which gave the means of regulating the heat in the water contained in the evaporating vessel to a considerable nicety, and of retaining it for a length of time at one degree of temperature."† It is at the least to the credit of the gas stove that with a water temperature of 192°, an air temperature of 65°, and a humidity ratio

* *Heat a Mode of Motion.* Lecture xiii.

† *Proceedings of the Meteorological Society*, vol. v., 1871. Mann gives the following formula:—

$$(4666\,E)^2 = G^2T\left\{1 - \left(\frac{e}{e_1}\right)^{\cdot 25}\right\}$$

In which E is the depth evaporated in inches per hour, G the weight in grains of a cubic foot of vapour due to the temperature of the water, T the absolute temperature of the evaporating surface, e the elastic force of the vapour in the air in inches, and e_1 the elastic force of vapour due to the water temperature.

of 94%, it was able to "evaporate" more than three-quarters of an inch in depth per hour!

Nearly two centuries before, however, the immortal Halley had attempted in much the same way to acquire "one of the most necessary ingredients of a real and philosophical meteorology," namely a knowledge of the quantity of water passing into the atmosphere in the form of vapour. "I thought it might not be unacceptable," he said, "to attempt by experiment to determine the quantity of the evaporations of water, so far as they arise from heat; which, upon trial, succeeded as follows: We took a pan of water, about 4 inches deep and 7·9 inches diameter, in which was placed a thermometer, and by means of a pan of coals we brought the water to the same degree of heat which is observed to be that of the air in our hottest summers, the thermometer nicely showing it. This done we affixed the pan of water, with the thermometer in it, to one end of a beam of the scales, and exactly counterpoised it with weights in the other scale, and by the application or removal of the pan of coals we found it very easy to maintain the water in the same degree of heat precisely. Doing thus we found the weight of the water sensibly to decrease;" the final result being that at summer temperatures the loss by evaporation was "a skin of water" of a depth equal to 0·1 inch in twelve hours.*

But a fatal defect in all such laboratory methods is that they do not apply to any meteorological problem: their application is strictly limited to a determination of the number of units of heat it is necessary *to apply to* a given volume of water in order to evaporate a given portion of it, and so forth. Almost invariably the heat is communicated from beneath, and the whole body of water experimented upon must be, in consequence, at nearly the same temperature throughout. Hence each successive surface stratum will be driven off as vapour without appreciably cooling that next below. Under natural conditions of exposure, however, the changes of temperature are communicated from above, and there may be great differences of temperature at different depths of the body of water.†

* *Phil. Trans.*, xvi., 1687. "An estimate of the quantity of vapour raised out of the sea by the warmth of the sun; derived from an experiment shown before the Royal Society." I have ventured to translate the given fractions into decimals.

† This fact has been known for more than a century. See *inter alia*, "Of the Saltness and Temperature of the Sea," by Bishop Watson, in his charming *Chemical Essays*, 1781. "On Dr. Hales's Ventilators; also the Temperature and Saltness of the Sea." H. Ellis. *Phil. Trans.*, xlvii., 1751. *Our Earth and its Story*, i., 331. R. Brown, 1887. "Lakes." J. Y. Buchanan, *Ency. Brit.*, xiv. Ellis was captain of the ship *Earl of Halifax*, and is to be considered happy in having made it particularly wholesome and comfortable. His paper is interesting

De Saussure found the surface of some of the Swiss lakes more than 30° warmer, in summer, than the bottom. Symons mentions occasional differences of 10° to 15° between the surface and bottom of the Strathfield Turgiss tank in June and July—the warmer water being at the top of course. Therefore, in the daytime at any rate, the temperature of the surface has not only to assist in the process of evaporation, but it has also to assist in raising the temperature of the next lower stratum. So that it is not at all evident (has any one ever attempted to prove ?) that a body of water heated from below will lose the same quantity by evaporation, so-called, as another equal body heated naturally from above, even though the surface temperatures be the same. There is another consideration : In heating the water from below, the heat of the stove, or of the sides of the vessel, will generate an upcast of warmer air whose humidity ratio will not be that of the air outside the laboratory, but something much less; consequently the readings of the dry and wet bulbs, meteorologically speaking, do not matter. These remarks refer more particularly to the experiments described in the few original papers on the subject it has been my good (or evil) fortune to have seen.

Halley has described the results of an experiment upon the rate of evaporation in which the water was allowed to evaporate without first being artificially heated. Unfortunately the results are scarcely more than a laboratory product, for the gauge was shielded from both sun and wind. His conclusions, nevertheless, were, as usual, pre-eminently sagacious: "I caused an experiment to be made," says the note, "of the quantity of vapour arising simply from the warmth of the water, without being exposed either to sun or wind, which has been performed with great care and accuracy by Mr. Hunt, operator to the Society: having added together the evaporations of the whole year, I find that from a surface, as near as could be measured, of 8 square inches there evaporated during the year 16,292 grains of water, which is 64 cube inches of water, and that divided by 8 inches, the area of the water surface, shows that the depth of water evaporated in one year amounts to 8 inches. But this is much too little to answer to the experiments of the French, who found that it rained

in these days of refrigerating machinery. He made several trials with a bucket sea-gauge in lat. 25′ 13″ N., long. 25′ 12″ W., letting it down to different depths from 360 to 5,346 feet. He discovered by means of a small thermometer of Fahrenheit, which went down with it, that the cold increased regularly, in proportion to the depths, to 3,900 feet, where the temperature was 53° or a little less ; the temperature of the air and of the ocean-surface being 84°. It is remarked that the experiments, "which seemed at first but mere food for curiosity," afterwards proved very useful. By its means they supplied their cold bath, and cooled their wines and water at pleasure—"which was vastly agreeable in that burning climate."

19 inches of water in a year at Paris; or those of Mr. Townley, who by a long-continued series of observations has sufficiently proved that in Lancashire, at the foot of the hills, there falls about 40 inches of water in a year. Whence it is very obvious that the sun and the wind are much more the causes of evaporation than any internal heat or agitation of the water. The same observations also show an odd quality in the vapours of water, which is that of adhering to the surface that exhaled them, which they clothe, as it were, with a fleece of vaporous air, which once investing it the vapour rises afterwards in much less quantity: which was showed by the small quantity of water that was lost in 24 hours' time, when the air was very still from wind in proportion to what went off when there blew a strong gale, although the experiment was made, as I said, in a place as close from the wind as could well be contrived. For which reason I do not at all doubt that had the experiment been made where the wind had come freely it would have carried away at least three times as much as we found, without the assistance of the sun, which might perhaps have doubled it." *

A few years ago I contemplated a series of experiments upon the variations in the rate of evaporation from a given water surface, under natural conditions of exposure, where any one factor was to be caused to vary at will, while the others remained unaffected. But a satisfactory method of treating the humidity factor independently has not hitherto suggested itself; and the site of the station would have made an inquiry into the effect of the wind to a large extent futile. Wherefore the scheme eventually narrowed itself to a consideration only of the effect of the varying temperature of the water. After a fair share of false starts, and a reasonable number of unconvincing results, I managed in the winter of 1896 to devise the following plan of varying the water temperature without altering the other elements:—

The gauges were ordinary tin mugs of approximately $4\frac{1}{4}$ inches in diameter, enamelled a very light green (almost white) inside and out. They were placed on and between bricks just above the ground. They were covered by glass plates one-sixteenth of an

* "Account of the Evaporation of Water, as Experimented in Gresham College, &c." *Phil. Trans.*, xviii. Though only bearing indirectly upon the subject of the text, some of Halley's concluding remarks are worth quoting: "This fleece of vapour in still weather hanging on the surface of the water is the occasion of very strange appearances by the refraction of the said vapours differing from that of the common air. . . . And this may give a tolerable account of what I have heard of seeing the cattle at high water-time in the Isle of Dogs from Greenwich, when none are to be seen at low-water (which some have endeavoured to explain by supposing the Isle of Dogs to have been lifted by the tide coming under it)."

inch thick, of different colours, placed horizontally about one inch above the rims of the mugs, and large enough to prevent any sunlight reaching the water without having first passed through the glass. The sides of the mugs were also protected by bricks from the rays of the sun. The measures were taken with a graduated glass belonging to an 8-inch rain-gauge, the measures being multiplied by 3·55 to give the true loss in inches. The results were also verified by weighing. The temperatures of the waters were determined nearly every day at XVII. and sometimes at XIV. by means of a standard Kew-certified thermometer. The following were the results for the period July 20 to November 22, 1896—125 days:—

1. *July* 20 *to August* 30, 1896.

Colour.	Mean Temp. at XIV.	Mean Temp. at XVII.	Total Evap.
	°	°	Inches.
Red	72·8	65·4	6·01
Yellow........	72·3	64·8	6·19
Green	69·6	64·1	5·59
Blue..........	70·8	64·3	6·17
Purple	72·2	64·8	6·27

2. *August* 31 *to November* 7, 1896.

Colour.	Mean Temp. at XVII.	Total Evap.
	°	Inches.
Red	77·7	20·21
Yellow	77·8	20·12
Green	77·0	18·76
Blue	77·8	19·97
Purple	77·6	20·38

3. *November* 8 *to* 22, 1896.

Colour.	Mean Temp. at XVII.	Total Evap.
	°	Inches.
Red	81·8	4·29
Yellow	81·6	4·22
Green	81·1	4·14
Blue	82·0	4·05
Purple	81·5	4·30

4. *July* 20 *to November* 22, 1896.

Colour.	Mean Temp. at XVII.	Total Evap.
	°	Inches.
Red	72·3	30·52
Yellow	72·3	30·53
Green	71·5	28·49
Blue	72·1	30·19
Purple	72·2	30·95

During the same period the 8-inch copper pan open to the sky lost 30·69 inches.

Considering the roughness of the tools some considerable discrepancies in the sequence of the results could only be expected. Now at 5 p.m. air and water are cooling rapidly, so that the temperatures given for that hour are of limited usefulness in comparison with the total evaporation for the day. But in the first set we have some temperatures at 2 p.m., at which time air and water are both near their maximum. Now the net result of the first set is approximately a loss of about three-quarters of an inch in 41 days for an excess of temperature of about 2½°. Also if we take the temperature variation between the different colours to be about the same throughout the year, we get a loss of about 2¼ inches in 125 days for the same excess of temperature. Or, taking ratios, a mean loss of about 2¼ inches per annum for each excess of 1° of temperature. As between a copper 5-inch gauge standing in water, and therefore in a relatively humid atmosphere, and another fully exposed to the air, Latham's results give an increase of evaporation which may not differ greatly from 9 inches per annum for each excess of mean temperature of 2°; or taking only the high temperatures of the middle of the day about 9 inches per annum for an excess of maximum temperature of about 5½°. Under all the circumstances this is not greatly different from the numbers derived from the use of coloured glass; although it must be admitted that the true temperature effect is not obvious from Latham's work.

During the progress of my experiment it was not expected that it should do more than furnish experience for a better future test. It seemed to be settled, at least, that it was possible to expose any number of gauges in an absolutely identical manner excepting that the one element of temperature could be easily varied at pleasure. Accordingly some better vessels were procured, and some thicker and better glass; and the subject re-examined under improved conditions, during the second half of 1897. In the following series of observations, from July 5 to November 21, 1897, the gauges used were unpainted copper pans, 5 inches in diameter and 5 inches deep, with turned brass rims, by Messrs. Negretti and Zambra. They were fixed in a wooden frame and floated about 3 feet above the ground in a tank of 3 feet cube, so that the gauges dipped about 3½ inches into the water with which the tank was kept nearly full. The plates of coloured glass covering them were 10 inches square and one-eighth of an inch thick. The five gauges were retained in the same relative position throughout, but the glass plates were permuted after each fortnightly determination of the loss. Water—rain-water—was added to the gauges as required during each fortnight, so as to keep the evaporating-level as near to the edge of the rim as safety would allow. There was a clear vertical space of about an inch between the gauge-rims and the glass plates, to allow the exhaled vapour to pass off. Temperatures were taken at intervals, as before, at XIV. and XVII., preferably on clear days.

The following tests of the absorptive properties of the glass plates will perhaps give the best idea of them :—

Col. 1 gives the colours.

Cols. 2 and 3 the relative absorptions of light, as determined by a wedge photometer, received from the sky in the vicinity of, and opposite to, the sun respectively.

Cols. 4 and 5, the temperatures shown by Board of Trade thermometers, the thermometers being about 1 inch underneath, and touching the glass underneath respectively.

Cols. 6 and 7, the colours transmitted, as determined by a direct-vision spectroscope, from the sun and from the sky.

Col.	Light.		Temperature.		Spectra.	
	Near sun.	Opposite sun.	Under glass.	Touching glass.	Sun.	Sky.
P.	5·76	5·41	97·2	104·3	V', B', G', Y', R'	V', B', G', Y', R'
B.	5·72	5·09	98·9	109·3	B^2, G^2, Y^2	B°, G°
G.	5·58	4·50	96·3	111·0	V', B', G', Y', R°	$V^\circ, B^\circ, G', Y^\circ, R^\circ$
Y.	5·69	4·82	98·4	108·4	V', B', G^2, Y', R^2	G', Y', R^2
R.	4·34	3·82	98·0	108·7	$V^\circ, B^\circ, G^\circ, Y^2, R^2$	Y°, R'

All the above values are means derived from a number of observations. I was not lucky enough, however, to get calm days for the temperature observations, so that wind has probably somewhat vitiated the numbers. The temperature shown by a thermometer touching the red glass underneath has sometimes been higher and sometimes lower than that touching the yellow, the differences being considerable. One whole series gave the red invariably lower, the mean defect being 1·3°.

The evaporation results for the first ten weeks are (A) :—

Colour.	Mean Temperature at XVII.	Total Evaporation.
	°	Inches.
Purple	59·14	7·695
Blue	59·08	7·335
Green	59·00	7·115
Yellow	59·08	7·265
Red	59·06	7·690
Tank	58·32	—
Air	64·88	—

And for the second ten weeks (B) :—

Colour.	Mean Temperature at XIV.	Mean Temperature at XVII.	Mean Temperature XIV. and XVII.	Total Evaporation.
	°	°	°	Inches.
Purple	76·08	70·08	73·08	12·955
Blue..........	75·22	70·18	72·70	12·880
Green	74·08	69·72	71·90	12·480
Yellow	74·80	69·64	72·22	12·530
Red	75·54	69·82	72·68	12·885
Tank	71·52	69·56	70·54	—
Air	81·54	79·50	80·52	—

It is curious that in each of these ten-week periods the gauges stand in the same order with regard to the water evaporated, *i.e.*, beginning with that losing the least :—

Nos. II., IV., V., III., I.

The mean of the noted temperatures at XVII. is not, however, in the same order; the first rising sequence being :—

Nos. III., I., II., V., IV.,

and the second :—

I., III., II., V., IV.

which is, notwithstanding, a remarkably similar pair. But both the evaporation and temperature arrays are doubtless accidental, although it is not unlikely that the former may be contributed to by some small differences in the sizes of the gauges, more particularly below the brass rims; for in spite of close attention the water level sometimes did sink below the rims.

In both (A) and (B) the depth of water evaporated occupies the same order relatively to the colours, albeit the ratios are not quite identical. The temperatures of (A) do not greatly differ, *inter se*, and seem to indicate that at XVII. they are falling to a nocturnal equality with that of the tank. In (B) we see that the greatest difference at XIV. is between the green and purple, and is exactly 2°. It is not likely that the mean difference would be much greater than this at any hour. We get, then, for a maximum increase of 2° of temperature an increase of evaporation in ten weeks of about half an inch, or, say, $2\frac{1}{2}$ to 3 inches per annum. This is in fair accordance with the previous result, considering the circumstances; and it is also not antagonistic to Latham's, in which, however, it happened that the gauge which was coolest by day was also warmest by night. On the other hand the Camden Square results work out one to a rate of increase of nearly 13 inches per annum for an increase of 2° of temperature, the other to a rate of increase of nearly 24 inches for an increase of 5°.

A further test was attempted in which the gauges should stand in air instead of water, and the temperatures should be taken at XI. instead of later in the day. The gauges were placed on a board nearly 5 feet above the ground, and their sides were sheltered from the sun's rays. The glass plates were fixed a little higher—about two inches—above the gauge-rims for the sake of variety. These were kept in the same place, the gauges being permuted this time. The experiment lasted from July 14 to September 21, 1901—seventy days. There were earlier observations beginning early in May, but as a slight leak was developed in one of the gauges, it was thought best to begin again after making the necessary repairs. The results are:—

Colour.	Mean Temp. at XI.	Total Evap.
	°	Inches.
Purple	62·8	10·08
Blue	61·9	9·78
Green	60·1	9·32
Yellow	61·8	9·73
Red	63·0	9·83
Air	67·2	—

The net result here, again, is an increase of evaporation of about $2\frac{1}{2}$ inches per annum for an excess of temperature of about 2°.

If we remember that in consequence of the absorption of heat by the green glass, the water-temperature will rise somewhat faster under the less absorptive colours, this result is practically a repetition of the former. Thus, in three different ways, in an excellent spot for receiving the maximum of insolation, and the greatest consequent heating of a gauge, we deduce an increased rate of evaporation due to overheating that looks ridiculously small by the side of some of the magnitudes advocated. It should be noted that observations of the temperatures at night, and very soon after sunrise, proved the temperatures of all the gauges to be equal, and almost uniformly that of the air. We may then enunciate this rule: *If the water-surfaces of a number of similar and similarly-situated evaporation gauges remain at a temperature in the shade the same for all, then if when fully exposed to the sun's rays, under the same elements of climate, they assume different maximum temperatures, the differences in the depth of water evaporated will be at the rate of* $1\frac{1}{2}$ *inches per annum for each excess of* 1° *of temperature* (*approximately*).

The care with which the tests were carried out, and the congruence of the different sets all go to warrant some present confidence in the accuracy of this rule within the limits of meteorological requirements. Some day I may be able to take the subject up again.

THE TRANSKEI GAP.

By A. W. Rogers and E. H. L. Schwarz.

(Read November 27, 1901.)

One of the most interesting features of the Transkei, in which territory the Geological Survey has lately been working, is a gap or trough that runs east and west through the country. It is locally known as the Transkei Gap and is produced by a vertical dyke of an easily weathering crystalline rock allied to diorite, which has been intruded into the sedimentary rocks of the district. The sedimentary rocks consist of Karroo Beds lying nearly horizontally; they had already been injected by sheets and dykes of dolerite before this later intrusion took place, so that the newer dyke cuts across both the sedimentary rocks and the dolerite. The Gap is reduplicated in several places, and there is an off-shoot at right angles to the general direction. We have observed the Gap from Toleni Bridge to the place where it runs into the sea at the mouth of the Kogha River, a distance of 50 miles, but we have more or less reliable information that the Gap continues across the Kei into the Colony, as far as parts of the Cathcart Division, which would make the whole length of the dyke to be over 100 miles.

The term "Gap" for a valley of this kind is of local origin and is found on most of the older maps, such as "A Plan of the Territories formerly known as Kaffraria Proper, Cape Town, 1884;" still older maps have a line drawn, showing the course of the Gap, with a note explaining that the Gap "was probably formed by an earthquake." Mr. McKay in the Transactions of this Society for 1884 (Cape Town, 1887) described the Gap and gives the proper explanation of the occurrence, but he did not see that this dyke was peculiar, and had important differences which distinguish it from the ordinary dykes of the neighbourhood.

It is of the first importance to distinguish such a trough, due to the weathering out of a soft dyke, from a "Rift-valley," which produces a somewhat similar type of surface feature. Rift-valleys such as occur in Central Africa, Egypt, the western States of

America, and possibly in the case of the Beagle channel south of Terra del Fuego, are due to the sinking of a long, narrow strip of country between vertical faults; thus, in one recently described in Egypt by Dr. Hume, a narrow slip of cretaceous beds is faulted down between granite cliffs that tower 1,500 feet above them on either side.* In Eastern Sinai, where there is a number of these rifts disposed in two diagonal series, in many of them there is no direct evidence of dislocation, the nature of the valley being inferred from their general appearance; this is the case in several places along the Transkei Gap where the rubble covers the underlying rock; and in such places it might very well be supposed that the valley, walled in by steep cliffs, running counter to the general drainage, might be due to the sinking of a narrow piece between faults; on following up, however, any particular valley, the true cause can always be found in the presence of the coarse crystalline rock in favourable positions. In the case of the Beagle Channel we have not yet any accurate account from which we could assign its origin to a Rift-valley or to a Gap-valley of the type we are describing; but from Darwin's description † of the geology of these parts, which consists essentially of clay-slate, and metamorphic schists with intrusive granite and trap rocks, the Beagle Channel may well be a dyke of crystalline rock which has been eaten into by the waters of the sea and the *débris* washed away. Darwin describes it in the "Voyage of the *Beagle*" as about 120 miles long with an average breadth of 2 miles: "it is throughout the greater part so perfectly straight that the view, bounded on each side by a line of mountains, gradually becomes indistinct in the long distance." This appearance would be produced if the Transkei Gap were to be carried below sea-level, the only difference, apart from its smaller size, being, that in the South African Gap there are usually *débris* slopes on either side; but these of course would be removed if there were a powerful sea running in the channel, and at the same time, owing to the undercutting of the sides, the gap would be widened.

Our definition of the term "Gap-valley," therefore, will be "a long depression between steep walls caused by the weathering of a dyke," a somewhat unusual use of the term Gap, perhaps, yet when seen in the country, the appearance of something missing, as though the earth had "gaped" and opened, which was actually thought to be the case by the older land surveyors, makes the use of the term more appropriate. It is caused by the weathering out of a dyke of diorite which yields more easily than the

* "Rift Valleys of Eastern Sinai," (Abstract) *Geol. Mag.*, May, 1901, p. 198.

† C. Darwin, "Geological Observations," pt. ii. p. 154–156, 1857.

compact horizontal shales and sandstones of the Karroo Series into which it has been intruded; on a small scale, the same phenomenon can be seen on any sea coast where basic dykes are intruded into harder rocks.

Actual mapping of the Transkei Gap was only carried out in the Kentani Division where it runs in an almost direct east and west line for a distance of 36 miles. It enters the division a little north of the N'Debe River where it debouches into the Gcua or Butterworth River; it is here an ordinary dyke of diorite weathering out on the surface of the ground in large boulders, 3 to 6 feet in diameter. It can be followed across the bed of the Gcua, eastwards up a short ravine; on looking eastwards from the low nek at the head of the ravine one sees the typical Gap-valley in which the course of the N'Debe River runs. The top of the cliff above the Gcua and N'Debe is at the general level of the hills and ridges in the neighbourhood and is, in fact, part of the plateau which is the dominant feature of the country. Into this plateau the rivers have cut deep and precipitous-sided valleys winding in and out in a manner one would expect them to do on a fairly level plain, and the original plateau-form is often obscured. These facts show us clearly the course of events which have taken place in the recent geological history of this region. The plateau was a plain of river erosion or a peneplain, near sea-level, and the rivers, having long courses over ground which gave them a very slight fall, wound about on the surface, constantly changing their beds, heaping up banks of sand and gravel at one place, and removing previously deposited material from another. Then the land gradually rose and immediately the rivers began to erode downwards, instead of sideways; the rising of the land has been so continuous that the rivers have not had an opportunity of straightening their courses, but still run in the tortuous channels in which they were running before the land movement took place.

The same elevation has taken place all along the south-east coast of South Africa, from Hang Klip to Natal, but in the west the average elevation of the coastal plain is less than in the country under discussion. The river-gravels were mostly washed away when the land rose and degradation set in with increased intensity; nevertheless, there are always patches, often considerable in the west, which have escaped and remain perched on the top of the ridges; such a patch of river-deposit is to be found on Kentani Hill south of the two Gap-valleys, and owing to its exposed position and the action of water, dissolving the silica of the grains, then depositing it again in the interstices on evaporation, the sandy parts have become an intensely hard quartzite. Mr. McKay, in the paper above referred to, calls this quartzite a boss of "trachyte," a mistake as to the nature of the rock often made in other parts of the colony, especially when the quartzite forms a level covering to a hill like the sheets of dolerite. At the time when the rivers were meandering across the plain now so deeply cut into, the Gap-valleys were probably not in existence, as the dykes which have since given rise to them would have been denuded no deeper than the surface of the river plain; but when the land rose, and the rivers again began to deepen their channels, certain of the minor streams took the course followed by the dioritic dykes, as these offered the least resistance to the erosive forces of the weather and the streams. The direction of the N'Debe Gap-valley is at first due east, but after a few miles it turns sharply to the east-north-east till it reaches the head of the N'Debe, near Gobogobo trading station. Midway in this diagonal course it is crossed by a branch of the Gap running east-south-east. This branch, which afterwards becomes the principal Gap, dies out on the surface, westwards, before it reaches the Gcua, its upward intrusion having been apparently stopped by a thick sheet of dolerite; nevertheless at the crossing it has cracked the dolerite on the under surface, and thin veins of the dioritic material have been squeezed into the dolerite. The rock at the crossing of the two branches forms a remarkable surface feature, owing to its weathering out in immense blocks as large as the ordinary Kaffir houses. Eastwards of the crossing, we have two Gaps, which soon turn back to a due easterly trend and run parallel, separated by about half a mile of undisturbed Karroo sandstone and shales.

In the following description we shall first follow the northern branch, which is the continuation of the one that was found crossing the Gcua River. It crosses the main road from Butterworth to Kentani, a little north of the trading station of Gobogobo; it is seen on the ridge on which the road lies, in the form of isolated boulders of the peculiar rock imbedded in the soil. On either side of the ridge looking east and west one sees two long depressions, the one on the west being the N'Debe River, that on the east containing a number of streams all endeavouring to assume the prevailing south-east trend, but being forced by the Gap to take, for a certain distance, an easterly or westerly course; each streamlet is separated from the next by a low nek. In this way the Gap reaches the Kobonqaba River, where it apparently stops, no evidence of the rock being found in the river-bed; but to the east we find, not a gap, but a ridge, whose summit runs due east and west and is composed of a particularly micaceous variety of the Gap-rock; this outcrop is only about three-quarters of a mile long; beyond it to the east there is a typical east and west valley, the head of the N'Kukuwana River, in which, however, no crystalline rock was found. East of this there is no evidence of either a Gap-valley or of any Gap-rock till we come to the Cat's Pass, the reason for this probably being the presence of a thick sheet of dolerite, a northward extension of the great Kologha sheet, which here covers the plateau and has apparently proved an insuperable barrier to the upward rending of the rocks by means of which the Gap-rock ascended. From the Cat's Pass there is a long, sharp ridge, almost a knife-edge, running east and west and bordered on the north and south by deeply-cut ravines. Along this ridge the main road from Butterworth to Manubi forest is carried for a distance of about 4 miles. At the Cat's Pass the diorite is seen on the northern side of the ridge somewhat far down, but it presently, as one goes eastwards, comes on top of the ridge and is practically the cause of the existence of the ridge—that is to say, the hardening that the sedimentary rocks have undergone, owing to the intrusion of the mass of molten rock, has been sufficient to render them more resistant to weathering than the rocks further away from the Gap-rock; the nature of the latter here is in no wise different from that in places where it forms the typical Gap. From the point where the main road to Manubi turns sharply south by Lusizi, the Gap-rock can be followed in isolated outcrops on the level plateau which exists here, each outcrop being linearly east of the last, until we get within 4 miles of the Kogha River. From here there is again a typical Gap-valley thickly wooded on the north side. The whole length of this part of the Gap is occupied by a single straight stream which eventually joins the Kogha, and a corresponding valley is seen on the other side of that river stretching away into the Willowvale Division. In the latter part of the course of this gap the direction is a little north of east. About 2 miles from its junction with the Kogha a long, straight valley is seen trending eastwards in an east-north-east direction; it crosses the Gap, and is seen to be continued over the other side of the Kogha running in a similar direction; no crystalline rock was found in this valley; it has, however, all the appearance of a Gap-valley and may owe its origin to the same cause.

Turning now to the southern branch, a very fine view can be obtained on the Kentani main road a little south of Gobogobo; to the west a succession of steep valleys running in a straight line and separated by low neks are seen, but no crystalline rock can be found in them until one reaches the crossing of the two branches of the dykes. On the east one looks down a long, straight valley, the

N'Gobe, which has a course due east without a twist or turn for 7 miles. A short way from the road, down in the kloof, some great rounded surfaces of the coarse micaceous variety of the Gap-rock occur, but elsewhere, along its course, the river-bed is kept constantly supplied with *débris* from the steep cliffs, so that the underlying rock is not seen. There is a marked difference everywhere between the north and south sides of the river, the northern being covered with forest, while the southern are steep grassy slopes, which the natives, in spite of the difficulty of working, use for planting their mealies and Kaffir corn.

On the other side of the Kobonqaba the Gap-valley is continued to the east; the portion between the Kobonqaba and the Nxaxo Pass being specially characteristic. An enlarged map of this portion is given (Fig. 1) to show the general nature of the valleys in the Gap; elsewhere the valleys approach this type more or less closely,

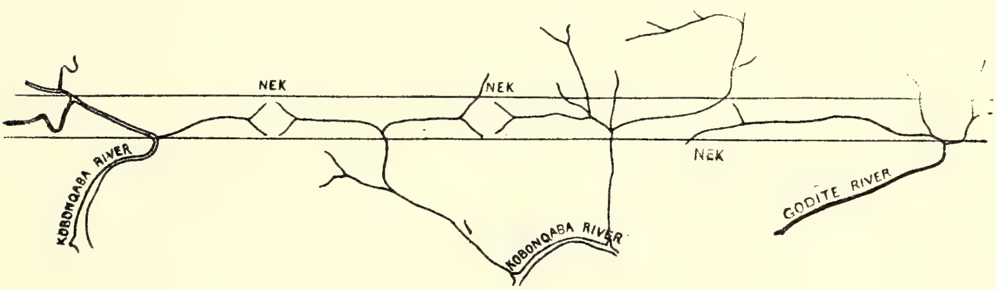


FIG. 1.

Showing the arrangement of the small streams in the Transkei Gap, with the several neks between the valleys. The parallel lines represent the boundaries of the Gap-rock; the country north and south is composed of sedimentary rocks lying nearly horizontal, and injected with dolerite.

but nowhere have we seen the system so neatly developed, or on so small a scale; the valleys here look as if they were artificial trenches with the banks trimmed by the spade. Actual outcrops of the Gap-rock are rare about here, owing to fallen *débris;* but under Nxaxo Pass, on the west, a small block of the diorite was discovered *in situ.* Between Nxaxo Pass and Lusizi Pass the valley is the same. It will be noticed that the Kologha sheet covers the plateau about here and that the south gap pierces it uninterruptedly, thus giving us an interesting comparison of the disruptive forces belonging to the northern and southern dykes.

Looking east from the Manubi main road near Lusizi in the line of the Gap, one has a magnificent view down the Kabakazi River, whose whole length is within the Gap. At the head of the River, however, the foothills of the cliffs overlap too much, and it is only towards the middle of the Kabakazi that a perfect view is obtained; standing on one of the foothills in this neighbourhood one can look right down the Gap for some ten miles, the last seven being occupied by the Kogha, and the last four of these containing the tidal estuary of that river. The tidal portion presents in miniature the appearance of the Beagle Channel; the height of the cliffs is here from 700 to 800 feet; the northern cliffs are densely wooded and the slope is so steep that each tree stands clear of those below it. The prevailing tints of these forests are dark olive and grey-green, and from the glossy masses of foliage lit up only for a short while in the middle of the day, one hears the hoarse bark of the Lory or the heartrending wails of the baby-bird. At the bottom of the Gap where a small ledge of rock protrudes, dew remains all day long, and the surface is slippery with sodden mosses. On the south side there are few trees, and those mostly Mimosas; the surface of the ground is covered with thick soil, on which rank long grass thrives.

The walls of the Gap consist principally of Karroo shales and sandstones, but in the southern Gap about Nxaxo these include a thin sheet of dolerite, double in places, which the Gap-rock apparently has not had much difficulty in piercing. East of the Manubi road by Lusizi, however, a thicker sheet comes in, which is probably an independent sheet above the one we have distinguished as the Manubi Sheet. It caps the plateau in isolated patches near the junction of the Kabakazi and the Kogha, and both the northern and southern portions of the Gap have here evidently pierced it. At the actual junction of the Kabakazi with the Kogha, the dolerite is seen rising from the bed of the river as a thick massive sheet, which eventually rises to the level of the plateau, and constitutes the Manubi sheet. At the junction of the Quaninga River with the Kogha, this sheet has already become a capping sheet, the lower walls of the Gap-valley being formed of sandstone and shale. At this place, also, the outcrop of the Manubi sheet turns south-west owing to the plateau being cut away by the coastal streams, and the rest of the course of the Gap-valley to the sea is between walls of sedimentary rocks. The actual mouth of the Kogha is turned south and away from the Gap-valley, the Gap-rock crossing over to the Willowvale side of the river, and running out to sea over a low nek between a small southward promontory and the mainland.

Between Gqunqi and the Kabakazi there is an outcrop of a peculiar rock running in a north and south direction; it is distinctly more acid than the Gap-rock and might be called a fine-grained granite or a granophyre. There are important differences between it and the Gap-rock, but its occurrence as a straight dyke, though at right angles to the Gap, shows a similarity in the nature of the crack in which it came to its present position. The outcrop is about 400 yards wide and about a mile long; on either side there are Karroo rocks and included dolerite sheets lying undisturbed, both of which have been pierced by the granophyre. It does not form a valley, but stands up more like a granite boss and the surface is weathered into large boulders. A fine section through the mass is afforded by a deep ravine that cuts through it, but the actual junction of the granite with the other rocks is obscured by *débris*.

The above description can only be regarded as a preliminary note, as there are still several points which further work only can make clear, such as the nature of the western termination, but as it will be some time before the survey can be carried on in those parts, the occurrences seemed of sufficient interest to give the Society a description of it, from the standpoint of our present knowledge.

The rock forming the dykes of the Gap is a peculiar one, differing in important respects from any intrusions hitherto found by us in the Karroo Series, although, as will be pointed out in the following notes, it has a distinct relationship to the olivine-dolerite of the sheets.* It consists chiefly of the following minerals in the order of their usual relative abundance:—plagioclase, hornblende, augite, quartz, red-brown mica, orthoclase, apatite, iron ores, sphene and decomposition products such as chlorite, uralite, and calcite. Variations in the proportions of these minerals show that the rock differs considerably in composition from point to point.

The plagioclase has almost always a zonal structure; the extinction angle of the innermost part of any particular section is in general much higher than that of the outer, which indicates that the inner part of the crystal is of more basic composition than the outer. The plagioclase frequently shows crystal outlines when in contact with the hornblende and augite, sometimes small crystals of the felspar are entirely enclosed by the hornblende and augite. This ophitic structure, though found without difficulty in all the slices of the rock examined, is not nearly so pronounced a feature as in the olivine-dolerite.

The original hornblende is mostly of a pale greenish-brown colour, with feeble plechroism, but a bright green strongly pleochroic variety

* The olivine-dolerite which forms the intrusive sheets of the Transkei is very like the rocks occurring in the same manner near Beaufort West, and described by E. Cohen, *Neu. Jahrb. f. Min.*, 1874, p. 195.

also occurs, sometimes forming part of a crystal which is chiefly made up of the pale kind. Occasionally small crystals showing the prism faces are met with, but the larger plates seen in the slices are always irregularly bounded by contact with other minerals, notably plagioclase. This last remark applies also to the augite, which is colourless in section and appears identical in character with the augite of the olivine-dolerite. The hornblende and augite usually occur together, intergrown with their orthopinacoidal faces parallel. The augite often forms the inner part of a section of the two minerals and is surrounded by a zone of a micropegmatitic intergrowth of the two minerals, outside this area hornblende encases the whole. The structure is easily seen by ordinary light under the microscope, as the augite is colourless and the hornblende pale greenish brown; but between crossed nicols the two minerals are still more clearly distinguished owing to their appearing dark at different positions of the nicols. The intergrowths of the two minerals are sometimes twinned, the twin-plane being the orthopinacoid, common to both minerals.

Hornblende is rarely found in the olivine-dolerites, but it does occur in them; *e.g.*, in the coarse olivine-dolerite of the sheet seen on the shore between the Gxagha and Kologha Rivers, and in the Kologha sheet; in a slice from the dolerite sheet exposed along the Kei River at Mimosa Hill (the Kologha sheet) there is much hornblende of the same variety as that in the Gap-rock, and it is also intergrown with the augite.

The mica is a red strongly pleochroic variety, frequently altered to a very pale greenish mineral with weak double refraction. The mica appears to be uniaxial when examined in convergent light. It is sometimes intergrown with the hornblende, but generally seems to have crystallised later than that mineral. It frequently encloses small zircons, round which there is always a "pleochroic halo"; zircon occurs similarly in the hornblende. This mica occurs frequently, and is an important constituent of the Gap dykes; a precisely similar variety of mica is found in almost all slices of the Transkei olivine-dolerites, but in very small quantity.

Quartz is abundant in some parts of the Gap dykes, and present in all slides examined. It was the latest constituent to crystallise out from the liquid magma; it frequently forms a micropegmatitic intergrowth with a cloudy untwinned felspar, which is probably orthoclase. Both micropegmatite and quartz are occasionally seen in the slices of the dolerites, but they are generally very subordinate constituents of that rock,

The iron ores are magnetite, titaniferous magnetite or ilmenite with which sphene is very often associated, and iron pyrites. Apatite is always present, sometimes in considerable quantity.

The rock forming the dykes of the Gap may be called a quartz-mica-augite diorite; it differs from the olivine-dolerite very considerably in the absence of olivine, and in the presence of large amounts of hornblende, brown mica and quartz, as well as of the more acid varieties of plagioclase. It is very noticeable, however, that none of the minerals which characterise the Gap-rock are foreign to the olivine dolerites, and in the case of Kologha sheet the dolerite in parts approaches the Gap-rock in character rather closely, by the increase in the amount of hornblende, red mica, and the zoning of the plagioclase. The affinity between the two rocks is sufficient to make it preferable to regard the Gap-rock as derived from the magma which supplied the dolerite intrusions rather than the result of a quite different order of events. If we consider the Gap-rock as a late product of the magma after the dolerite had been got rid of, our view will explain the facts observed under the microscope and in the field, for while the evidence of a microscopic examination shows that the Gap-rock and the dolerite are genetically related, the field evidence conclusively proves that the latter rock had solidified before the former was intruded through it.

IRRIGATION ON THE ORANGE RIVER.

By F. B. Parkinson, A.R.S.M.

(Read March 26, 1902.)

The economical irrigation of small areas along the banks of the Orange River by means of modern machinery is a problem that does not appear to have received as much attention as it deserves. A short description of a position and plant where this has been successfully accomplished may therefore prove of interest.

The position of Baviaankrantz is an exceptionally good one for the purpose, being only 20 miles up-stream from Orange River Station, and the road being good, it is easy to get the produce to market.

The essential geological features are the escarpment of a basalt-capped plateau, along the foot of which the river ran at no very distant period. As the river cut deeper and deeper into the friable shale, which is the principal country rock here, it has retired from the bay-shaped foot of the plateau, leaving behind it a smooth sheet of alluvial deposit, having an average thickness of 15 feet and an area of about 800 acres, almost perfectly level, with a gentle slope towards the present position of the river. The river has now canyoned itself some 60 feet below this alluvial, so that it is on very rare occasions that a flood reaches it to add its inch or so of new silt after the manner of the Nile.

The walls of the plateau rise quite abruptly to a height of 200 feet, and are scored with intermittent watercourses and capped with rugged cliffs of basalt, with their accompanying taluses and screes, and the wastings of these has deposited a fringe of soil around their bases varying from quite a clayey nature to the well-known red earth that results from the weathering of basalt. Thus, then, we have an ideal for agriculture, sheltered on three sides by hills and on the fourth by the dense fringe of trees along the river-banks, and having a more than sufficient depth of a variety of soils suitable to the different crops. At the up-stream end of this land the river issues from a cutting it has made in a ridge of hills that crosses its course nearly at right angles, and it is here, in a rocky pool some 200 yards from the main stream, that the intake of the water is made.

Above this pool a small hill rises and protects a shelf of ground a couple of acres in extent, and 6 feet below the general level of the irrigable. Here two shafts have been sunk 60 feet deep and 8 feet in diameter, lined with hammer-dressed stone, and above each shaft is a wooden frame carrying a double "Noria" pump.

Now any attempt to supply these shafts from the river by means of a level tunnel, whether open or by pipes laid there below the minimum river, would soon be frustrated by being silted up, so to obviate this an incline tunnel was driven from a point in one shaft 15 feet above minimum, and issuing from the bank of the river into a rocky pool 2 feet above low water. I should mention that this pool is supplied from up-stream, where the river runs sharply across a basaltic dyke; no matter how low the river may be, the minimum level of this pool is constant.

In the inclined tunnel a syphon is laid, as shown, and by exhausting this syphon the water enters the pumping shafts and rises to the level of the pool.

The two shafts are in communication at the bottom by means of a connecting drift 2 feet 6 inches wide and 4 feet high, so that it and the shafts can be easily cleaned from any silt that may accumulate. During the past season, however, while the pumps were running the rush of water from the syphon and the churning action of the "Noria" buckets showed that very little cleaning up of the shafts would ever be necessary. By opening the exhaust of the syphon a thorough flushing is given to the pipe, which prevents the slightest chance of its clogging up, even at the muddiest state of the river. In practice we flush the syphon once a day, when the river is very dirty, and find this quite sufficient.

It would appear that this simple system is well worth the notice of riparian owners, as I am convinced it embodies a means which many might avail themselves of to great advantage.

The two double "Noria" pumps and syphon exhaust pump are driven from a counter-shaft actuated by an 18-b.h.p. oil engine. There are a pair of these engines, so that in droughty times there is no delay in pumping while an engine is being cleaned up. The plant is so arranged that other shafts may be sunk and other pumps and power added in proportion as the land is brought under cultivation, and the whole system supplied by the one syphon common to all the shafts.

The pumps discharge the water into a stout galvanised trough

2 feet in diameter, that is, lead round the contour of the base of the escarpment, and has a fall of 6 feet per mile. From this trough the water can be taken out at any desired point for distribution over the land. The result of the arrangement is highly gratifying, as it is found that, taking the average river level throughout the year, 100 cubic metres of water can be given to the land with a consumption of 1·2 gallons of petroleum. Now 100 c.m. water per acre is just about equivalent to 1 inch of rain, and may be taken as a good soaking for a grain crop to be given at one time. The first watering after ploughing takes, of course, much more, varying between 200 and 400 c.m. per acre, according to the nature of the soil, but after that it is difficult to get more than 100 c.m., laid on at one time. The maximum required for a crop of barley or oats, supposing there was no rain during its growth, is found here to be 700 c.m. per acre, and this would make the total consumption of oil 8·4 gallons per acre per crop.

The property was only acquired a few months before the war commenced, so that after the erection of the machinery it was only possible to crop about 25 acres on account of the impossibility of obtaining petroleum and other supplies; however, sufficient has been done to give us an assurance of future success, and many interesting points of both scientific and practical use were brought to light.

Generally it is when the river is fairly clear that most pumping is done; a muddy river and showery weather may be expected together, and at such times the crops need little auxiliary water; however, there was one month in 1900, during which the pumps were running, that the suspended matter in the water discharged on the land averaged ·1 per cent. We found this sediment of great value to the crops, not only in supplying them with nutriment, but it was of such a nature that it left a protecting surface to the soil which retarded evaporation, but at the same time was sufficiently porous to allow abundance of air to follow the water down into the soil. The nature of the silt varies greatly according to the part of the country it comes from. The dark-coloured freshets from Basutoland, which are rich in vegetable matter, suit our crops the best, and at such times we found it pay to pump for the sake of the silt.

All the grain and root crops, and most of the varieties of fruit trees that we have so far planted, give us the greatest encouragement, and I hope at some future time to be able to add other facts that may be of interest to the Society.

THE LEGAL AND ECONOMIC BASES OF SOME COLONIAL TEACHING UNIVERSITIES, WITH A LOCAL APPLICATION.

By Rev. Wm. Flint, D.D.

(Read April 9, 1902.)

John Henry Newman defines a University as "A place of teaching universal knowledge," and, if such a definition be accepted in its entirety, such a title as an Examining University must be regarded as a misnomer. It is, however, too late to insist on the right of being purists in the use of the English language; the position has already been yielded, and when Universities are mentioned we need some qualifying term to describe the particular class of institution to which reference is made. We may have our own views as to the desirability, or otherwise, of broadening the meaning of words, but it is certainly a distinct loss to language when the meaning of a word is broadened at the expense of the clearness and exactness of definition which it previously possessed. Nor does it seem to be in accord with the highest morality to capture a word, possessed of ancient prestige and honourable meaning, and claim its shelter for inferior institutions, and such as are lacking in certain well-defined and essential characteristics. Still, we have to take the facts as they exist, and in doing so it would not be difficult to bring evidence to show that what we term an Examining University, however valuable its work, must be generally regarded as of a makeshift character, especially in a country where it is the only type. In older lands, and where institutions of a varied nature are in existence, this need not be insisted on, as both Teaching and Examining Universities find their distinct spheres in the national life.

In a Colony like our own, where at present there is no choice between the two classes of Universities, there will, moreover, be generally found an under-current of unrest and dissatisfaction with the nature of the ideal of education available, both on the part of professors and students, and it must not be surprising if, at recurring periods, discussion arises, and even agitation breaks forth, in favour of placing the University education of the Colony upon the higher level.

That such a discussion should take place in our Society will be regarded as most natural; the first University which ever existed was the product of the philosophical mind, and such societies as this depend largely for their ultimate and permanent value upon the influence of University training and life. This Society is one of the very few in South Africa which can lay any claim to being a learned Society, and it has the advantage of approaching the subject from a starting-point outside of any particular educational circle with vested interests, while it is certainly beyond suspicion of having any axe of its own to grind.

Our study of the bases of Colonial Universities brings us immediately to the fact that in scarcely a single instance have the promoters and founders of those institutions been able to start their work *ab initio*, or it is not too much to affirm that in very few cases, if any, would the idea of an Examining University have been entertained as meeting the necessities of the Colony. The vested interests of collegiate institutions, more or less firmly established, have had to be considered; the religious prejudices or requirements of the Churches have had to be conciliated or met; and even when some of these difficulties might have been surmounted, economical considerations have often prevented the necessary effort, to overcome them, being put forth. But, even when all due allowance has been made for the influences at work in favour of establishing Examining, in preference to Teaching Universities, it has to be recorded that in scarcely a single instance has a Colonial Examining University of the pure type been founded. Indeed it may be noted that the University of the Cape of Good Hope appears to be the purest type of an Examining University existing in the whole of the British Colonies, and in its freedom from legal connection with colleges and institutions is almost *sui generis*.

In studying the bases of other Universities in the Colonies, that of New Zealand may be taken as representing the first approach to a Teaching University, and we bring it into this category notwithstanding the fact that the Act of Parliament upon which it is founded expressly affirms that it shall not directly exercise functions of teaching. There is a somewhat interesting and suggestive history attaching to this condition. In 1869 the Superintendent and Provincial Council of Otago passed an ordinance under which a University of Otago was established. It should be noted, by way of explanation, that the body adopting this ordinance was one of nine such bodies which, under the old constitution of New Zealand, legislated within certain limitations for the provinces into which the Colony was divided. Naturally such a local arrangement could not be generally accepted as meeting the requirements of the Colony, and the following year the General Assembly passed the New Zealand University Act. It was intended that this legislation on the part of the superior authority should bring about the amalgamation of the two Universities, but negotiations which followed did not meet with success, and the two institutions were continued as distinct bodies. In 1874 the struggle was brought to an end by the University of Otago surrendering, or holding in abeyance, its power of conferring degrees, and becoming affiliated to the University of New Zealand, on the stipulation that the University should not, as we have stated, directly exercise teaching functions. Meanwhile the Provincial Council of Canterbury had passed an ordinance founding the Canterbury College, with the same standard of University education as Otago, but without the power of conferring degrees. Subsequently a Royal Commission sat on University and Secondary Education, and reported that two other colleges ought to be established, in Auckland and Wellington. It was not, however, until three years later that the Auckland University College Act was passed, and ten years later still when the claims of Wellington were met. These four colleges have now a large specified annual endowment and extensive lands, which in the course of years will be of immense value to the institutions concerned. These University colleges are definitely affiliated with the University, and the Act provides for undergraduates keeping their terms at these colleges, or in exceptional cases, where distance prevents constant attendance, students may enrol their names on the books of these colleges, and after more or less teaching, provided they satisfy the local authorities in their examinations, may then proceed to the usual candidature for University degrees. In exceptional cases, also, exemption from attendance at lectures may be granted by the Chancellor. These facts and considerations may be said to bring the New Zealand University within the category of the teaching Universities, although the platform may be accounted the lowest which can be occupied. The essential principle is there of definite and exclusive University recognition for certain colleges, entitled to call themselves University colleges, provision for the keeping of terms, and the establishing of chairs and lectureships. It does not require the gift of prophecy to see in the arrangement the elements of a fairly permanent settlement of University questions for New Zealand, especially as the University colleges, by their situation, fairly well cover the local as well as the national requirements of the country. The Council of one of these colleges is constituted of three members appointed by the Government, three elected by members of Legislature, three by Educational Board, three by graduates, three by public school teachers, and one by the Professorial Board. Of a similar type is the University of Manitoba, except that the contributing and affiliated colleges have in several instances a denominational basis, the recognition of the denominations having apparently been a prime motive.

When we pass to Teaching Universities, properly so called, Australasia provides us with four examples, the type of which does not greatly vary, inasmuch as they all make provision for the necessary chairs and lectures, and for the residence of students, while at the same time they admit of affiliated colleges under certain clearly defined conditions.

The object of such Universities has been well set forth in the preamble of the Act to incorporate and endow the University of Sydney.

"Whereas it is deemed expedient for the better advancement of religion and morality, and the promotion of useful knowledge to hold forth to all classes and denominations of Her Majesty's subjects resident in the Colony of New South Wales, without any distinction whatsoever an encouragement for pursuing a regular and liberal course of education, be it therefore enacted," &c.

That is the incontrovertible principle for which true University education must stand in Colonial life.

Like others, the Sydney University was met with the difficulty of vested interests when it sought to establish itself, and it therefore wisely made a bold stroke, and by purchase obtained possession of Sydney College, which was then in the possession of a joint-stock company. The price decided upon was that of shares at par, while a legacy which had been left to the college, having been bequeathed in the public interest, was transferred to the University. A comprehensive building scheme was adopted, and the Government voted £50,000 for buildings, on condition that not more than £10,000, and not less than £5,000, of that sum was to be expended each year. All this took place, it has to be recorded to the honour of New South Wales, half a century since. The governing body consisted of sixteen Fellows, twelve of whom must be laymen, and when the University got into working order, not more than six, and not less than three, professors were added from the University staff. The residence clause is practically similar throughout the Australian Universities, and provides that students who attend lectures or classes must reside with parent or guardian, or some relative or friend selected by the same, and approved by the Chancellor or Vice-Chancellor, or in some collegiate or educational establishment or with a tutor or master, or in a boarding-house licensed by Chancellor or Vice-Chancellor. No religious test is allowed, but regulations may be made for securing attendance at Divine worship with the approbation of parents or guardians.

The details as to the establishment and the number of chairs and lectures need not be referred to at length, the comparative curricula of the different Universities not lying necessarily within the range of our present review.

It is, however, not a little instructive to study how the problem of relation to outside colleges has been solved, or what attempts have been made in that direction. The principle recognised in dealing with these was thus set forth :—

"Whereas it is expedient to encourage and assist the establishment of colleges within the University of Sydney, in which systematic religious instruction and domestic supervision with efficient assistance in preparing for University lectures and examinations shall be provided for students of the University, be it therefore enacted," and so on. Although the question of finance is dealt with in a later section of this paper, it is noteworthy that in the case of Sydney reasonable endeavour has been put forth to make the affiliated colleges worthy of the Colony and the University. A peculiar endowment was provided for each college established and incorporated within the University upon the following conditions :—

That £10,000 at the least shall have been subscribed by its founders, and of that sum not less than £4,000 shall have been paid and invested in a manner approved by the Governor, and the residue secured to be paid within three years, the whole to be devoted to the erection of buildings on land granted for the purpose from University or other land. The permanent endowment for such colleges to be paid from general revenue being not more than £20,000, with an annual sum of £500 for the stipend of the principal.

The provisions by which such colleges are brought into relationship with the University set forth that students on entering such colleges must matriculate at the University immediately, and thereafter continue to be members thereof, and regularly and duly attend lectures. Candidates for degrees are then admitted from those colleges on presentation of a certificate that the candidate has completed the course of education determined upon by the Senate; no such certificate being accepted unless the Senate authorise the college to issue it.

The Universities of Melbourne and Adelaide have a somewhat similar relationship to affiliated colleges, varying in detail sufficiently to meet the requirements of the local conditions.

As an evidence of how the principle is appreciated it may be noted that the provision has resulted in three denominational colleges and a woman's college seeking affiliation in the case of Sydney, while in Melbourne, Trinity Church of England College, Ormond Presbyterian, and Queen's Methodist are duly affiliated to the University, the arrangement being found of great practical advantage to the Churches concerned, especially in the matter of offering facilities for the training of ministers, while the Universities themselves gain at least something in breadth of work and interest.

The details of arrangements for affiliating colleges have been particularly well worked out in the Melbourne University constitution, and are specially worthy of attention, while the provision of well-constituted faculties in law, medicine, and engineering, give that breadth and comprehensiveness to the University work which is always to be desired.

The declaration setting forth the relationship of an affiliated college, reads as follows: "The educational establishment hereinbefore mentioned shall be an educational establishment of and within the University of Melbourne, and be known and distinguished as, say, Trinity College. Provided always that every student at the College shall within six months after he has entered into residence either be matriculated at the University, or be admitted *ad eundem statum* therein."

The recognition of lectures in affiliated colleges, is thus provided for: "Students of any college affiliated to the University shall be allowed credit for attendance on such of the course of lectures in that college as shall be recognised in the statute of affiliation, and shall be permitted to proceed to any degree in the University, provided that every such student shall have complied in other respects with the regulations of the University and the conditions of the statute of affiliation."

These regulations are, in the opinion of some, capable of improvement, but that is a detail which need not be discussed here.

As a practical lesson, it is interesting to note in passing an illustration of how in the face of difficulties one University, that of Adelaide, obtained its legal constitution. An association was formed for the purpose of establishing such a University, through which association a sum of £20,000 was offered and given for endowing two chairs, one for classical and comparative philology and Latin, the other for English language and literature, with mental and moral philosophy, the two first professors being at the same time nominated by the donor.

The principle of the affiliation of colleges is one for which it has been found necessary to provide throughout the Colonies. Naturally this leads to some representation of the colleges in the governing body of the University concerned, and that is brought about not infrequently by ordinary elections, but in other cases has been provided for by the principal and acting principal of affiliated colleges having a seat in the University college or Senate.

The following may be taken as a fairly typical form of regulations for the recognition of colleges and institutions in the different faculties :—

(*a*) A statement containing full information regarding the constitution of the managing body, and the names of its members.

(*b*) A statement regarding the standard up to which it is desired that the college or institution should be affiliated.

(*c*) A statement showing the provision made for the instruction of the students up to the same standard.

(*d*) A statement showing the scale of fees to be charged.

(*e*) A statement showing the building accommodation provided, or proposed to be provided, and the sanitary arrangements.

(*f*) A statement sufficient to enable the Council to judge of the financial stability of the college or institution.

It should also be remembered that the principles we have sketched are usually so applied as to meet the necessities and requirements of medical colleges, mining and engineering schools, and kindred institutions, in which case there is usually mutual recognition of University and school on the governing bodies of the respective institutions concerned.

When we proceed to the examination of the Canadian Universities we find teaching to be characteristic of nearly all. It is not, however, possible in a paper necessarily limited in length, however broad its scope, to give detailed accounts of the founding of these Universities, many of which can boast quite a reverend antiquity, such as is associated with few institutions in the Southern Hemisphere. Canada cannot have suffered much from the want of Teaching Universities, although, perhaps, if the whole truth were stated, there have been periods in the past when some of these institutions could scarcely be said to represent that high culture which we associate with the venerable seats of learning in Europe. Still worthy histories might be related, and the early chapters of some of them give many examples which might be emulated with advantage in younger colonies south of the Line. In some districts it would appear as if University competition had been too keen for efficiency, and we consequently learn not only of affiliated colleges, but of Universities federating with each other in order the better to serve the interests of the community and to promote the means of reaching the common end in view.

We may present the results of a brief examination of the University of Toronto, which is undenominational in its character, and has in addition to its University college, three theological colleges affiliated, and one University confederated with it, the latter being the Victoria University, originally associated with the Methodist Church. The teaching faculty of the Toronto University is very complete, and includes a provision which is perhaps unique. It provides for the optional subjects of Biblical Greek, Biblical literature, Christian ethics, and kindred departments of learning, but any provision for instruction and examination in the same is left to the voluntary act of federating Universities and affiliating colleges. In connection with this there is an express provision to prevent such subjects becoming compulsory in the University itself.

When the federating principle comes in between minor Universities and that of Toronto it is according to this provision. On federation the University concerned suspends its power to confer degrees, save in divinity, and is then entitled to representation on the Senate of the University of Toronto, the fact being notified to the parties concerned, the federation is in due course proclaimed by the Government.

The due representation of the federating bodies is evidently regarded as a distinctive and essential figure.

As in the Australian Universities students coming forward for examination are required to present certificates of attendance at the ectures of the federating Universities, according to local regulations, n tne case of colleges established for specific purposes, such as medical halls, certificates are required of attendance at the prescribed course of instruction, and by this means what are otherwise independent hospitals and faculties are made to serve the purpose of the University, to the advantage of both students and Universities.

In order that deserving students, who are unable, for personal reasons, to receive instruction in any federated or affiliated institution, may not be debarred from advancement, the Senate reserves to itself the right to give admission to the different examinations, on such conditions as the senate may from time to time determine.

In some Canadian Universities we find another feature set forth in their respective constitutions which is worthy of notice. Incorporated theological colleges are given the power to confer their own degrees in Divinity, while retaining their status in relation to other subjects in the particular University with which they are associated. The principle adopted is made to operate in two directions. Some of the subjects required for the Divinity examination, such as Oriental literature, logic, mental and moral science, are accepted as taught in the University curriculum, while for a degree in arts the whole University course may be followed, or some subjects may be studied in the college, the student being throughout a member of his own theological college.

In the founding of the University of Toronto, a University college already in existence was dealt with by express recognition, with a legal definition of its teaching faculties. This wise step at once conserved its interests, and took it out of outside competition with the larger idea of the University.

The instance of the McGill University, with its affiliated colleges, is perhaps one of the most instructive studies, presenting as it does the complete realisation of the idea of a central Teaching University with affiliated theological colleges, having under instruction, accord-to a recent report, some 1,250 students. The ground plan of the buildings presents an instructive object-lesson. In the campus we find picturesquely grouped the arts, medical, engineering, physics, chemistry, and mining buildings, with an observatory, museum, and library, while around these are the Presbyterian, Wesleyan, Diocesan, and Congregational Colleges. Not too far away to be out of reach are to be found the College for Women, the Hospital and the Veterinary College. The Melbourne University presents a similar object-lesson, well worthy of special study.

Having pointed out the general principles on which affiliation takes place, it may not be out of place to obtain a clearer view of an affiliated college. To such colleges there is given a definite constitution, and provision is made to ensure maintenance of efficiency in work and dignity in administration. The illustrative institution is that connected with the Methodist Church, the largest numerically of the Canadian Protestant Churches. It has a Board of Governors appointed by the General Conference of the Methodist Church, the number of whom is limited by charter to 30, and those who are locally resident constitute the Executive Committee. The Senate of the college consists of the Board of Governors, the Members of Faculty, Representative Fellows, not to exceed 21 in number, one representative of past students, and two representatives of graduates. The Senate has authority over the curricula of the college, to appoint examiners, to enact regulations relating to examinations and the general educational work of the college, to provide the mode of election of the representatives of past students and graduates, and to present suitable candidates for degrees in Divinity. The Act of Incorporation gives the power to confer degrees in Divinity, which are: Licentiate of Sacred Theology, Bachelor of Divinity, Doctor of Sacred Theology, and Doctor of Divinity. The matriculation for these examinations is that of the ordinary University Arts course, with the addition of an examination in Greek, if the same has not been taken in the University examination. For matriculation for the B.D. degree, the holding of the degree of B.A. or M.A., from some accredited University, or of Licentiate of Sacred Theology, with not less than an average 60 per cent. pass.

These details are given as representing a typical constitution of an affiliated college, possessing the power of conferring Divinity degrees.

There are several Universities in Canada which are entirely of a denominational character, both Protestant and Roman Catholic, and in these there is generally some provision for students belonging to other Churches, but these institutions would scarcely be of more than local interest.

Our observations have fairly set forth the prominent and distinguishing features of Colonial Teaching Universities, and sufficient of their legal bases have probably been revealed to give some idea, though necessarily an imperfect one, of how other Colonies, not altogether dissimilarly placed from our own, have sought to solve the great problem of how to introduce into new and growing countries higher education, and to perpetuate its advantages for succeeding generations.

The question of the economic bases upon which these Universities have been built up has also to be included within our purview.

It is gratifying to find what liberality has been evinced towards the different Colonial Teaching Universities by their respective Governments. An evidence of this is supplied by the case of New Zealand. The investments of the University itself amount in value to nearly £18,000, while an annual support of about £3,000 is applied by Statutory Grant, this being applied half to the general fund of the University, and half to its Scholarship Fund.

What requires to be noted in connection with the finance of the Australasian Universities is the very wise and prudent use which has been made of Crown lands. Each of the four colleges affiliated with the New Zealand University has been richly endowed in this manner. Some 40,000 acres have been applied to the purposes of these institutions with the most admirable results. In the case of

Otago, the rent of the reserves amounts to £5,500 on one account, while incidental rents and royalties make up another £1,000, the Church Board of Property supplies £1,800, and there are scholarship funds producing £2,866. Canterbury has a capital account of £30,000 derived largely from similar sources, and the rent of the reserves amounts to £8,750. Auckland and Victoria Colleges are younger, and their land reserves are not yet so largely rent-producing, but the former college derives £366 from this source, with a statutory grant of £4,000, while the latter college enjoys a statutory grant of £3,800.

Of the incidental sources of income it is not necessary to take account here, as they are naturally such as are found in similar institutions the world over; the point we desire to make clear being that, whatever may have been accomplished by private enterprise, the respective Governments have realised that their duty was to foster true University life and teaching, which are so essential to the advancement of a Colony, and have acted upon the principle that the assets of the country in the shape of lands could nowhere be better invested than in the production of those forces which make for the advanced culture of the people.

South Australia has supported this view by a grant of 50,000 acres of waste land to the University of Adelaide, not perhaps of great value per acre, but standing at present on the books of the University at £55,000, and producing an income of £2,776 per annum. The Adelaide University has been, as deserving institutions of this nature usually are, fortunate in its private benefactors. The first sum of £20,000 to which we previously referred, has since been increased to £134,000, and stability is given to this by a provision made in the original constitution of the University that the Government should in perpetuity give a 5 per cent. subsidy as interest on such endowments up to the sum of £10,000 per annum. The amount derived from this source, according to the last report on which I have been able to place my hand, is £6,339. A valuable site of five acres for buildings in a convenient position in the city has to be added to the pledges of the Government interest in the work and objects of the University.

We cannot take each University and deal with it separately, but we may state in passing that the University of Melbourne receives £9,000 per annum from Government endowments, and a sum of about £4,500 additional has more recently been added.

The University of Sydney presents an object-lesson which may be regarded as specially valuable. The original statutory endowment was the sum of £5,000 per annum, to which has since been added another £4,000, and there is also now an additional endowment of £2,000 per annum in support of University extension work, which has been successfully undertaken. As necessity has arisen the Government has not hesitated to make additions to the amount of the statutory endowment, the sum voted in some years varying beyond the stated sum to as large a figure as £13,000. It may also be noted that three denominational and one women's affiliated colleges have an annual State endowment of £500 each towards the stipend of their respective principals. The feature which calls for special notice in connection with Sydney is the fact that the private foundations of the University have evidenced both a prudent and generous spirit on the part of those possessed of wealth. The total value of these private foundations, as they stand in the books of the University, is no less a sum than £404,752. The income from these sources devoted to the funds of the University is £6,392, besides some £12,000 given to special scholarships. Incomes such as these place University teaching upon no uncertain foundation, and it is specially well to bear in mind the principle of statutory endowment in reference to the annual contribution of these Colonial Governments.

It is so easy to challenge an annual grant, and to mar the work of an institution under the influence of some passing local excitement, so that it is no small advantage to have certain sums definitely secured to be devoted to the work in hand in stormy as well as in sunny years. The case of the University of Tasmania affords an illustration of a grant having been cut down on several occasions, for six successive years indeed, sums varying from £1,000 to £1,500 having been taken from the grant, necessitating amended legislation to provide for the original sum of £4,000, mentioned in the Act, being annually provided in the estimates. Educationalists are not always the most worldly-wise of men, nor are they all born diplomats, and it is desirable that the national support of a University should not be made contingent upon the passing excitement which may be created by an idiosyncracy of the man who receives a grant, and we may add, nor yet upon that of the man who votes it.

The Canadian Universities have largely benefited by private munificence, and are some of them rich in the endowments which they possess. McGill has endowments valued at some three millions of dollars, and in its equipment in many departments bears witness to the practical wisdom of many of its benefactors in bygone years. Commencing with an endowment which its founder designed at first for the establishing of a medical faculty, it has grown into a great University, but, to the honour of the memory of McGill, has never allowed the medical side to deteriorate, and to-day this is said to be unsurpassed in the quality of its equipment.

A measure of State-aid is given to many of the Canadian Universities, but one of the features which again calls for notice is the part which land has played in the endowments of these institutions. In connection with the Acts of Incorporation of Canadian Universities, it seems to have amounted almost to a custom to include a grant of a large acreage of Government lands, which in the course of years, in some instances, has attained to a high value. Indeed, the lands of Canada have been greatly exploited in the cause of education.

In some cases the towns in which the colleges are situated have accounted it a duty to make a contribution from local funds for the honour and advantage of having the University situated in their midst.

There is also one feature which appears in connection with some of the Canadian Universities which is noteworthy, and that is the large amount of money which has been raised, not in the large contributions of the very wealthy, but by the gifts of the people in sums varying greatly in amount. In a few instances denominational rivalry and honour have contributed not a little towards this end. But from whatever source the money required has come, Canada has abundant reason for being congratulated upon its magnificent University institutions, for in not a few cities the University, while helping to raise the life of the people, has contributed not a little to the beautifying of the city through its architecture. The younger States are also hastening to follow in the course of the older provinces of the Dominion, in some cases benefiting largely by the experience of those who have wrought and thought before.

It now remains to gather from this review what may be learned by way of local application, and there is not a little—although the work of studying the legal and economic bases of these Colonial Teaching Universities has been imperfectly accomplished.

What is hereafter given forth by way of suggestion is not intended in the least degree to disparage what has already been accomplished in the direction of higher education in South Africa. There was a time when criticism, and severe criticism, was necessary, but no one can have listened to the recent addresses of the Vice-Chancellors of the Cape of Good Hope University without being struck with the immense strides which have been made in the direction of the higher culture in recent years. It was not always thus. In 1857 there was a Select Committee appointed by the House of Assembly to examine certain educational returns which had been sent in dealing with the higher grade schools. The report of that committee begins by a reference to certain promises made by the Government seventeen years before, in 1839, and observes, regarding these: "We need not enter in detail the instances of neglect. In fact, with the exception of appointing one competent teacher in each school, the neglect in everything else has been, as far as the evidence goes, universal." Books, libraries, models, and philosophical apparatus are in turn mentioned, and with one trifling exception, the verdict is: "In no one instance has this promise been fulfilled." The report adds: "And it is to the lasting honour of the teachers and of the public that the schools have been sustained, and have in many cases accomplished so much good as they have done, and it is very great, under circumstances so discouraging. Believing that the House is disposed to look forward to what should and may be done to make the first-class schools a blessing to the country, rather than to censure the shortcomings of Government in past times, we respectfully submit the outlines of a system which we think may accomplish that object." If such was the attitude of the Government towards the higher grade of schools fifty years ago, it is not surprising that when Melbourne and Sydney were laying the foundations of their Universities, so little was being done for South African colleges, and nothing attempted in the direction of establishing a Teaching University for the country.

It is not, however, necessary here, where all, or most, are fairly well acquainted with the history of college and university movements in South Africa, to recapitulate what has been done, or to deplore in dolorous tones what has been left undone. Our vision must be rather directed to the present and towards the future.

It must, I think, be allowed that there are many reasons beyond those which exist in the nature of things, and which might bring this subject to the front at any time, why the matter of a Teaching University should come up for discussion at the present juncture. It is not alone the makeshift character of an Examining University which presses the subject upon us for consideration at this time. The standing objections to an Examining University as the only one in the country are always present. Educational schemes in connection with our colleges must be regarded as more or less of a tentative character, for, however excellent, it must be felt that after all they are not that which shall be, some time, in the near or distant future.

We have, however, to consider at the present moment that the country is in the throes of a new birth, and there is little or no probability that matters educational will continue as they have been in relation to this great question. Already we find in the London press references to certain towns in the new Colonies as containing the possibilities of becoming University centres. It is scarcely likely that Cape Colony will stand quietly by and let judgment go by default against her as being unworthy of the possession of the first Teaching University in South Africa. It has to be remembered what such a condition would mean. It would not mean certainly the retention of her present premier position in the matter of education, for the establishing of a Teaching University elsewhere could not fail to result in the draining off of not a little of the best educational life we possess at present. By history, by heritage, and, we may add, by worthiness, Cape Colony and Cape Town should be the first in the field in this matter. It is worth while to consider the possible ways in which the end may be reached.

Our review has shown us the systems in vogue in sister Colonies, and which of these may unhesitatingly be affirmed to be capable of application to South Africa, is perhaps not easy to determine.

There is first of all the simplest form of a University consisting of colleges duly affiliated, with regulations giving the University a voice in the making of the statutes governing the Colleges, and representation of those Colleges in the University Council. In connection with such Colleges there must be regulations governing the residence of students and their attendance at lectures, with due preparation for the University examinations. Such colleges may be scattered over a wide or a restricted area, with or without their buildings being vested in the Government or University, they must be entitled to a definite share in a Government endowment, they must be regarded, and exclusively so, as University Colleges. Their number need not be necessarily fixed in the beginning, leaving room for others to qualify.

Then there is the fully equipped University, with its own halls and colleges, the whole scheme being self-contained after the pattern with which we are familiar in the older countries. This is an ideal which is scarcely likely to be attained, and if we judge from what we have had brought before us from the experience of the other Colonies, it appears that this scarcely meets the varied necessities of Colonial life, however regretfully we may have to arrive at that conclusion.

The more practical method seems to be to take an existing college as a nucleus, establish and endow by statutory grant or private beneficence as many chairs as may be possible, and with this to permit of affiliated colleges. Such colleges may exist for specific teaching and training only as divinity, medicine, engineering, and mining, or they may cover certain other of the requisite subjects for examination, the conditions under which this is practicable having appeared before us in our review. Such colleges might be built upon a site granted by the Government or the University, on condition that buildings of not less than a specified value be erected. Or the affiliated colleges might be some already in existence, as in the case of Toronto, but receiving official recognition, and being empowered to carry on their work as additional colleges to those under the more direct auspices of the University.

Whatever University is established must be broad enough to attract, and so constituted as not to repel, those who have been seeking in past years in their own spheres and neighbourhoods to promote University ideas and interests. It must be borne in mind that whenever a Teaching University is set up there will probably be some inconvenience and possibly some passing loss to other bodies, but the longer the present condition continues the greater will be the measure of that inconvenience. The vested interests of the different teaching bodies will always be increasing. Should it be found necessary or desirable to take a particular college with its properties and interests as the nucleus of the University it must not be supposed that such a college becomes an unfair competitor with other colleges. It is taken out of the category of an ordinary competitor by the very act which creates it the nucleus of a University. In discussing any scheme which may be proposed it will be necessary to discriminate between the arguments against the weaknesses and defects incidental to a beginning, and those against the general principle involved.

If we look around us for a practical nucleus, taking the facts as we find them, it must, we think, be confessed that the whole history of the South African College, especially as it is related in Blue Books, shows that it has been approximating gradually through its whole career to the ideal of a Government institution, existing for the purpose of University teaching. Perhaps the same may be said of two or three other colleges, and in discussing schemes, it remains for such assertions to be proved, and due consideration must then be given to the claims established.

Should such an institution as the South African College be accepted as a nucleus of a Teaching University, it would at least bring with it the prestige of honourable lineage, and every old South African College student would have as a compensation for the loss of the familiar and inspirational initials, the feeling in relation to the

University of the future of having come over, as it were, with William the Conqueror.

How such a University should be supported has been perhaps nearly sufficiently indicated by what we have seen in other Colonies. First of all, there must necessarily be a large statutory grant to ensure stability, and to what better purpose could the Colonial revenue be put? If possible, Crown lands should also be set apart for the purpose of endowment, and Natal, the Transvaal, the Orange River Colony, and Rhodesia might be approached with the view of certain of their spare lands being granted for this purpose, and an annual payment made, with the proviso, if so desired, that should a Teaching University be established in those territories, the lands and grants should revert to the particular Colony concerned for local University purposes. Where lands are given, there is always a possibility of increase in value as the assets of the country ascend, which is an important aspect of endowment to be borne in mind. Should such a University be established in Cape Town, the Town Council might be asked to acknowledge the honour of having the centre of University life in its midst. In this connection I would suggest that the Standard Bank and Opera House might be handed over to the University for the purpose of endowment. The present peppercorn rents could be made available at once, and when the properties fall in later, the value would be considerable, while no ratepayer would be conscious that he or the town had made any sacrifice.

Nothing here suggested may reach the ideal which it is possible to conceive, but ideal schemes are seldom practicable, and we usually have to be content in accepting the next best, or the next but one even.

Once established, there can be little doubt that a Teaching University would attract large sums of money for its support and endowment, which are now taken elsewhere, or remain in private hands. The object-lesson of a broad South African culture, high-toned and spirited, could not fail to commend itself to the sympathetic support of those who are often glad to know that there are channels into which their wealth can be turned with the certainty of its being of permament use to the community.

Looking at the history of endowments for University education in South Africa, it would appear that the tendency is to establish scholarships tenable at the older Universities of Europe; but this plan, however admirable in some of its objects, cannot be regarded with unmixed satisfaction. It has the result of tending to drain the country of some of its most promising students, and to keep back the progress of University life in South Africa. It tends also to perpetuate the present expensive and wasteful staffing of colleges in which there are already too few students of the best calibre, while the effect upon the professors will continue to be seen in the readiness with which men will leave us for positions where their work has a true University status, with the consequent more ready accessibility of those offices associated with an educational career of the more advanced type. Scholarships available at European Universities we must always have, but if our own educational life is to be helped forward in the direction of its possible best, the European scholarship will serve the highest purpose when it is made post-graduate, when it partakes of the nature of reward for what has been attempted and done, and when it has a special object in view. It is difficult to give unmixed praise to any scheme which tends to defer the day when our own University shall exercise all those higher functions for which such a body ultimately exists, namely, the home of intellectual, moral, and social culture, and the centre of those forces which naturally spend themselves in research in the higher branches of the arts, sciences, and crafts.

What steps should be taken to secure the establishing of a Teaching University in South Africa, or how far it is practicable to go in the near future, there will doubtless be many to suggest. What must be taken for granted seems to be the necessity for working on broad lines. The question belongs to South Africa. It is not one for Cape Town or for the Cape Colony alone. South Africa as a whole needs this University, and never needed it more than it needs it to-day. Nothing that has transpired during the past fortnight has lessened that need. The time will probably come when there will be two or more Teaching Universities in South Africa, but it is doubtful if there is room for more than one at present, without perpetuating that wicked and weakening waste of resources and men which is one great condemnation of our present collegiate system.

To obtain the one University required there are several possible methods of procedure. We naturally turn to our present University as the centre from which expansion would most naturally proceed, and which will doubtless one day put forth effort in this direction and obtain the requisite powers and resources to enlarge the scope of its work. It is of course open for a particular college obtaining private endowments to force the question of applying to Parliament for a charter. Or, failing action in such quarters, those who are interested and believe in the object in view, might form themselves into an association and educate and agitate public opinion with the purpose of securing for the country what they desire. Our own view as to the best of all courses would be for the University authorities or the Government to promote a Commission which should be representative of the whole of South Africa, to inquire into the whole question with the express object, not of amiably appeasing those who feel earnestly on this matter, but of accepting and promoting the best scheme found to be available and practicable.

Were this done, it is not improbable that arrangements could and would be made whereby schools of mines and other technical institutions, situate in different parts of the country, would be given the University upon their work, and possibly if some colleges were perforce left outside the actual University scheme an advanced status would be granted to other educational establishments already in existence. In any decision arrived at with regard to existing institutions, possibly resulting in the survival of the fittest, it must be borne in mind that that education does not exist for the colleges, but the colleges for education, and the nation cannot afford to sacrifice the larger purpose for the sake of a local or personal feeling. But we are persuaded that difficulties of that kind are not insurmountable if we are really in earnest.

Possibly any or all these courses are too much to hope for, or to expect, at the present time, and we may have to remain content to hope and long and labour for our object through yet unnumbered years, but still it is not too much to observe that every well-wisher of South Africa anticipates with high expectation and gladness the time when the intellectual currency of the country shall bear worthy mark in the shape of degrees which represent not merely a narrow study under cramped local conditions, or a cram preparation for an examination, but a distinctive University life, and the discipline of daily contact with the noblest minds of this land, and many attracted from other lands beyond the seas.

THE VOLCANOES OF GRIQUALAND EAST.

By E. H. L. Schwarz, A.R.C.S., F.G.S.

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The Drakensberg Mountains have for a very long while been known to be of volcanic origin; the amygdaloid with which they are capped is easily recognised to be an undoubted volcanic lava which has been poured out on the surface of the earth, as opposed to a trap rock, in this country principally dolerite, which has been injected into the strata without any vent whereby it could come to the surface. Four years ago Mr. Churchill contributed a paper to this Society on the amygdaloids of the Drakensberg Mountains in Natal, and many other writers have also called attention to the character of the rocks which form this range.

In 1878 Mr. E. J. Dunn made a detailed survey of the country round Molteno and Jamestown, which lie at the western end of the Drakensberg range, and in the map accompanying the report he shows three centres of eruption, two near Molteno and one near Jamestown. In an unpublished map by him of the country east of Jamestown he shows two more centres of eruption. Although he described these volcanic pipes with accuracy, and saw the bearing the discovery of them had on the elucidation of the geology of this region, the fact seems to have been generally overlooked, and no further volcanoes had been discovered till the geological survey party recently found some nineteen or twenty well-marked vents in Matatiele. Mr. Dunn lays stress in his report on the similarity of these vents with the diamondiferous pipes of Kimberley and the west of the colony, but in spite of the similarity of the structure, both being large vertical pipes piercing the strata and filled in with ejected material which has fallen back and clogged up the hole, yet there is a great diversity in the character of the agglomerate or mixed-up material in the pipes. In the diamondiferous pipes, and similar ones in the west, and also in the Bingara diamond pipe in New South Wales, the agglomerate consists principally of the *débris* of very basic rocks, which are not known to occur *in situ* in South Africa, whereas the volcanic pipes of Griqualand East are filled in with material usually with a very high percentage of silica.

One fact makes the Griqualand East volcanoes of special interest. They are very old, belonging to the upper Jurassic or Cretaceous periods. Old volcanoes like these are known from many parts of the world, and many midway in age between these and recent ones; but in these foreign ones either all traces of surface features are entirely swept away by the long-continued action of wind and weather, and we have only a hardly recognisable stump remaining; or, like in the Eifel, the whole cone is covered in by sediments and the surface features are preserved while the internal structure is hidden. In Matatiele, however, we get these stumps, and can see the condition of things in the pipe many thousands of feet below what was once the orifice of the volcano, but we can also trace some of the surface features as well, and in one instance one can actually see the lava still in continuity with the mass of molten material in the pipe, pouring out over the surface of the old land-surface, and can trace the ropy surface which the viscid liquid acquired as it cooled, in days when the highest living being was a reptile. In this way one has, by piecing together the evidence from two or three closely adjoining vents, a natural section of a volcano of 4,000 or 5,000 feet in vertical extent.

A volcano either pours out liquid lava or throws out dust and ashes, or does both alternately. Among the Matatiele volcanoes one can find all three varieties; that is to say, some of the vents are filled almost entirely with solidified lavas, forming immense plugs; others are cylinders of dust and ashes, long consolidated into compact rock, while other pipes again are filled in with varying proportions of both. Of course one and the same volcano under different circumstances may play both parts at different times; a volcano may for centuries continue to quietly pour out lava, and then of a sudden enter on an explosive stage. From the fact that all the Matatiele pipes, with one possible exception, contain some ash or agglomerate, it is highly probable that the last stage of the volcanoes was an explosive one, whatever kind of activity they previously had.

It will be noticed that all these vents discovered in Matatiele occur south of the Drakensberg range, and at first sight it would seem that these volcanoes confined their attention to the northern side, leaving the country on the southern side of the vent uncovered, but it is easily seen how this state of affairs has arisen. Take, for instance, the volcanic range of hills east of Honolulu in the Hawaiian Islands. This range runs N.W., S.E. The eastern side bears the full brunt of the trade winds, and it is on this side that nearly all the rainfall of the island occurs; the high mountains wring from the trade wind all its moisture, and consequently as it blows over the western part of the island it assumes the character of a dry wind; the eastern side is therefore intensely eroded, presenting a gigantic cliff which, except at one point in the whole range, is hardly accessible to human foot, while the western side is gently inclined and has the appearance more of a sloping plateau than part of a mountain range. The same action has gone on in the Drakensberg. When the volcanic peaks towered up in a long line running in a north-easterly direction they caught the full blast of the rainy south-easters, which precipitated their moisture on the windward side; on the leeward side the rainfall was slight, consequently the windward slopes of the mountain were eroded at a great rate, while the leeward was gently carved out by the denuding action of running water, and formed an incised plateau, a character which Basutoland still expresses. The windward side, therefore, became steeper and steeper; great falls of rock occurred, which were carried away to sea by the impetuous mountain torrents, and presently the very centres of the volcanoes were exposed, and eventually the progress of erosion continued further till only the northern slopes of the old volcanic pile contributed to form the mountain chain, and the vents, no longer situated in the loftiest portion of the range, got worn down and down till most of them are now found at the lowest levels at the foot of the mountains. Some, however, strengthened by a weather-resisting backbone of solidified lava, held out longer than the rest, and now occupy outstanding positions on the flanks of the mountains, and these form the most interesting ones of the series, as it is in these that one can trace the lava-flows and other surface features.

I will not go into details of all the varieties of vents with the particular rocks that each contains; that information will be embodied in the usual Annual Report of the Geological Commission, but I will take one or two cases from which the general nature of these volcanoes can be understood. One of the best of the agglomerate pipes occurs on a farm, "Deer Park," belonging to a Dutchman named Bekker, who had for a long time speculated on the nature of this peculiar jumble of all sorts of rocks; it is just in front of his house, and forms a very conspicuous object along the road. The pipe is about a quarter of a mile in transverse section, and is slightly elongated in a N.W., S.E. direction; a river cuts it in two, but on the northern side the bed of the river runs for a short distance between the encasing Stormberg Beds and the pipe, so that the latter stands up like a cylinder on one bank of the river. The variety of rocks in the pipe is astonishing; the ground mass is a white sandy substance very like the ordinary trachyte-tuff that occurs with most volcanoes of a type less basic than these particular ones. The percentage of quartz in the ground-mass is unusually high. In this tuff there are all sorts of varieties of lava: some rounded and vesicular like bombs, others odd-shaped lumps of amygdaloid of every kind of igneous rock that is found in the district, and, in addition, large pieces of sandstone and shales, pieces of rock that have been torn from the sides of the vent and ejected with the other truly volcanic material. The size of the fragments lies between minute lapilli to boulders 3 feet in diameter. The beds adjacent to the present surface of the vent consist of Stormberg sandstone, and are bent downwards and inwards towards the pipe, as if the material in falling back into the vent had dragged the surrounding beds with them. There is a good deal of dolerite in the pipe, probably forming a dyke-like mass, but the surface of the ground where the dolerite occurs is too much covered with *débris* to allow one to make out the relationship of the rock. One very peculiar point about this pipe is that there are a few rare bits of charred wood in the tuff. It seems very curious at first glance to find wood in a volcanic pipe, but one can get a very reasonable explanation if one supposes that before the last outburst there had been a long period of quiescence, and the slopes of the volcano were not only covered with forest, but that trees had actually grown inside the crater. This is by no means an uncommon occurrence in volcanoes at the present day. When then the final eruption took place, some of the trees became dragged down with the rain of falling boulders and ashes, and broken bits of branches became embedded in the tuff.

This last pipe occurs in the river-bed at the foot of the range, at about 5,000 feet above sea-level. If we climb up the mountain we find a sharp-pointed peak standing out from the general line of escarpment (Fig. 1). It looks peculiar owing to the fact that the dolerite with which it is apparently capped is arranged in rough columns, but on getting on to the peak one finds that the dolerite forms a cylinder surrounded by a rim of white Cave Sandstone; at one spot there is a well-characterised mass of agglomerate, consisting of a blue, sandy matrix, with numberless rounded bombs of vesicular lava embedded in it. These features are sufficient to establish the nature of the hill as being of volcanic origin, but on the north side there is a thin flow of amygdaloidal lava passing from the pipe towards the great mass of lava that forms the mountain-crest behind; the lava-flow was the first that occurred in this region, for it can be traced underlying all the others in the escarpment at the top. This first flow is covered near the vent by two or three others, but at one place the latter have been weathered away, leaving a shelf which shows the actual surface of this first flow. The surface has the peculiar structure known as ropy, and is that which any viscid material acquires when allowed to flow slowly, and can be well seen in pitch that oozes out of a broken barrel. The ropy surface, I take it, is a proof that the lava was poured out on the surface of the ground, and not under the sea as has been suggested, as it is unlikely

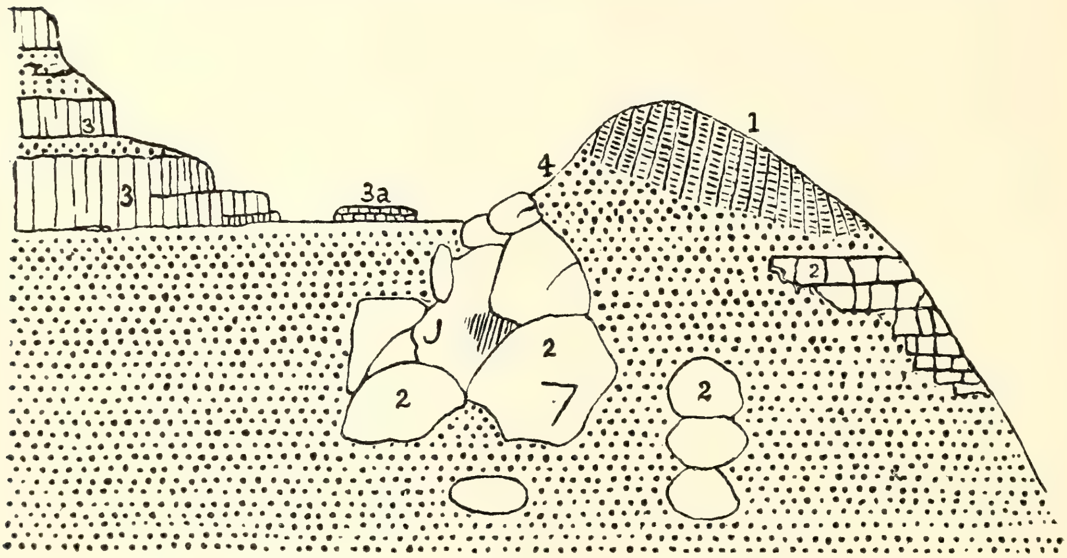

Fig. 1.

View of the high volcano on Deer Park, seen from the west. 1. Plug of columnar dolerite. 2. Cave sandstone forming a rim round the plug. 3. Amygdaloidal melaphyre forming the crest of the Drakensberg. 3a. A portion of a flow of amygdaloid which has evidently come from the vent, and which passes beneath the rest of the lavas on the north; at one place this flow shows the ropy surface of cooled lava. 4. A small tract of volcanic agglomerate with vesicular bombs and fragmental sedimentary rocks. The stipling represents the grass-covered slopes.

that such a structure could be formed under water with considerable pressure to add to the fluidity of the molten rock. The thickness of these three lava-flows that can be seen near the vent are remarkably thin, being only 1 foot to 3 feet in thickness, while there are small flows wedged in between the principal ones that are hardly a foot in thickness.

The main plug of the vent consists of dolerite, which on solidifying has assumed a rough columnar structure, and further each column has split up into a number of wedge-shaped fragments. To the south-east of this volcano there are a number of hills capped with a precisely similar rock, distant from the volcano from 2 to 3 miles. These caps are probably part of one of the early flows, and if so it is one of the few that can be traced flowing southwards. It can be easily seen how this particular flow would withstand denudation, owing to the hard, compact nature of the rock, the ordinary lavas being easily decomposable amygdaloids. The petrographical examination of this lava-flow promises many interesting features.

The ordinary lava is an amygdaloid, and forms the bulk of the crest of the Drakensberg range. It has been described by Professor Cohen * from specimens sent from Basutoland by Mr. J. Orpen. Professor Cohen calls the rock a melaphyre. I have, however, collected an immense number of varieties besides the melaphyre; the latter, though undoubtedly forming the larger proportion of the lava-flows, is interbedded with other types of more acid or more basic type, more crystalline or more glassy, of which I hope a preliminary description will be given in our next Annual Report. The lavas are full of blow-holes, as is usual in other lavas. These arise from the fact that all molten material, as it exists deep down in the earth's crust, is permeated with water-vapour, and owing to the great pressure at these depths the vapour is forced to occupy a very contracted space. When the lava is brought to the surface the same thing happens as when a deep-sea fish is brought to the surface, the water-vapour in the one case, and the air in the air-bladder of the other, expands, and as the fish bursts with the expansion, so the water-vapour forces the rock asunder and produces the cavities. No rock in its natural state is, however, entirely free from water, and this is always slowly creeping about, sucked in through cracks so minute that the highest powers of the microscope fail to reveal them, and even, as there is good reason to believe, through the very inter-molecular spaces of the crystals. Water thus circulating carries with it certain salts in solution, and when it oozes slowly into the cavities of the rock it deposits the salts before being driven out again through the substance of the rock. In this way nearly all the vesicles in ancient lavas are filled in with a group of minerals peculiar to such rocks and called zeolites. Cohen has described the zeolite occurring in his specimens as Heulandite, a hydrated calcium aluminium silicate, but I have not yet been able to determine the varieties in my specimens; besides the zeolites quartz and calcite

* *Neues Jahrbuch*, 1875.

are very common. Ordinarily these amygdules are rounded, but in the Drakensberg a peculiar variety occurs in the shape of long, thin pipes, about the thickness of a lead pencil. These often anastomose and form branched bodies like some of the corals. The pipes stand upright in the flow, and in typical cases there is at the bottom, at the contact with the sandstone or underlying lava, a compact mass which has cooled quickly. Then, half an inch above the lower surface, there is a zone of small vesicles; then, again, a thin layer of compact rock. Above this comes the regular layer of pipe amygdules standing thickly packed together, and averaging 4 or 5 inches in length; sometimes in the thicker flows there is another zone of pipe-amygdules above this first one, and separated from it by a layer of compact rock, but more frequently this second row consists of short pipes or vesicles elongated in a vertical direction; five to eight separate vesicles have been counted arranged above one of the pipes below. Such a prodigious development of large vesicles is not known to occur elsewhere, and points to a great amount of water-vapour held occluded in the molten magma than usually happens; it also points to the sudden eruption of the magma, which did not allow time for the water-vapour to get expelled on the way up from the regions of intense pressure. Agates in the form of pipe-amygdules have been for a long time familiar to the diamond diggers on the Vaal River, where they occur with ordinary rounded agates; they have probably been derived from the disintegration of the Drakensberg and Maluti amygdaloids. Many of the lava-flows, however, do not show this structure, but are filled with rounded vesicles, and others again are compact crystalline rocks, from which the excess of water-vapour was got rid of before extrusion.

Some of the lava-flows immediately above the sandstones are full of pieces of sedimentary rocks, which they have picked up in their course, and held up in their substance when liquid. A good example of this is to be found in Glen Alfred, where the base of the flow is like an agglomerate, so thickly studded are the bits of foreign material.

The two Deer Park volcanoes already mentioned are by no means the only ones on this farm. The general trend of the whole group in Matatiele is 60° E. of N., but the Deer Park volcanoes occupy a line nearly at right angles to this direction, and on the south side of the Drakensberg. I have been able to find altogether six distinct vents in a distance of about three miles, the two referred to above are the largest, the others are very much smaller, and the two ones at the southern end of the line are only 6 and 4 yards across. Possibly there are others, and I strongly suspect that the orchard by

Bekker's house is on a large volcano, since the soil around is particularly poor and sour, but just at this point it seems to be rich; at any rate trees flourish on it. The form of the hills around also leads one to suspect a volcano as they form a steep-sided amphitheatre, on the south of which two small pipes make their appearance. South of Makomereng also there are three volcanoes in a line at right angles to the general trend, and these lie right away from the mountains, and are separated from them by the deep valley of the Kenigha. At Ongeluk's Nek, the place over which Adam Kok came with all his waggons from Griqualand West, and where he smashed most of them up, there is a very large volcanic pipe partly filled in with agglomerate and partly with dolerite, which is in continuity with a heavy flow of that material in a south-easterly direction. The volcano is beautifully dissected by a tributary of the Mabele River, and a new road has been cut right through it, so that very perfect sections in a fresh state are available for study. On the west side of the volcano there is a bed of agglomerate wedged in between the sandstones, showing that the shower of ashes spread over the country far and wide. The particular spot was probably a lake, and when the agglomerate had been deposited the ordinary sedimentation followed and covered the agglomerate with sand. This is the only instance of such a bed that I found in Matatiele, but Dunn states that they are common round Jamestown and Molteno.

The amygdaloidal lavas at Ongeluk's Nek contain very large amygdules of quartz, calcite, and zeolites, and many of the flows have covered up soil and sediment that formed in previous flows. The soil now presents a crumbly, earthy appearance, and the sediments, formed either along the sides of the runnels that carried away the storm-water of the volcano, or in temporary lakes caused by the damming up of such runnels by cross flows of lavas, have been baked and hardened to such an extent that some of the shaly beds have been actually porcellanised. One bed is particularly interesting, showing that the greatest change is not along the sides of the bed, where it was in contact with the molten lava, but in the centre. This porcellanised shale was thought to be gold quartz, and it, and the larger amygdules were actively prospected not long ago, but with no results, though gold is reported to have been found in minute quantities.

At the bottom of the Ongeluk's Nek pass the amygdaloids descend to the level of the plain, so that they are much more available for study than at other places where they are high up on the mountain-side; beautiful examples are here afforded of ropy surface, and of sections showing the lavas filling in the inequalities on the surface of the older lavas which had been produced by erosion during a period of rest from volcanic activity. Here also three thin dykes of dolerite cross each other at a particular point, and they can be traced for many miles running each in a straight direction through the horizontal beds of amygdaloid.

Between George Moshesh's country and Makomereng there is a larger dyke of dolerite which thickens out to an enormous mass in Maklagala's country and thins out gradually on either side. The direction of the great dyke is not quite parallel to the present line of the Drakensberg crest, but approximates more nearly to the general direction of the line of volcanoes. Sections showing the relationship of the dolerite to the amygdaloid are not frequent, but on Makomereng there are some which show the dolerite cutting through the lower beds of lava, and then bending over and covering these as a thin sheet, which again is covered with more amygdaloids.

I was not able to determine finally whether the dolerite was only intrusive between the amygdaloids or had been poured out on the surface and then covered with more vesicular lavas. I am strongly inclined to believe that the latter was the case, both from the appearance of the rocks in section, and also since the dyke in some places is curiously mixed up with the encasing wall, and appears to have arisen explosively in the crack; in another place the amygdaloidal lavas seem to be in continuity with the dolerite of the fissure. It is very doubtful, also, whether such an immense body of molten rock could come so near the surface as this one did without pouring out some of its material. It is an interesting point which I hope the petrographical examination of the rocks will be able to clear up, for if it proves to be a true fissure of eruption we have a splendid example of a phenomenon which has been surmised to exist from theoretical considerations, but never yet actually found to exist.

South of this there is a smaller dyke which has also the appearance of having arisen explosively in its crack, for it includes many fragments of the wall of the dyke included in the substance; the igneous rock and the north wall is intensely crumpled and injected with small dykes, and these phenomena are unknown in the ordinary dykes of the district. Further west again, near Rankakata's Nek, there is another great dyke with the lava apparently pouring over the surface of the sandstone, but the surface features have been too much eroded to allow of any definite statement to be made as to the nature of the fissure.

Before going into the consideration of these volcanoes in regard to their tectonic aspect, I should like to mention the Cave Sandstone which has puzzled me exceedingly. It is a soft granular sandstone, creamy to brilliantly white. It forms thick massive beds often 60 to 100 feet thick, and weathers in extraordinary pepper-pot and mushroom shapes, or again in immense tabular masses. It sometimes contains structures that look like plant stems, and cavities also in it are filled in with chalcedonic silica, like in the agates and opals of the lavas that lie upon it. It always accompanies the volcanoes, and is especially thick in their neighbourhood, whereas in the east of the district where the volcano line crosses over the Drakensberg Mountains into Basutoland, the Cave Sandstone is absent for some distance south of the Drakensberg, and the lavas rest directly on the Red Beds. The whole appearance of the rock is so strikingly similar to a trachyte tuff, that I at first took it to be such, and thought that it was the result of the first explosive outbursts of the volcanoes, which were situated at that time beneath the sea, but microscopic examination shows it to be made of quartz and felspar, the latter largely microcline, but, except in one doubtful case, I have found no volcanic glass, and no mica or other ferro-magnesium constituent. Mr. Lewis, of the Government Analytical Laboratory, has analysed it for the Geological Commission, and his analysis finally settles that it is a sedimentary rock and not a tuff.

The group of volcanoes just described taken together are arranged along a line trending roughly 60° E. of N.; if the western end is produced it will run through the three volcanoes discovered by Mr. Dunn near Jamestown and Molteno. Whether there are volcanic vents in between these two groups, and whether they occur along this line it is impossible to say until the survey of Barkly West and Herschel is undertaken, but from the description of the country, and from what we know of the occurrence of volcanoes elsewhere, I think most geologists would say that there could be very little doubt on the matter.* If we accept the view that there is a whole series of volcanoes arranged along a line of weakness in a direction about 60° E. of N., we have a weapon for attacking some very difficult problems in the past history of South Africa—problems which have a bearing on the structure of the continent as a whole.

I am afraid this line of reasoning is somewhat complicated, not that it involves obscure points, but as each step forms a problem in itself, and as nothing has yet been published on the matter, each step wants a great deal of discussion before it can be accepted as proven. First of all it is essential to understand the river system of South Africa. This consists of two quite distinct series, an old

* Mr. Dunn in a map made to accompany the same report, G4, 1878, but never published, shows two more volcanoes to the east of Jamestown, namely, Glat Kopjes and Wonderbosch Klip.

and a comparatively new one. The old one was started before the eruption of the Drakensberg volcanoes, and was developed on a comparatively featureless plain. It consisted of a number of rivers having their sources along a straight line which ran through the country in a direction roughly 60° E. of N. From this watershed, which can still be clearly traced from the Cape Peninsula to Delagoa Bay, a distance of about 1,000 miles, the waters flowed on one side in a south-easterly direction and on the other in a north-westerly one. The watershed now is only once cut through by the Orange River. After this principal river system was developed stresses in the earth's crust forced the strata round the coast into folds whereby the main mountain ranges of South Africa were formed, but all this went on so slowly that the old rivers were able to cut their way through the folds as quickly as the ground rose across their courses,

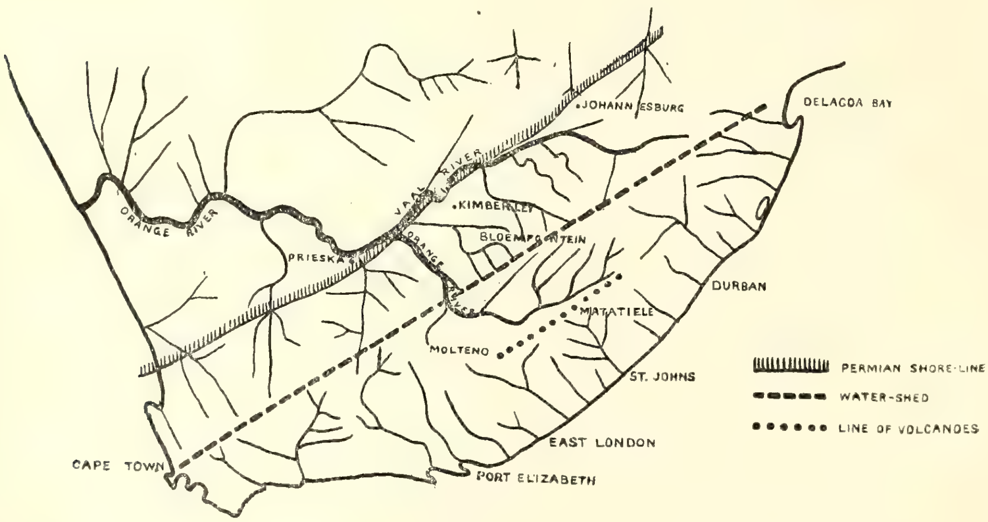

Fig. 2.

Map of South Africa showing the relation of the rivers to the water-shed and the line of volcanoes. It also shows the parallelism between the probable course of the Permian shore-line, the water-shed, the line of volcanoes, and the present shore-line on the south-east of the continent.

and for this reason we get the extraordinary gorges that traverse all the mountain ranges in the south-west of the Colony. When the mountains were formed the old simple drainage system was naturally disturbed, and a new one was instituted to accommodate the new order of things, and in this way we get the two systems, a new one superimposed on an old one. Looking now at the area in which the volcanoes occur (Fig. 2) one notices that the rivers on the north-west side of the watershed arise in exactly the same manner as those on other parts of the same watershed. On the south-east side the rivers are crowded together, and their arrangement is quite different from any other group of principal rivers in South Africa; they bear evidence of having been deflected from their natural course, which was to the south-east, and having been forced to flow across their natural water-parting. The case of the Caledon River, which flows practically on the watershed, is particularly interesting. I think the map showing the courses of the rivers affords very satisfactory evidence of the volcanic range having been thrown across the primitive river system, which means that the volcanic outbursts occurred after that system had been developed, and that the new land of the Karroo, formed off the shores of the old continent, was already dry land at the time. We know from evidence we can get from the Western Province that this river system was instituted in Jurassic times, so here we have a link in the chain of proof that these volcanoes were Upper Jurassic or Cretaceous.

The second step deals with the deposition of the sediment from the Dwyka Conglomerate upwards, and for this we only have a knowledge of the distribution of a small part of the Cape Colony, and a still less complete knowledge of the distribution in the Transvaal. The Dwyka Conglomerate in the Colony is a deposit containing glaciated or scratched boulders of a number of peculiar types, all of which have now been traced to their origin in the north-west of the Colony, Bechuanaland, and the Transvaal. From which it follows that the glaciers which carried these boulders flowed from the north-west. Mr. Rogers and myself have found in the Colony the actual beds of these glaciers, and have seen the old land-surface over which they flowed. The course of the glaciers was to the south, between S.S.W. and S.S.E., and the old shore-line ran through Prieska in a direction about N.E., passing west of Johannesburg and near Mafeking. Dr. Molengraaff, in Vrijheid in the Eastern Transvaal, has found a similar land-surface, over which the ice moved in a north-westerly direction, so here we have evidence of two shore-lines, separated by the width of the Transvaal, which in Permian times was occupied by an inland sea.*

In the south of the Colony the Dwyka was not deposited on a land-surface, but the mud was laid down under water and the boulders dropped into it from the floating ice that broke off the ends of the glaciers. In this way we are able to get an idea of the trend of

* The conglomerate in Natal, to the east of the Vryheid occurrence, was also probably formed on land, which leads one to suspect that the country from which the Vryheid glaciers flowed was an island.

the old shore-line of the continent that existed in Permian times, which afforded the sediments for the Dwyka Conglomerate and succeeding strata.

It is interesting at this stage to notice the change of sediment that resulted from the degradation of this old continent from the times when it rose in mighty mountains towering above the snow-line, although so near the Equator, and glaciers, with their peculiar morainal matter, crept down their sides; through times when, in the course of ages, the effects of weathering had cut the mountains down so that snow no longer accumulated on them, and the climate of the continent became more genial, the rivers discharged sediments which now form the Ecca shales, characterised by abundance of vegetable life; to the time when the continent became hot and the Karroo reptiles multiplied on the land, and sediments peculiar to shores off tropical lands were deposited.

The third step depends on what becomes of the sediments deposited off the shores of continents. It is by no means universally accepted, but the view is every day gaining in favour that the crust sinks under the weight of accumulated sediments, and certainly we have the fact that the sediments from the Dwyka Conglomerate to the Upper Karroo are bent into a basin-shaped form: this can only have happened by the crust bending; but the question whether this is due to surface being weighted by the sediments or to some other cause I will not now enter upon, but for the sake of brevity I will take it that the crust did sink under the weight. The sediments from the old north-western continent went on accumulating; sinking allowed a vast amount of material to be deposited, but finally the sea became very shallow. It was about this time that the great dykes and sheets of dolerite were intruded into the Karroo Beds, and the sediments, up to the Upper Karroo, were lifted above the surface of the water and became dry land. It was on this new land that the first river system was developed as explained previously. The new land formed a fringe of some 100–150 miles broad running parallel to the old shore-line.

We come now to the question of the Stormberg Beds, which were deposited outside this new land. Are the Stormberg Beds made up of sediments such as we should expect from the degradation of a land formed in the manner we have just described? The sediments from such a land would consist entirely of very fine detrital material, as it is itself entirely formed of fine *débris* from the waste of the old continent.

The Stormberg Beds are certainly formed close in shore. The muds which occur in the series are full of the most perfect remains of fossil ferns which could not have floated far before they became embedded, but the softer beds are separated at repeated intervals by great beds of coarse sandstone. This sandstone is what Mr. Dunn calls "glittering sandstone," and seen in the strong sunlight it has the appearance of having every grain specially faceted to catch and reflect the light. The grains consist of clear fresh quartz, such as one gets in granite or felsite, often as big as peas, and sometimes showing unworn crystal faces; besides quartz there is a very large amount of felspar, now weathered and turned into kaolin, but many grains still retaining sharp crystal faces, and in addition large mica flakes are frequently found. These sandstones must have been derived from a granite or quartz-felsite, and not a dyke of such material is present in the Karroo, and again, the grains of quartz, felspar, and mica are too fresh to have travelled all the way from the old northern land. The Karroo land in Jurassic times then could not have afforded the material for the Stormberg Beds. Whence, then, was the material derived? The only answer is, from a land-mass to the south which has since sunk beneath the sea. From other considerations derived from the study of the western part of the Colony we had already begun to believe that an old land-mass had once existed along our southern shores, but we had no very safe arguments to go upon; but taking all the evidence now it is highly probable that in Cretaceous times there existed a large archipelago of islands, if not a connected land-mass, in the neighbourhood of our present southern shores; and that it was in the sea, enclosed between this southern land and the old northern land that the sediments from the Table Mountain Sandstone upwards were deposited. It is very probable that Madagascar and the Seychelles are remnants of this southern continent, but off our present shores the sea-bottom shows no trace of the presence of a submerged land.

Let us now see how all this bears on our volcanoes. First of all there was a shore-line running roughly N.E. Sediments were deposited off the shore of this continent in a band parallel to it, that is, also N.E. A watershed afterwards was formed in these new sediments running N.E. A line of volcanoes broke out, that line running N.E., and the shore of our present land was cut off in a N.E. direction. I think few people would deny that all these phenomena had some common cause which gave the dominant trend to all.

My explanation is as follows:—The sediments from the Dwyka Conglomerate upwards were deposited on an inland sea,* the centre

* It should be noted that this is not the same inland sea that Mr. Dunn postulated in his paper to this Society (*Trans.*, vol. xi., pt. 1, pl. i.), since where he

of which ran in a N.E. direction, parallel to the old southern land surface, and it was here that the greatest depth of sedimentation occurred. The crust sank under the extra weight in doing so, the underlying beds became strained, and eventually lines of weakness were produced which allowed the molten material beneath the solid crust to force its way upwards in the form of dykes and sheets of dolerite. The sediments thereby became intensely heated, expanded, and tended to decrease their curvature, hence the whole mass rose, sediments and injected dolerite together. The line of greatest deposition, and consequent most intense heating, had the greatest relative elevation, hence on emerging from the water the flat lands of the Karroo already had a very well-marked water-parting to begin with, and this is the watershed that still dominates the river system to-day. Where the dolerite had not been injected the strata remained stationary, and on the hinge of the movement a further weakness was produced, and that hinge would be situated in the position where we now find the volcanoes. There are dykes of dolerite in the Stormberg Beds, but there is very good reason to believe that they are of a later date than the central Karroo ones. Given a line of weakness in the earth's crust, there needs no explanation to understand how volcanoes become formed along it.

Such are some of the points raised by the discovery of these new volcanoes, and though much may have to be altered later, when the survey of the Colony progresses and new material accumulates and the survey of Natal and Eastern Transvaal is brought into line with our work, yet I have thought it well to bring the points before the Society at this early date because they form an entirely new departure in the way of regarding the structure of our continent and have an important bearing on some of the theories of the origin of continental areas in general.

places his southern shore line, along the flanks of the Zwarteberg range, the sediments show no signs of being shore-deposits, and to the south of the mountain-belt, near Worcester, there are occurrences of Dwyka Conglomerate and Ecca Beds that must have once been continuous with those on the north of the mountains, and these also are deep water-deposits. The inland sea that I am referring to must have had its shore line to the south of our present coast.

SOME RESULTS DERIVED FROM THE CONSTANT VALUES IN THE PERIODIC FORMULÆ.

By J. R. Sutton, M.A. (Cantab.).

(Read May 28, 1902.)

In a previous communication dealing at some length with certain pressure and temperature observations made in South Africa,* I omitted—chiefly for want of time—to discuss the coefficients and angles derivable from Bessel's periodic formula. The omission is to be regretted, because, apart from the no little interest of the results, a number of errors both of calculation and of faulty copying would have been detected in such values as were given. But having had reason lately to compute the periodic constants for a number of places, as opportunity offered, I have made a synopsis of them here, correcting also the errors which were found in the MS. of the previous paper which, as it fortunately happened, had not been destroyed.

The formula is, for monthly co-ordinates—

$$
\begin{aligned}
a = p &+ a_1 \sin (A_1 + m \,.\, 30) \\
&+ a_2 \sin (A_2 + 2 \,.\, m \,.\, 30) \\
&+ \dots \\
&+ a_n \sin (A_n + n \,.\, m \,.\, 30) + \dots
\end{aligned}
$$

where a is the value required,
p is the mean of the year,
$A_n = \tan^{-1} p_n/q_n$,
$a_n = p_n/\sin A_n = q_n/\cos A_n$,

p_n and q_n being the known coefficients in Lambert's formula; a_n and A_n the respective amplitude and phase-time of the harmonic constituents.

* "Some Pressure and Temperature Results, &c.," read in April last, but not yet (April, 1902) printed.

The formula is essentially an equation to a curve, and can in fact be applied to any pulsatory graph if a sufficient number of terms be taken. It seems to have been claimed that the individual terms represent separate physical processes; but that, surely, is to strain its applicability to undue lengths. If, for example, we imagine the term involving $m30$ in the curve of maximum temperature to represent the direct solar effect, cleared of all secondary influences, then obviously A_{I} should have a constant value equal to about 114° for all places south of the tropics. But while this value of the angle is closely approached in the interior of South Africa, we shall see presently that the values for other places greatly reduce the significance of the circumstance.* The virtue of the formula is geometrical rather than physical; it assigns interpolated terms to any degree of accuracy, and it is most convenient for purposes of comparison.† There is not a single term in it which can be proved to epitomise any natural sequence of events with reference to their cause, although it is not unlikely—and this is important—that a comparison of a number of corresponding terms taken from the equations referring to places having different geographical positions and climates may suggest such an epitome. It is from this point of view that the results collected here should be examined.

In the Tables below will be found values of the coefficients and angles in the respective formulæ representing the pressures at Kimberley, Umtata, and Durban, and the maximum, minimum, and mean $[=(M+m)/2]$ temperatures of the same places, together with those of Queenstown, Aliwal North, and Philippolis. There are also given computed values of most of these, compared with observation, at twenty-four equidistant intervals throughout the year, say at the middle and end of each month.

In the case of the barometric pressure the term of single annual period is by far the most important, its amplitude being, in each case, about twelve times as great as any of the following terms. The ratios between one station and another, of this term, are—

$$\text{Durban} : \text{Umtata} : \text{Kimberley} = 100 : 88 : 96.$$

Thus Umtata, on the slopes, approximates to mountain conditions, whereas Kimberley, which is at a much greater altitude on the Table-land, does not. The phase-time of maximum for this term at

* In corresponding latitudes in the interior of South America the constant angle does not exceed 85°.

† See, *e.g.*, its use at Greenwich to represent the diurnal march of the magnetic elements.

Kimberley falls about the 1st of July, and the minimum, therefore, about the 1st of January; at Umtata it is some six or seven days, and at Durban twelve days later. The sequence, then, is the same as that of temperature, but with a shorter interval of time: for while the maximum temperature phase at Kimberley comes five days earlier than the minimum pressure phase, at Durban the pressure phase precedes that of the maximum temperature by nearly eighteen days. The inference seems to be that many of the phenomena of pressure at Durban are the outcome of a chain of operations originating on the Table-land above.

The term of six-months period decreases its amplitude with altitude; the phase-time at Kimberley precedes that of Umtata by nearly 40 degrees of arc, and that of Durban by more than 87 degrees, corresponding to time intervals of about twenty and forty-four days. The phase-times of highest mean pressure are roughly—

Kimberley	Dec. 15th and June 15th
Umtata	Jan. 5th and July 5th
Durban	Jan. 30th and July 30th

The amplitude of the term of four-months period is larger at Kimberley than at Durban, and still larger than it is at Umtata. The phase-times of highest mean pressure are about—

Kimberley.....................	13th Mar., July, and Nov.
Umtata	3rd Mar., July, and Nov.
Durban	2nd Mar., July, and Nov.

The amplitude of the term of three-months period is remarkably small at Umtata, therein being in marked contrast to the collateral maximum temperature term. The phase-times of highest mean pressure are about—

Kimberley	27th Mar., June, Sept., Dec.
Umtata	16th Mar., June, Sept., Dec.
Durban	8th Jan., Apr., July, Oct.

The temperatures prove to be of exceptional interest. Upon referring to the Tables it will be seen that so far as the mean temperature is concerned the amplitude of the annual term increases with fair regularity from the coast to the interior, and also that the phase-time comes earlier in the same direction, ranging from a time interval of ten days at Umtata to twenty-one days at Kimberley. The phase-times of the term of six-months period are in the reverse order, the coast being fully twelve days earlier than Kimberley, although the amplitudes stand in no regular sequence. It is noteworthy, however, that the Philippolis observations determine a break in the uniform increase of a_1 with distance from the coast, and also another in the retardation of phase-time of A_2. But since the observations cover a shorter period it is possible that the peculiarity might eliminate itself in time.

In the case of the maximum temperature the amplitude of the annual term increases with distance from the sea, as is also the case with the term of six-months period. The term of four-months period, however, increases from Durban to Umtata, falls almost to zero at Queenstown, and then rises again. The term of three-months period behaves irregularly; but chiefly it would seem from the smallness of the magnitudes it deals with: the influence of a tenth of a degree in the values of p_4 and q_4 being very considerable in the final evaluation of a_4. But both in the term of four-months and in that of three-months period, the greatness of the amplitudes at Umtata, as compared with those of the other places, deserves attention. This not improbably has a solar origin, for the magnitudes dwindle to something like an average in the corresponding values of minimum. The relative smallness of a_2 at Durban, the fact that a_3 is almost as great, coupled with the anti-synchronism of the phase-times of A_2 and A_3 during January, combine to explain why the Durban curve of annual mean maximum temperature is almost a simple sine curve.

The phase-time of A_1 for the curve of maximum temperatures comes earlier with distance from the sea, Kimberley being not quite thirty-five days earlier than Durban. Moreover, it is the distance from the sea in particular, and not the altitude, which is responsible both for the epoch and for the above-mentioned progressive increase in the value of a_1: for Queenstown, which is less than a third of the distance of Kimberley from the sea, is only 500 feet lower, while Aliwal North and Philippolis, at respective distances of about one-half and two-thirds, are both considerably higher.* The phase-time of A_2 is much earlier on the coast than it is at the inland places. Here Umtata forms a sort of connecting link, midway between the coast and the interior.

The phase-time of A_2 for the minimum temperatures is pretty nearly constant everywhere; but, on the other hand, A_1 shows great variation over a small range of differences, falling two days earlier at Umtata and Kimberley than it does at Queenstown, and

* See the remarks on their altitudes in "Some Pressure and Temperature Results, &c." Also the *Reports* of the Meteorological Commission.

two days later than it does at Aliwal North. Also a_1 displays a tendency to be greater or less according as A_1 is greater or less. It seems not unlikely that the values of a_1 may depend in some measure upon the geographical gradients.

The ratio of a_1 [max.] to a_1 [min.] is one of lesser inequality at Durban and of greater inequality at Kimberley, approaching equality at something over 250 miles from the sea. Also the ratio of a_2 [max.] to a_2 [min.] increases in magnitude from the sea to the interior. The values of these ratios are:—

	a_1	a_2
Durban	·73	·36
Umtata	·43	·35
Queenstown	·88	·62
Aliwal North	·83	·70
Philippolis	·95	·90
Kimberley	1·21	·95

They intimate that the influence of the ocean upon the temperatures is appreciable up to at least 250 miles inland. But not because of any increase of moisture in the air consequent upon nearer approach to the sea; for, as it happens, there is not, so far as can be judged from the observations, any very great increase in this element between Kimberley and Queenstown. We judge from the values of a_1 and a_2, A_1 and A_2, for Umtata, that the character of its annual curve of day temperature is oceanic, whereas that of the night is continental; so that we find, upon reference to the records, that the analytical constants translate themselves into a mean daily range of temperature more than half as great again in the winter than it is in the summer. Now at Kimberley we get the greatest range of temperature in the late spring months, and the fact has a partial explanation in the excessive dryness of the air then. But at Umtata the percentage of humidity seems not to vary very much month by month during the year, and thus furnishes no key to the interpretation of a daily range of temperature equal, at its maximum in the winter, to the greatest found on the Northern Karoo, and at its minimum in the summer, scarcely greater than that of Durban.

It seems to be a reasonable conclusion, from the analysis, that we have really before us a phenomenon analogous to, if not identical with, the familiar land-and-sea breeze, whereby the littoral air is displaced seawards during the night and landwards during the day, carrying its temperature with it. Probably the bodily transfer of air to and fro may be considerable, preponderating considerably on the whole, landwards by day during the summer, and even more considerably seawards by night during the winter. Is it hazarding too sweeping a suggestion that the energy of this movement may be propagated in some form up to at least such a limit as is defined by the condition—

$$a_{\mathrm{I}}\,[\text{max.}] = a_{\mathrm{I}}\,[\text{min.}]\,?$$

If so, we have a glimmering of the possible explanation of the intrusion of easterly winds at Kimberley somewhat earlier at night than would be the case if the vane followed the sun's diurnal march with uniform angular velocity.* For the lower air-strata trending seawards at night must be replaced in great part by air from above. Now because of the much higher temperature of the sea-surface along the eastern coast than upon the western, the greater air-transfer of the two will take place across the eastern littoral, and hence such air as may be supposed to settle down into the depleted space inland, at night, must have in the long run a pronounced easterly component. A little consideration will make it clear, moreover, that it could only appear very plainly beyond—and perhaps not far beyond—the area over which the influence of the sea upon the temperatures was felt. For all of the inflowing upper current that settled down upon, coming into actual contact with, the outflowing lower current must, of course, have its flight modified by friction, and either be retarded, or brought to rest, or turned aside, or even forced into the lower drift, according to circumstances. The momentum of such portion of the mass as had not been checked carrying it beyond the limits of outflowing air, it would here impress its own velocity, westwards, most strongly upon the air remaining. Thus, upon this view, the winds in question mark a sort of backwash to the diurnal pendulum-like swing of the air at right angles to the coast-line. As a further argument upon the same side it may be mentioned that winds with an easterly component seem to be more frequent over Kimberley in winter than in summer between the hours of XX. and midnight.

Now it has been shown in the paper two or three times mentioned that the maximum temperatures day by day at Kimberley appreciably satisfy the equation—

$$a = \mathrm{AS}^2 \cos \mathrm{Z} + \mathrm{B} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

* Some further information is now being prepared bearing upon this curious circumstance.

And therefore the expression on the right-hand side is very nearly the summation of the sine series evaluated for any month at Kimberley. We shall obtain from this equation the following set of theoretical values corresponding to the middle day of each month :—

	°		°
Jan.	92·3	July	65·8
Feb.	89·6	Aug.	71·8
Mar.	83·7	Sept.	80·0
Apr.	75·5	Oct.	87·2
May	67·3	Nov.	91·3
June	63·3	Dec.	92·7

And if we compute the numerical coefficients and angles in the periodic formulæ for these we get, to the fourth periodic term—

$$\begin{array}{ll} p_1 = +\ 13{\cdot}5377 & q_1 = -\ 5{\cdot}8467 \\ p_2 = -\quad 1{\cdot}1750 & q_2 = +\ 1{\cdot}5155 \\ p_3 = -\quad {\cdot}2000 & q_3 = +\ \ {\cdot}0167 \\ p_4 = +\quad {\cdot}1583 & q_4 = +\ \ {\cdot}0433 \end{array}$$

$$\begin{aligned} a = 80^\circ &+ 14{\cdot}747 \sin (113^\circ\ 22' + m30) \\ &+ 1{\cdot}918 \sin (322^\circ\ 13' + m60) \\ &+ {\cdot}201 \sin (274^\circ\ 46' + m90) \\ &+ {\cdot}164 \sin (\ 74^\circ\ 42' + m120) \quad \ldots\ldots\ldots(2) \end{aligned}$$

where evidently only the coefficient of the last term differs by a material percentage from that given in Table 2.

Denoting the amplitudes and phase-times of this particular formula by a_1, a_2, . . . A_1, A_2, . . . as before, and supposing the successive differences between these theoretical values and the values from observation, given in Table 2, to be β_1, β_2, . . . we find for the normal maximum temperature on any assigned day, very nearly—

$$\begin{aligned} a = AS^2 \cos Z + B - 2\Big\{ &a_1 \cos \left(A_1 - \frac{\beta_1}{2} + m30\right) \sin \frac{\beta_1}{2} \\ &+ a_2 \cos \left(A_2 - \frac{\beta_2}{2} + m60\right) \sin \frac{\beta_2}{2} + \ .\ .\ .\ \Big\} \quad \ldots\ldots\ldots(3) \end{aligned}$$

in which twice the quantity within the ceratic brackets is the correction to be applied to either of the standard forms—

$$AS^2 \cos Z + B$$

or—

$$p + a_1 \sin (A_1 + m30) + \ .\ .\ .$$

in order to obtain the observed series—

$$p + a_1 \sin (A_1 + \beta_1 + m30) + \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Over the centre of the Table-land of South Africa the equational correction will, in most cases, be small. What it will be elsewhere remains to be seen. We shall apply the equation (3) to the temperatures observed at other places in the country, using the local values previously found for a_1, a_2, a_3, . . . in evaluating the equation (4); A_1, A_2, A_3, . . . being assumed constant for all and having the numerical magnitudes assigned in (2). This amounts, in fact, to an assumption that the unperturbed maximum temperatures considered as proceeding directly from the action of the sun will everywhere evolve the same phase-times in Bessel's equation, while the amplitudes will vary with geographical position. Hence, obviously, final success must depend upon the initial accuracy of the angles determined in equation (2).

It is known that, generally speaking, the highest and lowest mean maximum temperatures of the year come some time after the epochs of the sun's greatest and least meridian altitude at noon. This is easily perceived to depend in some way upon the balance that is being struck continuously between the heat received from the sun and that radiated again by the earth into space. It is commonly spoken of as though it must be a magnified presentment of the diurnal lagging of maximum temperature: the diurnal maximum falling about a twelfth of a day after midday, while the annual maximum falls about a twelfth of a year after midsummer. Or as an authority puts it: "While the sun stands farthest north or south of the equator in June or December, the greatest migration of the heat equator northward or southward is found in July or August and January or February; just as the hottest part of the day is an hour or two after noon." * It is difficult, however, to see that the two phenomena are so closely analogous. At Kimberley the hottest time of the day is some time after XIV., like other places. But the hottest time of the year is not far from Christmas Day—just after the solstice. At Kimberley, moreover, the temperature of the surface layers of the soil reaches its highest degree during the day an hour or more earlier than the air does; while at Cordoba the observations of a number of years seem to indicate an annual maximum just beneath the surface some ten days earlier than that of the air. These facts compared seem to imply that the lagging of the hottest time of the day depends upon the vertical temperature gradient. When this is steep, *i.e.*, when the superincumbent layers are relatively very cold, the lower layers will tend to ascend; but when sufficient heat has been communicated to the

* Davis, *Elementary Meteorology.*

former by the latter there will be equilibrium in accordance with certain thermodynamical principles that are not difficult to understand. And then the lower layers of air will run up a temperature nearly equal to what it would have been at noon had there been no upper layers to warm. But the annual lag seems to depend largely upon conditions of circulation manifested upon a much larger scale, in which Kimberley, with its lack of a prevailing wind setting in from elsewhere, does not participate. That is to say, the temperatures of most places are in part determined elsewhere, whereas that of the Table-land of South Africa, from its simplicity, almost reaches the character of the result of a laboratory experiment—determined on the spot. It is this nearly universal lagging of temperature that makes it so difficult of representation by a physical formula. The formula (3), however, enables us to eliminate some of the complication, and to deduce monthly series which are fairly good linear functions of the sun's altitude at noon—giving, moreover, the same annual mean maximum, and much the same values of y (though of course different values of x) for the condition expressed by $dy/dx = 0$, as the original observed series.

The results for four different stations are given in Table 8, in which under the name of the station will be found:—

Col. 1. The monthly mean observed maximum temperature, M;
Col. 2. The correction E computed by means of the series given in the formula (3);
Col. 3. The series D deduced from M by the addition or subtraction of E;
Col. 4. The series T deduced from a consideration of the sun's altitude and distance, but in which the constants A and B of formula (1) are indicated by Col. 3;
Col. 5. The differences T – D.

East London was added to the Table more as an afterthought because of the very small variation of its mean maximum temperature month by month, and the lateness of its spring period. Only the amplitudes and phase-times of the maximum curve have been computed. They are—

$$p_1 = +\,3{\cdot}4204 \qquad q_1 = +\,1{\cdot}3207$$
$$p_2 = +\,{\cdot}5250 \qquad q_2 = -\,{\cdot}1010$$
$$p_3 = \;\;{\cdot}0000 \qquad q_3 = -\,{\cdot}2000$$
$$p_4 = -\,{\cdot}1083 \qquad q_4 = -\,{\cdot}3608$$

$a_1 = 3{\cdot}666$	$A_1 = 68^\circ\ 53'$
$a_2 = {\cdot}535$	$A_2 = 100\ \ 53$
$a_3 = {\cdot}200$	$A_3 = 180\ \ 0$
$a_4 = {\cdot}377$	$A_4 = 196\ \ 42$

The differences T – D are not great so far as Durban, Queenstown, and East London are concerned. It may be suggested that they partly arise because the numbers in M do not stand for quite the same things as those in T : M, indeed, containing the mean monthly values (assumed, without too much warrant, to be equal to the normal value for the middle day of each month) ; whereas T is computed for an actual day. The Umtata differences are greater ; no doubt partly because of the importation of alien conditions, as pointed out a page or two earlier, and in a less degree because the observations are not yet extended enough in years to give the normal curve.* It is curious how uniformly T – D changes from *minus* to *plus* from April to May, the excess of T over D being in the latter month the greatest of all. In this instance the average difference (leaving out Umtata) is $0^\circ{\cdot}6$. None of the other months reach an average, positive or negative, so great as half a degree. Such a result surely justifies the applicability of the process employed. It is important to observe that the numbers in the columns T could also have been empirically deduced directly from the physical formula (1). This method, however, would not in the least connect them with the numbers in the columns M. The advantage of the actual procedure is that it shows that the maximum temperature upon any day of the year at either a coast or an inland station may be very well stated by means of an algebraic equation of an invariable form.

A comparison of the respective values of A and B so far found is interesting. Leaving out the decimal places they are :—

	A	B
East London	16	61
Durban	24	62
Umtata	25	56
Queenstown	42	43
Aliwal North	53	34
Bloemfontein	56	33
Kimberley	73	23

* And partly perhaps in consequence of some disturbances arising out of the topography of the district in which it is situated.

Thus, in each case, we have $A = 5a_1$ very nearly; so that the magnitude of A increases with distance from the sea.

The values of the angles in the expressions stating the corrections to be applied to the physical formula in order to elicit the co-ordinates in the curve of observed temperatures are given here for reference:—

	East London.	Durban.	Umtata.	Queenstown.
$A_1 - \beta_1/2$	91° 7′	94° 36′	99° 56′	105° 56′
$A_2 - \beta_2/2$	211 23	188 27	161 36	319 29
$A_3 - \beta_3/2$	227 23	245 34	244 53	101 36
$A_4 - \beta_4/2$	315 42	352 21	352 21	311 16
$\beta_1/2$	22° 15′	18° 46′	13° 26′	7° 26′
$\beta_2/2$	69 20	46 14	19 24	2 44
$\beta_3/2$	47 23	29 12	29 53	6 50
$\beta_4/2$	61 0	82 21	82 21	57 34

The subjoined Tables are these :—

Table 1.—Numerical values of p_n, q_n, a_n, A_n, for pressure, computed from the observed values given in the previous paper referred to.

Tables 2, 3, 4.—The same for the maximum, minimum, and mean temperatures of selected stations. The averages are only reckoned to the first decimal place, so that the mean temperature of a month may not always appear as the exact arithmetical mean of the mean maximum and mean minimum. Such small differences as there are in this respect are responsible for the fact that the value of p_n in Table 4 is not always exactly midway between the values of p_n in Tables 2 and 3.

Tables 5, 6, 7.—Computed values (a) of pressure, and of temperature for the middle and end of each month, and the difference ($c - o$) between the computed and observed mean monthly values of the different elements. The value of $m = o$ indicates the middle of January.

Table 8.—This has been sufficiently explained on a previous page.*

* To save space only the final results are given, and not the intermediate steps. The calculations of this nature involve great labour.

TABLE 1.

Pressure Values in the Sine Series.

	Durban.	Umtata.	Kimberley.
p	inches 30·105	inches 27·703	inches 26·055
p_1	— ·11724	— ·10243	— ·10857
q_1	+ ·00641	+ ·01607	+ ·02916
p_2	+ ·00858	+ ·00817	+ ·00350
q_2	— ·00447	— ·00300	— ·00606
p_3	— ·00500	— ·00333	— ·00867
q_3	+ ·00417	+ ·00250	+ ·00083
p_4	+ ·00775	— ·00083	+ ·00150
q_4	— ·00442	— ·00173	— ·00500
a_1	+ ·1175	+ ·1037	+ ·1124
a_2	·0097	·0087	·0070
a_3	·0066	·0042	·0087
a_4	·0089	·0019	·0050
A_1	273° 8′	278° 55′	285° 2′
A_2	62 28	110 10	150 0
A_3	309 48	306 54	275 29
A_4	119 42	205 38	163 18

TABLE 2.

Maximum Temperature Values in the Sine Series.

	Durban.	Umtata.	Queenstown.	Aliwal North.	Philippolis.	Kimberley.
p	° 80·6	° 75·1	° 74·4	° 73·8	° 72·6	° 79·3
p_1	+ 4·9310	+ 5·0054	+ 9·3160	+ 10·9686	+ 11·4408	+ 13·8660
q_1	+ 1·2469	+ ·3061	— 1·3933	— 2·5929	— 3·2721	— 4·9582
p_2	+ ·3667	+ ·0167	— ·7333	— ·9167	— ·3750	— 1·0500
q_2	+ ·2598	+ ·9667	+ ·7794	+ 1·2124	+ 1·6600	+ 1·2124
p_3	— ·2333	— ·4667	— ·0500	+ ·1500	+ ·2000	— ·0833
q_3	— ·3167	— ·6667	+ ·0167	— ·0667	+ ·0333	— ·2167
p_4	— ·1833	— ·5667	— ·0500	— ·2000	— ·0083	— ·1167
q_4	·0000	·0000	— ·2887	— ·1443	— ·0433	— ·2309
a_1	+ 5·086	+ 5·015	+ 9·430	+ 11·271	+ 11·899	+ 14·725
a_2	·449	·957	1·070	1·520	1·701	1·604
a_3	·393	·814	·053	·164	·202	·232
a_4	·183	·567	·293	·247	·044	·259
A_1	75° 49′	86° 30′	98° 30′	103° 18′	105° 58′	109° 40′
A_2	54 41	1 0	316 45	322 54	347 16	319 6
A_3	216 23	215 0	288 26	113 58	80 32	201 2
A_4	270 0	270 0	189 50	234 11	190 52	206 49

TABLE 3.

Minimum Temperature Values in the Sine Series.

	Durban.	Umtata.	Queenstown.	Aliwal North.	Philippolis.	Kimberley.
p ...	61·8°	50·1°	48·3°	43·8°	45·5°	49·8°
p_1 ...	+ 6·8980	+ 11·5946	+ 10·7555	+ 13·5650	+ 12·5376	+ 12·1717
q_1 ...	+ ·7352	— ·4232	— ·1094	— ·9592	— ·2250	— ·5010
p_2 ...	— ·7250	— 1·7333	— ·7333	— 1·3083	— ·9583	— 1·1750
q_2 ...	+ 1·0248	+ 2·1073	+ 1·5588	+ 1·7465	+ 1·6310	+ 1·2269
p_3 ...	— ·1333	·0000	— ·0667	+ ·3167	— ·4333	— ·3000
q_3 ...	— ·1667	— ·5500	+ ·1333	— ·1333	— ·3000	— ·1833
p_4 ...	— ·1250	— ·2333	— ·3167	— ·3583	— ·3083	— ·0083
q_4 ...	+ ·1876	— ·1000	— ·2021	— ·0433	+ ·2167	— ·0833
a_1 ...	+ 6·937	+ 11·602	+ 10·756	+ 13·599	+ 12·540	+ 12·182
a_2 ...	1·255	2·729	1·722	2·182	1·892	1·699
a_3 ...	·213	·550	·149	·344	·527	·351
a_4 ...	·225	·256	·376	·359	·377	·084
A_1 ...	83° 55′	92° 5′	90° 35′	94° 3′	91° 2′	92° 21′
A_2 ...	324 42	320 34	334 48	323 10	329 34	316 14
A_3 ...	218 40	180 0	343 26	113 10	235 18	238 35
A_4 ...	326 20	245 53	237 27	263 7	305 6	185 43

TABLE 4.

Mean Temperature Values in the Sine Series.

	Durban.	Umtata.	Queenstown.	Aliwal North.	Philippolis.	Kimberley.
p ...	71·2°	62·6°	61·3°	58·8°	59·0°	64·5°
p_1 ...	+ 5·8990	+ 8·3303	+ 10·0441	+ 12·2770	+ 12·0006	+ 13·0147
q_1 ...	+ ·9785	— ·0783	— ·7741	— 1·7772	— 1·7516	— 2·7307
p_2 ...	— ·2000	— ·8583	— ·7333	— 1·1083	— ·6583	— 1·0833
q_2 ...	+ ·6640	+ 1·4578	+ 1·1836	+ 1·4867	+ 1·6600	+ 1·2124
p_3 ...	— ·1667	— ·2333	— ·0500	+ ·2167	— ·1000	— ·1833
q_3 ...	— ·2667	— ·5833	+ ·0833	— ·1167	— ·1500	— ·2000
p_4 ...	— ·1667	— ·4083	— ·1833	— ·2750	— ·1583	— ·0667
q_4 ...	+ ·0866	— ·0500	— ·3000	— ·1167	+ ·0833	— ·1443
a_1 ...	+ 5·980	+ 8·336	+ 10·073	+ 12·405	+ 12·128	+ 13·298
a_2 ...	·693	1·692	1·392	1·855	1·859	1·626
a_3 ...	·315	·628	·097	·246	·189	·271
...	·188	·411	·352	·299	·179	·159
A_1 ...	80° 35′	90° 32′	94° 24′	98° 14′	98° 18′	101° 51′
A_2 ...	343 14	329 31	328 13	323 18	338 22	318 13
A_3 ...	212 0	201 48	329 2	118 18	213 42	222 30
A_4 ...	297 27	263 1	211 25	247 0	297 45	335 12

TABLE 5.

Calculated Values of Pressure.

	Durban.		Umtata.		Kimberley.	
m	a	$c-o$	a	$c-o$	a	$c-o$
	inches	inches	inches	inches	inches	inches
0·0	29·999	+ ·002	27·605	+ ·003	25·943	+ ·002
0·5	30·002		·606		·949	
1·0	·011	+ ·001	·625	— ·003	·968	— ·004
1·5	·030		·644		·998	
2·0	·057	— ·002	·664	·000	26·031	+ ·004
2·5	·084		·685		·059	
3·0	·106	— ·001	·708	— ·002	·081	— ·004
3·5	·125		·733		·101	
4·0	·148	+ ·003	·762	·000	·124	+ ·001
4·5	·170		·790		·152	
5·0	·214	— ·005	·811	— ·001	·175	·000
5·5	·240		·820		·185	
6·0	·244	+ ·003	·816	+ ·002	·177	— ·002
6·5	·227		·802		·154	
7·0	·200	— ·001	·782	— ·001	·125	+ ·002
7·5	·174		·758		·097	
8·0	·153	+ ·002	·732	+ ·004	·072	— ·003
8·5	·131		·706		·048	
9·0	·102	— ·005	·680	— ·001	·024	+ ·002
9·5	·065		·657		·002	
10·0	·030	+ ·007	·639	+ ·005	25·983	— ·002
10·5	·006		·624		·968	
11·0	29·996	— ·007	·611	— ·002	·956	·000
11·5	·996		·605		·947	

TABLE 6.

Calculated Values of Maximum Temperature.

	Durban.		Umtata.		Queenstown.		Aliwal North.		Kimberley.	
m	a	$c-o$	a	$c-o$	a	$c-o$	a	$c-o$	a	$c-o$
	°	°	°	°	°	°	°	°	°	°
0·0	85·5	— 0·1	79·1	0·0	82·9	0·0	83·8	+ 0·5	91·9	— 0·1
0·5	85·6		79·3		82·5		83·4		90·1	
1·0	85·7	0·0	80·0	— 0·1	81·9	— 0·2	82·5	— 0·4	89·0	+ 0·1
1·5	85·4		80·2		80·9		81·0		86·8	
2·0	84·5	+ 0·1	79·4	+ 0·3	79·2	+ 0·2	78·6	+ 0·3	83·9	— 0·1
2·5	83·2		77·7		76·7		75·5		80·0	
3·0	81·6	— 0·2	75·5	— 0·3	73·7	— 0·3	72·0	— 0·1	75·5	+ 0·1
3·5	80·0		73·5		70·6		68·6		71·6	
4·0	78·7	+ 0·2	71·8	+ 0·1	67·9	+ 0·1	65·6	0·0	67·3	— 0·1
4·5	77·5		70·6		66·1		63·3		64·7	
5·0	76·7	— 0·1	69·7	— 0·3	64·9	— 0·1	61·7	+ 0·2	63·3	0·0
5·5	76·2		69·5		64·3		61·0		63·2	
6·0	76·1	0·0	70·0	0·0	64·3	— 0·2	61·6	— 0·1	64·3	0·0
6·5	76·3		71·2		65·3		63·4		66·3	
7·0	76·5	+ 0·1	72·4	+ 0·2	67·1	+ 0·2	66·2	+ 0·1	70·4	— 0·1
7·5	76·7		73·0		69·6		69·4		74·4	
8·0	77·0	— 0·2	73·0	— 0·1	72·2	— 0·4	72·4	0·0	78·4	+ 0·1
8·5	77·4		72·9		74·6		74·9		81·9	
9·0	78·5	+ 0·3	73·5	+ 0·2	76·5	+ 0·3	77·0	— 0·2	85·0	— 0·1
9·5	80·1		75·2		78·2		79·0		88·1	
10·0	81·9	— 0·3	77·2	— 0·4	79·8	— 0·3	80·8	+ 0·4	89·9	0·0
10·5	83·5		78·8		81·3		82·3		91·7	
11·0	84·7	+ 0·3	79·4	0·0	82·4	+ 0·1	83·4	— 0·4	92·7	0·0
11·5	85·2		79·2		82·9		83·8		92·7	

TABLE 7.

Calculated Values of Minimum Temperature.

	Durban.		Umtata.		Queenstown.		Aliwal North.		Kimberley.	
m	*a*	*c*−*o*	*a*	*c*−*o*	*a*	*c*−*o*	*a*	*c*−*o*	*a*	*c*−*o*
	°	°	°	°	°	°	°	°	°	°
0·0	67·7	0·0	59·7	−0·3	58·0	0·0	56·0	+0·1	60·5	−0·1
0·5	68·4		60·1		58·5		56·1		60·6	
1·0	68·7	+0·1	60·4	+0·1	58·7	0·0	55·8	−0·1	60·3	+0·2
1·5	68·4		60·0		57·8		54·5		59·4	
2·0	67·2	0·0	58·4	−0·2	55·7	+0·1	51·8	−0·2	57·5	−0·2
2·5	65·4		55·6		52·3		48·2		54·5	
3·0	63·3	+0·1	51·7	0·0	48·5	−0·2	43·9	+0·2	50·7	+0·2
3·5	61·0		47·3		44·8		39·7		46·4	
4·0	58·6	+0·1	43·0	+0·1	41·8	+0·3	35·6	−0·4	42·4	0·0
4·5	56·3		39·3		39·4		32·3		39·3	
5·0	54·7	0·0	36·8	−0·1	37·7	−0·3	29·5	+0·1	37·3	−0·2
5·5	53·9		35·8		36·6		28·0		36·4	
6·0	54·2	+0·2	36·5	+0·3	36·5	+0·2	28·3	+0·1	36·7	+0·4
6·5	55·2		38·7		37·7		30·3		38·0	
7·0	56·4	−0·1	41·8	−0·2	39·8	−0·3	33·8	−0·1	40·1	−0·6
7·5	57·6		44·9		42·5		37·3		42·7	
8·0	58·7	+0·2	47·6	+0·3	45·0	+0·1	40·5	+0·3	45·6	+0·6
8·5	60·0		49·6		47·1		43·2		48·5	
9·0	61·5	−0·1	51·5	−0·1	49·0	0·0	45·6	−0·4	51·3	−0·5
9·5	63·1		53·4		50·8		48·0		53·8	
10·0	64·4	+0·1	55·3	−0.1	52·8	−0·1	50·5	+0·5	56·1	+0·3
10·5	65·4		57·1		54·7		52·6		57·9	
11·0	66·2	0·0	58·4	0·0	56·1	0·0	54·2	−0·3	59·2	−0·1
11·5	66·9		59·2		57·2		55·4		60·0	

TABLE 8.

Reducing the Observations to a Solar Series.

	Durban.					Umtata.					Queenstown.					East London.				
	M	E	D	T	T−D	M	E	D	T	T−D	M	E	D	T	T−D	M	E	D	T	T−D
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Jan..........	85·6	−0·7	84·9	84·9	0·0	79·1	−0·2	78·9	79·8	+0·9	82·9	−0·3	82·6	82·1	−0·5	76·3	−0·6	75·7	75·5	−0·2
Feb.	85·7	−1·9	83·8	83·9	+0·1	80·1	−1·7	78·4	78·7	+0·3	82·1	−1·5	80·6	80·3	−0·3	75·9	−1·0	74·9	74·6	−0·3
Mar.	84·4	−2·6	81·8	81·9	+0·1	79·1	−2·4	76·7	76·6	−0·1	79·0	−2·8	76·2	76·6	+0·4	75·2	−2·0	73·2	73·4	+0·2
April	81·8	−2·6	79·2	79·1	−0·1	75·8	−1·3	74·5	73·5	−1·0	74·0	−2·1	71·9	71·4	−0·5	73·6	−1·7	71·9	71·4	−0·5
May..........	78·5	−2·8	75·7	76·4	+0·7	71·7	−2·1	69·6	70·7	+1·1	67·8	−1·6	66·2	66·7	+0·5	71·2	−2·4	68·8	69·5	+0·7
June	76·8	+1·7	75·1	75·0	−0·1	70·0	−0·9	69·1	69·2	+0·1	65·0	−0·9	64·1	64·1	0·0	71·0	−2·6	68·4	68·5	+0·1
July..........	76·1	+0·1	76·0	75·6	−0·4	70·0	+1·3	71·3	69·8	−1·5	64·5	+1·1	65·6	65·1	−0·5	69·2	−0·1	69·1	68·9	−0·2
Aug.	76·4	+1·1	77·5	77·8	+0·3	72·2	−0·1	72·1	72·2	+0·1	66·9	+2·0	68·9	69·4	+0·5	69·2	+1·4	70·6	70·5	−0·1
Sept.	77·2	+3·0	80·2	80·6	+0·4	73·1	+1·3	74·4	75.2	+0·8	72·6	+1·9	74·5	74·3	−0·2	69·5	+2·5	72·0	72·5	+0·5
Oct..........	78·2	+4·6	82·8	83·0	+0·2	73·3	+4·7	78·0	77·8	−0·2	76·2	+2·6	78·8	78·7	−0·1	70·4	+4·3	74·7	74·2	−0·5
Nov.	82·2	+3·0	85·2	84·5	−0·7	77·6	+2·2	79·8	79·4	−0·4	80·1	+1·8	81·9	81·4	−0·5	72·6	+2·7	75·3	75·3	0·0
Dec..........	84·4	+0·4	84·8	85·0	+0·2	79·4	+0·8	78·6	80·0	+1·4	82·3	−0·1	82·2	82·4	+0·2	75·7	−0·4	75·3	75·7	+0·4
Year	80·6	...	80·6	80·7	...	75·1	...	75·1	75·1	...	74·4	...	74·5	74·4	...	72·5	...	72·5	72·5	...

OBSERVATIONS OF ATMOSPHERIC ELECTRICITY AT CAPE TOWN.

By W. H. Logeman, B.A.

(Communicated by Professor Beattie.)
(Read August 27, 1902.)

Observations were taken at the suggestion of Dr. Beattie on the sheltered space behind the pillars of the Physical Laboratory of the South African College, Cape Town. An aluminium leaf electroscope, of the form originally used by Messrs. Elster and Geitel,* was connected with a distributor similar to that used by them. This consists of a small metal cylinder, about 2 inches in diameter and 4 inches long, connected with the leaves, and taking the place of the plate of an ordinary electroscope. This is surrounded by a large hollow metal cylinder about 7 inches in diameter and $5\frac{1}{2}$ inches long, open at the bottom, but closed at the top with a lid, and connected with the case of the instrument, and thus to earth. The observations were taken as follows :—

The instrument was charged positively and allowed to stand for about five minutes, then it was recharged if it had leaked at all, and placed outside, and the reading and time was noted. Fifteen minutes later the reading was again noted. The instrument was then charged negatively and allowed to stand for five minutes, and the above process was then repeated with the negative charge.

When two sets of readings were taken on one day, the first set was taken as above, and the second set was taken in the reverse

* See Elster and Geitel, "Ueber die Existenz electrischer Ionen in der Atmosphäre," vol. iv., No. 4, of "Terrestrial Magnetism and Atmospheric Electricity," published by the Johns Hopkins Press.

order, so that the mean time for the positive pair was approximately the same as for the negative pair. The charging was done from the town lighting mains, and was generally at a potential of $\pm$ 210–230 volts.

The insulation of the instrument, with the distributor removed, was found to be to all intents and purposes perfect.

The series of observations was commenced on May 21st, and has been continued up to the present (August 25, 1902). The readings of the barometer, wet and dry bulb thermometers, and the state of the weather were noted at about the mean time of each set of observations.

During the interval between May 21st and May 30th inclusive, the mean positive and negative leaks in the morning were 3·0 and 2·8 scale divisions respectively, and in the afternoon 3·7 and 3·8 scale divisions, showing no remarkable differences between the rates of leak of positive and negative electricities, but a decided increase in the afternoon over the leak in the morning.

The results for the month of June bear this out, showing average leaks of 2·65 divisions in the morning and 3·5 divisions in the afternoon for both positive and negative electricity.

The figures for July were 3·02 and 3·33 for positive and negative respectively in the morning, and 4·66 and 4·57 in the afternoon.

The readings for June have been more fully analysed than the rest, having been converted into volts and the fall in each case divided by the mean P.D. between the leaves and the case, for the time during which the fall took place.

The results so obtained are plotted side by side in a diagram, with the corresponding barometer readings. No close connection is noticeable between the atmospheric pressure and the rate of leak, nor was the relation between the relative humidity of the atmosphere and the rate of leak found to be any more marked.

The results of the months of May, June, July may then be summarised as follows :—

Month.	Mean pos. leak in scale div.		Mean neg. leak in scale div.	
	Morning.	Afternoon.	Morning.	Afternoon.
May	3·0	3·7	2·8	3·8
June	2·65	3·5	2·65	3·5
July	3·02	4·66	3·33	4·57

Date.	Approx. mean time.	Barom.	D.B.	W.B.	Diff.	Press. of aq. vap. at dew pt.	Mean P.D.	Fall in 15'.	$\frac{\text{Fall}}{\text{P.D.}} \times 10^3$.	Mean P.D.	Fall in 15'.	$\frac{\text{Fall}}{\text{P.D.}} \times 10^3$.
1	12.15 p.m.	763·5	13·3	11.2	2·1	9·0	203	50	246	203	50	246
2	9.0 a.m.	767	13·6	12·8	0·8	10·6	214	28	131	214	28	131
2	4.15 p.m.	766	15·0	13·6	1·4	10·9	204	28	137	214	28	131
3	9.20 a.m.	769	14·3	10·9	3·4	8·0	227	10	44	227	10	44
3	4.40 p.m.	767	15·9	14·2	1·7	10·0	200	44	220	200	44	220
4	9.30 a.m.	770	14·7	14·1	0·6	11·7	216	24	111	216	24	111
5	11.30 a.m.	770·5	16·1	15·3	0·8	12·5	224	22	98	211	22	104
6	10.40 a.m.	769·5	15·3	14·4	0·9	11·7	201	23	114	208	27	130
6	3.45 p.m.	768·5	15·9	14·7	1·2	11.9	181	31	172	209	27	129
7	11.5 a.m.	766	15·6	14·4	1·2	11·1	192	24	125	209	27	129
9	2.15 p.m.	768	12·0	8·0	4·0	6.0	192	61	317	195	54	277
10	8.55 a.m.	770	9·4	7·5	1·9	6·8	200	56	280	193	41	212
10	3.45 p.m.	771	11·1	8·1	3·0	6·5	182	47	257	200	56	280
11	10.40 a.m.	773	13·6	10·0	3·6	7·4	206	45	217	212	33	156
11	4.5 p.m.	773	14·4	10·9	3·5	8·1	209	27	129	213	9	42
12	9.25 a.m.	773	10·9	9·7	1·2	8·6	211	4	19	227	3	13
12	2.40 p.m.	772	13·1	11·3	1·8	9·1	211	22	104	209	27	129
13	9.50 a.m.	771·5	12·8	11·4	1·4	9·6	206	32	155	204	18	88
13	3.20 p.m.	769	13·6	12·2	1·4	10·0	216	25	116	203	38	187
16	9.35 a.m.	771·5	15·0	14·4	0·6	11·9	211	11	52	223	10	45
16	3.30 p.m.	771	16·1	14·7	1·4	11·8	189	40	212	200	56	280
17	11.5 a.m.	771	15·9	13·9	2·0	10·8	225	3	13	213	19	89
17	3.40 p.m.	769·5	18·3	15·0	3·3	11·0	225	6	26	225	6	26
18	9.35 a.m.	766·5	15·9	12·8	3·1	9·6	222	7	32	221	8	36
18	2·25 p.m.	765	20·4	14·2	6·2	8·9	203	50	246	214	48	225
19	9.35 a.m.	769	14·2	12·8	1·4	10·3	225	6	26	225	6	26
19	3.15 p.m.	767	17·5	13·6	3·9	9·6	225	6	26	221	8	36
20	9.5 a.m.	763·5	15·0	11·4	3·6	8·3	218	9	41	225	6	26
20	2.30 p.m.	763	17·0	14·4	2·6	10·9	212	33	156	189	34	180
21	10.40 a.m.	767	15·0	11·4	3·6	8·3	210	51	243	195	67	343
21	4.5 p.m.	767	15·6	11·4	4·2	7·9	198	61	308	188	48	255
22	11.10 a.m.	773·5	15·0	11·1	3·9	7·9	221	15	68	221	15	68
23	9.10 a.m.	771	10·9	9·7	1·2	8·4	224	3	13	225	6	26
23	4.5 p.m.	769	16·1	12·5	3·6	9·0	228	13	57	225	6	26
24	11.35 a.m.	770	14·2	12·8	1·4	10·3	220	4	18	225	6	26
24	4.25 p.m.	769	15·6	13·6	2·0	10·6	234	3	13	222	7	32
25	11.40 a.m.	764	15·6	13·3	2·3	10·2	225	6	26	229	7	31
25	3.40 p.m.	762	20·0	14·4	5·6	9·3	216	24	111	214	28	136
26	4.0 p.m.	763	15·0	13·9	1·1	11·3	212	33	156	208	35	168
27	11.40 a.m.	767·5	15·0	12·8	2·2	9·9	214	28	136	206	44	214
27	3.35 p.m.	767·5	14·2	12·0	2·2	9·3	200	56	280	170	56	330
28	3.35 p.m.	767·5	15·6	14·7	0·9	12·0	200	56	280	197	50	254

AN ELEMENTARY SYNOPSIS OF THE DIURNAL METEOROLOGICAL CONDITIONS AT KIMBERLEY.

By J. R. Sutton, M.A. (Camb.).

(Read October 29, 1902.)

This paper is to be regarded as the fourth of the series planned some years ago to embody a preliminary statement of the principles of the meteorology of South Africa, particularly that of the great Table-land, arranged in a form suitable to the requirements of the physicist. The three previous papers have been read at former meetings of the South African Philosophical Society, and are in various stages of publication.*

The matter in hand gives mainly a synopsis of the diurnal variations of the principal meteorological elements at Kimberley, as observed and recorded by means of instruments of the highest class. The observations selected for the purpose of comparison *inter se* belong to the period 1898–1901 (*i.e.*, four years); but for occasional illustration a longer series will be introduced. Some, but not much, reference will also be made to the work of the eminent men who direct such studies elsewhere, under better conditions of labour, perhaps, though with less advantage of geographical position.

The mathematical and numerical work as set forth in the Tables may be accepted as generally accurate. Every value given here has been tested twice at least, and wherever expedient mathematical tables have been used in preference to mere processes of arithmetic, being in some cases especially computed for the purposes of this discussion. Previous experience, however, constrains me to admit that errors may be more numerous than might antecedently have been expected, in spite of the many tricks of verification that all

* "The Winds of Kimberley," 1899; "Some Pressure and Temperature Results for the great Plateau of South Africa," April, 1901; "Some Constants in the Periodic Formulæ," May, 1902.

competent computers are supposed to have at their fingers' ends. It is sincerely to be hoped that such as they may be they are neither important nor numerous enough to neutralise whatever may be found of interest here.*

Although the labour entailed in the construction of the Tables at the end has been very great, a period of four years is actually, for the purpose of discovering normal means, rather short. The stated values must, for that reason, be accepted as only first approximations, though correct enough to more than the limits of accuracy of a preliminary statement. There is no question that a longer period would have yielded more valuable results; but, on the other hand, it seems safer to secure earlier publication of the somewhat less valuable rather than take the risk of no publication at all. Which risk is a very serious contingency: for depending entirely on private enterprise, and perhaps also on a single life, the Kenilworth Meteorological Station cannot, in the nature of things, be assured a very long lease of existence.†

If the tangle of incidents lying between cause and effect in meteorological phenomena was not already well known, there would be no difficulty in recognising it in the results given in the following pages. With the idea of simplifying the problem, most of the elements are shown under three aspects: (1) in the ordinary way, the means being arranged from a continuous record; (2) when the sky is clear; (3) when the sky is cloudy. A clear sky is meant when the mean cloudiness of the day does not exceed 20 per cent., nor the cloudiness of a single observation exceed 30 per cent. All other days are cloudy. The effect of this subdivision is to vary the conditions we are studying through the agency of a most influential factor. In 1898 and 1899 only three observations of cloud per diem were made, namely, at VIII., XIV., and XX.; in 1900 and 1901 three others were added, namely at XI., XVII., and XXIII. It is possible, therefore, that the two earlier years have a relatively larger number of "clear" days than the latter.

In comparing the conditions prevailing on clear and on cloudy days it is necessary to know at the outset that no systematic difference exists between them depending upon some fortuitous tendency to a grouping of one or the other at the beginning or end of a month.

* Reasoning from previous experience, the most likely errors are reversed signs and digits in the wrong order: + for —, 35 for 53, and so on. Tabular matter, I find, begins to become blurred and indistinct to eye and sense after midnight.

† Hann has expressed the urgent need for more material from the Southern Hemisphere. See, *e.g.*, the *Quarterly Journal* of the Royal Meteorological Society for January, 1888.

If, for example, we wished to compare the average shade temperature of clear and of cloudy days in any month, we could not justly draw conclusions from a mere average of tabulated results, should it happen that the beginning of the month was clear and the end cloudy; for the simple reason that our previous discussions have established the intimate relation existing between the maximum temperatures of the air and the varying altitudes of the sun day by day. In Table 1 will be found the average zenith-distance of the sun on the clear days, compared with the average of all days, month by month. The values are reduced from the sun's declination published by the *Nautical Almanac* (p. II). And since there is a good deal of difference at present between these declinations on a given date in different years, all four years have been used rather than trust to a mere approximation derived from one year only. The result is so far satisfactory, that the greatest departure from the mean zenith-distance of the month is just over one degree of arc, in April, corresponding to a time-interval for the season of about three days. The Table also contains the number of clear days found for each month, showing a variation in the number of clear days from 25 per cent. of the whole, in summer, to 60 per cent. in winter.

Table 2 gives the cloudiness of the sky, month by month, from observations taken at intervals during the day. It will be seen that the mean cloudiness of the months, given in the last column but one, does not always agree with the average of respective hours. The deviation arises out of the circumstance already noted that only three observations *per diem* were taken in 1898 and 1899. The bottom line gives clear indication of at least a double diurnal oscillation, one maximum being in the vicinity of XIV., with a minimum on either side at about XI., and perhaps later than XXIII., respectively. We shall see later on that an analysis of the more important meteorological elements indicates a very curious determination of the diurnal cloud-period. The last column contains the average monthly percentage of cloud on the days we denote clear. The results, of course, neglect some of the night hours. Hourly observations of cloud all over the world, and particularly in South Africa, are badly wanted for the purpose of determining the diurnal period.

It is scarcely necessary, perhaps, to introduce the element of sunshine here, although at some future time I hope to bring it under the notice of the Society. Some results of observations taken with a Jordan Recorder, however, for the eight years 1894–1901 will be found in the *Meteorologische Zeitschrift* for May, 1902.

Table 3 shows the mean temperature of the air, hour by hour, in each month and for the year. Since no individual monthly series of hourly temperatures ever lies evenly upon a re-entering curve, the columns have each been extended to include the second midnight, and 1 a.m.; these, however, have not been used in forming the mean values of the last line. The time of minimum temperature evidently accompanies the time of sunrise pretty closely month by month. But the time of maximum temperature falls irregularly anywhere between half-past one o'clock p.m. and a quarter to three. Fortunately we shall be in a position later on to give some explanation of this circumstance. It appears that a period of four years is not sufficient to eliminate all irregularity in the monthly means; for the maximum temperature of February happens in the present case to be greater than that of January. Yet the shape of the diurnal curve will be found true enough.

Table 4 gives the mean temperature variation in each hour, *i.e.*, the rise or fall of temperature from one hour to the next. The heavier type indicates that the temperature is rising; in all other cases it is falling. A glance is sufficient to show us that the former operation lasts for about eight hours, only, of the twenty-four, month after month, with a small extension of time in the spring months. It would appear, then, at first sight, that the temperature shows a disposition to rise for a given length of time after sunrise—a quite fallacious conclusion, however, as we shall see presently. From a consideration of Table 4 we may distinguish the following epochs of temperature for the year:—

1. The transition from a falling temperature to a rising (*i.e.*, the minimum) about the time of sunrise, say at half-past five o'clock a.m. for the year.

2. The time when the temperature is rising most rapidly, about two hours after sunrise, or about eight a.m. on the mean of the year.

3. The transit from a rising temperature to a falling (*i.e.*, the maximum) between XIII. and XV., or say at about a quarter past two o'clock p.m. for the year.

4. The time when the temperature is falling most rapidly, a little before sunset, or not much later than half-past five p.m. for the year.

Table 5 gives us the hourly and monthly temperatures under clear skies. The last column (giving the year) is the average of the twelve monthly columns. By reckoning it in this way the greater number of clear days in the winter is not allowed to unduly influence the final result.* We see that under clear skies the average shade temperature is, upon the whole, less than the normal, though slightly greater in the middle of summer. The total diurnal range is, how-

* It is equivalent to the supposition that there was an equal number (*i.e.*, 12) of clear days in each month.

ever, nearly 4° greater, falling 3° lower at night and rising 1° higher by day. It is a curious fact, in this connection, that when the sky is clear the hourly temperature values exhibit an upward tendency, so that in nearly every month the temperature is higher at the close of the day than it was at the beginning.

Turning now to the hourly variation of temperature on clear days as given in Table 6, we find that while the instants at which temperature is changing most rapidly, rising or falling, are almost identical with those of Table 4, yet XV. is the invariable hour at which the hourly temperatures are highest. Considering the hourly values alone, that is, the time of maximum shows a tendency to symmetry with the times of sunrise and sunset, both. We conclude that the maximum temperature does not depend so much upon the length of the day as upon the altitude of the sun, the undisturbed temperature rising not for a fixed time after the sun's appearance above the horizon, but for a fixed time after that has reached its greatest meridian altitude.

A closer examination of Table 5 will tell us that the actual maximum temperature does not always fall exactly at XV., but either a little before or a little after. The fact is pretty obvious from a consideration of the sequences of hourly values, without going into any refinements of analysis to determine what the actual epochs are. It is a curious fact, however, that if we were to apply a correction for the equation of time, so as to reduce the observed temperatures to their equivalents at hours of apparent time—in other words, referring them directly to the sun—the resulting maxima would approximate even more closely to a given hour of the day. Taking the equation of time into account, and remembering that Cape Colony mean time for the meridian of 22° 30′ East is used, while the longitude is really 24° 40′, it appears that the true apparent time of maximum is very near to XV. And since this is the hour at all seasons, irrespective of the sun's distance and meridian altitude, it seems to follow that it is also a planetary time, or, in other words, the hour of maximum temperature on any planet in whose atmosphere clouds do not form.

The deviations from the normal of temperature on clear days, hour by hour, are given in Table 7; the hourly values in each month having first been increased or decreased by a numerical constant which has brought the monthly means of the clear days into coincidence with the normal means. Heavier type is used to indicate that the deviation is *plus;* in all other cases it is *minus.* It is evident that the temperature on clear days is longer above the normal in summer, and the magnitude of the deviation greater than it is in winter. These effects, however, are largely due to the greater number of clear days in the winter, whereby they have already entered into the production of the normals. The Table shows very strikingly how largely the intrusion of cloud warps the diurnal curve of temperature.

In Table 8 will be found the hourly temperatures on cloudy days. The values are uniformly decreased throughout so as to bring them into conformity with the supposition that the last column of Table 5 is the true average temperature of 576 clear days. If we were to extend the diurnal series to include the midnight following, as well as that preceding, we should find a temperature not exceeding 57°·0, or about a whole degree less at the end of the day than at the beginning. Now we have seen that the opposite is the case when the sky is clear. It follows that the total effect of the clouds is actually to permanently lower the air temperature, by preventing more heat from entering than from leaving the lower reaches of the air. Thus we see that the higher mean temperature on a cloudy day is due more to the formation of cloud at the end of a hot period, than to any advantage the clouds may be supposed to have as a heat-trap.

The range of shade temperature under a clear sky runs along much the same lines as when all weathers are reckoned, that is to say, it is least in April and May, when dew is abundant by night, greatest in the dryness of spring (Table 9). The monthly range for cloudy days is more irregular, giving three maxima in the year. They are caused entirely by the access of heat in the day and not by radiation at night. Probably they might be levelled out in a longer series of observations; but as they stand they indicate a partially clouded sky, in which Cumulus prevails, admitting the solar heat with some freedom, but checking, in part, its simultaneous radiative exit.

Table 10 gives the constituents in the Harmonic Series to the fourth periodic term, counting from midnight.* For the mean temperature monthly values are given; the values of mean temperature, temperature under clear, and temperature under cloudy skies, are given for the year.

The term V_1, of twenty-four hours' period, is fairly uniform throughout the year, the greatest difference of phase-time for any two months not exceeding a quarter of an hour. The term V_2, of twelve-hours' period, has a difference of phase-time of upwards of an hour between the earliest and latest months; V_3 of more than two and a quarter hours; and V_4 of rather more than an hour. Each of the four angles tends to its latest phase-time about midwinter, and its earliest in November. There is also a tendency to a second

* Cape Colony Mean Time for the meridian of 22½° E. is understood.

maximum value of the angle (*i.e.*, to a second earliest phase-time) in January or February. Comparing Tables 5 and 8, we shall conclude that these differences owe their origin more to variation in the amount of cloud than to anything else, although the equation of time may be responsible for much of the variation in the monthly values of V_1.

A comparison between the clear- and the cloudy-day constants is noteworthy. The amplitudes of the former are much larger in each term; but there is very little difference in the phase-times of V_1, V_2, and V_4—twenty minutes being the greatest, in V_1. The angle V_3, however, is exceptional: not only is the difference of phase-time between the clear and cloudy days greatest of the four, but its affection is also in the other direction, the clear coming earlier than the other. It is indeed curious that the cloud factor should act with the greatest intensity on the term of eight-hours' period, and suggests perchance a cloud-wave oscillating three times a day—shall we say once for each of the three simple cloud-forms?

Whether this triple oscillation exists as a general rule is a moot point. Cloud observation is in a very unsatisfactory state. The best published observations of the hourly amount of cloud with which I am acquainted are those of—

1. A. L. Rotch, in "Observations made at the Blue Hill Meteorological Observatory in the year 1896," pp. 19–27.

2. The Trevandrum Observations made under the direction of the late J. A. Broun for six days in each week during a number of years, observations on the Sabbath being omitted with a praiseworthy regard for the Shorter Catechism mightily edifying to the Hindoo computers.*

3. The hourly observations made at selected stations in India on four days in each month, for ten years or more.†

In the first, maxima are not improbably indicated at midnight, VIII., and XIV., and the Kenilworth observations, such as they are, agree reasonably with these epochs. The *Challenger* observations at sea indicate maxima at about VIII. and XVI., from a short series of observations extending only over nine months. At Cordoba, from observations made at irregular intervals during the day, W. G. Davis deduced a formula for the diurnal cloud-period from which he claimed with some confidence two maxima, one about IX. and the other at XVI.‡ It is curious, though, that of the four specimen months

* *Indian Met. Memoirs*, passim.

† Ibid.

‡ "La forma de las curvas resulta bastante irregular, pero demuestra concluyentemente la existencia de dos máxima uno por la mañana y otro en la tarde" (*Anales de la Officina Met. Arg.*, vol. ix., p. 273). There is, however, an abortive maximum at 1 a.m.

computed, April shows a distinct triple maximum, at II., X., and XVII.; July also at VI. and XIV., with an abortive maximum at XX.; January at VII. and XV., with a suspicion of a maximum curvature about I., while October has distinctly no trace of more than the two, at III. and XVIII. April and October combined give maxima at a little before III., between X. and XI., and between XVII. and XVIII. These, however, are partially eliminated by the maximum and minimum points of January and July. The Trevandrum observations indicate a triple maximum pretty clearly at XI., XVII., and midnight, but the other Indian stations seem to show but two.

Upon the whole the outside evidence lends some colour to the idea that the successive crests of the cloud-waves approximate at Kimberley to the time whose distance from a fixed origin is some multiple of eight hours, and thus operate to the full upon the third periodic term of the Bessel-formula for temperature. Against this, however, may be set the opinion of Eliot: "The curves giving the diurnal variation of cloud [in India] differ entirely from those of temperature and air-movement. . . . As might further be expected, the Besselian resolution of the diurnal variation of cloud differs entirely from the corresponding resolution of the air-pressure velocity and temperature. The relation of the amplitudes and the epochs differ so widely and irregularly as to show there is no direct relation between the corresponding elements of the resolution of cloud and those of the other elements named above." *

This opinion notwithstanding, a comparison between the harmonic constants of cloud and temperature at Trevandrum furnishes food for reflection. For the nine years, 1856–1864, counting from midnight, they are :—†

	Temperature.	Cloud.
V_1	240° 6′	232° 4′
V_2	82 46	258 43
V_3	23 41	43 15
V_4	244 28	127 5
u_1	5·101	0·551
u_3	1·354	0·123
u_2	0·376	0·222
u_4	0·295	0·162

* *Indian Met. Memoirs*, vol. xii., part 2, pp. 196–7.

† *Indian Met. Memoirs*, vol. x., part 1, pp. 22 and 135.

It will be noticed here that the two most important terms in the cloud series are the first and third, and that the second has an amplitude scarcely more than one-half that of the third. Also that the first and third differ little in phase-time from the first and third in the temperature series. Now the Trevandrum temperature constants in V_1 and V_3 are not very materially different, excepting that their maxima come somewhat earlier, from those of Kenilworth; nor, as it happens, from those of Allahabad and Cordoba. And it is, as we have seen, the same two angular magnitudes, and only these two, that vary so conspicuously in the transition from a clear to a cloudy sky.

To test this matter further, the cloudy days at Kenilworth have been divided into two sets, containing respectively—

1. All days on which the percentage of cloud averaged 50 per cent., or more, and—

2. All days on which the percentage of cloud was greater than 20 per cent. and less than 50 per cent.

The respective monthly distribution will be found in Table 11. There were 412 days in the four years upon which the sky was more than one-half covered with cloud, and the average percentage of cloud for these days was 72 per cent. There were 472 cloudy days in the same period in which the sky was less than one-half covered with cloud, the average percentage in this case being 29 per cent. The first set of days may be styled "very cloudy," and the second "moderately cloudy." The monthly distribution will be found in Tables 12 and 13. As before, the last columns, giving the hourly temperatures for the year, are the means of the monthly columns. It would appear, according to these results, that the mean temperature of a typical very cloudy day is somewhat greater than the mean, but that the air finds itself fully a degree cooler at the end of the day than it was at the beginning. On a moderately cloudy day, however, the temperature tends to a secular increase. It is nearly half a degree warmer at the end of the day; and also the mean temperature is greater than the mean. And since the maximum on a moderately cloudy day rises almost to that of a clear day, it seems to follow that a clouded sky, so long as it is not more than half obscured, may to a certain limited extent conserve the solar heat, admitting it with a little more freedom than it permits its escape. The actual range, under such conditions, is about seven degrees greater than under very cloudy skies, this total being created more by the excess of maximum than the decline of minimum.

The harmonic constants are given in Table 14, and for purposes of comparison, others appearing in isolation elsewhere in this paper, together with values found for Allahabad and Cordoba. All the tabular matter refers to Kenilworth, except when it is stated otherwise at the head of the column. Cordoba amplitudes are expressed in Centigrade degrees. The outcome is to establish the great punctuality of the first, second, and fourth periodic terms, whatever the state of the sky, the phases of V_1 being only twenty-five minutes later under clear skies than they are under much cloud. On the other hand, our investigation has accentuated the variation previously found in the case of V_3; for this angle (of $9° 10'$ under all cloudy skies) is increased by $17° 44'$ under moderate cloud, and decreased by $13° 27'$ under much cloud; that is to say, there is a difference between a clear day and a very cloudy day of upwards of thirty-nine degrees, the clear falling earlier. The phase of V_4 would seem to be practically constant in magnitude in all weathers, and all over the world.

In view of the interest centred about the behaviour of the angle V_3, it is worth while to inquire whether the fact that neither the diurnal temperature curves for clear, nor those for cloudy skies, are re-entering has any material influence upon its varying epochs. A great influence is obviously not to be expected; nor is it altogether a fair question to Nature. Yet, as Lord Rayleigh has most pregnantly remarked, "In order to introduce greater precision into our ideas respecting the behaviour of the earth's atmosphere, it seems advisable to solve any problems that may present themselves, even though the search for simplicity may lead us to stray rather far from the actual question." We shall, then, take the observed diurnal curve of temperature under clear skies, considering the midnight value fixed, but reducing every following hourly value proportionately to its time-interval from midnight, so as to make the temperatures of both the preceding and following midnights identical, thereafter subjecting the deduced re-entering curve to the usual analysis. Some such process as this is, or seems to be, made use of in reducing for discussion the hourly observations taken four times a month in India. The effect upon the amplitudes is not great; the angular magnitudes are changed each rather more than a degree, two becoming greater and two less, by nearly equal amounts. In fact we now have—

$$p = 62°\cdot 4.$$

V_1..............	229° 52′	u_1..............	14·252
V_2..............	60 4	u_2..............	3·427
V_3..............	33 26	u_3..............	1·088
V_4..............	224 14	u_4..............	0·997

Among other things it will be seen that u_3 is greater than u_4 now.

Table 15 shows the mean barometric pressure of the air, hour by hour, in each month and for the year. Here again, as in Table 3, the columns have been extended past the second midnight. The increase or decrease of pressure from one hour to the next will be the most easily followed in Table 16, where the increases are shown as before in heavier type. The first and greater maximum is at IX., the second is a little before XXIII. The respective rises to each of these, from the preceding minima, occupy about six hours. The fall of pressure from these maxima occupy some 7·5 and 4·5 hours respectively. The morning maximum follows the sun; it is some two hours earlier at midsummer than it is at midwinter. The most rapid rate of rise of pressure to the first maximum happens within an hour after the temperature minimum at sunrise. The pressure maximum happens within an hour after the most rapid rate of rise of temperature. So far, then, we have probably a fairly direct solar effect.

The most rapid rate of fall of pressure happens shortly after noon at midwinter; but an hour or so later at midsummer. And, consequently, the portions of the monthly curves of pressure variation (*not* the curves of pressure) lying between the times of pressure maximum and greatest hourly decrease of pressure are twice as steep in winter as in summer. Hence it seems to be a logical performance to assign the rate of decrease of pressure to the influence of the primary, afternoon, minimum of pressure following, with some regularity, four hours later. The primary minimum of pressure for the year is shortly after XVI., the monthly hour changing from 3.30 p.m. in June to 4.30 p.m. in December. The greater rate of increase of pressure to the second maximum falls pretty regularly in the fourth hour after minimum; but there is very little indication of a monthly variation in the time of the second maximum. Now there is nearly a two-hours' difference between the times of sunset in June and December. Therefore, since all the barometric phases, with the exception of the primary maximum, vary by one hour only at most, it seems to follow that these, with the one exception, have no close affinities to the temperature changes in the lower air. We need not claim this as a new suggestion. Hann, long ago, was "convinced that attempts to explain the diurnal oscillation by means of the daily variation at any one place will lead to no conclusions." He further adds, "I am of opinion that the observed daily variation of wind and temperature do not stand in as close a relation to the diurnal barometric oscillation as has hitherto been assumed . . . for how could it come about that, *e.g.*, at Batavia, where the diurnal range of temperature is 5° 9′ C., that of pressure is 2·7 mm., whereas at Vienna, where the temperature range is 8°, that of pressure is only about 9 mm. We had better deal with the action of the sun on the upper strata of the atmosphere." Buchan goes a little further, ascribing the generation of the barometric tides directly to the solar and terrestrial radiations of the regions where they occur. "The barometric oscillations," he adds, "are independent of any change of temperature of the floor on which the atmosphere rests."

In Tables 17 and 18 will be found the hourly pressures, and the hourly changes of pressure, month by month, under clear skies. The first point to be noticed is the secular increase of pressure, amounting at the end of a day to ·006 inch. It is curious that a clear day should force up both pressure and temperature. The different phases, with the exception of the morning minimum, come a little later, although the difference does not run into many minutes. The greater average pressure under clear skies is mainly due to the high barometer characterising anticyclone weather. It is important to notice, however, that the pressure during the first quarter of the year falls to less than the mean when the sky is clear, just as the collateral temperature rises. Upon referring to Table 19 it will be found that the pressure increases relatively to the true mean without a break from midnight to XVI., differing in this respect from the corresponding temperature, which only begins to increase from V. It follows of course that the pressures and temperatures of the same hours, on cloudy days, must fall.

Table 20 contains the hourly pressures under cloudy skies. The numbers in the difference column are all *minus*, and therefore appear in ordinary type.

The differences in the ranges of pressure on clear, and on cloudy days, are of interest. They are :—

1. From midnight to first minimum :—

	Observed. Inch.	Reduced. Inch.
Clear skies	·006	·006
Cloudy skies	·014	

2. From first minimum to first maximum :—

Clear skies	·051	·049
Cloudy skies	·044	

3. From first maximum to second minimum:—

Clear skies	·086	·088
Cloudy skies	·093	

4. From second minimum to second maximum:—

Clear skies	·049	·048
Cloudy skies	·061	

The column headed "Reduced" above, means that the diurnal curve of pressure has been reduced to re-enter. Evidently a clear sky reduces, and a cloudy sky increases, the range of pressure in every case excepting the second. Remembering that a clear day increases the range of temperature, this fact seems to confirm the origin of the primary maximum in the temperature, and the independence upon the same of the other phases.

The mean morning minimum only falls ·003 inch below the mean pressure, and the evening maximum only rises ·009 inch above it. It is difficult to state the corresponding amounts when the sky is clear or cloudy because of the secular increase and decrease already referred to. If we eliminate the appearance of this secular change by the addition and subtraction, as necessary, of a number varying with the time, we find that the morning minimum under both clear and cloudy skies, falls, as in the mean case, ·003 inch below the average of the day; the second maximum, however, is ·004 inch above the average when the sky is clear, and ·012 inch above when it is cloudy.

Table 21 is worth a little attention. It gives the average pressure for each of the twelve-hour periods beginning at the time in the first column. The mean annual Kimberley pressure over the night hours averages 26·1382 inches, and over the day hours 26·1398 inches—pretty much the same thing; or, to be more precise, one pole of the great circle bounding the two hemispheres over which the average pressure is the same, is slightly in advance of the subsolar point. It is therefore unquestionable that the view held by some meteorologists * that there is a bodily transfer of air from the light hemisphere to the dark, cannot be sustained by the evidence of the barometer alone.

If we suppose Kimberley conditions to be general—incorrectly, of course, but for the sake of simplifying the argument—the hemisphere whose pole is not far from VI. will have the maximum pressure, and that at XVIII. the minimum. Also the meridian

* *E.g.*, Sir John Herschel, *Meteorology*, 2nd ed., pp. 72, 73, and 161.

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through the subsolar point will divide the earth into two hemispheres in which that lying to the west of the subsolar point (*i.e.*, that rising to meet the sun) has the maximum pressure; and that lying to the east (*i.e.*, that falling away from the sun) the minimum. The position of the great circle varies, apparently, through the months, probably coming earliest in October and latest in February. It cannot be quite accurately located in any month, because the period of four years, with which this discussion deals, is not long enough to eliminate the effects of occasional perturbations, and also because in no month can the true normal curve of pressure be re-entering.

If we adopt the same process for the clear skies, we shall find the mean pressure for the daylight hours to be 26·1613 inches, and for the dark hours 26·1542 inches. The daylight pole of the great circle which divides the Kimberley belt of latitude into two halves throughout which the average pressure is the same, will now be found to have shifted from the subsolar point through nearly an hour and a half of time in the direction of the hottest meridian. It follows as a matter of course that the same pole will shift in the opposite direction under clouded skies, and that *then* the dark hours will have the higher average pressure. Now, as we have seen in the Tables of Temperature, the time of culmination of the heat-meridian depends upon the amount of cloud. Thus the rule is for the pole of symmetrical pressure to precede the heat meridian by some twenty degrees of arc.

We have seen that the range of pressure at Kimberley, from the morning maximum to the afternoon minimum, is somewhat less under clear than it is under cloudy skies. This is an exception to the rule laid down by Buchan; for "over the land," says this authority, "the amplitude of the oscillation from the morning maximum to the afternoon minimum is greatest when the atmosphere is driest and the sky clearest, and least where the atmosphere is highly saturated and the sky more frequently and densely covered with clouds, being thus, generally, the reverse of what is observed to take place over the open sea. . . . At Bombay, in April, during the dry atmosphere and clear skies of the north-east monsoon, the oscillation is ·118 inch; but in July, during the humid atmosphere and clouded skies of the south-east monsoon, it falls to ·067 inch." * It may be doubted, though, whether one month may be legitimately compared with another in this way, and especially in India, where the con-

* *Ency. Brit.*, IX. Ed., Art. "Meteorology." In another place the same author remarks that "the *Challenger* observations all show that over the ocean, latitude for latitude, the amplitude of the oscillations is larger in an atmosphere highly charged with aqueous vapour, and less in a dry atmosphere."

ditions as to temperature are so exceptionally variable, to say nothing of the hour or so difference in the duration of sunshine in April and July. Certainly at Kimberley we have an entirely opposite state of things, in that with the low dew-point and clear skies of June and July the total range of the barometer is ·08 inch, whereas in December and January, with their greater rainfall and cloud, the range is upwards of ·10 inch. And the place stands on no isolated peak, but on the most typical of table-lands in the world.

It is at any rate worth while looking a little more closely into this question of the effect of moisture upon the behaviour of the barometer. Table 22 gives the mean annual hourly values of dew-point and humidity for the four years, computed from the simultaneous readings of dry and wet bulbs by means of the Greenwich Factors.* Table 23 gives the monthly values of the same elements compared with the monthly values under clear skies. Here again, as before, the yearly average for clear days is taken as the mean of the twelve months. We see that in every case, when the sky is clear, the dew-point and humidity-ratio are both less than the mean—as indeed might have been anticipated. It has not been thought worth while in this essentially preliminary statement, for the present at any rate, to go to the great labour of determining the mean hourly dew-points for clear days only.

In Table 24 the pressures have been arranged according to the magnitude of the dew-point. A progressive decrease of pressure is shown to accompany an increase of moisture. Also there are some indications of a secular increase of pressure for low dew-points, and a corresponding decrease for high ones. The range numbers at the foot of the columns have been estimated after the approximate elimination of this secular variation. Their periods are :—

A. From midnight to the first minimum ;
B. ,, first minimum to first maximum ;
C. ,, first maximum to second minimum ;
D. ,, second minimum to second maximum.

The net result of the Table is rather disappointingly negative. Excepting in the first column, including the very driest conditions of the atmosphere, we have no indications at all of any such aqueous influence upon the barometer as the comparison of clear and cloudy skies might have been supposed to suggest. It might, therefore, at first, appear that the clouds act not because of the greater moisture

* See Glaisher's *Hygrometrical Tables*, 7th Ed., 1885.

they imply in Table 23, but rather because of the lower temperature. But the question arises whether the test is a fair one. And if we examine the almanac distribution of the dew-points used here we shall soon see that it is anything but fair. This distribution is displayed in Table 25, intended to show the number of days in any month upon which the mean hourly dew-point of the day had any assigned degree. Evidently the low dew-points are characteristic of the winter months, and the higher ones of the summer. So that after all we have merely epitomised, and rather obscurely at the best, the facts of Table 17. The classification, in fact, has failed to isolate the moisture conditions from the equally potent temperatures and lengths of daylight; and is no more solid argument than the Indian case of Buchan's already cited. It is, therefore, up to this point, and so far as Table 24 can help us, still an open question whether the cloud effect is one of temperature or of moisture.

Now Tables 26 and 27 are constructed upon a different plan. Instead of attempting to determine directly the ranges of pressure corresponding to the quantities of aqueous vapour present, the dew-points under clear skies have been roughly divided into two sets, one in which they are less, and the other in which they are greater, than the mean of all the clear days of the month; the concurrent barometric pressures being then averaged in monthly columns. On the face of it the inference is that the barometer rises secularly when the dew-point is low, but displays some disposition to fall when it is high. Nevertheless, considering that the rule, when the monthly numbers are submitted to individual scrutiny, is not universal, this is possibly a fortuitous result.

As they stand they give these mean ranges :—

	High Dew-points. Inch.	Low Dew-points. Inch.
A	·008	·004
B	·047	·055
C	·091	·083
D	·047	·052

But if we eliminate the secular variation they become :—

A	·008	·004
B	·049	·049
C	·089	·090
D	·048	·045

The first of these results would seem to support that obtained when clear and cloudy days of pressure are arrayed over against each other, namely, that the range from the first maximum to the second minimum increases with the quantity of vapour present in the air. The second makes the very substantial claim that the vapour has no effect whatever, excepting in the important case of the second maximum. Here we have grounds for thinking that this particular phase is a more or less direct result of the presence of moisture, and that if this moisture were quite removed the second maximum would go with it. For in the group of barometric pressures pertaining to dew-points greater than the mean the night maximum is some ·004 inch above, and the night minimum the same below the mean of the day; whereas in the other group the same oscillations would seem to sink to about one-half. Such a conclusion, at any rate, is not in disagreement with the known increase in the magnitude of the night oscillation of the barometer at insular stations, and at sea in the tropics. It is, on the other hand, not altogether corroborative of Buchan's view that "the morning minimum is due not to any removal of the mass of air overhead, but to a reduction of the tension by a lowering of the temperature, and change of state of a part of the aqueous vapour." * Certainly, since at this juncture we are speaking of clear skies alone, the only possible change of state would arise through the deposit of dew on the surface of the earth. But at Kimberley even dew is not common unless it be during the nights of the late summer months. Taking March, April, and May together, the mean fall of pressure from midnight to the first minimum is ·008 inch upon very damp clear nights, and ·006 inch upon moderately damp clear nights. Or, leaving March out, the mean fall for April and May is the same whether the nights be dry or damp. (Tables 26 and 27.)

It is worth while here to briefly note a paper by J. A. Broun "On the Semidiurnal and Annual Variations of the Barometer" in the British Association *Report* for 1859. It is chiefly devoted to a criticism of Dove's professed subduction of vapour tension from the whole atmospheric pressure. He proves quite conclusively that Dove's hypothesis "that the tension of vapour deduced from the psychrometer observation is due to an atmosphere of vapour pressing with a weight equal to that tension . . . fails completely." He further remarks, *inter alia:* "M. Dove had brought forward as a proof of the accuracy of his method, the statement that in places far in the interior of the Asiatic continent, such as Catherinenburg, Nertchinsk, &c., distant from large masses of water and with dry atmospheres the double diurnal oscillation was not shown in the barometric observations. Mr. Broun pointed out that this should not depend

* "*Challenger*" *Report on Atmospheric Circulation.*

upon the mean dryness of the atmosphere, but upon the diurnal *variation* of vapour tension as computed by the psychrometer. He compared the diurnal variations of vapour tension at Nertchinsk and Makerstoun in 1844, which were as follows :—

	4–5 a.m.	1 p.m.	Range.
Nertchinsk	·122 in.	·155 in.	·033 in.
Makerstoun	·267 ,,	·301 ,,	·034 ,,

As the range is as great at one place as at the other, there can be no better reason (so far as this point is concerned) for the barometric oscillation being single at Nertchinsk than at Makerstoun."

The whole of Broun's remarks deserve more attention than they seem to have received. He had, indeed, in 1846, maintained the insufficiency of Dove's method, being in this supported (*circa* 1852), to some extent by Guyot.*

The constants in the Bessel Series for the monthly values of the diurnal curves of pressure are given in Table 28. In the main they are on much the same lines as physicists have determined elsewhere. Perhaps, since they depend only upon four years of observation, it would be unfair to draw very hard-and-fast conclusions from them.

The angle V_1 has a maximum in September and October, and a minimum in June. The amplitude u_1 has, upon the whole, a maximum at midsummer and a minimum at midwinter.

The angle V_2 has minima in February and July, and maxima in October and June. In this it agrees very closely with those made out from both theory and observation by Hann, for Jaluit, in the Marshall Islands, within six degrees of the equator. The monthly values of the amplitude u_2 have the cosmical characteristics indicated by Hann : namely that the maxima occur at the equinoxes, and the minima at the solstices ; and that its magnitude is greater at perihelion than it is at aphelion. The greater maximum at Kimberley, however, is in September, whereas in India it is in March ; † so that it would seem to be not quite independent of the earth's seasons.

The angle V_3 is for half the year in the vicinity of the zero-point, and in the vicinity of 180° during the other half. "Cole points out that at all stations the phase-time is reversed at the equinoxes." ‡ At Kimberley the reversal is pretty rapid at the vernal equinox, but at the autumnal equinox it is much more gradual. The amplitude

* See the *Smithsonian Meteorological Tables*, p. xxiii, 1893. Also Scott, *Elementary Meteorology*, p. 110.

† See Eliot, *Indian Met. Memoirs*, vol. xii., part 2, p. 286.

‡ *Quarterly Journal* of the R. Met. S., vol. xxv., p. 52.

u_3 has the usual winter maximum, and also the common equinoctial minima. In the Northern Hemisphere, however, the smaller minimum is in September, and the larger in March. In the Southern Hemisphere the smaller minimum is possibly pretty generally in October, and the larger in March. At Kimberley the two are nearly equal. At Melbourne, according to Cole's Tables, the October minimum almost vanishes; while at Cordoba, on the other hand, the March minimum is relatively very small.

The angle V_4 backs during upwards of half the year from near 360° in February, to near 180° in August; a sudden change then returning it to 360°, whence it veers rather more than half a right angle. There seems to be a tendency to a maximum in the amplitude u_4 just before these sudden changes, and a minimum afterwards. The quantities in question are, however, so very small that no great weight should be attached to the results in their case from so small a period of observation as four years.

Table 29 gives annual values of the harmonic constants deduced after varying certain of the presumably influential factors. The first column of constants is computed from Table 27, the second from Table 26, the third, fourth, and fifth from Tables 17, 20, and 15. In these last three no allowance or correction has been made for the secular variation; but in the first two, because of the noteworthy constancy of the ranges B, C, and D, above, this correction has been made. This of course introduces some discordance into the comparison.

If we consider first the differences between clear and cloudy days we see a large difference in the phase-times of the first components. As in the case of the temperature, that of the cloudy days is the earlier, and by fully three times the amount. Nevertheless, while a cloudy day accelerates the phase-time of temperature by half as much again as a clear day retards it, in the case of the pressures the time-ratio is almost exactly the other way about. The phase-times of the second component are practically identical, as are also the nearly equal amplitudes u_1 and u_2. So far this is in accordance with Hann's rule, *i.e.*, (1) "I have shown that the remarkable difference in the daily march of the barometer with difference in weather is entirely due to a modification of the diurnal pressure curve, and that the corresponding differences in this wave have the same character as the differences between the diurnal curves on land and at sea, and that both are probably due to the same causes." (2) "The double daily oscillation . . . is subject to quite simple laws, and is not affected in either amplitude or phase-time by the weather."

On the other hand, the third component is an exception. Of this

Hann says that it is almost undisturbed, despite its slight amplitude. Under cloudy skies at Kimberley the epochs of V_3 are much alike in both temperature and pressure; but while a clear sky makes the temperature epoch 25° earlier, the pressure epoch becomes 39° later. No doubt the true nature of the connection between the third components of temperature and pressure is not by this made any less obscure; but it does, I think, show that there is such a connection, and also that the cloud-period is sufficiently near to eight hours to effectively disturb the phase-times of V_3. The amplitudes, also again, reflect the same phenomenon; for while the clear-day amplitude of temperature in u_3 is double that of the cloudy day, the cloudy-day amplitude of pressure is double that of the clear day.

The imperturbable angle in the fourth component of temperature is in striking contrast to the vacillation of the corresponding angle of pressure. This matter may come up for discussion at some later date. It will be sufficient here to suggest that failing a barometer reading comfortably to four decimal places, a longer term of observation would be required to smooth out much of the pressure irregularity in V_4.

That clouds constitute the disturbing factor in both first and third components of pressure rather in virtue of the temperature they interrupt than by the increased amount of moisture they accompany seems made out by the subdivision (given in the first and second columns of numbers) of clear days into sets of greater or less dew-point than the monthly means; and after, as said before, correcting them for secular variation. Saving the doubtful fourth component the amplitudes are not affected at all, nor the epochs very much. Perhaps it may not be out of place to observe that one reason why the column for all clear days is not the mean of the two subdivisions is that each column is made up on the assumption that what is called the mean yearly average is derived from the twelve sets of results for each month.

A periodic curve may be built up by the superposition of any number of periodic curves. Thus the mean diurnal curves of temperature, or pressure, are constructed from the monthly diurnal curves; the equation of time is built upon the separate irregular motions of our worst timekeeper, the sun. Both classes of curve represent physical facts as truly as the curves from whence they sprang. But while the subordinate curves are most easily combined, it is not so easy to separate them out again; nor really certain that the decomposition will necessarily yield any one of the original curves. That is in general. The question here is, then, Are the harmonic constituents, formed as above, actual realities, or mere figments of the mathematical imagination? Some of the most accomplished physicists claim the former—others object! Eliot seems —if I am not mistaken—to regard the first and second as certainly, and the third and fourth as probably, belonging to the former. Thus, evidently, the problem is in the unusual position for a mathematical subject of depending upon experiment, and not theory, for its solution. And, perhaps equally evidently, the harmonic analysis may not be expected to separate out every contributory to the composite curve. Bessel seems to have favoured, on the whole, the latter and perhaps the safer alternative. He observes, for instance, in his paper on the determination of the law of a periodical phenomenon, "that, by the determination of the development which belongs to a phenomenon, we meet its theory half-way. Thus, *e.g.*, the observed solar longitudes, if developed in this way, according to the yearly period, would give a formula from which, if Kepler's discovery were yet to be made, we could discover the elliptic motion much more easily than from the observations themselves. . . ." * Prof. Cleveland Abbe, dealing with the complex formulæ representing the relations between the pressures and motions of the atmosphere on a rotating globe remarks that "it is to be expected that long before we have attained to what may be called a complete solution of all these equations of condition, we shall, by means of general theorems, have at least obtained some approximately correct ideas concerning the general mechanics of the atmosphere. Already many have proposed to skip this long process of reasoning, and substitute for each locality, and for the prospective rigorous solutions, some approximate sine and cosine formula, as though it were certain that the Bessel-Fourier series, or some other combination of periodicities, would satisfactorily represent the motions and other phenomena of the atmosphere. But the problem is undoubtedly too complex for plane harmonics, &c." † At any rate, whether the separate constituents are actual physical entities, or merely portions of terms in the algebraic equation to a curve, it seems not unlikely that a study of their respective changes, when any of the elements either of climate or locality are made to vary, may eventually suggest the explanation of the double diurnal

* *Quarterly Weather* Report for 1870, Appendix.

† *Monthly Weather Review*, 1901, p. 558. The student may also, with advantage, consult "A theorem on Fourier Series, and its application in Geophysics," by A. Nippoldt, Jr., in *Terrestrial Magnetism* for June, 1902; also "The Diurnal Variation of Barometric Pressure," by F. N. Cole in *Weather Bulletin* No. 6. Lord Kelvin, in a paper read before the British Association at Plymouth, in 1877, recommended that in order to avoid the enormous bulk of accumulated statistics, all meteorological results should be published in the shape determined by harmonic analysis. But I have only seen a short abstract of his paper.

oscillation of the barometer, although it may not be certain that they will actually represent it.

In this connection the annual harmonic elements of dew-point are added, for purposes of comparison, in the last column of Table 29. It has not been thought necessary to give the monthly values, nor, for this preliminary statement, to go through the great labour of separating clear days from cloudy. So much is therefore reserved for a future communication.

The dew-point amplitudes have no obvious relationship to those of corresponding denomination in the curves of temperature and pressure, nor, as we shall see presently, in those of the wind. The amplitude of the diurnal wave of moisture is more than double that of the semi-diurnal wave; the latter is not greatly larger than the eight-hour wave. The relatively great amplitude of the eight-hour wave is noteworthy because of the influence of the clouds over this period.

The epoch of the diurnal wave of moisture agrees more closely with that of the wind than with anything else: the maximum of the wind wave being less than three minutes earlier (see Table 44). Such an approach to synchronism may be important. There is no such approach at all on the part of the diurnal wave of pressure, which is a singular circumstance taken in conjunction with the fact that the total barometric pressure is necessarily made up of the sum of the individual pressures of dry air and water-vapour. The sympathy between these two constituents of the atmosphere, however, is shown in the semi-diurnal term, the difference between the epochs of barometer and dew-point being little in excess of three minutes of time. Much the same may be said of the eight-hour term, the difference here being about ten minutes.

It would seem from this comparison that the diurnal wave of barometric pressure does not arise from any access or defect of air to the superincumbent mass, for if it did there would surely be a proportionate access or defect of water-vapour, and a consequent proportionate variation in the dew-point at the same time. This wave is perhaps, then, the outcome of purely thermal actions: an increase of tension to the westward of the place where temperature is rising most rapidly, and a decrease to the eastward of the most rapid fall. There must be also, of course, a concomitant increase of tension of the contained vapour singly, although no increase of its quantity, and therefore no rise in the dew-point. That is to say, if we were to weigh the quantity of air in a given space, as we virtually weigh (roughly) the quantity of vapour per cubic foot by determining the dewpoint, we should not, on this view, find actually any more air, albeit its pressure might be greater; exactly in the same way as the weight of a sealed bottle of air could not be increased whatever internal pressure we might impart by heating it. A moment's consideration will show that this increase of atmospheric pressure must exist, even without any actual access of air, and must be greatest somewhere near the place where the diurnal wave of temperature is rising most rapidly. The sides of the bottle in the hypothetical case are now represented by surrounding masses of air whose thermal condition is changing less rapidly. No movement can take place on account of heat received until the differences of pressure set up are sufficient to overcome the inertia and viscosity of the surrounding air.

There is an independent maximum of moisture in the first harmonic component an hour or so after noon, arising probably out of the enhanced evaporation from water, vegetation, and the ground, due to insolation, sunlight, and wind, at the time. There are dependent maxima, in the second harmonic component, coinciding with the germane maxima of barometric pressure, and answering, no doubt, to the same causes. The semi-diurnal wave of pressure, then, appears to be largely mechanical, with an actual alteration in the quantity of air overhead, and of the moisture it contains in the same degree. There is a tri-daily wave agreeing with the cloud-period, and also forming part of the tri-daily wave of pressure. It is large in proportion to the air wave, relatively to the corresponding semi-diurnal waves.

If we compare these phenomena with those existing elsewhere, we find that the independent wave of moisture, having a diurnal period, and a maximum just after XIII., found only by analysis for Kimberley, becomes materialised over the open ocean, so that the observed diurnal curve of the "elastic force of vapour" (delightful description!) is practically the same as that of the temperature, though rather earlier in phase, whereas nearer land the double diurnal oscillation makes its appearance—the summit of the curve being, as it were, pressed downwards.

According to Table 30 the harmonic phase-times over both the open sea, and near land, are also very nearly those of the temperature for the first two terms. The amplitude of the first term for the open sea is nearly double that for near land; but the amplitudes of the second terms are practically unaltered.

The third terms are very unlike both in amplitude and epoch: near land the epoch is nearly that of the temperature on land, while the amplitude is nearly equal to that of the second term; out at sea the epoch falls nearly three hours earlier, and the amplitude almost vanishes.

The general features of the curve of vapour-tension, as it is called, in the above two cases, may be readily explained. On the open sea in low latitudes, the lower air is always nearly saturated, and no matter what quantity of moisture any harmonic wave of pressure may be supposed to contain, it cannot add, *as vapour*, anything to that already existing, nor, for that matter, add any material percentage of moisture in any form. The humid conditions seem, indeed, to be determined directly and entirely by the temperature. The elimination of the ocean maximun near land " points unmistakably to an intermixture with the air forming the sea-breeze of descending thin [and drier] air filaments or currents to take the place of the masses of air removed by the currents that ascend from the heated surface of the land."*

We should not expect, therefore, to find any traces of barometric affinities in the harmonic components of moisture near the surface of the open sea, although it is not impossible that they may exist at higher altitudes over the sea.

If we compare the harmonic constants of pressure at Kimberley with those of places having different climates, we shall soon get corroboration of the great influence exercised by the vapour of the atmosphere upon the magnitude of the harmonic constants, more particularly in the second term. Thus Lahore, in a partial degree similarly situated to Kimberley, has amplitudes u_1 and u_2 almost identical with those of this station, its u_1 being nearly equal to u_2; Madras, a coast station, has $u_1 = \cdot 024$, $u_2 = \cdot 043$; Bombay, another coast station, has $u_1 = \cdot 018$, $u_2 = \cdot 038$; Agustia, on the summit of a peak, at an altitude of 6,200 feet, has $u_1 = \cdot 005$, $u_2 = \cdot 031$; Fort Rae, near the Arctic Circle, in the middle of the great Dominion, has $u_1 = \cdot 007$, $u_2 = \cdot 001$. Thus on the whole, other things being equal, the amplitude of the second component increases with the moisture of the air, while the amplitude of the first varies with range of temperature. But because the range of temperature becomes generally greater as the amount of vapour in the air becomes less, it follows that when a resultant curve is constructed from its first two harmonic components, the daylight range from the first maximum to the second minimum will be increased pretty much by a greater range of temperature as it is decreased by a smaller quantity of moisture. And therefore the graphical aspect of this daylight range will be somewhat similar for either the centre of a flat continent or for mid-ocean. On an ocean shore the circumstances are complicated by the land- and sea-breeze. It would seem that the tension along the coast at night is lowered partly by the rapidly

* Buchan, in the *Challenger* Report, p. 12.

falling temperature inland, and still more by the land-breeze, the process going on until the upper current has set in with sufficient strength to establish a return to equilibrium. During the day, on the other hand, the conditions are reversed, and the sea-breeze tends to fill up the partial void of the afternoon minimum. There are other agencies in operation, doubtless; nevertheless, the most pronounced features of the pressure-curves of stations on an ocean littoral are more largely dynamical than any others.*

The winds of Kimberley have been previously treated at some length,† so that it will not be necessary here to do more than discuss just so much of this division of the subject as comes within present limits. In Table 31 will be found—

1. The total hours of wind from each given direction upon clear days in each month during the four years 1898–1901.

2. The total hours of wind from each given direction upon clear days, cloudy days, and all days, during the same four years; and also—

3. The ratios of each per 10,000.

4. The gross total hours from each direction during the period March, 1896 (when hourly observations of wind were commenced)–February, 1902, *i.e.*, six years.

Tables 32, 33, 34, give the hourly distribution according to direction, during the four years, upon clear days, cloudy days, and all days. From these Table 35 has been deduced. It gives the magnitude of the N. and E. component directions, decimal parts being omitted, found in the same manner as a mechanical component; the resultant direction R; and the vectorial angle ϕ (measured from E. round by N., W., and S.) made by R.

The east component is very little affected, whether the sky be clear or cloudy. It changes from *plus* to *minus* sign (*i.e.*, becomes W.) a full hour earlier; and from *minus* to *plus* (*i.e.*, becomes E. again) perhaps half an hour earlier when the sky is cloudy than

* [Upon the whole question of the double diurnal oscillation of the barometer, a great store of valuable information will be found in Eliot's "Discussion of the Results of the Hourly Observations Recorded at 29 Stations in India," in the *Indian Met. Memoirs*, vol. xii., part 3, recently published. Eliot claims that the diurnal variations of pressure are chiefly due to the absorption of solar energy by our atmosphere. But to my mind the argument is not convincing. It seems to confuse the issue between the amount of absorption suffered by any given solar ray, and the amount effected by any given mass of air. The former has a maximum at sunrise or sunset; the latter at noon. (Note added in reading the proof, Feb., 1903.)]

† *Transactions* of the S. A. Phil. Soc., vol. xi., part 1. *Met. Zeitschrift*, Nov., 1901.

when it is clear; or, in other words, is westerly for at least an hour longer.

The north component is positive for between six and seven hours under a clear sky, whereas it is negative for about the same space under clouds. The maximum excursion of this component, positively or negatively, falls about half an hour later when the sky is clear.

Upon a clear day the minima of R, in the order of their magnitudes fall at about X., XVII., and III.; upon a cloudy day they fall at about 6.15 p.m., and 7.30 a.m.

Taking the four years as they stand, there was practically as much wind with an east component upon a clear as upon a cloudy day; but the south components changed into half as many again north. There were, however, more than three days cloudy to every two days clear; hence if we allow for these we get the following daily average unbalanced hours of component direction:—

	N.	E.	R.
Clear days	− 3·6	+ 4·2	5·5
Cloudy days	+ 3·5	+ 2·6	4·4
All days	+ 0·7	+ 3·2	3·3

If we compare the angle ϕ at any hour upon a clear day with what it is upon a cloudy day, we shall see that the effect of a clear sky is to accelerate the velocity of the resultant, whereas a cloudy sky retards it. R begins the clear day 25° behind the mean, and ends about 8° behind. R begins the cloudy day 18° in front of the mean, and ends about 10° in front. This statement of the acceleration and retardation of velocity will require some sort of qualification, of course, because in general the greater number of cloudy days come in summer, and the clear days in winter; and there is, as has been proved before, a prevailing wind-direction for each of these seasons.

Reason has been given for supposing that apart from the seasonal changes of prevailing direction, there is not, strictly speaking, a true prevailing direction for the year. It is seldom, indeed, that any two consecutive years have a like resultant. For the four years under consideration, out of a gross total of 35,040 hours of wind (of which 142 were variable hours, and therefore not taken into account) the unbalanced components were—

From the north............................ 1,059 hours,
From the east .... 4,725 hours;

the resultant direction being 4,942 hours, almost exactly from E. by N.: its magnitude being therefore rather less than 14 per cent. of the whole period. But in the whole six years of observation, out of 52,560 hours of wind (of which 465 were variable), the unbalanced components were—

From the north...........................	888 hours;
From the east	3,134 hours,

the resultant direction being 3,258 hours from a rather more northerly direction; its actual magnitude being therefore a shade over 6 per cent. of the period, or, say, an hour and a half *per diem.*

It has been shown, in the paper referred to, that an inverted diurnal temperature curve and a curve of east component variation look very much alike, and that if they be drawn to suitable scale one will overlie the other for some hours of the day. The same fact is brought out in another way by Table 36, where the increase in bulk of the east component is compared with the decrease of temperature hour by hour. The heavier type signifies a positive decrease of temperature, or increase of east component respectively, and ordinary type signifies negative quantities. The temperature change is for the hour ending with the stroke; the wind hours are in reality half an hour later. It is seen that after the quantities first change sign (about VI.), the wind variation is more gradual than the temperature variation, but more abrupt at the second change of sign (about XVI.). Apart from this the gradients are remarkably similar, and have their maxima about the same time, whether the sky be clear or cloudy. There is an exception to the rule in the hours on one side or the other of midnight, which has been explained as due to the influx of easterly winds.

The north and east components of Table 35 have been submitted to analysis, the result as far as third harmonic term appearing in Table 37. The angular quantities are reckoned from zero at midnight. The amplitudes u_1, u_2, and u_3, are total, not average, and it might therefore be anticipated that they would be greater for the 884 cloudy days than for the 576 clear days; and *a fortiori* still greater for the whole four years. They are reduced to yearly proportional and comparable magnitudes in the quantities u'_1, u'_2, and u'_3.

The first and second amplitudes of the north component are decreased under cloudy skies, the second noticeably so; the third amplitude is slightly increased. The east component shows the decrease very plainly in each amplitude; the second cloud amplitude being 55 per cent. of the clear and the third amplitude less than 22 per cent. of the clear.

The epochs of the north component show that under cloudy skies V_1 is 42 minutes earlier, V_2 is 32 minutes earlier, and V_3 is 21 minutes later than under clear skies. The epochs of the east component show that under cloudy skies V_1 and V_3 are practically unaffected, while V_2 falls nearly 73 minutes earlier.

It can scarcely be claimed from this result that the north and east components of wind-direction bear any very simple harmonic relationship to the concurrent temperatures and pressures. The east component epochs in which, bearing Table 36 in mind, they might be looked for, are indeed less in agreement than the north; and whereas the cloud effect upon V_2 is almost non-existent in both temperature and pressure, in the case of the east component direction it is practically the only effect to be detected. Certainly there is no trace of an eight-hour cloud period in the east component of direction, so far as the phase-time is concerned: if anything, the place where the cloud disturbance of an eight-hour period is exhibited is in the amplitudes. In the north component epochs, on the other hand, there are traces of a temperature effect, each angle varying in the same direction, though not at quite the same rate, as those of the temperature.

The conclusions we may draw from all these circumstances are :—

1. That the wind-direction is determined largely by the position of the geographical area at which the temperature is highest irrespective of whether this maximum is high or low—the orbits of the air particles, that is to say, depending upon the sun's apparent path; and—

2. That clouds do not so much determine wind-direction as accompany perturbations of the normal directions generated by remoter influences.

Table 38 gives the mean wind-velocity, hour by hour, during each month, and for the year, from the average of the observations taken during the four years 1898–1901. The subdivision into clear days and cloudy, will be found in Tables 39 and 41, and the respective deviations of these from the normal in Tables 40 and 41. In the latter a wind-velocity greater than the mean is printed in heavier type.

Under clear skies the velocity of the wind at any hour in any month is rarely greater than the mean; in the case of the yearly averages, never. Consequently, under cloudy skies, the yearly averages are always greater than the mean. At midnight the velocities under both clear and cloudy skies are appreciably equal to the mean, the deviation increasing from that time to its maximum, in both cases, about ten o'clock a.m. With clear skies the velocity increases from the absolute minimum about V. to the absolute maximum about XIV.: from 4·1 to 6·7 miles per hour; with cloudy skies the corresponding times are not far from V. and XIII.: and the hourly values range from 4·6 to 8·6. Or, putting it in a different way, the range in the second case is half as much again as it is in the first. This fact is not in concordance with some previous results obtained elsewhere: "Hann has shown for a number of places in Northern Europe, that with a clear sky the velocity is doubled from the minimum to the maximum, with a sky half covered the velocity is three-fourths greater, and with a sky wholly covered the velocity is only a half more. . . . At the strictly inland situation of Vienna, with a clear sky the velocity is double, and with a sky half-covered it is two-thirds greater, but with a covered sky the diurnal variation of the wind's velocity becomes irregular and faintly marked." *

The approach to equality of velocity between night and day under clear skies as compared with the departure therefrom under clouds suggests at first sight either that the temperature is not so great a motive power as might have been supposed and claimed, or else that terrestrial radiation is scarcely less influential than insolation. Both ideas, however, fall short of the truth. For the winds, equally with the clouds, are governed largely by cyclonic and anticyclonic conditions; and consequently the subdivision of wind-movement into clear-day and cloudy-day quantities does not really refer the wind to a preceding cause so much as group it in a manner that may make the reference more promising. The study that can strip the wind-phenomena bare to the mental sense has yet to be completed. We have progressed far enough, nevertheless, even in this discussion, to discover that certain wind-directions do tend to prevail in the two states of the sky; clouds indicating northerly directions, and clear skies southerly (Table 31); the associated shift of the mechanical resultant direction from one to the other being more than a right angle—from the first quadrant into the fourth (Table 35). Now we have already proved the "important fact that for any hour of the day the mean velocity of the wind from any quarter decreases, relatively to the mean diurnal curve, with the deviation of the vane from its normal position." † Therefore, since the normal winds are northerly by day and southerly by night, it must be that a northerly wind by night and a southerly wind by day will lose speed. Thus

* Buchan, *Ency. Brit.*, IX. Ed. Art. "Meteorology," p. 125.

† "The Winds of Kimberley," p. 85.

the amplitude of the curve of wind-velocity will vary with the variation of cloud. And thus the solution we have obtained from the physical problem is not the one we sought. It is important, though, to observe that the result introduces a very substantial reason why there should be a diurnal cloud period.

Table 42 gives the annual average miles of wind from each of the principal directions during each hour of the four years. This Table proves in reality to be only an emphasised epitome of Table 34. The points of dissimilarity between them will be best appreciated after comparing together the mechanical resolutions of each given respectively in Tables 35 and 43. The only material dissimilarity revealed is that the maximum of the east component of velocity is more than four hours earlier than the maximum of direction. In all the other cases the phases of the wind-direction components are half an hour or so earlier than those of the wind-movement. The range in magnitude of the resultants is much the same in each curve, the maximum being about three and a half times the minimum. The minima occur near sunset; but the maximum velocity-resultant is at noon, while the maximum direction-resultant is an hour before sunrise. There is, likewise, a second, small, maximum of resultant direction at noon, and a second maximum of resultant velocity at midnight. The vectorial angle ϕ made between OR and OE (*i.e.*, the angle EOR) is pretty much the same in either case, there being a relative increase in the angular velocity of the velocity resultant just after sunrise, and a corresponding decrease just after sunset.

The harmonic constants of the diurnal curve of wind-velocity are given in Table 44, where the angles are reckoned from midnight. Both in amplitude and epoch the curves have strong temperature traits. When all days are considered the amplitudes are seen to follow the same order of magnitude as the amplitudes of temperature. The epochs in V_1, V_2, and V_3, are each an hour (more or less) earlier than the corresponding epochs of temperature, the epoch in V_4 being, however, only half an hour earlier. Also a change from a clear sky to a cloudy varies the first three epochs in the same direction as, though by a greater amount than, those of temperature. As compared with a clear day the effect of a cloudy sky is to accelerate V_1 and V_2, and to retard V_4 by half an hour or so. But in the case of V_3 we have again the remarkable cloud feature noted before, the variation here carrying the epoch more than two hours later. This further instance must be regarded as completing the proof that the most potent perturbing periodicity under a clouded sky has a wave-length of eight hours. There are not any pressure characteristics in the unresolved and unreduced curve of wind velocity.

Now the curve of wind velocity is to a very large extent a curve of temperature, and so also is the curve of east component direction. But the north component is not. If we consider separately each hourly meridian in the latitude of Kimberley we find that the numerical values of the north component of velocity moving along them are different for each; and at some small distance, say a few miles, north or south of Kimberley we should still, probably, obtain the same values for the same meridians—or even if the values were different, their ratios, between north and south stations, of the same meridian, could not differ largely. Hence there should be no inherent likelihood of discovering any underlying diurnal temperature or pressure affinities in the north component variation, for this reason. But the east component, moving very nearly along the Kimberley parallel, reveals quite a different state of things. Its numerical value varies, so that no two adjacent hourly arcs contain the same amount of surface wind-movement. There must, then, be local compression and exhaustion of air, according to circumstances, at the different meridians. Suppose the time to be noon, for example. Along the hour-arc to the east, *i.e.*, from noon to XIII., the annual average value of the east component is *minus* 1,095, or, otherwise, there are 1,095 miles of wind from the west. Along the hour-arc to the west, *i.e.*, from XI. to noon, there are 865 miles from the west. That is to say, 230 more miles of wind are moving from the meridian than to it. Therefore there is an exhaust which the north component cannot altogether fill, because much the same exhaust will be found for some distance north and south along the same meridian. Here, then, is a remarkable circumstance: an actual variation in the quantity of air due to the veering of the surface wind current. Does it stand as a link in some probable sequence of cause and effect?

The magnitude of the increase, positive or negative, at each meridian will be found in the last column of Table 43. The first fourteen meridians show an outflow, the other ten an influx. The IX. meridian has the greatest deficit; that of XVIII. the greatest surplus. The actual minimum is some time after IX.; the actual maximum some little time before XVIII. Thus they seem to follow, and depend upon, the principal maximum and minimum of the barometer. The first effect of the thermal expansion of the air after sunrise, and of the contraction before sunset, respectively, is an increase and decrease of pressure. The second effect is an air movement, outwards or inwards, to relieve the disturbed tensions.

We have here, apparently, a confirmation of Hann's contention that the barometric oscillations belong more to the upper than to the lower reaches of the air. For if they belonged below, the air current would be setting inwards at IX. instead of outwards.

The barometric characteristics of this air current become plainer if we separate it out into its harmonic constituents. Its second amplitude is relatively large compared with the first. Its respective epochs fall approximately :—

V_1 an hour and three-quarters later,
V_2 an hour later,
V_3 an hour earlier, and
V_4 an hour and three-quarters later

than those of pressure. It is curious that the earlier phase of the third periodic term should be accompanied by an amplitude so modest. Curious too that the phase should be almost exactly that of the cloud term for Trevanarum.

It seems not improbable that the fact of the variation in the quantity of air over each meridian, due to the east component of wind-velocity, may prove of considerable moment in the hands of the physicist. I have not seen it referred to before, and indeed it is not likely to have been easily detected at any place having a less favourable geographical position than Kimberley has.*

* [It is interesting to compare this result with that discovered by Hann, and described by him in a paper read on Dec. 11, 1902, before the Academy of Sciences in Vienna, on the daily rotation of the mean wind-direction, and on an oscillation of the atmosphere, of semidiurnal period, over mountain-peaks of altitudes lying between 6,500 and 13,000 feet, a "Sonderabdruck" of which has recently been published :—"Das wichtigste Ergebnis ist, dass bei allen vier Componenten, namentlich aber bei der N- und S-Componente, eine grosze halbtägige Periode vorhanden ist, welche der ganztägigen gleichkommt oder sie selbst an Grösze übertrifft. . . . Die Constanz der Phasenzeiten und die Grösze der halbtägigen Peroide macht es wahrscheinlich, dass diese regelmäszige tägliche Oscillation der Luftmassen in 2 bis 4 *km* Seehöhe mit der regelmäszigen täglichen Barometerschwankung in Beziehung stehe." (Feb., 1903).]

ERRATA IN VOL. XI., PART 4.

Page 244, last line, and third line from the bottom ; also page 245, second and fifth lines, *for* "temperature of the day" *read* "temperature of the month."

Page 263, twenty-fifth line, *for* "present volumes" *read* "annual volumes."

TABLE 1.

Average Zenith-distance of the Sun in each Month.

	No. of Clear Days.	Mean ζ of Month.	Mean ζ of Clear Days.	Diff.
Jan.	31	7° 19′ 32″	7° 4′ 21″	15′ 11″
Feb.	29	15 1 45	15 2 0	0 15
Mar.	34	26 55 8	26 52 50	2 18
April	33	38 29 54	39 34 42	64 48
May	67	47 32 23	47 33 41	1 18
June	70	51 44 50	51 43 30	1 20
July	75	49 49 6	49 53 48	4 42
Aug.	69	42 17 54	42 44 54	27 0
Sept.	50	31 30 7	31 59 11	29 4
Oct.	39	19 53 1	20 28 8	35 7
Nov.	43	10 15 39	10 49 11	33 32
Dec.	36	5 39 1	5 37 32	1 29
Year	576	28 52 22	29 6 59	14 37

TABLE 2.

Percentage of Cloud.

	VIII.	XI.	XIV.	XVII.	XX.	XXIII.	Month.	Month: Clear Days only.
Jan.	37	31	51	44	42	28	43	4·2
Feb.	38	29	47	47	45	41	43	4·6
Mar.	34	33	46	45	37	28	38	3·0
April	33	30	45	40	33	25	36	1·3
May	24	17	26	16	13	13	22	1·7
June	21	24	19	28	17	17	19	0·9
July	20	19	18	19	14	11	18	0·5
Aug.	22	17	27	18	11	10	19	1·1
Sept.	29	32	32	37	19	17	27	1·0
Oct.	35	44	43	47	31	33	37	1·7
Nov.	23	30	40	37	25	21	30	2·0
Dec.	31	33	47	41	38	31	37	2·1
Year	29	28	37	35	27	23	30	2·0

TABLE 3.

Mean Temperature of the Air.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Midnight.	68·0	67·8	63·4	57·3	48·1	43·7	42·0	47·1	53·9	57·8	62·8	67·0	56·6
I.	66·8	66·6	62·4	56·5	47·0	42·7	40·9	45·9	52·6	56·4	61·4	65·7	55·4
II..........	65·6	65·2	61·4	55·6	46·0	41·4	39·9	44·8	51·2	55·1	59·9	64·7	54·2
III.	64·7	64·6	60·9	54·8	45·4	40·4	39·1	43·8	50·2	54·1	58·9	63·7	53·4
IV.	63·8	63·9	60·4	54·2	44·7	39·7	38·5	43·1	49·2	53·2	57·7	62·7	52·6
V..........	63·0	63·1	59·7	53·6	43·9	38·8	37·8	42·3	48·2	52·2	56·7	61·8	51·8
VI.	63·5	62·7	59·1	53·1	43·3	38·3	37·3	41·5	47·6	52·8	58·9	63·7	51·8
VII.	67·3	66·0	60·9	53·7	42·8	37·7	36·6	41·6	50·0	57·6	64·3	68·1	53·9
VIII.......	71·8	71·0	66·3	59·2	47·8	42·2	40·9	48·4	58·3	63·7	69·8	72·8	59·4
IX.	75·8	75·4	70·5	64·3	54·8	49·7	48·4	55·4	63·9	68·0	74·1	76·7	64·8
X..........	79·5	79·3	74·2	68·2	59·4	55·3	53·5	60·3	68·9	71·7	77·7	80·2	69·0
XI.	82·5	82·6	77·1	71·3	63·1	59·5	57·5	64·4	72·6	74·9	80·8	83·5	72·5
Noon ...	84·6	84·6	79·4	73·4	65·7	62·0	60·3	67·2	75·2	76·6	82·7	85·4	74·8
XIII.......	85·7	86·3	80·8	74·9	67·4	63·8	62·3	69·5	77·2	78·1	84·2	86·9	76·4
XIV.......	85·6	87·2	81·4	75·2	68·3	64·7	63·3	70·5	77·9	78·8	84·7	86·8	77·0
XV.	84·8	86·8	81·1	74·9	68·4	64·6	63·5	70·8	78·0	78·5	84·6	86·1	76·8
XVI.......	84·0	86·0	80·3	73·9	67·0	62·9	62·2	69·8	76·9	77·4	83·5	85·3	75·7
XVII......	82·6	84·0	78·0	70·5	61·8	56·8	57·1	65·9	74·0	75·1	81·0	83·8	72·6
XVIII. ...	80·7	80·9	74·1	65·6	56·7	51·9	51·6	59·0	68·1	70·7	77·7	80·8	68·1
XIX.......	76·5	76·5	70·5	63·3	54·4	49·5	48·9	55·5	63·7	66·8	73·4	76·5	64·6
XX.	73·7	73·5	68·5	61·7	52·7	48·1	47·4	53·5	61·2	64·5	70·5	73·7	62·4
XXI.......	71·6	71·6	66·7	60·1	51·1	46·7	45·7	51·6	58·7	62·5	68·0	71·7	60·5
XXII. ...	70·2	70·0	65·5	59·0	49·8	45·7	44·3	49·9	57·0	60·8	66·5	70·2	59·1
XXIII. ...	69·1	69·2	64·4	58·0	48·9	44·7	43·2	48·7	55·5	59·4	64·9	68·6	57·7
Midnight.	67·8	67·9	63·3	57·1	47·9	43·6	42·0	47·6	54·1	57·8	63·1	67·1	56·6
I.	66·6	66·7	62·3	56·3	46·8	42·6	40·9	46·1	52·8	56·4	61·7	65·8	55·4
Mean ...	74·2	74·4	69·5	63·0	54·1	49·6	48·4	54·6	62·1	65·3	71·0	74·4	63·4
Min.......	61·7	61·8	58·5	52·1	41·7	36·8	35·6	39·9	46·4	50·6	55·5	60·6	50·1
Max.......	89·1	89·5	83·6	76·8	69·4	65·4	64·3	71·8	79·4	80·7	87·1	89·6	78·9

TABLE 4.

Hourly Temperature Variation.

For the hour ending	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
I.	1·2	1·2	1·0	0·8	1·1	1·0	1·1	1·2	1·3	1·4	1·4	1·3	1·2
II.	1·2	1·4	1·0	0·9	1·0	1·3	1·0	1·1	1·4	1·3	1·5	1·0	1·2
III.	0·9	0·6	0·5	0·8	0·6	1·0	0·8	1·0	1·0	1·0	1·0	1·0	0·8
IV.	0·9	0·7	0·5	0·6	0·7	0·7	0·6	0·7	1·0	0·9	1·2	1·0	0·8
V.	0·8	0·8	0·7	0·6	0·8	0·9	0·7	0·8	1·0	1·0	1·0	0·9	0·8
VI.	**0·5**	0·4	0·6	0·5	0·6	0·5	0·5	0·8	0·6	**0·6**	**2·2**	**1·9**	0·0
VII.	**3·8**	**3·3**	**1·8**	**0·6**	0·5	0·6	0·7	**0·1**	**2·4**	**4·8**	**5·4**	**4·4**	**2·1**
VIII.	**4·5**	**5·0**	**5·4**	**5·5**	**5·0**	**4·5**	**4·3**	**6·8**	**8·3**	**6·1**	**5·5**	**4·7**	**5·5**
IX.	**4·0**	**4·4**	**4·2**	**5·1**	**7·0**	**7·5**	**7·5**	**7·0**	**5·6**	**4·3**	**4·3**	**3·9**	**5·4**
X.	**3·7**	**3·9**	**3·7**	**3·9**	**4·6**	**5·6**	**5·1**	**4·9**	**5·0**	**3·7**	**3·6**	**3·5**	**4·2**
XI.	**3·0**	**3·3**	**2·9**	**3·1**	**3·7**	**4·2**	**4·0**	**4·1**	**3·7**	**3·2**	**3·1**	**3·3**	**3·5**
Noon..........	**2·1**	**2·0**	**2·3**	**2·1**	**2·6**	**2·5**	**2·8**	**2·8**	**2·6**	**1·7**	**1·9**	**1·9**	**2·3**
XIII.	**1·1**	**1·7**	**1·4**	**1·5**	**1·7**	**1·8**	**2·0**	**2·3**	**2·0**	**1·5**	**1·5**	**1·5**	**1·6**
XIV.	0·1	**0·9**	**0·6**	**0·3**	**0·9**	**0·9**	**1·0**	**1·0**	**0·7**	**0·7**	**0·5**	0·1	**0·6**
XV.	0·8	0·4	0·3	0·3	**0·1**	0·1	**0·2**	**0·3**	**0·1**	0·3	0·1	0·7	0·2
XVI.	0·8	0·8	0·8	1·0	1·4	1·7	1·3	1·0	1·1	1·1	1·1	0·8	1·1
XVII..........	1·4	2·0	2·3	3·4	5·2	6·1	5·1	3·9	2·9	2·3	2·5	1·5	3·1
XVIII.	1·9	3·1	3·9	4·9	5·1	4·9	5·5	6·9	5·9	4·4	3·3	3·0	4·5
XIX.	4·2	4·4	3·6	2·3	2·3	2·4	2·7	3·5	4·4	3·8	4·3	4·3	3·5
XX.	2·8	3·0	2·0	1·6	1·7	1·4	1·5	2·1	2·5	2·4	2·9	2·8	2·2
XXI.	2·1	1·9	1·8	1·6	1·6	1·4	1·7	1·8	2·5	2·0	2·5	2·0	1·9
XXII..........	1·4	1·6	1·2	1·1	1·3	1·0	1·4	1·7	1·7	1·7	1·5	1·5	1·4
XXIII.	1·1	0·8	1·1	1·0	0·9	1·0	1·1	1·2	1·5	1·4	1·6	1·6	1·4
Midnight. ...	1·3	1·3	1·1	0·9	1·0	1·1	1·2	1·4	1·4	1·6	1·8	1·5	1·1
I................	1·2	1·2	1·0	0·8	1·1	1·0	1·1	1·2	1·3	1·4	1·4	1·3	1·2

TABLE 5.

Mean Temperature of the Air on Clear Days.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Midnight.	65·5	66·5	62·1	54·6	46·7	41·8	40·3	46·3	51·2	55·5	60·0	66·0	54·7
I.	64·3	65·0	60·6	53·5	45·6	40·7	39·1	45·0	49·8	54·3	58·1	64·1	53·4
II.	62·8	63·4	59·4	52·5	44·4	39·4	38·0	43·9	48·0	52·4	56·5	62·7	52·0
III.	61·8	62·3	58·6	51·4	43·7	38·4	37·2	42·7	46·7	51·0	55·2	61·0	50·8
IV.	60·5	61·3	57·7	50·4	42·8	37·5	36·3	41·6	45·5	49·9	53·9	59·7	49·7
V.	59·2	60·4	56·6	49·5	42·0	36·7	35·5	40·8	44·5	48·6	52·6	58·3	48·7
VI.	60·0	60·0	55·8	48·6	41·3	36·1	35·0	39·8	43·6	49·4	55·0	60·5	48·8
VII.	65·1	64·1	58·0	48·8	40·6	35·3	34·2	39·8	46·5	55·3	61·5	66·0	51·3
VIII.......	70·5	70·3	65·1	55·6	46·0	40·3	39·0	47·7	56·6	62·8	68·0	71·7	57·8
IX.	75·0	75·5	71·1	62·2	54·3	48·7	47·8	55·7	63·0	67·8	72·6	76·1	64·2
X.	79·2	80·0	75·5	67·0	59·7	54·7	53·8	61·3	68·2	71·9	76·5	80·1	69·0
XI.	82·7	83·6	78·9	70·7	63·4	59·0	58·4	65·5	71·9	75·1	79·7	83·4	72·7
Noon. ...	85·2	86·1	81·4	72·9	66·0	61·6	61·6	68·7	74·8	77·4	81·7	86·0	75·3
XIII.......	87·1	88·3	83·4	74·7	67·9	63·5	63·9	71·0	77·0	79·6	83·5	87·7	77·3
XIV.......	88·5	89·6	84·4	75·6	68·8	64·4	65·1	72·1	78·1	80·7	84·7	88·8	78·4
XV.	89·4	90·4	84·9	75·9	68·9	64·6	65·4	72·6	78·4	81·0	85·1	89·3	78·8
XVI.......	89·3	90·1	84·4	75·4	67·7	62·9	64·4	71·4	77·3	80·3	84·4	89·0	78·0
XVII. ...	87·6	88·3	81·8	70·9	61·4	56·1	58·4	66·9	74·4	77·8	82·6	87·5	74·5
XVIII. ...	85·2	85·2	76·2	64·0	55·4	50·6	51·7	59·1	67·2	72·6	78·6	84·2	69·2
XIX.......	79·5	78·8	70·9	61·2	52·8	48·1	48·7	55·5	62·2	67·3	72·9	78·8	64·7
XX.	75·5	74·7	68·7	59·6	51·0	46·4	47·0	53·2	59·4	64·6	69·8	74·9	62·1
XXI.......	73·2	72·4	66·6	57·9	49·4	44·9	45·1	51·2	56·8	62·4	67·6	72·3	60·0
XXII. ...	71·4	70·5	65·1	56·8	48·0	43·8	43·2	49·5	55·0	60·7	65·5	70·3	58·3
XXIII. ...	69·7	69·3	64·0	55·7	47·2	42·8	41·9	48·3	53·7	58·6	63·6	68·5	56·9
Mean. ...	74·5	74·9	69·7	61·1	53·1	48·2	48·0	54·6	60·4	64·9	69·6	74·4	62·8
Min.	58·2	59·2	55·2	47·9	39·8	34·7	33·6	38·6	42·8	47·3	51·8	57·6	47·2
Max.	90·4	91·4	85·7	76·6	69·6	65·7	65·8	73·0	79·1	82·5	86·2	90·3	79·7

TABLE 5a.

Mean Temperature of the Air on Cloudy Days.

Min.	62·9	63·0	59·7	53·7	43·9	39·7	38·7	41·5	49·0	52·1	57·6	61·8	52·0
Max.	88·7	88·8	82·6	76·9	69·2	65·0	62·0	70·3	79·6	79·9	87·6	89·3	78·4

TABLE 6.

Hourly Temperature Variation on Clear Days.

For the hour ending	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
I.	1·2	1·5	1·5	1·1	1·1	1·1	1·2	1·3	1·4	1·2	1·9	1·9	1·3
II.	1·5	1·6	1·2	1·0	1·2	1·3	1·1	1·1	1·8	1·9	1·6	1·4	1·4
III............	1·0	1·1	0·8	1·1	0·7	1·0	0·8	1·2	1·3	1·4	1·3	1·7	1·2
IV............	1·3	1·0	0·9	1·0	0·9	0·9	0·9	1·1	1·2	1·1	1·3	1·3	1·1
V.	1·3	0·9	1·1	0·9	0·8	0·8	0·8	0·8	1·0	1·3	1·3	1·4	1·0
VI............	**0·8**	0·4	0·8	0·9	0·7	0·6	0·5	1·0	0·9	**0·8**	**2·4**	**2·2**	**0·1**
VII.	**5·1**	**4·1**	**2·2**	**0·2**	0·7	0·8	0·8	0·0	**2·9**	**5·9**	**6·5**	**5·5**	**2·5**
VIII.	**5·4**	**6·2**	**7·1**	**6·8**	**5·4**	**5·0**	**4·8**	**7·9**	**10·1**	**7·5**	**6·5**	**5·7**	**6·5**
IX............	**4·5**	**5·2**	**6·0**	**6·6**	**8·3**	**8·4**	**8·8**	**8·0**	**6·4**	**5·0**	**4·6**	**4·4**	**6·4**
X.	**4·2**	**4·5**	**4·4**	**4·8**	**5·4**	**6·0**	**6·0**	**5·6**	**5·2**	**4·1**	**3·9**	**4·0**	**4·8**
XI............	**3·5**	**3·6**	**3·4**	**3.7**	**3·7**	**4·3**	**4·6**	**4·2**	**3·7**	**3·2**	**3·2**	**3·3**	**3·7**
Noon	**2·5**	**2·5**	**2·5**	**2·2**	**2·6**	**2·6**	**3·2**	**3·2**	**2·9**	**2·3**	**2·0**	**2·6**	**2·6**
XIII.	**1·9**	**2·2**	**2·0**	**1·8**	**1·9**	**1·9**	**2·3**	**2·3**	**2·2**	**2·2**	**1·8**	**1·7**	**2·0**
XIV.	**1·4**	**1·3**	**1·0**	**0·9**	**0·9**	**0·9**	**1·2**	**1·1**	**1·1**	**1·1**	**1·2**	**1·1**	**1·1**
XV.	**0·9**	**0·8**	**0·5**	**0·3**	**0·1**	**0·2**	**0·3**	**0·5**	**0·3**	**0·3**	**0·4**	**0·5**	**0·4**
XVI.	0·1	0·3	0·5	0·5	1·2	1·7	1·0	1·2	1·1	0·7	0·7	0·3	0·8
XVII..........	1·7	1·8	2·6	4·5	6·3	6·8	6·0	4·5	2·9	2·5	1·8	1·5	3·5
XVIII.	2·4	3·1	5·6	6·9	6·0	5·5	6·7	7·8	7·2	5·2	4·0	3·3	5·3
XIX.	5·7	6·4	5·3	2·8	2·6	2·5	3·0	3·6	5·0	5·3	5·7	5·4	4·5
XX.	4·0	4·1	2·2	1·6	1·8	1·7	1·7	2·3	2·8	2·7	3·1	3·9	2.6
XXI.	2·3	2·3	2·1	1·7	1·6	1·5	1·9	2·0	2·6	2·2	2·2	2·6	2·1
XXII..........	1·8	1·9	1·5	1·1	1·4	1·1	1·9	1·7	1·8	1·7	2·1	2·0	1·7
XXIII.	1·7	1·2	1·1	1·1	0·8	1·0	1·3	1·2	1·3	2·1	1·9	1·8	1·4

TABLE 7.

Temperature Deviations from the Normal (reduced to the Normal Mean) on Clear Days.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Midnight ...	2·8	1·8	1·5	0·8	0·4	0·5	1·3	0·8	1·0	1·9	1·4	1·0	1·3
I.	2·8	2·1	2·0	1·1	0·4	0·6	1·4	0·9	1·1	1·7	1·5	1·6	1·4
II.	3·1	2·3	2·2	1·2	0·6	0·6	1·5	0·9	1·5	2·3	2·0	2·0	1·6
III............	3·2	2·6	2·5	1·5	0·7	0·6	1·5	1·1	1·8	2·7	2·3	2·7	2·0
IV............	3·6	3·1	2·9	1·9	0·9	0·8	1·8	1·5	2·0	2·9	2·4	3·0	2·3
V.	4·1	3·2	3·3	2·2	0·9	0·7	1·9	1·5	2·0	3·2	2·7	3·5	2·5
VI............	3·8	3·2	3·5	2·6	1·0	0·8	1·9	1·7	2·3	3·0	2·5	3·2	2·4
VII.	2·5	2·4	2·1	3·0	1·2	1·0	2·0	1·8	1·8	1·9	1·4	2·1	2·0
VIII.	1·6	1·2	1·0	1·7	0·8	0·5	1·5	0·7	0·0	0·5	0·4	1·1	1·0
IX............	1·1	0·4	**0·4**	0·2	**0·5**	**0·4**	0·2	**0·3**	**0·8**	**0·2**	0·1	0·6	0·0
X.	0·6	**0·2**	**1·1**	**0·7**	**1·3**	**0·6**	**0·7**	**1·0**	**1·0**	**0·6**	**0·2**	0·1	**0·6**
XI............	0·1	**0·5**	**1·6**	**1·3**	**1·3**	**0·9**	**1·6**	**1·1**	**1·0**	**0·6**	**0·3**	0·1	**0·8**
Noon	**0·3**	**1·0**	**1·8**	**1·4**	**1·3**	**1·0**	**1·7**	**1·5**	**1·3**	**1·2**	**0·4**	**0·6**	**1·1**
XIII.	**1·1**	**1·5**	**2·4**	**1·7**	**1·5**	**1·1**	**2·0**	**1·5**	**1·5**	**1·9**	**0·7**	**0·8**	**1·7**
XIV.	**2·6**	**1·9**	**2·8**	**2·3**	**1·5**	**1·1**	**2·0**	**1·6**	**1·9**	**2·3**	**1·4**	**2·0**	**2·0**
XV.	**4·3**	**3·1**	**3·6**	**2·9**	**1·5**	**1·4**	**2·3**	**1·8**	**2·1**	**2·9**	**1·9**	**3·2**	**2·6**
XVI.	**5·0**	**3·6**	**3·9**	**3·4**	**1·7**	**1·4**	**2·6**	**1·6**	**2·1**	**3·3**	**2·3**	**3·7**	**2·9**
XVII..........	**4·7**	**3·8**	**3·6**	**2·3**	**0·6**	**0·7**	**1·7**	**1·0**	**2·1**	**3·1**	**3·0**	**3·7**	**2·5**
XVIII.	**4·2**	**3·8**	**1·9**	**0·3**	0·3	**0·1**	**0·5**	**0·1**	**0·8**	**2·3**	**2·3**	**3·4**	**1·7**
XIX.	**2·7**	**1·8**	**0·2**	0·2	0·6	0·0	**0·2**	0·0	**0·2**	**0·8**	**0·9**	**2·3**	**0·7**
XX.	**1·5**	**0·7**	0·0	0·2	0·7	0·3	0·0	0·2	0·1	**0·5**	**0·7**	**1·2**	**0·3**
XXI.	**1·3**	**0·3**	0·3	0·3	0·7	0·4	0·2	0·4	0·2	**0·3**	**1·0**	**0·6**	**0·1**
XXII..........	**0·9**	0·0	0·6	0·3	0·8	0·5	0·7	0·4	0·2	**0·3**	**0·4**	**0·1**	0·2
XXIII.	**0·3**	0·4	0·6	0·4	0·7	0·5	0·9	0·4	0·2	0·8	**0·1**	**0·1**	0·2
Min.	3·8	3·1	3·5	2·3	0·9	0·7	1·6	1·3	1·9	2·9	2·3	3·0	2·3
Max.	**1·0**	**1·4**	**1·9**	**1·7**	**1·2**	**1·7**	**1·9**	**1·2**	**1·4**	**1·2**	**0·5**	**0·7**	**1·6**

TABLE 8.

Temperature on Cloudy Days.

	Year.	Difference: Cloudy *minus* Clear.		Year.	Difference Cloudy *minus* Clear.
	°	°		°	°
Midnight......	57·8	**3·1**	XIII. ...	75·8	1·5
I.	56·7	**3·3**	XIV.......	76·1	2·3
II.	55·6	**3·6**	XV.	75·5	3·3
III.	55·1	**4·3**	XVI. ...	74·2	3·8
IV.	54·4	**4·7**	XVII. ...	71·4	3·1
V.	53·8	**5·1**	XVIII....	67·4	1·8
VI.	53·8	**5·0**	XIX. ...	64·5	0·2
VII.	55·6	**4·3**	XX.	62·6	**0·5**
VIII.	60·4	**2·6**	XXI. ...	60·8	**0·8**
IX.	65·2	**1·0**	XXII. ...	59·6	**1·3**
X.	69·0	0·0	XXIII....	58·2	**1·3**
XI.	72·4	0·3			
Noon	74·5	0·8	Mean ...	63·8	**1·0**

TABLE 9.

Mean Monthly Range of Temperature.

	Clear Days.	Cloudy Days.	Normal Mean.
	°	°	°
Jan.	32·2	25·8	27·4
Feb.	32·2	25·8	27·7
Mar.	30·5	22·9	25·1
April	28·7	23·2	24·7
May	29·8	25·3	27·7
June	31·0	25·3	28·6
July	32·2	23·3	28·7
Aug.	34·4	28·8	31·9
Sept.	36·3	30·6	33·0
Oct.	35·2	27·8	30·1
Nov.	34·4	30·0	31·6
Dec.	32·7	27·5	29·0
Year	32·5	26·4	28·8

TABLE 10.

Harmonic Constants in the Diurnal Curve of Temperature.

	p_1	q_1	p_2	q_2	p_3	q_3	p_4	q_4
Jan.	− 8·5165	−6·8479	+2·0776	+0·5617	+0·2831	+0·9777	−0·0375	−0·1227
Feb.	− 8·8963	−7·5688	+2·1272	+1·2176	+0·4278	+0·8531	−0·2750	−0·4186
Mar.	− 8·2473	−6·6509	+2·2175	+1·3829	+0·2360	+0·6501	−0·4417	−0·5340
April	− 8·2778	−6·2572	+2·7895	+1·6044	+0·0858	+0·4991	−0·6083	−0·6206
May	− 8·9881	−7·2544	+3·3168	+2·2889	−0·1109	+0·2940	−0·7583	−0·8805
June	− 9·2464	−7·5631	+3·7302	+2·4198	−0·2306	+0·1272	−0·7292	−0·9598
July	− 9·2159	−7·9383	+3·3126	+2·4888	−0·1859	+0·1615	−0·6958	−1·0031
Aug.	−10·3720	−8·9396	+3·2743	+2·3608	+0·2040	+0·5605	−0·8333	−1·0681
Sept.	−11·4775	−9·2064	+3·0960	+1·5989	+0·4920	+1·0289	−0·7833	−0·7361
Oct.	−10·0883	−7·6685	+2·4519	+0·5742	+0·7546	+0·8434	−0·6250	−0·2598
Nov.	−10·7369	−8·0380	+2·1933	+0·2063	+0·9224	+0·8399	−0·4417	−0·0433
Dec.	− 9·5678	−7·2333	+2·0131	+0·3668	+0·5637	+0·8115	−0·1708	−0·0650
Year	− 9·3171	−7·5764	+2·7273	+1·4179	+0·2703	+0·6427	−0·5333	−0·5468
Year: Clear days	−10·7546	−9·4394	+2·9436	+1·5825	+0·5721	+0·8218	−0·7250	−0·7794
Year: Cloudy Days	− 8·6606	−6·3651	+2·5721	+1·3029	+0·0868	+0·5383	−0·4042	−0·4114

	V_1	V_2	V_3	V_4	u_1	u_2	u_3	u_4
Jan.	231° 12′	74° 52′	16° 9′	197° 0′	10·928	2·152	1·018	0·128
Feb.	229 37	60 13	26 38	213 18	11·680	2·451	0·950	0·501
Mar.	231 7	58 3	19 57	219 36	10·595	2·616	0·692	0·693
April	232 55	60 5	9 45	224 26	10·376	3·218	0·507	0·869
May	231 6	55 24	339 20	220 44	11·549	4·030	0·314	1·162
June	230 43	57 2	298 53	217 13	11·946	4·446	0·263	1·206
July	229 15	53 5	310 59	214 42	12·165	4·143	0·260	1·222
Aug.	229 15	54 12	20 0	217 58	13·691	4·037	0·597	1·355
Sept.	231 16	62 41	25 33	226 47	14·713	3·485	1·141	1·748
Oct.	232 46	76 49	41 49	247 26	12·671	2·518	1·132	0·677
Nov.	233 11	84 38	47 41	264 24	13·412	2·203	1·248	0·444
Dec.	232 55	79 40	34 47	250 14	11·993	2·046	0·988	0·181
Year	230 53	62 32	22 48	224 17	12·009	3·074	0·697	0·764
Year: Clear Days	228 44	61 44	34 51	222 56	14·308	3·342	1·001	1·064
Year: Cloudy Days	233 41	63 8	9 10	224 30	10·748	2·883	0·545	0·577

TABLE 11.

Number of Cloudy Days in each Month.

	Cloud Ratio: 50 per cent.—100 per cent.		Cloud Ratio: 20 per cent.—50 per cent.	
	Number of Days.	Mean per cent.	Number of Days.	Mean per cent.
Jan.	52	76	41	30
Feb.	47	75	36	32
Mar.	47	72	43	28
April	39	75	48	26
May	22	68	35	32
June	16	72	34	32
July	18	71	31	30
Aug.	19	66	36	29
Sept.	30	72	40	26
Oct.	43	75	42	31
Nov.	31	70	46	29
Dec.	48	71	40	28
Year	412	72	472	29

TABLE 12.

Mean Temperature of the Air on very Cloudy Days.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Midnight.	68·9	68·2	64·2	59·0	50·9	47·1	46·6	50·5	58·2	60·1	64·7	68·8	58·9
I.	68·0	67·4	63·6	58·3	50·0	46·1	45·5	49·6	57·4	59·0	63·5	67·9	58·0
II..........	67·3	66·1	62·7	57·5	49·0	45·0	44·8	48·6	56·5	57·9	62·8	66·9	57·1
III.	66·8	65·7	62·4	56·9	48·4	44·1	44·0	48·2	55·7	57·1	62·1	66·2	56·5
IV.	66·3	65·2	62·2	56·4	48·3	43·7	43·6	48·0	55·0	56·8	61·6	65·5	56·0
V.	65·6	64·5	61·6	56·2	47·8	43·3	43·1	47·3	54·4	56·2	61·3	65·0	55·5
VI.	65·9	64·1	61·2	56·0	47·4	43·0	43·2	47·2	53·8	56·7	62·7	66·5	55·6
VII.	68·7	66·4	62·7	56·8	47·0	42·5	43·0	47·7	55·2	60·5	65·9	69·8	57·2
VIII.......	72·4	70·1	66·3	60·8	50·0	45·8	45·9	51·7	60·2	65·1	69·7	73·5	61·0
IX.	75·8	73·7	69·3	64·1	54·1	50·9	50·2	55·6	65·0	68·8	72·9	76·7	64·7
X.	79·2	77·0	72·0	66·9	56·9	55·8	53·9	59·1	69·9	71·9	76·0	79·6	68·2
XI.	81·6	80·1	74·5	69·6	59·8	59·3	57·1	62·9	73·4	74·3	78·5	83·0	71·2
Noon......	83·3	81·7	76·6	71·6	61·4	61·4	58·5	64·6	76·2	75·3	80·5	84·4	73·0
XIII.......	84·0	83·1	77·3	72·6	62·4	62·6	59·3	66·9	78·0	76·1	81·2	85·5	74·1
XIV.......	82·6	83·6	77·7	72·2	63·1	63·6	59·4	67·7	77·7	76·1	80·2	84·2	74·0
XV.	80·7	82·9	76·3	71·3	63·5	63·2	59·1	67·7	77·2	74·9	79·0	82·4	73·2
XVI.......	79·1	81·8	75·2	69·9	62·3	61·5	57·2	66·9	75·8	73·2	78·0	80·7	71·8
XVII. ...	77·4	78·8	73·5	67·8	59·5	57·6	54·4	64·3	73·5	71·2	75·3	79·2	69·4
XVIII. ...	76·0	75·7	70·8	64·9	56·4	54·4	51·5	59·9	69·2	68·3	72·9	76·6	66·4
XIX.......	73·4	72·8	68·7	63·2	55·1	52·8	49·8	57·3	65·1	65·6	70·1	73·5	64·0
XX.	71·7	71·0	67·3	62·1	54·0	51·9	48·3	56·0	63·9	64·2	67·8	71·6	62·5
XXI.......	70·1	69·6	66·2	60·7	52·7	50·7	47·6	54·9	61·8	62·1	66·1	70·0	61·0
XXII. ...	69·3	68·6	65·4	59·7	51·6	50·1	46·7	53·4	60·2	60·5	64·8	68·8	59·9
XXIII....	68·5	68·0	64·3	58·7	51·1	49·6	45·7	52·4	59·0	59·4	63·9	67·7	59·0
Year	73·5	72·8	68·4	63·1	54·3	51·9	49·9	56·2	64·7	65·5	70·1	73·9	63·7

TABLE 13.

Mean Temperature of the Air on Moderately Cloudy Days.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Midnight.	68·8	68·4	63·6	57·8	49·0	46·0	43·4	46·9	54·0	57·6	64·1	65·7	57·1
I.	67·2	66·9	62·5	57·1	47·8	45·2	42·5	45·7	52·5	55·7	62·7	64·6	55·9
II.	65·5	65·6	61·6	56·2	47·1	43·8	41·6	44·5	51·2	54·6	61·1	63·9	54·7
III.	64·2	65·1	61·1	55·4	46·8	42·9	40·9	43·6	50·4	53·8	60·1	63·1	53·9
IV.	63·1	64·3	60·5	55·0	46·1	42·3	40·9	43·4	49·5	52·5	58·6	62·3	53·2
V.	62·6	63·5	60·1	54·3	45·2	41·1	40·4	42·5	48·2	51·5	57·5	61·2	52·3
VI.	63·1	63·1	59·1	53·8	44·5	40·7	39·5	41·7	47·9	51·9	60·0	63·3	52·4
VII.	67·2	67·0	61·2	54·6	44·3	40·4	38·7	41·8	50·4	56·8	65·9	67·9	54·7
VIII.......	72·1	72·7	66·9	60·4	49·8	44·5	42·8	48·1	59·0	63·1	71·6	72·9	60·3
IX.	76·4	77·5	71·5	65·9	56·2	51·3	48·9	54·8	64·2	67·3	76·3	79·7	65·8
X.	80·1	81·8	75·5	70·1	60·4	56·4	52·5	58·9	67·5	71·3	80·0	81·0	69·6
XI.	83·5	85·0	78·5	73·1	64·6	60·6	55·5	63·2	72·9	75·3	83·3	84·1	73·3
Noon. ...	85·9	87·2	80·9	75·2	67·8	63·1	58·4	65·6	74·9	77·2	85·1	86·1	75·6
XIII.......	86·9	88·9	82·6	76·9	69·6	64·9	60·1	67·9	76·8	78·8	86·9	87·8	77·3
XIV.......	87·2	89·9	83·3	77·4	70·5	65·9	61·2	68·9	77·8	79·8	87·7	88·1	78·1
XV.	86·5	89·0	83·3	77·1	70·5	65·4	61·5	69·1	78·1	79·9	87·9	87·7	78·0
XVI.......	86·2	88·2	82·7	76·2	68·6	63·5	59·9	68·2	77·2	79·0	86·3	87·5	77·0
XVII. ...	85·4	87·3	82·3	72·5	63·9	57·9	55·6	64·8	73·9	76·7	83·3	86·0	74·1
XVIII. ...	83·2	84·2	76·0	67·2	59·4	53·4	51·3	58·4	70·9	71·4	80·2	82·8	69·9
XIX.......	78·2	79·4	72·2	64·8	56·9	50·9	48·9	54·6	64·5	67·6	76·1	77·9	66·0
XX.	74·8	75·8	69·7	62·9	55·2	49·9	47·8	52·8	61·5	64·8	72·9	75·1	63·6
XXI.......	72·3	73·6	67·4	61·1	53·3	48·6	46·1	50·7	58·7	62·9	69·6	73·3	61·5
XXII. ...	70·5	71·5	65·9	59·9	52·1	47·6	45·7	48·9	57·1	61·2	68·6	71·8	60·1
XXIII. ...	69·4	70·6	64·9	59·0	50·8	46·4	44·8	47·6	55·1	60·1	66·8	69·8	58·8
Mean ...	75·0	76·1	70·6	64·3	55·8	51·4	48·7	53·9	62·3	65·5	73·0	75·1	64·3

TABLE 14.

Some Harmonic Constants in the Diurnal Curve of Temperature.

	Clear Days.	Moderately Cloudy Days.	Very Cloudy Days.	All Cloudy Days.	All Days.	Allahabad.	Cordoba.	Trevandrum.
p_1	—10·7546	—9·560	—7·210	—8·6606	—9·3171	—	—	—
q_1	— 9·4394	—7·973	—5·023	—6·3651	—7·5764	—	—	—
p_2	+ 2·9436	+2·530	+2·323	+2·5721	+2·7273	—	—	—
q_2	+ 1·5825	+1·345	+1·093	+1·3029	+1·4179	—	—	—
p_3	+ 0·5721	+0·3434	—0·0305	+0·0868	+0·2703	—	—	—
q_3	+ 0·8218	+0·6771	+0·4072	+0·5383	+0·6427	—	—	—
p_4	— 0·7250	—0·525	—0·2125	—0·4042	—0·5333	—	—	—
q_4	— 0·7794	—0·5485	—0·2237	—0·4114	—0·5468	—	—	—
V_1	228° 44′	230° 10′	235° 8′	233° 41′	230° 53′	233° 13′	231° 18′	240° 6′
V_2	61 44	62 0	64 48	63 8	62 32	62 34	61 45	82 46
V_3	34 51	26 54	355 43	9 10	22 48	20 0	15 57	23 41
V_4	222 56	223 45	223 32	224 30	224 17	225 25	225 0	244 28
u_1	14·308	12·450	8·787	10·748	12·009	9·923	5·742*	5·101
u_2	3·342	2·865	2·567	2·883	3·074	2·747	1·266	1·354
u_3	1·001	0·759	0·408	0·545	0·697	0·427	0·408	0·376
u_4	1·064	0·759	0·309	0·577	0·764	0·679	0·252	0·295

* Measured in Centigrade degrees.

TABLE 15.

MEAN PRESSURE OF THE AIR.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
Midnight	26·018	26·074	26·098	26·183	26·230	26·299	26·257	26·237	26·185	29·096	26·044	26·033	26·146
I.	·014	·072	·094	·179	·228	·297	·256	·234	·179	·089	·039	·028	·142
II.	·007	·069	·089	·174	·224	·296	·252	·229	·171	·083	·037	·024	·138
III.	·006	·066	·085	·168	·219	·295	·250	·226	·167	·081	·038	·024	·136
IV.	·011	·069	·085	·166	·218	·294	·247	·226	·170	·086	·045	·032	·137
V.	·022	·076	·091	·172	·221	·297	·250	·232	·179	·097	·057	·042	·145
VI.	·036	·090	·103	·181	·230	·306	·257	·241	·193	·114	·072	·058	·157
VII.	·047	·103	·115	·194	·240	·316	·269	·253	·207	·126	·083	·068	·169
VIII.	·050	·112	·127	·211	·255	·329	·279	·267	·219	·131	·089	·071	·179
IX.	·048	·113	·131	·217	·263	·339	·288	·275	·222	·132	·086	·069	·182
X.	·044	108	·130	·216	·264	·342	·293	·274	·214	·123	·078	·062	·179
XI.	·035	·098	·121	·208	·255	·332	·282	·265	·201	·108	·065	·052	·169
Noon.	·018	·082	·104	·189	·234	·312	·261	·243	·175	·088	·046	·034	·149
XIII.	·001	·065	·084	·165	·212	·289	·237	·217	·152	·069	·026	·017	·128
XIV.	25·981	·043	·063	·148	·193	·270	·219	·196	·130	·049	·003	25·995	·108
XV.	·966	·027	·051	·143	·187	·265	·212	·187	·121	·037	25·991	·983	·098
XVI.	·954	·017	·044	·139	·185	·265	·210	·186	·119	·035	·982	·968	·092
XVII.	·952	·013	·045	·141	·190	·270	·214	·190	·124	·039	·983	·968	·094
XVIII.	·963	·022	·052	·149	·199	·279	·222	·200	·134	·050	·993	·981	·104
XIX.	·978	·036	·062	·161	·210	·289	·232	·214	·148	·065	26·009	·993	·117
XX.	·993	·052	·080	·175	·219	·297	·242	·226	·167	·084	·027	25·010	·131
XXI.	26·007	·064	·091	·183	·225	·301	·247	·235	·176	·092	·037	·023	·140
XXII.	·019	·072	·096	·187	·228	·305	·252	·241	·180	·097	·047	·033	·147
XXIII.	·021	·076	·100	·187	·229	·306	·253	·242	·180	·097	·050	·036	·148
Midnight.	·018	·077	·100	·185	·228	·305	·250	·240	·178	·095	·045	·032	·146
I.	·014	·075	·096	·181	·226	·303	·249	·237	·172	·088	·040	·027	·142
Mean.	26·008	26·067	26·089	26·177	26·223	26·299	26·249	26·231	26·171	26·086	26·039	26·025	26·139

TABLE 16.

HOURLY PRESSURE VARIATION.

For the hour ending	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
I.	·004	·002	·004	·004	·002	·002	·001	·003	·006	·007	·005	·005	·004
II.	7	3	5	5	4	1	4	5	8	6	2	4	·004
III.	1	3	4	6	5	1	2	3	4	2	**1**	0	·002
IV.	**5**	**3**	0	2	1	1	3	0	**3**	**5**	**7**	**8**	**·001**
V.	**11**	**7**	**6**	**6**	**3**	**3**	**3**	**6**	**9**	**11**	**12**	**10**	**·008**
VI.	**14**	**14**	**12**	**9**	**9**	**9**	**7**	**9**	**14**	**17**	**15**	**16**	**·012**
VII.	**11**	**13**	**12**	**13**	**10**	**10**	**12**	**12**	**14**	**12**	**11**	**10**	**·012**
VIII.	**3**	**9**	**12**	**17**	**15**	**13**	**10**	**14**	**12**	**5**	**6**	**3**	**·010**
IX.	2	**1**	**4**	**6**	**8**	**10**	**9**	**8**	**3**	**1**	3	2	**·003**
X.	4	5	1	1	1	**3**	**5**	1	8	9	8	7	·003
XI.	9	10	9	8	9	10	11	9	13	15	13	10	·010
Noon.	17	16	17	19	21	20	21	22	26	20	19	18	·020
XIII.	17	17	20	24	23	23	24	26	23	19	20	17	·021
XIV.	20	22	21	17	19	19	18	21	22	20	23	22	·020
XV.	15	16	12	5	6	5	7	9	9	12	12	12	·010
XVI.	12	10	7	4	2	0	2	1	2	2	9	15	·006
XVII.	2	4	**1**	**2**	**5**	**5**	**4**	**4**	**5**	**4**	**1**	0	**·002**
XVIII.	**11**	**9**	**7**	**8**	**9**	**9**	**8**	**10**	**10**	**11**	**10**	**13**	**·010**
XIX.	**15**	**14**	**10**	**12**	**11**	**10**	**10**	**14**	**14**	**15**	**16**	**12**	**·013**
XX.	**15**	**16**	**18**	**14**	**9**	**8**	**10**	**12**	**19**	**19**	**18**	**17**	**·014**
XXI.	**14**	**12**	**11**	**8**	**6**	**4**	**5**	**9**	**9**	**8**	**10**	**13**	**·009**
XXII.	**12**	**8**	**5**	**4**	**3**	**4**	**5**	**6**	**4**	**5**	**10**	**10**	**·007**
XXIII.	**2**	**4**	**4**	0	**1**	**1**	**1**	**1**	0	0	**3**	**3**	**·001**
Midnight.	3	**1**	0	2	1	1	3	2	2	2	5	4	·002
I.	4	2	4	4	2	2	1	3	6	7	5	5	·004

TABLE 17.

Mean Pressure of the Air on Clear Days.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
Midnight	26·006	26·057	26·081	26·209	26·259	26·313	26·291	26·264	26·208	26·105	26·069	26·025	26·157
I.	·003	·056	·077	·208	·259	·312	·290	·261	·204	·102	·065	·022	·155
II.	·002	·053	·074	·206	·255	·312	·288	·257	·196	·098	·063	·020	·152
III.	·004	·052	·074	·202	·252	·311	·287	·256	·192	·098	·064	·022	·151
IV.	·010	·057	·076	·202	·252	·310	·286	·256	·196	·105	·072	·031	·154
V.	·023	·066	·084	·208	·255	·313	·288	·262	·204	·117	·084	·042	·162
VI.	·037	·081	·096	·220	·263	·323	·295	·273	·217	·136	·101	·060	·175
VII.	·049	·095	·107	·231	·274	·333	·308	·285	·232	·150	·112	·071	·187
VIII.	·054	·104	·121	·248	·291	·347	·317	·300	·244	·159	·119	·077	·198
IX.	·053	·105	·125	·253	·299	·357	·327	·307	·247	·160	·118	·075	·202
X.	·050	·099	·125	·252	·301	·360	·330	·307	·241	·153	·112	·070	·200
XI.	·042	·088	·118	·246	·292	·351	·319	·298	·225	·138	·102	·062	·190
Noon.	·028	·072	·103	·229	·274	·332	·300	·277	·200	·119	·085	·049	·172
XIII.	·012	·056	·085	·207	·252	·310	·276	·251	·177	·100	·067	·032	·152
XIV.	25·991	·034	·066	·191	·235	·292	·256	·231	·155	·079	·043	·012	·132
XV.	·975	·018	·054	·186	·230	·287	·248	·222	·146	·068	·032	25·995	·122
XVI.	·963	·006	·048	·184	·229	·288	·247	·221	·142	·063	·020	·980	·116
XVII.	·956	25·998	·048	·184	·233	·291	·250	·224	·148	·068	·018	·978	·116
XVIII.	·965	26·004	·052	·191	·241	·300	·256	·234	·156	·077	·028	·985	·124
XIX.	·978	·014	.059	·200	·252	·310	·265	·245	·170	·092	·041	·998	·135
XX.	·993	·027	.076	·211	·261	·318	·274	·257	·188	·109	·058	26·013	·149
XXI.	26·006	·039	·084	·218	·267	·323	·280	·266	·196	·117	·069	·028	·158
XXII.	·018	·049	·087	·221	·269	·327	·284	·271	·198	·119	·077	·039	·163
XXIII.	·022	·052	·091	·220	·270	·327	·285	·273	·200	·119	·078	·042	·165
Mean.	26·010	26·053	26·084	26·214	26·261	26·319	26·285	26·262	26·195	26·110	26·072	26·030	26·158

TABLE 18.

Hourly Pressure Variation on Clear Days.

For the hour ending	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
I.	·003	·001	·004	·001	·000	·001	·001	·003	·004	·003	·004	·003	·002
II.	1	3	3	2	4	0	2	4	8	4	2	2	·003
III.	**2**	1	0	4	3	1	1	1	4	0	**1**	**2**	·001
IV.	**6**	**5**	**2**	0	0	1	1	0	**4**	**7**	**8**	**9**	**·003**
V.	**13**	**9**	**8**	**6**	**3**	**3**	**2**	**6**	**8**	**12**	**12**	**11**	**·008**
VI.	**14**	**15**	**12**	**12**	**8**	**10**	**7**	**11**	**13**	**19**	**17**	**18**	**·013**
VII.	**12**	**14**	**11**	**11**	**11**	**10**	**13**	**12**	**15**	**14**	**11**	**11**	**·012**
VIII.	**5**	**9**	**14**	**17**	**17**	**14**	**9**	**15**	**12**	**9**	**7**	**6**	**·011**
IX.	1	**1**	**4**	**5**	**8**	**10**	**10**	**7**	**3**	**1**	1	2	**·004**
X.	3	6	0	1	**2**	**3**	**3**	0	6	7	6	5	·002
XI.	8	11	7	6	9	9	11	9	6	15	10	8	·010
Noon.	14	16	15	17	18	19	19	21	25	19	17	13	·018
XIII.	16	16	18	22	22	22	24	26	23	19	18	17	·020
XIV.	21	22	19	16	17	18	20	20	22	21	24	20	·020
XV.	16	16	12	5	5	5	8	9	9	11	11	17	·010
XVI.	12	12	6	2	1	**1**	1	1	4	5	12	15	·006
XVII.	7	8	0	0	**4**	**3**	**3**	**3**	**6**	**5**	2	2	·000
XVIII.	**9**	**6**	**4**	**7**	**8**	**9**	**6**	**10**	**8**	**9**	**10**	**7**	**·008**
XIX.	**13**	**10**	**7**	**9**	**11**	**10**	**9**	**11**	**14**	**15**	**13**	**13**	**·011**
XX.	**15**	**13**	**17**	**11**	**9**	**8**	**9**	**12**	**18**	**17**	**17**	**15**	**·014**
XXI.	**13**	**12**	**8**	**7**	**6**	**5**	**6**	**9**	**8**	**8**	**11**	**15**	**·009**
XXII.	**12**	**10**	**3**	**3**	**2**	**4**	**4**	**5**	**2**	**2**	**8**	**11**	**·005**
XXIII.	**4**	**3**	**4**	**1**	**1**	0	**1**	**2**	**2**	0	**1**	**3**	**·002**

TABLE 19.

PRESSURE DEVIATIONS FROM THE NORMAL (REDUCED TO THE NORMAL MEAN) ON CLEAR DAYS.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Midnight.	·014	·003	·012	·011	·009	·006	·002	·004	·001	·015	·008	·013	·008
I.	13	2	12	8	7	5	2	4	**1**	11	7	11	·006
II..........	7	2	10	5	7	4	0	3	**1**	9	7	9	·005
III.	4	0	6	3	5	4	**1**	1	**1**	7	7	7	·004
IV.	3	**2**	4	1	4	4	**3**	1	**2**	5	6	6	·002
V..........	1	**4**	2	1	4	4	**2**	1	**1**	4	6	5	·002
VI.	1	**5**	2	1	4	3	**2**	**1**	0	2	4	3	·001
VII.	0	**6**	3	0	4	3	**3**	**1**	**1**	0	4	2	·001
VIII. ...	**2**	**6**	1	0	2	2	**2**	**2**	**1**	**4**	3	**1**	·000
IX.	**3**	**6**	1	1	2	2	**3**	**1**	**1**	**4**	1	**1**	**·001**
X..........	**4**	**5**	0	1	1	2	**1**	**2**	**3**	**6**	**1**	**3**	**·002**
XI.	**5**	**4**	**2**	**1**	1	1	**1**	**2**	0	**6**	**4**	**5**	**·002**
Noon ...	**8**	**4**	**4**	**3**	**2**	0	**3**	**3**	**1**	**7**	**6**	**10**	**·004**
XIII. ...	**9**	**5**	**6**	**5**	**2**	**3**	**3**	**3**	**1**	**7**	**8**	**10**	**·005**
XIV.......	**8**	**5**	**8**	**6**	**4**	**2**	**1**	**4**	**1**	**6**	**7**	**12**	**·005**
XV.	**7**	**5**	**8**	**6**	**5**	**2**	0	**4**	**1**	**7**	**8**	**8**	**·005**
XVI. ...	**7**	**3**	**9**	**8**	**6**	**3**	**1**	**4**	1	**4**	**5**	**7**	**·005**
XVII. ...	**2**	1	**8**	**6**	**5**	**1**	0	**3**	0	**5**	**2**	**5**	**·003**
XVIII....	0	4	**5**	**5**	**4**	**1**	2	**3**	2	**3**	**2**	1	**·001**
XIX.......	2	8	**2**	**2**	**4**	**1**	3	0	2	**3**	1	0	·001
XX.	2	11	**1**	1	**4**	**1**	4	0	3	**1**	2	2	·001
XXI.......	3	11	2	2	**4**	**2**	3	0	4	**1**	1	0	·001
XXII. ...	3	9	4	3	**3**	**2**	4	1	6	2	3	**1**	·002
XXIII....	1	10	4	4	**3**	**1**	4	0	2	2	5	**1**	·002

TABLE 20.

PRESSURE ON CLOUDY DAYS.

	Year.	Difference: Cloudy *minus* Clear.		Year.	Difference: Cloudy *minus* Clear.
	inches	inches		inches	inches
Midnight..	26·139	·018	XIII. ...	·112	·040
I............	·135	·020	XIV. ...	·092	·040
II.	·129	·023	XV. ...	·082	·040
III.	·125	·026	XVI. ...	·076	·040
IV.	·126	·028	XVII. ...	·080	·036
V.	·134	·028	XVIII.	·091	·033
VI.	·145	·030	XIX. ...	·105	·030
VII.	·157	·030	XX.......	·119	·030
VIII.	·167	·031	XXI. ...	·128	·030
IX.	·169	·033	XXII. ...	·137	·026
X.	·165	·035	XXIII...	·137	·028
XI.	·155	·035			
Noon	·134	·038	Mean ...	26·127	·031

TABLE 21.

Average Barometric Pressure in Twelve-hour Periods.

For the 12 hours beginning	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
Midnight ...	26·0282	26·0875	26·1057	26·1891	26·2373	26·3118	26·2650	26·2466	26·1992	26·1055	26·0611	26·0469	26·1566
I.	·0282	·0882	·1063	·1896	·2376	·3128	·2653	·2471	·1914	·1048	·0613	·0470	·1568
II.	·0271	·0876	·1054	·1884	·2363	·3123	·2637	·2457	·1892	·1032	·0602	·0461	·1557
III............	·0249	·0854	·1033	·1863	·2337	·3101	·2610	·2429	·1857	·1003	·0573	·0437	·1532
IV.	·0216	·0822	·1004	·1842	·2310	·3076	·2578	·2397	·1819	·0967	·0534	·0403	·1500
V.	·0168	·0778	·0970	·1819	·2283	·3052	·2547	·2363	·1777	·0924	·0482	·0349	·1463
VI.	·0110	·0726	·0932	·1793	·2257	·3029	·2517	·2328	·1731	·0876	·0420	·0287	·1420
VII.	·0049	·0669	·0889	·1767	·2231	·3007	·2488	·2294	·1682	·0823	·0354	·0223	·1376
VIII.	25·9992	·0613	·0845	·1739	·2206	·2984	·2457	·2262	·1633	·0772	·0293	·0161	·1333
IX.	·9944	·0563	·0806	·1709	·2176	·2957	·2427	·2227	·1589	·0733	·0241	·0110	·1293
X.	·9910	·0523	·0773	·1681	·2144	·2926	·2393	·2194	·1551	·0699	·0200	·0072	·1257
XI.	·9889	·0493	·0744	·1657	·2114	·2895	·2358	·2167	·1523	·0677	·0174	·0048	·1231
Noon	·9877	·0474	·0727	·1639	·2093	·2873	·2334	·2147	·1505	·0668	·0162	·0034	·1213
XIII.	·9877	·0467	·0722	·1634	·2089	·2863	·2331	·2143	·1513	·0675	·0160	·0033	·1211
XIV.	·9888	·0473	·0730	·1646	·2103	·2869	·2347	·2157	·1536	·0692	·0171	·0043	·1223
XV............	·9910	·0495	·0752	·1667	·2128	·2891	·2374	·2184	·1570	·0720	·0199	·0067	·1248
XVI.	·9943	·0528	·0780	·1688	·2155	·2916	·2406	·2217	·1608	·0757	·0238	·0101	·1279
XVII.........	·9992	·0571	·0814	·1711	·2183	·2940	·2437	·2250	·1651	·0799	·0291	·0154	·1317
XVIII.	26·0049	·0623	·0852	·1737	·2208	·2963	·2467	·2285	·1697	·0848	·0353	·0216	·1367
XIX.	·0110	·0680	·0895	·1763	·2234	·2985	·2496	·2319	·1746	·0901	·0418	·0280	·1403
XX.	·0167	·0736	·0939	·1791	·2259	·3007	·2527	·2352	·1795	·0952	·0480	·0343	·1447
XXI.	·0215	·0786	·0978	·1821	·2289	·3034	·2558	·2386	·1838	·0991	·0532	·0393	·1487
XXII.........	·0249	·0827	·1012	·1849	·2321	·3064	·2592	·2419	·1877	·1024	·0573	·0432	·1522
XXIII.	·0270	·0857	·1040	·1873	·2351	·3097	·2626	·2447	·1905	·1046	·0598	·0456	·1548

TABLE 22.

Mean Hourly Moisture Conditions.

	Dew-point.	Humidity per cent.		Dew-point.	Humidity per cent.
	°			°	
Midnight	43·0	63·2	XIII................	44·8	35·2
I......................	43·1	65·7	XIV................	44·7	34·5
II.	43·1	68·3	XV.	44·3	34·5
III....................	42·8	69·4	XVI................	44·0	35·6
IV.	42·5	70·7	XVII.	44·8	40·9
V.	42·7	72·9	XVIII.	44·6	46·8
VI.	43·0	73·5	XIX................	44·5	51·7
VII...................	43·6	70·7	XX.	44·0	54·3
VIII.	44·7	61·1	XXI................	43·6	56·9
IX.	45·6	52·6	XXII.	43·3	59·0
X.	45·7	46·1	XXIII.	43·1	60·7
XI.	45·6	41·0			
Noon	45·3	37·6	Mean	44·0	54·3

TABLE 23.

Monthly Moisture Conditions.

	Dew-point.			Humidity per cent.		
	Mean.	Clear Days.	Difference.	Mean.	Clear Days.	Difference.
	°	°	°			
Jan.	52·4	45·8	6·6	52·3	40·7	11·6
Feb.	52·6	48·0	4·6	51·9	43·4	8·5
Mar.	55·2	50·2	5·0	64·9	54·7	10·2
April............	50·4	46·2	4·2	67·1	62·0	5·1
May	39·5	36·9	2·6	61·2	57·2	4·0
June	34·8	33·1	1·7	59·5	58·7	0·8
July	33·8	30·9	2·9	60·4	54·7	5·7
Aug.	35·0	33·5	1·5	51·3	48·5	2·8
Sept.	37·9	34·7	3·2	44·6	41·5	3·1
Oct.	42·2	38·7	3·5	47·8	41·8	6·0
Nov.	44·3	39·5	4·8	42·9	37·4	5·5
Dec.	50·1	44·9	5·2	47·6	38·9	8·7
Year	44·0	40·2	3·8	54·3	48·3	6·0

TABLE 24.

Pressure on Clear Days for Various Dew-points.

	Less than 30°	30–35°	35–40°	40–45°	45–50°	Greater than 50°
	inches	inches	inches	inches	inches	inches
Midnight	26·301	26·240	26·202	26·117	26·108	26·093
I.	·300	·238	·199	·114	·106	·090
II.	·298	·236	·196	·111	·103	·086
III.	·298	·234	·195	·111	·101	·084
IV.	·299	·235	·198	·115	·104	·087
V.	·303	·238	·205	·124	·113	·094
VI.	·314	·251	·218	·137	·125	·107
VII.	·326	·264	·230	·150	·136	·119
VIII.............	·333	·278	·240	·160	·147	·129
IX.	·348	·285	·244	·162	·150	·132
X.	·351	·286	·242	·159	·146	·128
XI.	·341	·275	·230	·150	·138	·120
Noon............	·324	·254	·211	·133	·121	·103
XIII.............	·306	·231	·189	·113	·102	·085
XIV.............	·287	·211	·170	·093	·081	·065
XV.	·281	·203	·159	·080	·069	·051
XVI.............	·282	·202	·154	·076	·059	·043
XVII.	·285	·206	·157	·075	·057	·039
XVIII.	·292	·212	·166	·083	·064	·043
XIX.............	·302	·226	·178	·095	·075	·053
XX.	·312	·237	·190	·110	·089	·066
XXI.............	·319	·245	·197	·121	·099	·074
XXII.	·323	·248	·202	·128	·106	·080
XXIII.	·325	·249	·203	·130	·108	·082
Mean	26·311	26·241	26·199	26·119	26·105	26·086

Range.

A.	·006	·007	·007	·008	·008	·008
B.	·046	·050	·049	·048	·049	·051
C.	·075	·087	·090	·091	·093	·090
D.	·036	·044	·049	·052	·051	·046

TABLE 25.

Monthly Distribution of the Various Mean Dew-points under Clear Skies.

	Less than 30°	30–50°	35–40°	40–45°	45–50°	Greater than 50°
Jan.	—	—	4	13	8	6
Feb.	—	—	3	5	10	11
Mar.	—	—	—	7	8	19
April	—	1	5	4	16	7
May	7	25	11	21	3	—
June	16	31	22	1	—	—
July	29	33	8	4	1	—
Aug.	10	38	17	4	—	—
Sept.	6	23	15	5	1	—
Oct.	1	8	15	11	2	2
Nov.	—	6	21	11	2	3
Dec.	—	—	4	16	12	4
Year	69	165	125	102	63	52

TABLE 26.

Pressure on Clear Days for Dew-points greater than the Mean of each Month.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
Midnight	26·034	26·065	26·097	26·196	26·243	26·327	26·289	26·234	26·222	26·118	26·095	26·040	26·163
I.	·028	·063	·094	·196	·244	·325	·288	·231	·218	·114	·090	·037	·161
II.	·029	·058	·089	·193	·240	·324	·286	·227	·210	·109	·084	·030	·157
III.	·029	·056	·088	·189	·237	·323	·284	·225	·207	·108	·083	·029	·155
IV.	·035	·060	·089	·188	·237	·322	·282	·227	·210	·112	·090	·030	·157
V.	·049	·070	·095	·195	·240	·324	·285	·233	·218	·124	·101	·046	·166
VI.	·062	·080	·107	·205	·247	·334	·292	·244	·230	·139	·113	·060	·176
VII.	·074	·096	·112	·218	·259	·347	·303	·254	·244	·149	·125	·071	·188
VIII.	·078	·106	·124	·234	·274	·359	·314	·271	·255	·155	·130	·076	·198
IX.	·079	·106	·134	·240	·282	·372	·316	·278	·255	·154	·128	·076	·202
X.	·074	·099	·133	·240	·281	·375	·327	·277	·248	·145	·123	·071	·199
XI.	·066	·088	·125	·235	·273	·366	·306	·268	·233	·128	·113	·061	·189
Noon	·050	·069	·109	·219	·254	·349	·282	·245	·208	·106	·095	·048	·170
XIII.	·030	·053	·091	·200	·229	·325	·268	·218	·184	·087	·076	·031	·149
XIV.	·009	·031	·071	·182	·211	·315	·249	·202	·161	·062	·052	·010	·130
XV.	25·993	·012	·058	·178	·206	·306	·239	·191	·151	·050	·037	25·994	·118
XVI.	·976	·002	·053	·174	·203	·307	·238	·190	·147	·044	·026	·976	·111
XVII.	·969	25·997	·052	·175	·207	·311	·241	·193	·151	·046	·023	·973	·112
XVIII.	·979	26·001	·055	·182	·215	·322	·248	·204	·160	·050	·032	·976	·119
XIX.	·989	·011	·063	·191	·225	·334	·257	·217	·171	·068	·043	·989	·130
XX.	26·004	·023	·078	·204	·235	·341	·266	·231	·188	·084	·060	26·003	·143
XXI.	·014	·034	·085	·210	·240	·344	·271	·240	·195	·091	·077	·017	·151
XXII.	·025	·047	·088	·213	·243	·348	·274	·247	·198	·093	·078	·026	·157
XXIII.	·031	·050	·091	·214	·242	·349	·274	·250	·201	·092	·081	·027	·158
Mean	26·029	26·053	26·091	26·203	26·240	26·335	26·279	26·233	26·203	26·101	26·081	26·030	26·157
No. of days	14	16	19	15	35	33	39	34	21	22	16	16	280

TABLE 27.

Pressure on Clear Days for Dew-points less than the Mean of each Month.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches	inches
Midnight	25·984	26·047	26·059	26·220	26·275	26·300	26·293	26·293	26·198	26·089	26·053	26·012	26·152
I.	·982	·047	·055	·219	·275	·299	·292	·290	·193	·087	·051	·010	·150
II.	·979	·047	·055	·217	·271	·300	·290	·286	·186	·084	·049	·011	·148
III.	·983	·047	·056	·213	·269	·299	·290	·284	·181	·085	·053	·015	·148
IV.	·991	·054	·059	·213	·269	·299	·290	·284	·186	·096	·062	·026	·152
V.	26·001	·062	·069	·220	·271	·303	·291	·290	·193	·110	·075	·039	·160
VI.	·016	·079	·083	·226	·279	·314	·299	·301	·208	·132	·094	·059	·174
VII.	·029	·093	·094	·241	·291	·321	·313	·313	·223	·151	·104	·071	·187
VIII.	·034	·103	·110	·260	·309	·335	·326	·327	·237	·164	·112	·077	·200
IX.	·031	·103	·114	·264	·318	·344	·333	·335	·241	·166	·112	·074	·203
X.	·029	·099	·114	·262	·322	·347	·334	·336	·235	·163	·106	·069	·201
XI.	·022	·087	·109	·254	·314	·337	·323	·327	·219	·151	·095	·062	·192
Noon	·010	·075	·096	·237	·296	·318	·305	·307	·195	·135	·080	·049	·175
XIII.	25·997	·060	·077	·213	·277	·297	·284	·284	·171	·117	·062	·033	·156
XIV.	·976	·039	·059	·197	·261	·277	·264	·256	·151	·102	·038	·015	·136
XV.	·961	·026	·049	·192	·256	·270	·257	·252	·143	·091	·026	25·996	·127
XVI.	·952	·005	·041	·191	·250	·271	·256	·252	·138	·088	·016	·984	·120
XVII.	·944	·000	·042	·193	·261	·274	·259	·254	·145	·095	·016	·984	·122
XVIII.	·947	·008	·047	·199	·270	·281	·265	·263	·153	·106	·026	·991	·130
XIX.	·969	·017	·056	·208	·281	·289	·274	·273	·169	·122	·040	26·006	·142
XX.	·984	·032	·073	·218	·290	·298	·283	·283	·187	·141	·057	·021	·155
XXI.	26·000	·045	·083	·224	·296	·303	·290	·291	·197	·150	·067	·038	·165
XXII.	·012	·052	·087	·227	·298	·307	·294	·295	·198	·154	·076	·049	·171
XXIII.	·015	·054	·092	·226	·300	·308	·297	·295	·199	·154	·076	·054	·172
Mean	25·994	26·054	26·074	26·222	26·283	26·304	26·292	26·291	26·190	26·122	26·064	26·031	26·160
No. of days	17	13	15	18	32	37	36	35	29	17	27	20	296

TABLE 28.

Harmonic Constants in the Diurnal Curve of Pressure.

	p_1	q_1	p_2	q_2	p_3	q_3	p_4	q_4
Jan.	— ·001331	+ ·032980	+ ·010071	— ·021792	— ·000059	— ·003660	+ ·001125	+ ·000938
Feb.	— ·003605	+ ·032608	+ ·011407	— ·021162	— ·000059	— ·001266	— ·000292	+ ·001660
Mar.	— ·002717	+ ·026099	+ ·011873	— ·021636	+ ·000118	+ ·001104	— ·000175	+ ·000144
April	— ·002228	+ ·018888	+ ·010041	— ·022983	+ ·000486	+ ·003688	— ·001125	— ·000650
May	— ·001956	+ ·020295	+ ·008797	— ·020828	— ·000378	+ ·006005	— ·000125	— ·000650
June	— ·003923	+ ·018364	+ ·007086	— ·021098	— ·001423	+ ·005828	— ·000417	— ·002021
July	— ·001914	+ ·022907	+ ·009380	— ·019334	— ·000687	+ ·006432	— ·000042	— ·001083
Aug.	— ·001019	+ ·024050	+ ·009688	— ·024633	— ·000888	+ ·004323	— ·000083	— ·001443
Sept.	+ ·001667	+ ·031108	+ ·007480	— ·027129	+ ·001506	+ ·002865	+ ·000083	+ ·000433
Oct.	+ ·002306	+ ·030103	+ ·004931	— ·026218	+ ·000805	— ·000569	+ ·000583	+ ·001010
Nov.	— ·000187	+ ·036487	+ ·006464	— ·024641	— ·000250	— ·002581	+ ·000417	+ ·000433
Dec.	— ·000677	+ ·035557	+ ·008183	— ·022330	— ·000274	— ·003646	+ ·000958	+ ·000938

	V_1	V_2	V_3	V_4	u_1	u_2	u_3	u_4
Jan.	357° 41′	155° 12′	180° 55′	50° 11′	·0329	·0240	·0037	·0015
Feb.	353 41	151 40	182 40	350 1	·0328	·0240	·0013	·0017
Mar.	354 3	151 14	6 6	309 27	·0262	·0247	·0011	·0002
April	353 16	156 24	7 33	239 59	·0190	·0251	·0037	·0013
May	354 30	157 6	356 24	190 53	·0204	·0227	·0060	·0007
June	347 57	161 26	346 17	191 39	·0188	·0223	·0060	·0021
July	355 13	154 7	353 54	182 13	·0230	·0215	·0064	·0011
Aug.	357 34	158 32	348 24	183 18	·0240	·0264	·0044	·0014
Sept.	3 4	164 35	27 44	10 51	·0312	·0281	·0033	·0004
Oct.	4 23	169 21	125 15	30 0	·0302	·0267	·0010	·0012
Nov.	359 42	165 18	185 32	43 55	·0357	·0255	·0026	·0006
Dec.	358 55	159 52	184 19	45 36	·0358	·0238	·0036	·0013

TABLE 29.

Some Harmonic Constants in the Diurnal Curve of Pressure.

	Dry Clear Days.	Damp Clear Days.	All Clear Days.	Cloudy Days.	All Days.	Dew-point.
p_1	— ·006486	— ·004758	— ·005719	+ ·001713	— ·001340	— 1·1422
q_1	+ ·028944	+ ·028143	+ ·025698	+ ·028647	+ ·027472	— 0·3525
p_2	+ ·007947	+ ·008736	+ ·008224	+ ·009088	+ ·008683	+ 0·1972
q_2	— ·020889	— ·021056	— ·022342	— ·023283	— ·022869	— 0·4787
p_3	— ·000319	— ·000142	— ·000392	+ ·000309	— ·000118	+ 0·0211
q_3	+ ·001457	+ ·001516	+ ·000677	+ ·002036	+ ·001457	+ 0·4533
p_4	— ·000375	— ·000042	— ·000500	+ ·000583	+ ·000042	— 0·0250
q_4	+ ·000361	+ ·000072	— ·000288	+ ·000433	+ ·000071	+ 0·0577
V_1......	347° 22′	350° 24′	347° 27′	3° 26′	357° 12′	252° 51′
V_2......	159 10	157 28	159 34	158 41	159 12	157 37
V_3......	347 39	354 39	329 56	8 38	355 22	2 40
V_4......	313 55	329 45	240 4	53 52	30 15	336 35
u_1	·030	·029	·026	·029	·027	1·1954
u_2	·022	·023	·023	·025	·024	·5178
u_3	·0015	·0015	·0008	·0021	·0015	·4542
u_4	·0005	·0001	·0006	·0001	·0001	·0629

TABLE 30.

Some Comparative Harmonic Constants.

	Vapour Tension. Open Sea.	Vapour Tension. Near Land.	Air Pressure. Fort Rae.
V_1	226° 12′	245° 47′	310° 10′
V_2	72 31	70 53	116 5
V_3	161 34	22 50	36 30
u_1...............	·018	·010	·007
u_2...............	·004	·0035	·001
u_4...............	·0005	·0034	·0004

TABLE 31.

Total Hours of Wind Direction, 1898–1901: Monthly Numbers.

	Clear Days.												Total.			Ratios per XM.			Total 1896 to 1902.
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Clear Days.	Cloudy Days.	All Days.	Clear Days.	Cloudy Days.	All Days.	All Days.
N..........	36	33	41	36	61	75	87	90	61	33	24	18	595	1790	2385	432	847	683	3360
N.N.E....	25	58	43	38	57	88	121	67	37	23	25	20	602	1638	2240	437	775	642	3234
N.E.......	21	52	37	27	99	75	93	125	31	21	26	17	624	1677	2301	453	794	659	3164
E.N.E....	25	59	61	48	143	185	290	250	76	50	37	30	1254	2298	3552	910	1088	1018	4636
E..........	12	37	69	63	133	181	157	199	71	19	58	21	1020	1247	2267	740	590	650	2824
E.S.E. ...	33	49	93	73	173	215	172	165	85	45	51	91	1245	1302	2547	904	616	730	3348
S.E.......	26	75	75	123	160	129	178	122	109	101	60	101	1259	965	2224	914	457	637	3013
S.S.E. ...	54	64	109	120	204	246	173	91	153	124	108	89	1535	1116	2651	1114	528	760	3916
S..........	27	36	42	43	109	102	87	64	118	89	106	80	903	928	1831	656	439	525	2983
S.S.W....	118	25	56	41	116	56	60	80	102	115	198	110	1077	1364	2441	782	646	699	3851
S.W. ...	129	53	33	26	61	47	39	50	70	95	104	98	805	1015	1820	584	481	522	3130
W.S.W.	90	36	28	26	58	25	26	45	52	62	88	66	602	901	1503	437	427	431	2728
W.	39	19	17	32	37	37	33	43	39	33	27	50	406	557	963	295	264	276	1765
W.N.W.	29	27	39	36	39	44	39	60	48	50	50	38	499	967	1466	362	457	420	2599
N.W. ...	22	26	30	27	48	57	81	58	45	36	34	17	481	1120	1601	349	530	459	2803
N.N.W.	56	39	36	30	107	112	161	140	100	38	34	15	868	2238	3106	630	1060	890	4741

TABLE 32.

TOTAL HOURS OF WIND-DIRECTION ON CLEAR DAYS, 1898–1901: HOURLY NUMBERS.

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.	17	21	16	61	63	75	71	92	38	48	33	6	4	6	7	17
II.	22	16	26	68	61	66	80	88	29	52	28	9	6	5	9	11
III.	15	20	25	77	60	52	83	93	33	45	29	5	8	8	12	11
IV.	16	21	27	80	55	67	85	87	36	33	28	7	9	10	6	8
V.	10	23	28	98	57	72	80	85	33	28	27	7	9	8	6	5
VI.	10	12	37	107	65	69	83	80	27	26	27	10	9	1	4	9
VII.	14	19	41	102	63	71	86	67	26	21	25	11	8	4	6	11
VIII.	17	33	61	96	43	73	78	54	21	26	25	11	7	4	4	23
IX.	52	80	55	45	30	53	52	48	26	22	26	17	7	13	11	39
X.	67	67	25	23	18	43	41	36	24	25	26	29	7	19	27	97
XI.	67	37	26	26	9	26	31	37	28	22	26	26	23	34	52	101
Noon.	52	32	18	15	7	18	28	35	24	26	29	49	36	40	49	114
XIII.	32	24	20	13	6	12	21	41	26	24	36	59	33	72	60	89
XIV.	20	29	13	10	9	14	17	46	25	30	38	60	45	67	63	80
XV.	27	20	8	13	13	16	20	35	32	41	56	64	52	61	47	67
XVI.	25	19	11	10	10	15	25	36	42	61	66	62	46	50	38	56
XVII.	29	23	14	15	13	19	29	42	51	69	83	43	35	38	20	50
XVIII.	26	32	25	25	16	18	32	62	54	93	54	44	25	23	20	26
XIX.	16	16	26	50	37	35	37	70	63	93	46	30	10	17	11	19
XX.	13	6	23	51	60	64	57	67	72	82	25	18	9	8	6	12
XXI.	13	6	22	56	77	83	51	80	64	72	17	15	5	3	7	5
XXII.	12	12	23	65	79	89	66	82	45	57	16	8	7	1	6	7
XXIII.	14	15	29	64	88	100	50	83	44	47	18	6	3	5	6	4
Midnight.	9	19	25	84	81	95	56	89	40	34	21	6	3	2	4	7

TABLE 33.

Total Hours of Wind-Direction on Cloudy Days, 1898–1901 : Hourly Numbers.

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.	47	68	81	166	87	101	62	69	32	57	22	14	11	9	16	41
II.	53	72	89	156	90	98	70	65	35	38	29	14	10	11	14	39
III.	45	76	86	170	82	100	71	55	36	43	30	17	5	10	16	41
IV.	47	81	103	176	72	95	68	51	29	45	25	19	6	6	16	40
V.	49	76	124	179	79	93	57	48	26	38	33	19	6	7	13	36
VI.	57	84	124	178	81	68	60	47	25	42	31	16	3	10	21	37
VII.	84	90	135	168	57	61	51	47	19	47	22	17	5	14	20	42
VIII.	119	129	123	101	43	61	36	33	26	24	30	23	8	16	26	85
IX.	145	129	86	66	28	40	25	33	18	17	28	36	13	30	36	153
X.	162	104	54	42	18	30	16	24	16	29	26	33	20	35	65	210
XI.	141	58	39	30	17	22	9	25	12	33	32	35	24	52	99	253
Noon.	109	58	31	23	13	18	13	20	14	38	28	48	40	76	128	225
XIII.	87	48	32	20	10	12	14	19	20	31	41	66	48	98	116	212
XIV.	69	45	36	22	13	12	14	21	23	47	46	79	58	124	106	159
XV.	71	38	32	19	23	16	16	24	31	63	62	72	64	110	107	121
XVI.	71	44	34	27	27	18	21	36	32	65	83	87	60	80	76	113
XVII.	66	55	35	44	28	26	28	41	48	82	91	74	50	74	55	82
XVIII.	64	46	52	54	35	41	32	49	55	105	72	57	36	63	38	82
XIX.	65	55	51	61	61	51	39	51	77	109	58	41	29	43	36	55
XX.	57	51	58	81	79	67	38	65	79	96	57	36	13	32	30	44
XXI.	52	59	67	106	74	63	42	70	77	89	45	31	14	21	22	45
XXII.	40	61	78	111	83	58	52	75	78	86	33	22	14	21	26	43
XXIII.	34	59	62	150	72	76	61	72	58	82	43	23	9	15	18	45
Midnight.	56	52	65	148	75	75	70	76	62	58	48	22	11	10	20	35

TABLE 34.

Total Hours of Wind-Direction on all Days, 1898–1901 : Hourly Numbers.

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.	64	89	97	227	150	176	133	161	70	105	55	20	15	15	23	58
II.	75	88	115	224	151	164	150	153	74	90	57	23	16	16	23	50
III.	60	96	111	247	142	152	154	148	69	88	59	22	13	18	28	52
IV.	63	102	130	256	127	162	153	138	65	78	50	26	15	16	22	48
V.	59	99	152	277	136	165	137	133	59	66	60	26	15	15	19	41
VI.	67	96	161	285	146	137	143	127	52	68	58	26	12	11	25	46
VII.	98	109	176	270	120	132	137	114	45	68	47	28	13	18	26	53
VIII.	136	162	184	197	86	134	114	87	47	50	55	34	15	20	30	108
IX.	197	209	141	111	58	93	77	81	44	39	54	53	20	43	47	192
X.	229	171	79	65	36	73	57	60	40	54	52	62	27	54	92	307
XI.	208	95	65	56	26	48	40	62	40	55	58	61	47	86	151	354
Noon.	161	90	49	38	20	36	41	55	38	64	57	97	76	116	177	339
XIII.	119	72	52	33	16	24	35	60	46	55	77	125	81	170	176	301
XIV.	89	74	49	32	22	26	31	67	48	77	84	139	103	191	169	239
XV.	98	58	40	32	36	32	36	59	63	104	118	136	116	171	154	188
XVI.	96	63	45	37	37	33	46	72	74	126	149	149	106	130	114	169
XVII.	95	78	49	59	41	45	57	83	99	151	174	117	85	112	75	132
XVIII.	90	78	77	79	51	59	64	111	109	198	126	101	61	86	58	108
XIX.	81	71	77	111	98	86	76	121	140	202	104	71	39	60	47	74
XX.	70	57	81	132	139	131	95	132	151	178	82	54	22	40	36	56
XXI.	65	65	89	162	151	146	93	150	141	161	62	46	19	24	29	50
XXII.	52	73	101	176	162	147	118	157	123	143	49	30	21	22	32	50
XXIII.	48	74	91	214	160	176	111	155	102	129	61	29	12	20	24	49
Midnight.	65	71	90	232	156	170	126	165	102	92	69	28	14	12	24	42

TABLE 35.

Wind-Direction Components in Hours.

For the hour ending	N.			E.			R.			φ.		
	Clear Days.	Cloudy Days.	All Days.	Clear Days.	Cloudy Days.	All Days.	Clear Days.	Cloudy Days.	All Days.	Clear Days.	Cloudy Days.	All Days.
I.	— 178	+ 31	— 146	+ 225	+ 391	+ 616	287	392	633	321° 41′	4° 36′	346° 38′
II.	164	49	115	230	397	627	283	400	637	324 35	7 5	349 39
III.	159	51	108	228	398	626	278	401	636	325 3	7 22	350 14
IV.	154	86	69	247	403	650	291	412	654	327 57	11 58	353 56
V.	143	109	— 34	273	415	688	308	429	689	332 23	14 40	357 9
VI.	133	140	+ 6	293	395	688	322	418	688	335 34	19 28	0 31
VII.	102	198	96	290	355	645	307	406	652	340 39	29 8	8 29
VIII.	— 47	309	263	271	242	512	275	393	576	350 10	51 31	27 7
IX.	+ 58	398	456	161	+ 82	+ 243	171	406	517	19 52	78 20	61 56
X.	116	447	563	+ 30	— 56	— 26	120	450	564	75 42	97 6	92 39
XI.	130	441	571	— 55	176	231	141	475	616	112 57	111 44	112 0
Noon	109	399	508	131	254	385	171	473	637	140 18	122 27	125 11
XIII.	72	342	414	182	306	488	196	459	640	158 26	131 48	139 41
XIV.	+ 41	251	292	195	327	522	199	412	598	167 58	142 30	150 45
XV.	— 12	165	153	201	309	510	201	351	533	183 26	151 52	163 16
XVI.	74	96	+ 22	188	257	445	202	274	446	201 20	159 33	177 8
XVII.	116	+ 17	— 98	129	179	307	173	180	323	222 0	174 28	197 45
XVIII.	152	— 18	170	— 53	— 78	— 131	161	80	214	250 50	192 46	232 26
XIX.	197	61	258	+ 56	+ 33	+ 89	205	69	273	285 58	298 23	289 5
XX.	226	84	310	160	137	297	277	161	430	305 13	328 28	313 44
XXI.	224	62	286	222	196	418	315	205	506	314 45	342 40	325 39
XXII.	193	57	250	265	238	503	328	245	562	323 53	346 29	333 32
XXIII.	170	62	232	283	282	565	330	289	611	329 1	347 37	337 41
Midnight	— 160	— 49	— 210	+ 301	+ 301	+ 602	341	305	638	331 59	350 41	340 48
Total	— 2,077	+ 3,136	+ 1,059	+ 2,401	+ 2,324	+ 4,725	3,175	3,903	4,842	319 8	53 27	12 38
Annual Mean	— 519	+ 784	+ 265	+ 600	+ 581	+ 1,181	794	976	1,210			

TABLE 36.

Comparison of the Gradients in the Curves of Wind and Temperature.

For the hour ending	Clear Days.		Cloudy Days.		All Days.	
	Decrease of Temperature.	Increase of East Component.	Decrease of Temperature.	Increase of East Component.	Decrease of Temperature.	Increase of East Component.
	°		°		°	
I.	**1·3**	**0·3**	**1·1**	**0·6**	**1·2**	**0·2**
II.	**1·4**	0·1	**1·1**	**0·4**	**1·2**	0·0
III.	**1·2**	**1·0**	**0·5**	**0·6**	**0·8**	**0·5**
IV.	**1·1**	**1·3**	**0·7**	**0·8**	**0·8**	**0·8**
V.	**1·0**	**1·0**	**0·6**	0·2	**0·8**	0·0
VI.	0·1	0·1	0·0	0·9	0·0	0·9
VII.	2·5	1·0	1·8	3·3	2·1	2·7
VIII.	6·5	5·5	4·8	4·8	5·5	5·5
IX.	6·4	6·6	4·8	4·1	5·4	5·5
X.	4·8	4·3	3·8	3·5	4·2	4·2
XI.	3·7	3·8	3·4	2·1	3·5	3·1
Noon	2·6	2·6	2·1	1·3	2·3	2 1
XIII.	2·0	0·7	1·3	0·3	1·6	0·7
XIV.	1·1	0·3	0·3	**1·0**	0·6	**0·2**
XV.	0·4	**0·6**	**0·6**	**2·1**	**0·2**	**1·3**
XVI.	**0·8**	**3·0**	**1·3**	**2·9**	**1·1**	**2·8**
XVII.	**3·5**	**3·8**	**2·8**	**3·7**	**3·1**	**3·6**
XVIII.	**5·3**	**5·4**	**4·0**	**4·0**	**4·5**	**4·5**
XIX.	**4·5**	**5·2**	**2·9**	**3·8**	**3·5**	**4·2**
XX.	**2·6**	**3·1**	**1·9**	**2·3**	**2·2**	**2·5**
XXI.	**2·1**	**2·1**	**1·8**	**1·8**	**1·9**	**1·7**
XXII.	**1·7**	**0·9**	**1·2**	**2·0**	**1·4**	**1·3**
XXIII.	**1·4**	**0·9**	**1·4**	**1·0**	**1·4**	**0·8**
Midnight	—	—	—	—	**1·1**	**0·3**

TABLE 37.

Some Harmonic Constants in the Diurnal Curve of Wind-Direction.

	North Component.			East Component.		
	Clear Days.	Cloudy Days.	All Days.	Clear Days.	Cloudy Days.	All Days.
p_1 ...	− 130·495	− 173·455	− 304·091	− 222·094	− 338·764	− 560·837
q_1 ...	+ 39·652	+ 90·460	+ 130·003	− 96·321	− 143·586	− 239·755
p_2 ...	+ 52·713	+ 47·075	+ 99·758	+ 70·214	+ 80·327	+ 150·511
q_2 ...	− 32·210	− 50·627	− 82·929	+ 65·004	+ 8·883	+ 73·774
p_3 ...	+ 9·336	+ 10·584	+ 19·851	+ 7·495	+ 3·451	+ 10·921
q_3 ...	+ 10·431	+ 21·970	+ 32·401	+ 27·073	+ 8·617	+ 36·031
V_1 ...	279° 34′	290° 3′	285° 39′	239° 3′	239° 32′	239° 21′
V_2 ...	106 26	122 24	114 44	32 12	68 41	48 53
V_3 ...	19 20	3 12	9 0	352 59	359 18	354 22
u_1 ...	136·358	195·665	330·712	242·091	346·219	609·937
u_2 ...	67·796	69·534	129·724	95·699	80·812	167·607
u_3 ...	13·447	24·404	37·999	28·071	9·302	37·659
u'_1 ...	86·451	80·810	82·678	153·486	142·988	152·484
u'_2 ...	39·179	28·718	32·431	60·673	33·375	41·902
u'_3 ...	8·525	10·079	9·500	17·797	3·842	9·415

TABLE 38.

Mean Hourly Wind-Velocity, 1898–1901, in Miles per Hour.

For the hour ending	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
I.	5·4	5·8	4·6	4·0	4·4	4·7	4·6	4·8	5·2	5·7	5·4	5·1	5·0
II.	5·5	5·5	4·4	3·9	4·2	4·4	4·4	4·6	5·1	5·5	5·2	5·6	4·9
III.	5·5	5·6	4·2	3·7	4·1	4·2	4·0	4·5	4·9	5·1	5·0	5·2	4·7
IV.	5·3	6·0	4·1	3·4	4·1	3·9	3·9	4·3	4·6	5·2	5·0	4·9	4·6
V..........	5·0	5·9	3·9	3·3	4·0	3·8	3·9	4·2	4·4	4·9	4·7	4·7	4·4
VI.	5·1	5·8	3·7	3·1	3·9	3·9	3·7	4·2	4·5	5·0	4·7	4·9	4·4
VII.......	5·9	6·9	4·0	3·2	3·8	3·7	3·6	4·2	4·7	5·9	5·8	6·0	4·8
VIII. ...	7·4	7·6	4·9	3·7	3·7	3·5	3·5	4·2	5·7	7·7	7·1	7·2	5·5
IX.	7·9	8·1	6·2	5·1	5·1	4·5	4·4	5·6	7·0	8·2	7·6	7·5	6·5
X..........	8·1	8·4	6·6	6·1	6·4	5·7	6·2	7·0	8·0	8·3	8·1	7·6	7·2
XI.	8·2	8·0	6·9	6·4	7·0	6·2	6·8	7·5	8·4	8·7	8·2	7·7	7·6
Noon. ...	8·2	7·6	6·9	6·7	7·4	6·5	7·3	7·7	9·0	9·3	8·3	7·8	7·7
XIII. ...	8·4	7·3	6·8	6·6	7·6	6·5	7·4	7·6	9·1	9·4	8·7	8·0	7·8
XIV. ...	8·5	7·1	6·7	6·3	7·2	6·3	7·3	7·5	9·1	9·6	8·9	8·3	7·7
XV.	8·9	7·2	6·7	6·1	7·1	5·8	7·0	7·1	9·1	9·6	9·3	8·4	7·7
XVI. ...	8·8	7·0	6·5	5·3	6·6	5·3	6·4	6·6	8·7	9·4	9·1	8·8	7·3
XVII. ...	8·7	7·0	6·0	4·6	5·1	4·0	5·0	5·7	7·7	9·0	9·3	8·5	6·7
XVIII....	8·3	7·0	5·3	3·7	3·5	3·4	3·9	4·1	6·2	7·9	8·6	7·9	5·8
XIX. ...	7·6	6·2	4·3	3·7	3·7	3·9	4·5	4·0	5·2	6·2	6·7	6·7	5·2
XX.	6·2	5·6	4·3	4·2	4·6	4·4	5·0	4·4	5·3	6·0	6·0	5·8	5·2
XXI. ...	5·8	5·3	4·5	4·5	4·8	4·4	5·3	5·2	5·4	6·0	6·1	5·7	5·3
XXII. ...	5·7	5·2	4·6	4·6	5·0	4·8	5·1	4·9	5·1	5·9	6·0	5·7	5·2
XXIII....	5·6	5·5	4·6	4·3	5·2	5·0	4·8	4·9	5·6	5·8	5·9	5·5	5·2
Midnight.	5·5	5·7	4·7	4·2	4·9	4·9	4·7	4·9	5·6	5·7	5·7	5·5	5·2
Month...	6·9	6·6	5·2	4·6	5·1	4·8	5·1	5·4	6·4	7·2	6·9	6·6	5·9

TABLE 39.

Mean Hourly Wind-Velocity on Clear Days, in Miles per Hour.

For the hour ending	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
I.	5·1	5·4	3·8	4·2	4·4	4·5	4·4	4·5	5·2	5·3	5·8	5·8	4·9
II.	5·1	5·2	3·7	4·1	4·2	4·3	4·2	4·2	4·7	4·9	4·9	6·2	4·7
III.	5·1	5·4	4·1	3·7	4·0	4·0	3·9	4·0	4·6	4·4	4·7	5·7	4·5
IV.	4·9	5·6	3·8	3·3	3·7	3·8	3·7	3·8	4·4	4·4	4·6	5·3	4·3
V..........	4·2	5·5	3·4	3·1	3·6	3·7	3·6	3·7	4·5	4·2	4·3	5·2	4·1
VI.	4·5	5·5	3·3	3·1	3·6	3·5	3·5	3·6	4·5	4·8	4·2	5·0	4·1
VII.......	5·1	6·5	3·5	2·9	3·3	3·2	3·3	3·7	4·1	5·6	5·3	6·0	4·4
VIII. ...	6·4	7·9	3·8	2·6	3·0	2·9	3·0	3·6	5·0	7·4	5·6	6·0	4·8
IX.	6·3	8·0	4·6	3·4	4·0	3·9	3·9	4·8	6·1	7·3	5·8	5·3	5·3
X.	6·0	7·6	4·8	4·3	4·9	4·8	5·4	5·9	6·8	7·5	5·7	4·9	5·7
XI.	6·4	7·0	5·1	4·6	5·6	5·1	6·1	6·4	7·1	7·7	6·2	5·3	6·0
Noon. ...	7·0	6·9	5·3	4·6	5·8	5·4	6·5	6·5	7·6	7·9	6·8	6·2	6·4
XIII. ...	7·5	7·0	6·0	4·6	6·0	5·6	6·7	6·4	7·6	8·3	7·5	6·6	6·6
XIV. ...	7·9	6·7	5·8	4·5	5·9	5·3	6·6	6·2	7·6	8·3	7·8	7·3	6·7
XV.	8·3	6·5	6·0	4·4	5·6	5·0	6·2	5·8	7·6	8·7	8·4	7·7	6·7
XVI. ...	8·1	6·3	5·7	3·7	5·2	4·6	5·7	5·3	7·4	8·2	8·3	7·5	6·3
XVII. ...	8·5	5·7	5·1	3·0	4·2	3·5	4·3	4·3	6·5	7·7	7·9	7·3	5·7
XVIII....	7·9	6·0	4·2	2·3	2·9	3·0	3·0	3·2	5·6	6·5	7·5	7·0	4·9
XIX. ...	7·4	4·8	3·5	2·8	3·3	3·7	3·7	3·8	4·7	5·3	5·5	5·3	4·5
XX.	5·7	4·3	4·3	3·4	4·2	4·4	4·7	4·5	5·1	5·2	5·2	4·4	4·6
XXI. ...	5·3	4·5	4·5	3·7	4·5	4·8	5·0	4·9	5·2	5·4	5·5	4·5	4·8
XXII. ...	5·5	4·8	4·9	4·1	4·6	4·9	4·7	4·7	5·3	5·4	5·8	4·5	4·9
XXIII....	5·3	4·9	4·7	4·3	5·0	5·1	4·4	4·9	5·8	5·2	5·5	4·9	5·0
Midnight.	5·1	5·3	4·9	4·4	4·8	5·1	4·4	5·0	5·6	5·3	5·4	5·3	5·1
Month....	6·2	6·0	4·5	3·7	4·4	4·3	4·6	4·7	5·8	6·3	6·0	5·8	5·2

TABLE 40.

Mean Hourly Deviation, on Clear Days, from the Normal Wind-Velocity, in Miles per Hour.

For the hour ending	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
I.	0·3	0·4	0·8	**0·2**	0·0	0·2	0·2	0·3	0·0	0·4	**0·4**	**0·7**	0·1
II.	0·4	0·3	0·7	**0·2**	0·0	0·1	0·2	0·4	0·4	0·6	0·3	**0·6**	0·2
III.	0·4	0·2	0·1	0·0	0·1	0·2	0·1	0·5	0·3	0·7	0·3	**0·5**	0·2
IV.	0·4	0·4	0·3	0·1	0·4	0·1	0·2	0·5	0·2	0·8	0·4	**0·4**	0·3
V.	0·8	0·4	0·5	0·2	0·4	0·1	0·3	0·5	**0·1**	0·7	0·4	**0·5**	0·3
VI.	0·6	0·3	0·4	0·0	0·3	0·4	0·2	0·6	0·0	0·2	0·5	**0·1**	0·3
VII.	0·8	0·4	0·5	0·3	0·5	0·5	0·3	0·5	0·6	0·3	0·5	0·0	0·4
VIII. ...	1·0	**0·3**	1·1	1·1	0·7	0·6	0·5	0·6	0·7	0·3	1·5	1·2	0·7
IX.	1·6	0·1	1·6	1·7	1·1	1·0	0·5	0·8	0·9	0·9	1·8	2·2	1·2
X.	2·1	0·8	1·8	1·8	1·5	0·9	0·8	1·1	1·2	0·8	2·4	2·7	1·5
XI.	1·8	1·0	1·8	1·8	1·4	1·1	0·7	1·1	1·3	1·0	2·0	2·4	1·6
Noon. ...	1·2	0·7	1·6	2·1	1·6	1·1	0·8	1·2	1·4	1·4	1·3	1·6	1·3
XIII. ...	0·9	0·3	0·8	2·0	1·6	0·9	0·7	1.2	1·5	1·1	1·2	1·4	1·2
XIV. ...	0·6	0·4	0·9	1·8	1·3	1·0	0·7	1·3	1·5	1·3	1·1	1·0	1·0
XV.	0·6	0·7	0·7	1·7	1·5	0·8	0·8	1·3	1·5	0·9	0·9	0·7	1·0
XVI. ...	0·7	0·7	0·8	1·6	1·4	0·7	0·7	1·3	1·3	1·2	0·8	1·3	1·0
XVII. ...	0·2	1·3	0·9	1·6	1·0	0·5	0·7	1·4	1·2	1·3	1·4	1·2	1·0
XVIII....	0·4	1·0	1·1	1·4	0·6	0·4	0·9	0·9	0·6	1·4	1·1	0·9	0·9
XIX. ...	0·2	1·4	0·8	0·9	0·4	0·2	0·8	0·2	0·5	0·9	1·2	1·4	0·7
XX.	0·5	1·3	0·0	0·8	0·4	0·0	0·3	**0·1**	0·2	0·8	0·8	1·4	0·6
XXI. ...	0·5	0·8	0·0	0·8	0·3	**0·4**	0·3	0·3	0·2	0·6	0·6	1·2	0·5
XXII. ...	0·2	0·4	**0·3**	0·5	0·4	**0·1**	0·4	0·2	**0·2**	0·5	0·2	1·2	0·3
XXIII....	0·3	0·6	**0·1**	0·0	0·2	**0·1**	0·4	0·0	**0·2**	0·6	0·4	0·6	0·2
Midnight.	0·4	0·4	**0·2**	**0·2**	0·1	**0·2**	0·3	**0·1**	0·0	0·4	0·3	0·2	0·1
Month....	0·7	0·6	0·7	0·9	0·7	0·5	0·5	0·7	0·6	0·9	0·9	0·8	0·7

TABLE 41.

Mean Wind-Velocity on Cloudy Days.

For the hour ending	Velocity.	Deviation from the Normal.	For the hour ending.	Velocity.	Deviation from the Normal.
I.	5·1	**0·1**	XIV.	8·4	**0·7**
II.	5·0	**0·1**	XV.	8·4	**0·7**
III.	4·8	**0·1**	XVI.	8·0	**0·7**
IV.	4·8	**0·2**	XVII.	7·4	**0·7**
V.	4·6	**0·2**	XVIII.	6·4	**0·6**
VI.	4·6	**0·2**	XIX.	5·7	**0·5**
VII.	5·1	**0·3**	XX.	5·6	**0·4**
VIII.	6·0	**0·5**	XXI.	5·6	**0·3**
IX.	7·3	**0·8**	XXII.	5·4	**0·2**
X.	8·2	**1·0**	XXIII.	5·3	**0·1**
XI.	8·6	**1·0**	Midnight	5·3	**0·1**
Noon	8·5	**0·8**			
XIII.	8·6	**0·8**	Year	6·4	**0·5**

TABLE 42.

MEAN ANNUAL WIND-MOVEMENT, IN MILES, FROM EACH DIRECTION, 1898–1901.

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.	72	101	131	269	177	238	190	218	82	133	83	26	11	11	17	56
II.	76	99	152	268	172	192	207	207	68	110	84	37	11	15	16	54
III.	71	107	144	299	145	185	199	189	65	107	79	30	7	14	16	49
IV.	72	112	165	302	133	168	200	163	62	94	66	32	9	6	18	55
V.	69	109	190	311	131	152	170	155	53	75	71	31	9	14	14	48
VI.	85	108	205	331	118	114	176	153	42	66	69	27	9	12	24	52
VII.	154	151	255	309	99	131	156	146	35	74	68	29	8	17	23	75
VIII.	249	265	281	223	67	136	132	101	52	66	88	53	18	19	50	203
IX.	411	342	241	135	47	114	104	108	39	60	94	87	22	55	84	395
X.	475	307	143	96	43	83	83	89	47	78	97	114	33	78	172	688
XI.	461	177	117	80	31	55	57	86	53	89	114	114	56	148	293	807
Noon	347	165	85	60	29	39	50	76	55	104	106	180	117	208	388	795
XIII.	256	132	83	57	21	25	42	83	64	87	153	245	137	327	404	705
XIV.	190	128	79	54	29	29	43	84	75	132	173	293	188	374	392	542
XV.	205	95	62	51	51	39	50	79	90	176	241	298	227	377	334	405
XVI.	171	95	68	57	58	39	59	90	107	220	323	326	187	311	231	334
XVII.	144	99	73	91	45	53	66	98	134	268	351	284	148	231	143	220
XVIII.	114	79	92	94	53	62	69	130	151	323	242	219	94	137	83	178
XIX.	90	92	96	128	108	91	88	156	176	303	180	123	51	70	48	102
XX.	75	75	99	160	170	164	104	172	200	260	148	77	22	45	47	61
XXI.	68	81	104	203	207	185	112	218	186	255	107	56	17	27	25	64
XXII.	53	85	126	223	213	188	150	220	161	236	76	35	21	21	31	58
XXIII.	57	84	122	271	202	231	146	213	128	206	96	33	11	16	19	58
Midnight	73	81	129	264	214	230	176	223	128	129	111	35	9	15	18	46
Year	4,040	3,171	3,243	4,334	2,566	2,943	2,830	3,457	2,255	3,650	3,222	2,784	1,422	2,548	2,888	6,050

TABLE 43.

Mean Annual Mileage Components, 1898–1901.

For the hour ending	N.	E.	R.	ϕ.	Increase of Wind Pressure at Station.
I.	— 272	+ 813	857	341° 32′	— 38
II.	— 210	+ 775	803	344 52	— 2
III.	— 169	+ 773	792	347 39	— 3
IV.	— 90	+ 770	775	353 18	— 13
V.	— 23	+ 757	757	358 14	— 14
VI.	+ 55	+ 743	744	4 12	— 5
VII.	+ 226	+ 738	772	17 3	— 192
VIII.	+ 574	+ 546	792	46 27	— 308
IX.	+ 981	+ 238	1,010	76 22	— 410
X.	+ 1,282	— 172	1,293	97 38	— 377
XI.	+ 1,347	— 549	1,455	112 11	— 316
Noon	+ 1,256	— 865	1,524	124 33	— 230
XIII.	+ 1,058	— 1,095	1,523	135 59	— 94
XIV.	+ 755	— 1,189	1,408	147 34	— 11
XV.	+ 450	— 1,200	1,284	159 25	+ 128
XVI.	+ 116	— 1,072	1,124	173 48	+ 264
XVII.	— 181	— 808	828	192 32	+ 354
XVIII.	— 333	— 454	563	216 19	+ 444
XIX.	— 425	— 10	425	268 37	+ 322
XX.	— 487	+ 312	578	302 38	+ 212
XXI.	— 489	+ 524	716	316 57	+ 120
XXII.	— 438	+ 644	779	325 46	+ 86
XXIII.	— 390	+ 730	828	331 56	+ 59
Midnight	— 357	+ 789	857	335 41	+ 24
Annual Mean	+ 4,237	+ 1,738	4,579	67 45	

TABLE 44.

Some Harmonic Constants in the Diurnal Curve of Wind-Velocity.

	Clear Days.	Cloudy Days.	All Days.	Increase of Wind Pressure at Station.
p_1	— ·9123	— 1·9094	— 1·5078	— 126·708
q_1	— ·2718	— ·2825	— ·2757	+ 230·677
p_2	+ ·6373	+ ·6653	+ ·6570	+ 134·868
q_2	— ·0281	— ·2238	— ·1533	— 93·647
p_3	+ ·0628	+ ·1776	+ ·1290	+ 5·801
q_3	— ·1683	+ ·0721	— ·0833	+ 6·191
p_4	— ·1000	— ·2500	— ·2000	— 42·750
q_4	+ ·0577	+ ·0289	+ ·0289	+ 11·114
V_1	245° 55′	254° 5′	252° 8′	331° 13′
V_2	77 31	93 35	88 8	124 46
V_3	137 2	45 24	71 12	43 9
V_4	269 59	246 36	248 18	284 34
u_1	·952	1·930	1·534	263·153
u_2	·638	·702	·675	164·173
u_3	·180	·192	·129	8·481
u_4	·115	·252	·200	44·163

ON AN ALMOST PERFECT SKULL OF A NEW PRIMITIVE THERIODONT (*LYCOSUCHUS VANDERRIETI*).

By R. Broom, M.D., B.Sc., C.M.Z.S.

Read November 26th, 1902.

Plates I. & II.

For some time there has been in the Museum of the Victoria College, Stellenbosch, a very fine fossil Theriodont skull. It was presented to the College by the Rev. Mr. Van der Merwe, of Beaufort West, who stated that it had been got on the Groot Vlakte between Prince Albert, Beaufort West, and Willowmore. We may therefore assume that it was found either in the Lower Karroo or the Ecca Beds and that it belongs to the early Triassic or Permian period. This valuable skull Prof. Van der Riet has very kindly forwarded to me on loan that I might examine and describe it.

The skull with its matrix has formed a large carcareous nodule, so hard that I have found it impossible to do much in the way of development. Fortunately, however, the skull has been so well weathered that most of the superficial bones are thoroughly displayed. The lower jaw is in position and its structure is well shown; but the palate, unfortunately, is completely hidden by the matrix.

The skull, which is long and comparatively narrow, bears some superficial resemblance to that of Cynognathus platyceps, Seeley, but differs greatly in the structure of the lower jaw, and of the temporal arch, and in the dentition. And whereas Cynognathus is one of the most highly developed Theriodonts yet discovered, the skull under consideration—for which I propose the name *Lycosuchus vanderrieti*—represents one of the most generalised of Theriodont types.

Bones of the Skull.

The orbits, which are situated a little behind the middle region of the skull, are oval-shaped and look outwards and slightly upwards.

Between them lie the pair of moderately large frontals. These bones are almost three times as long as they are broad, and are slightly concave both antero-posteriorly and transversely. They form well-marked supraorbital ridges. In front they meet the nasals and prefrontals, and posteriorly the postfrontals and the parietal.

The prefrontal is an irregular oblong bone which lies between the frontal, the nasal, the maxillary, and the lachrymal, and forms the upper and anterior border of the orbit.

The lachrymal is considerably shorter than the prefrontal, and fits in between the prefrontal, the maxillary, and the jugal. It has apparently only a single lachrymal canal, well within the orbit.

The nasals are large bones, being about equal in size to the frontals. They are rather broader in front than behind. Unfortunately the region of the anterior nares is damaged in the skull, but most probably the nasals articulated in front with an ascending process from the premaxillaries, as in Lycosaurus and most other Theriodonts. The surface of the bones in the middle region is very irregular and probably supported a horny plate. The nasals are bordered laterally by the premaxillaries, the maxillaries, and the prefrontals.

The maxillary is a large bone which occupies about three-quarters of the side of the snout. It is divided by a longitudinal ridge into a large upper and a small lower portion. The upper portion resembles the maxillary in Ælurosaurus and other Theriodonts in the way in which the bony structure shows a radiation from a point near the base of the large canine. It has most probably been covered by a horny plate, the longitudinal ridge marking the lower border of the horny covering. Below the ridge lies a portion of the maxillary about one-fifth the size of the upper portion, and whose surface is considerably internal to the general level of the surface of the upper portion. It supports the large canine and the small molar. Probably this portion of the bone, as well as the teeth, was protected by a fleshy lip which was attached to the longitudinal ridge immediately below the horny plate. In front the maxillary to a large extent overlaps the premaxillary, while posteriorly it sends a moderately long process under the jugal.

The premaxillaries, unfortunately, are rather imperfectly preserved. They appear to be distinct. At the sides they are to a considerable extent overlapped by the maxillaries, but a process which passes backwards between the nasals and the maxillary to a slight extent overlaps the maxillary. A median process formed by the two premaxillaries has most probably divided the nares.

I fail to find on the side of the snout any foramen by which the infraorbital nerve could have had its exit. Most probably the foramen is in that portion of the maxillary which lies below the longitudinal ridge, and which in the specimen is very imperfectly displayed. The absence of a foramen for the nerve, above the ridge, would tend to confirm the idea that the greater part of the snout had a horny or scaly covering.

The jugal is a moderate-sized bone which forms almost the whole of the lower and about half of the posterior margin of the orbit. Below the orbit it is broad and flat and rests largely on the posterior process of the maxillary. Behind the orbit is a strong process which passes first mainly upwards and then inwards to meet the postfrontal. The jugal sends a long process backwards which passes underneath the squamosal and forms with it the temporal arch.

The postfrontal forms less of the postorbital arch than is usual in Theriodonts and Anomodonts. Its postorbital portion, however, is moderately strong. It passes outwards and slightly backwards and articulates with the front of the postorbital process of the jugal. The inner part of the postfrontal passes inwards and backwards behind the frontal and meets the parietal slightly in front of the parietal foramen.

The parietal is apparently single, though in front of the foramen there is evidence of a median suture. So far as displayed the parietal forms a prominent median crest, from which are given off posteriorly two large post-temporal crests. It is difficult to be sure how much of the parietal is covered by matrix, but its limits are probably near those shown in the restoration (Fig. 5). In front the parietal forms a strong interdigitating suture with the frontal, and almost immediately behind the suture is the large parietal foramen—large enough to have accommodated a well-developed pineal eye. The large lateral crests of the parietal articulate near the posterior end of the temporal fosse with the squamosals.

The squamosal is a moderately large bone. It bears a considerable resemblance to the squamosal in Ictidosuchus and also shows some affinities with the squamosals of the Anomodonts and Mammals. Internally it articulates with the parietal and forms part of the posterior wall of the temporal fossa. Passing outwards it curves forwards and forms the greater part of the temporal arch. The anterior part of this zygomatic process rests on the posterior process of the jugal. At the posterior part of the zygomatic arch the squamosal forms a downward convex fanlike expansion which gives articulation to the quadrate and also probably serves to some extent as a protection to the masseteric muscle. Behind this downward expansion of the squamosal and somewhat internal to it there passes outwards a prominent vertical ridge, between which and the part of the squamosal which gives articulation to the quadrate there is left a deep groove. This groove doubtless accommodated the external auditory meatus. The whole structure of the squamosal, it will be seen, presents a striking resemblance to that in the Polyprotodont Marsupials (*e.g.*, Thylacinus).

The quadrate is not well preserved on either side of the skull. Enough, however, remains to show that it was a fairly well-developed element which articulated with the descending powers of the squamosal. It appears to have had an ascending plate which rested on the squamosal, somewhat after the manner of the quadrate in the Anomodonts.

The occiput is too imperfectly displayed to allow of description. There is evidently, however, a median depression such as occurs in Cynognathus.

The lower jaw is well preserved on the right side of the skull. It consists of a large dentary, large angular, and surangular, and a small articular, with internally a small splenial.

The dentary forms about two-thirds of the jaw. It is very much more powerful than the dentary of Ictidosuchus, but not so powerful as that in Lycosaurus, Cynodraco, or Cynosuchus. In front it curves gently upwards, and does not form a "chin," as in Cynosuchus and most other known early Theriodonts. Posteriorly it articulates with the angular and surangular. It has a large coronoid process.

Internal to the dentaries in front are a pair of slender splenials.

The angular is a shield-like bone lying between the dentary and the articular. It rests on and almost completely hides from view the surangular. A little behind its centre the bone is pierced by a moderate-sized foramen. A round opening through the jaw is also formed in the line of the suture between the dentary and the angular, which probably corresponds to the large oval opening through the jaw of the Anomodont.

The surangular is apparently a large bone but is almost hidden by the angular. It forms the whole of the upper margin of the posterior part of the jaw.

The articular is not well preserved. It appears, however, to have been comparatively small, and to have articulated with the angular and surangular in front.

Dentition.

On the right side the teeth are fairly well preserved, but badly on the left. The teeth are more irregular than is usual in Theriodonts, and it is difficult to be quite certain of their determination.

Beginning in front, we find exposed on the right side of the skull the point of a rather small but probably fully formed tooth (fig. 6, i'). This is doubtless one of a pair which may be regarded as the first incisors. This tooth is followed by a larger pointed tooth, which is seen on both sides of the skull, and which may be regarded as the 2nd incisor. On the right side, between this 2nd incisor and the next developed tooth, is a diastema of sufficient size to have accommodated a third tooth as large as or slightly larger than the 2nd. This tooth, however, has disappeared, and the point of apparently a young tooth is seen coming down to fill the gap. On the left side we find the remains of the root of the old 3rd incisor, while behind it and slightly internal to it is the root of the succeeding 3rd incisor. The 4th incisor is to be seen on both sides, as a well-developed pointed tooth, slightly larger than the 2nd incisor. Behind the 4th is present on both sides a 5th incisor. This 5th is somewhat smaller than the 4th, though possibly this may be due to its being a younger tooth which has replaced a lost older 5th incisor. Though on the outer surface of the skull the suture between the maxillary and the premaxillary is in a line with the anterior border of the 4th incisor, the root of the 4th incisor is undoubtedly, and that of the 5th almost certainly, fixed in the premaxillary bone.

So far, then, as the premaxillary teeth are concerned we may safely assume that there are 5 incisors, and also that there is a dental succession. But whether a definite deciduous dentition is replaced by a single permanent set, or whether each tooth when lost is replaced by another indefinitely it is impossible to decide with certainty.

Those incisors which are well displayed show the posterior borders finely serrated.

Immediately behind the last incisor in most of the Theriodonts hitherto discovered there is present a large canine, but in this skull the 5th incisor is followed by two large teeth, either of which, if alone, would unhesitatingly be regarded as the canine. The first of the two is not very much thicker than one of the incisors, but is about twice as long. It is only very slightly curved, and is remarkable for being, unlike the other teeth, serrated both in front and behind. The second of the large pair is situated a little behind the first, and slightly external to it. It is a powerful tooth—about twice as broad as the largest of the incisors. It is very markedly flattened, with a rounded anterior and a serrated posterior border. The only other Theriodont skull, so far as I am aware, in which two canines are known is the Theriodont snout in the Albany Museum, which Seeley has made the type of ?Cynognathus leptorhinus. In it there are two canines side by side, and as in the case of the Lycosuchus skull the anterior canine has both edges serrated. It is impossible to say from the evidence whether one canine corresponds to the mammalian permanent one and the other to the deciduous canine, or whether both canines belong to the set.

Close behind the 2nd canine, and partly resting on it, there is seen on the right side the remains of the root of a medium-sized tooth. This root is not in its natural position, and may be the displaced remains of the 3rd incisor which has apparently been just shed.

Some little distance behind the large canine there is seen on both sides a small simple-pointed molar. It is less than half the size of one of the incisors, and shows no indication of serration. I cannot find any evidence of more than the one molar on each side, and there does not appear to be room on the maxillary for more than three at the most.

Affinities of Lycosuchus.

In endeavouring to trace the affinities of Lycosuchus the chief difficulty lies in the fact that the majority of the hitherto discovered Theriodonts are known only by fragments of the snout. If, however, we neglect the very imperfectly known forms we find that the remaining more perfectly preserved Theriodonts arrange themselves into four fairly well marked-groups. Of these, two are made up of primitive Theriodonts, and two of highly specialised forms. Of the primitive forms we have (1) the Lycosaurus type with simple molars, powerful dentary, well-developed quadrate, and large parietal foramen, and (2) the Ictidosuchus type, somewhat similar, but with very slender lower jaw and temporal arch. The highly specialised Theriodonts belong—(1) to the Cynognathus type, characterised by having cusped molars, rudimentary quadrate, two occipital condyles, and the parietal foramen small or absent; or (2) to the Gomphognathas type, allied to the former, but with flattened grinding molars.

The affinities of Lycosuchus are undoubtedly with the primitive types Lycosaurus and Ictidosuchus; and though Lycosuchus has a powerful jaw, in some respects it seems to come nearer to Ictidosuchus. Unfortunately, the temporal region of Lycosaurus is not well known, but it seems probable that Lycosuchus is somewhat more primitive than Lycosaurus. The squamosal in Lycosuchus closely resembles that in Ictidosuchus, but the two genera differ markedly in the structure of the postorbital arch. In Ictidosuchus the arch is apparently entirely formed by the postfrontal, while in Lycosuchus the ascending process of the jugal forms at least half of the arch. In both Ictidosuchus and apparently Lycosaurus the dentary forms a larger proportion of the lower jaw than in Lycosuchus. It is very interesting to observe that in those points in which Lycosuchus differs from Ictidosuchus it makes a nearer approach to the Anomodonts.

In Udenodon the postorbital arch is formed almost exactly as in Lycosuchus. The Anomodont squamosal is more developed and more highly specialised, but it agrees with that in Lycosuchus in having an anterior zygomatic process, an internal portion articulating with the parietal and a descending portion which supports the quadrate. The lower jaw in Lycosuchus also agrees closely with that in Udenodon, the only essential difference being that in the former there is a large coronoid process, while in the toothless Anomodont the process is rudimentary. In both the angular forms the greater part of the posterior half of the jaw.

The whole structure of the skull in Lycosuchus is so essentially similar to that in the Anomodonts that there can be but little doubt the Anomodonts are descended from Theriodont ancestors. Lycosuchus, though much nearer the Anomodont ancestor than Ictidosuchus, has the posterior part of the squamosal too specialised to have itself been the ancestor; but it is probably allied to the ancestral form. Pristerodon and another small Endothiodont [Prodicynodon], which I am elsewhere describing, almost completely bridge the gap between the Theriodont and Dicynodon.

While Lycosuchus is probably allied to the Theriodont, from which the Anomodonts are sprung, it is probably also allied to the Theriodont, which was the ancestor of the Monotremes and higher mammals. Cynognathus and Gomphognathus in many respects make very near approaches to the mammals—as in the specialisation of the teeth, in the great reduction of the quadrate, in having two occipital condyles, and in having a well-developed secondary palate. In some respects, however, both these genera are too specialised to have been the ancestor of the Monotremes. And it is probable that the first mammals sprang from a Theriodont ancestor somewhat intermediate between Lycosuchus and Cynognathus, having the simple type of skull of the former, but with a full set of simple molars.

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REFERENCE TO PLATES.

Ang., angular; art., articular; c., canine; dent., dentary; fr., frontal; i., incisor; ju., jugal; la., lachrymal; mx., maxillary; na., nasal; pa., parietal; pmx., premaxillary; pr.f., prefrontal; po.f., postfrontal; qu., quadrate; sq., squamosal; sur., surangular.

PLATE I.

Fig. 1. Right side of skull of Lycosuchus vanderrieti. ×·518.
,, 2. Right side of restoration of skull of ditto. ×·518.
,, 3. Left side of skull of Lycosuchus vanderrieti. ×·518.

PLATE II.

Fig. 4. Upper view of skull of Lycosuchus vanderrieti. ×·518.
,, 5. Upper view of restoration of skull of ditto. ×·518.
,, 6. Under view of snout of Lycosuchus vanderrieti. ×·518.
,, 7. Side view of canines of right side of Lycosuchus vanderrieti. Nat. size.

ADDENDUM (December 5, 1902).—Since the above paper was written I have had an opportunity of examining the Theriodont specimens in the Albany Museum. The specimen which Seeley took as the type of ?Cynognathus leptorhinus does not seem to me to differ in any important characters from Cynognathus platyceps, Seeley. The depression on the upper surface of the snout is mani-

Fig. 1.

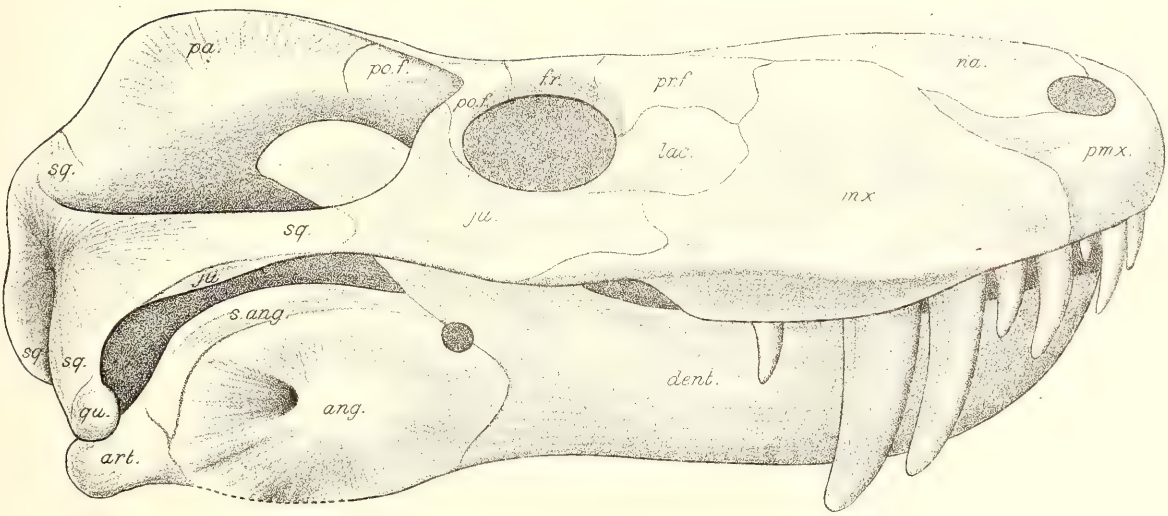

Fig. 2.

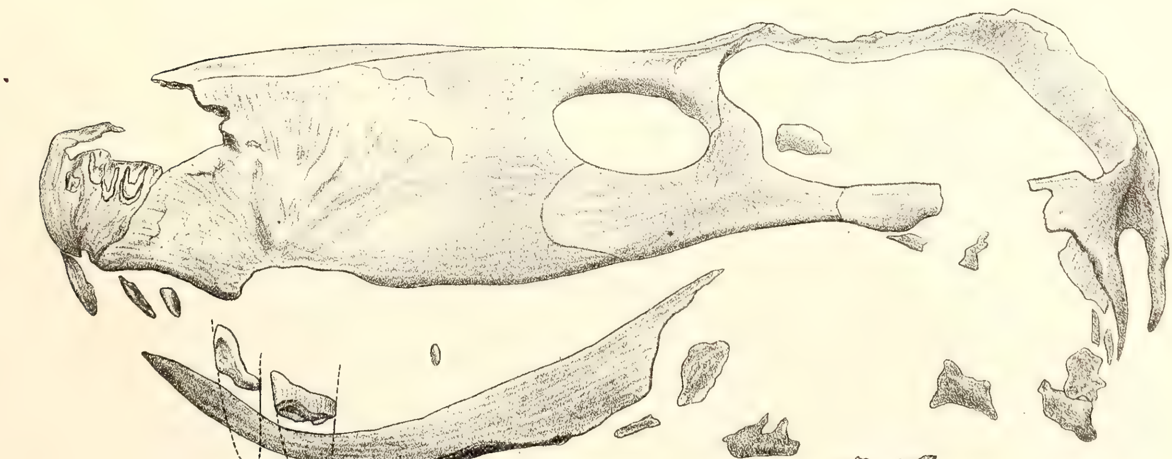

Fig. 3.

R.B.del.   West, Newman lith.

R. BROOM; LYCOSUCHUS VANDERRIETI.

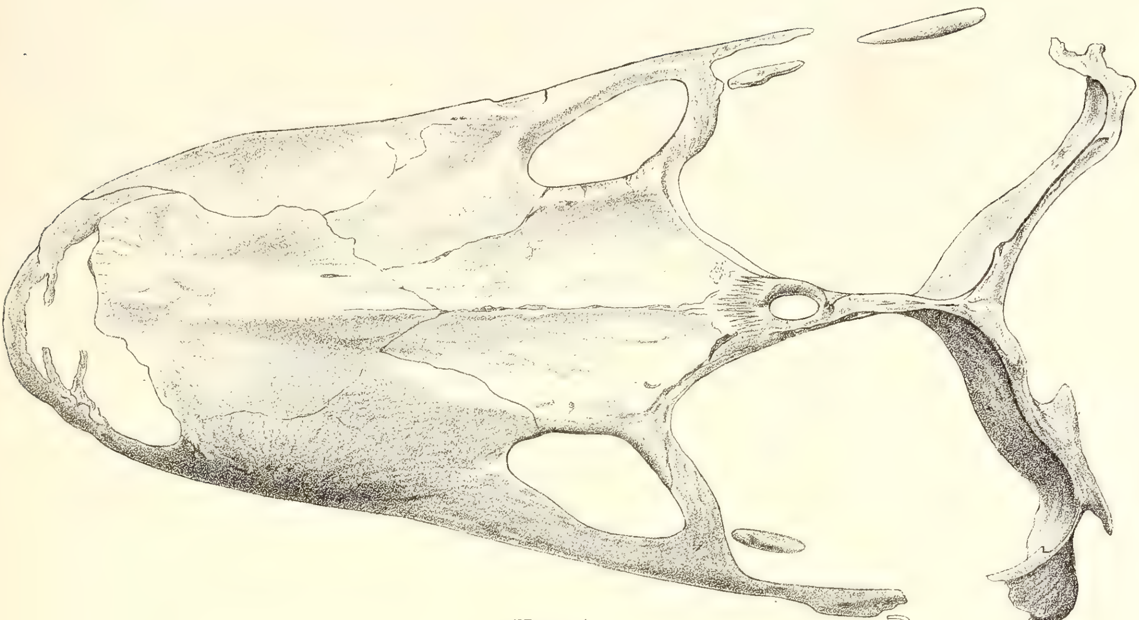

Fig. 4.

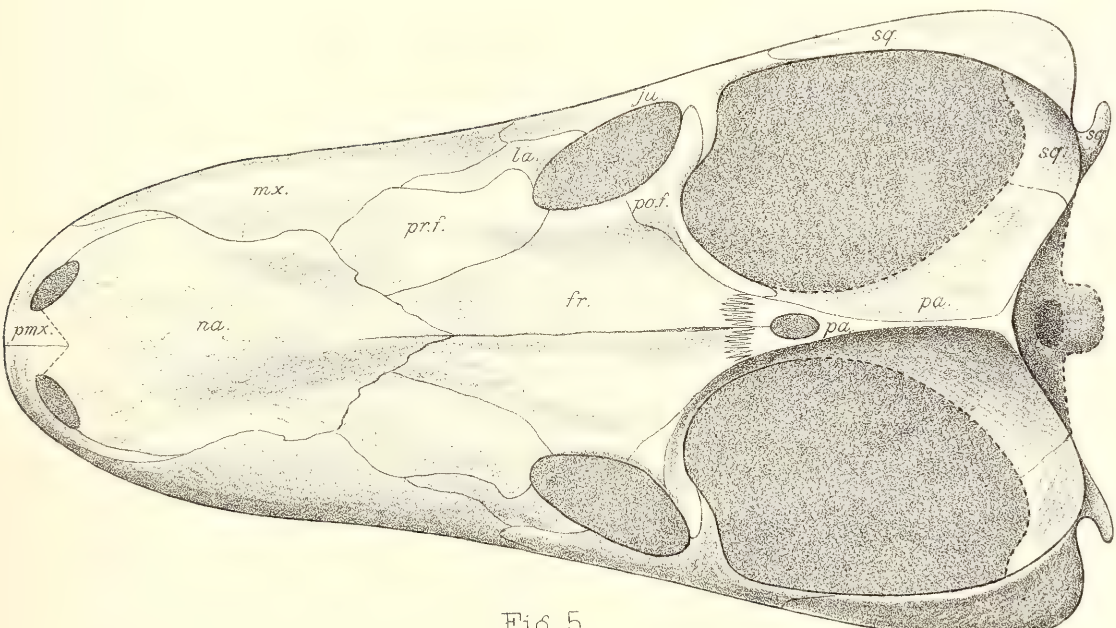

Fig. 5.

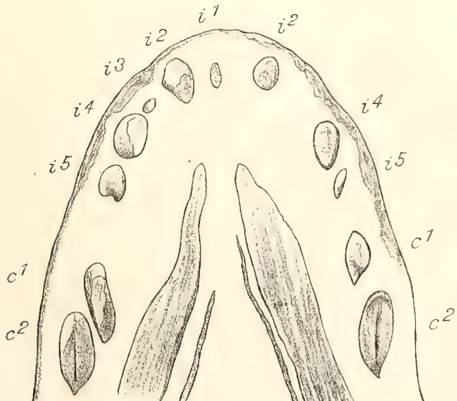

Fig. 6.

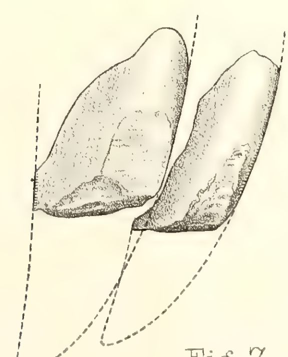

Fig. 7.

R.B. del

West, Newman lith.

R. BROOM; LYCOSUCHUS VANDERRIETI.

festly due to crushing. From Seeley's figure of the specimen (Fig. 31) one would be led to believe that the depression was bordered in front by a crescent of bone, but in the specimen this is seen to be a crescent of remaining matrix. As Cynognathus crateronotus and other species of the same genus have only one canine present it is manifest that the presence of two canines in the snout of Cynognathus platyceps is a temporary condition.

In the skull which forms the type of Trirachodon Kannemeyeri, Seeley, there is seen in front of the canine on one side the point of a second canine which resembles the anterior canine of both Cynognathus and Lycosuchus in being serrated in front.

We may therefore assume that the anterior canine is morphologically equivalent to the permanent mammalian canine and that the posterior corresponds to the deciduous canine of the mammal. It is quite probable, however, that both teeth are retained as functional for a considerable time in Lycosuchus and possibly also in the higher Theriodonts. This is rendered the more probable from the fact that the posterior canine which is the first to be developed is a much more powerful tooth than the other and also from the fact that the anterior canine is peculiarly specialised, as if developed for some function slightly different from that of the large canine.

A LIST OF THE FLOWERING PLANTS AND FERNS OF THE CAPE PENINSULA, WITH NOTES ON SOME OF THE CRITICAL SPECIES.

COMPILED BY
HARRY BOLUS, D.Sc., F.L.S., AND MAJOR A. H. WOLLEY-DOD.

PREFACE.

It is a somewhat remarkable circumstance that although a "Flora Capensis," embracing the whole Colony, so far as then known, was compiled by the celebrated botanist and traveller, Dr. C. P. Thunberg, about the beginning of the last century, and though a further and much more elaborate "Flora" of South Africa was commenced by Harvey and Sonder in 1859, and is now only approaching completion, yet no catalogue of the plants found upon the Cape Peninsula, the portion of the Colony earliest known and colonised, and that still containing the largest population, has ever been compiled or published.

The catalogue subjoined, which we have prepared from the records of many collections besides our own, must be regarded as a preliminary one, and only approximately complete or correct. Botanists, and especially those who have visited or resided at the Cape, will understand that errors of omission, probably still more of commission, must be frequent. The difficulties in the identification of many of the older or more obscure species are very great, and can only be overcome by time and successive workers. We have been careful, as a rule, to avoid including any plant of which the evidence of its having been collected on the Peninsula is not reasonably good, though a certain number have been mentioned, as explained below. But we have omitted some species, marked by the collectors merely "Cape Flats," unless we have other evidence of their occurrence within our limits, because the Cape Flats stretch for miles beyond our assumed boundary line of the Peninsula; while yet some of those so excluded may, and probably do, grow within the limits of our Flora, and may hereafter be added to it.

A brief explanation must be given of the system followed in our catalogue. The species, after the first in each genus, are numbered consecutively, excepting the excluded ones mentioned below. The sign † before a name indicates that the species, genus, or order so marked is believed to be not native within our limits. Species known to be planted, though a person unacquainted with the Flora might believe some of them to be native, are not included, *e.g.*, species of *Acacia*, *Alnus*, *Hakea*, *Pinus*, *Populus*, *Quercus*, &c. A ? after a name indicates doubt as to the correctness of the name given, though the species quoted is believed to be distinct from any other in the catalogue. A ? before a name means that we are not satisfied that the species so marked has really ever been gathered within our limits, though we do not feel justified in rejecting it altogether; these are not numbered consecutively in their genera.

After each species we give the habitat, the relative frequency, and the months of flowering, followed, in the case of the less frequent ones, by the stations in which they have been gathered, the stations being separated by semicolons. The localities quoted are those in which one or other of us has seen the plant growing; those of other collectors we quote in inverted commas followed by the name of the collector, and usually by the collector's number, at least in the case of the rarer species.

We have found great difficulty in correctly quoting the months of flowering of many of the species. Not only do some vary greatly in different parts of our area, but their time of appearance depends much upon the season, and above all, on the effect of fires. Nor is it easy to define with any degree of accuracy the relative frequency of many of our species. This is liable to variation from the above-quoted causes; moreover, a considerable number have only hitherto been found in more or less restricted areas, so that perhaps a freer use of the expression "locally common" instead of "rare" or "occasional" should have been made, and there is much difference of opinion as to which are "frequent," "occasional," or "rare" species.

We cannot conclude these remarks without thanking those who have been of assistance to us in naming many critical plants. Firstly, we would express our indebtedness to Sir W. T. Thiselton-Dyer, K.C.M.G., Director of the Royal Gardens, Kew, who has kindly permitted the assistance of several members of the staff of the Kew Herbarium. Amongst these, Mr. N. E. Brown has been indefatigable in bringing his special knowledge of South African botany to bear on a very large number of our specimens. The majority of the Orders SCROPHULARIACEÆ, RESTIONACEÆ, CYPERACEÆ, GRAMINEÆ, and CHARACEÆ have been seen and named by Mr. W. P. Hiern, Dr. W. H. Masters, Mr. C. B. Clarke, Dr. O. Stapf, and Messrs. H. and J. Groves respectively, without whose kind help, willingly given, these critical genera would have been very inadequately set forth. Mr. R. A. Rolfe has also kindly examined most of our SELAGINACEÆ.

H. B.
A. H. W.-D.

INTRODUCTION.

By Harry Bolus, D.Sc., F.L.S.

The Cape Peninsula is a narrow mountainous tract of land lying in a direction nearly due north and south, situate at the south-western extremity of Southern Africa. In length it is about forty miles (from Mouille Point to Cape Point), with a width varying from two to eight or nine miles. For the purposes of this inquiry and to avoid the tortuous line of an ill-defined water-shed, an arbitrary line has been assumed as its landward boundary across the low-lying sandy isthmus which connects it with the mainland. This line, which is about thirteen miles in length, lies in a north-easterly and easterly direction three miles distant from, and parallel with, the great high-road which skirts the foot-hills of the mountain range, and which runs from Cape Town to Muizenberg (continuing to Simon's Town). Thus, it commences from the shore of Table Bay, a little beyond Salt River, and terminates on the shore of False Bay, three miles east of the eastern extremity of the Muizenberg. The area of the Peninsula thus enclosed is $197\frac{1}{2}$ square miles,* or about one-fourth larger than the Isle of Wight, which contains 155 square miles.

When we speak of a Peninsula we also, by a natural connection of ideas, think of an island. When we discuss its physical characters, and more especially its natural history, it is almost necessary to know something of the nature of its connection with the mainland from which it is partially cut off. From the mountain range, then, which forms the backbone of the Peninsula there stretches a wide expanse of sandy downs, broken here and there into low, yet still sandy, hills or hillocks. That portion of this expanse which is within our limits lies at an altitude of from forty to one hundred feet above the level of the sea. But further landward the hills gradually attain a greater height, and become less sandy, until at length, towards the north-east, the Tygerbergen and other important hills are reached at a distance of about twelve miles, and on the east at twenty-five to thirty miles, the great range of mountains known in that portion as the Hottentots-Holland Mountains, attaining to a height of from 1,500 to 5,000 feet.

These downs, commonly known by the name of the "Cape Flats,"

* For this calculation I am indebted to the kindness of Abraham de Smidt, Esq., formerly Surveyor-General of the Cape Colony.

have a climate very similar to that of the Peninsula in its lower portions, except that the rainfall is less, and the temperature is probably somewhat warmer. But there is little to lead us to suppose that they present any serious barrier to the transmigration of living organisms; and, as a matter of fact, a large number of vegetable forms in the Cape Peninsula are identical with, or closely allied to, those in the region immediately beyond it; in other words, the Cape Flats forming the isthmus constitute, in no respect, a boundary between two Floral Regions.

The South-western Region of the Cape Flora.

A few words may conveniently here be said respecting the Floral Region of which the Cape Peninsula forms the south-western extremity. This consists of an angular littoral strip, bounded on the west coast by the Olifant's River; thence inland to the Bokkeveld Berg, and southward along considerable mountain chains under various names; thence eastward, generally more or less parallel with the coast, until at last they trend towards the sea near the districts of Humansdorp and Uitenhage. About this part the South-western Region gradually passes into the Eastern or Sub-tropical Region, in the neighbourhood of the Van Stadensbergen, in the latter district.* Its greatest width does not exceed eighty, and probably averages not more than fifty miles; while its length measured along the middle is about 500 miles. Its boundaries, since it passes over to other Regions both on its northern and eastern extremities, by a gradual transition, are necessarily somewhat arbitrary and approximate. But inland, where the mountains form an effectual check to the rain-bearing winds, (whether from the westward or south-eastward) the boundary-line is much more definite.

Professor Ernst Meyer, of Koenigsberg, and J. F. Drège, the botanical explorer and traveller (1826–34), were the first to investigate South Africa from a phytogeographic point of view and to publish a detailed scheme for its division into botanical Regions and Sub-Regions.† These were based upon laborious recorded observations,

* Recent German writers have established a Transition Region (Uebergangsgebiet) between what I have called the South-western and Sub-tropical Regions. This appears to be scarcely an improvement on Drège's chief divisions. It multiplies their number, which seems undesirable in view of the advantages of clearness and simplicity; it makes two somewhat arbitrary boundaries instead of one; and is open to the objection that the process of division might, with equal reason, be carried on indefinitely.

† *Commentariorum de Plantis Africæ Australioris*, Leipsic, 1835; and *Zwei Pflanzen geographische Documente, nebst einer Einleitung von Dr. E. Meyer*, in the "Flora" for 1843, vol. ii.

and thus constituted the foundation of all future work upon the subject. The authors divided the Cape Colony and Natal into five great divisions. Of these, the third, named by them "Terra inferior Occidentalis," and the fourth, "Terra inferior Australis," are almost exactly what I have called the South-western Region.

This Region, which I have treated of somewhat more fully, though quite inadequately, elsewhere ("Sketch of the Flora of South Africa," in the Official Handbook of the Cape of Good Hope, 1886), is probably one of the oldest, most distinct, and most interesting, botanical Regions of the world. Though it has now been considerably explored, probably 90–95 per cent. of its species being known, no systematic tabulation or census of its Orders, genera, and species has been made within recent years; and Drège's researches, valuable as they were, taken alone, are too incomplete to be useful at the present time.

The chief characteristics of the Flora of the South-western Region, as to its general appearance, and stating them very briefly, are:—

1. The great prevalence of dwarf bushy plants, with small and often heath-like leaves.

2. A deficiency in the luxuriance of the vegetation.

3. The general paucity of trees (only the small forest-area near its eastern extremity being excepted).

4. A deficiency of stretches of grass, or turf-formations; grasses being by no means wanting, but characterised by growth in separate tufts, intermingled with other plants.

5. The fewness of sociable plants, *i.e.*, of species growing together to the more or less complete exclusion of others.

6. The small proportion (in individuals rather than in species) of annual plants.

7. The great diversity of species; or, in other words, the large proportion of species which have a small area of distribution.

8. The small proportion, both in respect of species and individuals, of introduced, or foreign plants (excepting only recent forest-plantations).

In all these characters the Flora of the Peninsula agrees with that of the larger Region of which it forms part.

In respect of the systematic character of the Flora of the South-western Region, as above stated, the data for an exact comparison are wanting. For the most part, doubtless, the chief Orders and genera are the same. But towards the eastern portion of the Region the influence of the Eastern or Sub-tropical Flora begins to be felt; whereas in the Cape Peninsula it is scarcely perceptible. Speaking broadly, the orders ORCHIDACEÆ, ERICACEÆ, and FICOIDEÆ probably rank in a higher position in our Peninsula List than they would in that of the South-western Region as a whole, while some others would be proportionately lower; but the differences would probably be inconsiderable.

Sketch of the Physiography of the Peninsula.

The Peninsula itself is traversed throughout its entire length by a range of mountains (with some lower intervals) which are at their loftiest point in the well-known Table Mountain, near Cape Town (3,562 feet); and which gradually diminish toward their southern extremity.

The exposed rocks are, for the most part, the series known as the "Table Mountain Sandstone"; secondly, and chiefly on the Lion's Mountain, the older clay-slate, or "Malmesbury Beds." The soil from the first formation is chiefly of a sandy character, with, in some parts, a remarkably small admixture of humus; from the clay-slate it is a reddish, not very tenacious, clay. These are pierced, here and there, by outcrops of granite, which are of comparatively small superficial extent. With insignificant exceptions tertiary deposits are absent, occurring only in low places and of shallow depth. The influence of soils upon the distribution of plants in South Africa has not yet been investigated, and would be a new and interesting field for the student of œcological botany.

Meteorology.

The mean annual temperature is 61°·25 F. (16°·25 C.) at the Royal Observatory, about 40 feet above the sea-level; of the six summer months 68° F. (20° C.); of the six winter months 54°·5 F. (12°·5 C.). The minimum temperature recorded at the same station in the year 1898 was 34°·1 F. (in June); the maximum, in a Stevenson screen, 95°·7 F. (in Feb.). These extremes are of short duration and infrequent occurrence, and vary in different parts of the Peninsula. Frosts are practically unknown, and never such as to affect the vine, which is largely cultivated.

The rainfall varies considerably in different parts of the Peninsula, owing, apparently, to the position of each spot relatively to the conformation of the mountains, and to the prevailing rain-bearing winds. For the ten years 1885–1894 the annual average fall was at Sea Point, 21·35 inches; in Cape Town, 23·84; at the Royal Observatory, 27·95; at Wynberg, 42·83; on Table Mountain (Waai Kopje), 61·97 in. The extremes are considerable. At the station at Kenilworth, Wynberg, during thirteen years (1889–1901) the maximum annual fall was 63·08 in.; the minimum, 32·30 in. The proportionate fall during the several seasons appears to be more regular. Nearly three-fourths (at Kenilworth, Wynberg, during thirteen years, the mean proportion was 73 per cent.) of the total annual fall takes place in the five months May–September, inclusive. During the remaining seven months, and especially in January–April, the fall is very deficient, and the surface soil, in dry years, becomes extremely dry; until, at varying dates in April–May, the winter rains again set in. Snow or sleet occasionally, or rarely, falls on Table Mountain, but not in every year, and rapidly vanishes.

Thunderstorms are uncommon, comparatively slight, and of short duration.

The prevailing winds are in the winter months from W. to N. W.; in the summer months from S. to S.E.; and often blow with considerable force.

Aspect of the Vegetation.

The prevailing aspect of the vegetation, apart from the modifications effected by the hand of man, is that of a number of low-growing shrubs, of a dark or bluish-green hue. At a distance these appear to be growing closely, but this is not generally the case. The mountain-sides on the north and west mostly appear barren and dry, except for a month or two in early spring, an appearance due to the absence of turf. But on the eastern sides they are of a more luxuriant green, and everywhere the deep and steep ravines are clothed with groves of dark-foliaged dwarf trees and shrubs, few of which attain a greater height than 20 feet to 30 feet, and many even less. Amongst them may be named the genera:—*Scolopia, Kiggelaria, Grewia, Ilex, Gymnosporia, Pterocelastrus, Cassine, Hartogia, Scutia, Noltea, Rhus, Virgilia, Cunonia, Olinia, Curtisia, Plectronia, Myrsine, Sideroxylon, Royena, Olea, Brabejum, Podocarpus*, &c. On the open mountain-sides and foot-hills are also some of the foregoing, together with more scattered bushes, and especially numerous Proteaceæ: *Leucadendron, Protea, Leucospermum.* The well-known *Leucadendron argenteum*, or "Silver-tree," is a prominent feature in some parts, growing in a zone between about 400 feet to 1,000 feet above the sea; *Leucospermum conocarpum* is still frequent, but of late years has been much destroyed for firewood.

On the lower foot-hills and on the Flats the bulk of the vegetation consists of small shrubs, of which one of the chief peculiarities, already referred to, is the large proportion which bear small and narrow or heath-like leaves. These occur in very diverse Orders and genera, a few of which only can be mentioned: In POLYGALACEÆ (*Polygala, Muraltia*); RUTACEÆ (*Macrostylis, Diosma, Coleonema, Agathosma*, many); RHAMNACEÆ (*Phylica*,many); LEGUMINOSÆ (*Cyclopia, Amphithalea, Lebeckia, Aspalathus*, many,—*Indigofera*); ROSACEÆ (*Cliffortia*); BRUNIACEÆ (*Berzelia, Brunia, Staavia*); FICOIDEÆ (*Acrosanthes, Pharnaceum, Cœlanthium, Adenogramma*); RUBIACEÆ (*Anthospermum, Nenax, Carpacoce*); COMPOSITÆ (many species, chiefly in the genera *Felicia, Helichrysum, Metalasia, Eriocephalus*, and others); CAMPANULACEÆ (*Lobelia, Lightfootia, Wahlenbergia, Roella, Prismatocarpus*, &c.); ERICACEÆ (the entire Order, as here represented by about 112 species); SELAGINACEÆ (*Selago* and several species of five other genera); PROTEACEÆ (several species of seven genera); THYMELÆACEÆ (*Passerina, Chymococca, Cryptadenia, Lachnæa, Struthiola, Gnidia*); SANTALACEÆ (*Thesium*, many species); EUPHORBIACEÆ (a few species).

Intermingled with these there is an immense variety of other plant-forms: annuals, herbaceous perennials, succulents, bulbous plants with conspicuous or small petaloid flowers, glumaceous plants, &c., of which only a few of the more striking can here be mentioned.

Annuals are small in number of species compared with other plants; and only a few occur in considerable number as to individuals. Amongst the more noticeable are *Heliophila pusilla* and *pilosa; Grammanthes gentianoides; Mesembrianthemum pyropæum* and *criniflorum; Charieis heterophylla; Cotula turbinata; Senecio arenarius*, and others; *Gymnodiscus capillaris; Dimorphotheca pluvialis; Ursinia* spp.; *Cryptostemma calendulaceum; Venidium hirsutum; Hypochœris glabra; Sonchus oleraceus; Sebæa aurea* and *albens; Belmontia cordata; Diascia montana* and *sabulosa; Nemesia barbata* and *pinnata; Zaluzianskya villosa; Harveya* spp., several of which are very handsome; *Hyobanche sanguinea; Utricularia capensis*, and others.

Amongst the more conspicuous or noteworthy dicotyledonous perennials are the fine *Anemone capensis*, on the higher mountain-sides; the lovely blue *Nymphæa stellata*, in the pools on the eastern side; *Polygala virgata* and *myrtifolia;* several *Pelargonia;* many LEGUMINOSÆ, especially the handsome *Podalyria calyptrata* and *Liparia sphærica;* amongst BRUNIACEÆ (which, though having inconspicuous flowers, are interesting as a purely South African Order), three species are somewhat abundant, viz., *Berzelia abrotanoides, Brunia nodiflora*, and *Staavia radiata*, besides the more local *S. Dodii*, of which the large white radiating involucral scales produce the aspect of a shrubby *Chrysanthemum ;* lastly, the heath-like *Audouinia capitata* (so frequently taken by the tyro for an *Erica*). In COMPOSITÆ the Flora is also rich in handsome species, as *Aster fruticosus ;* many *Heliptera* and *Helichrysa ; Phœnocoma prolifera ; Alciope tabularis ; Senecio elegans, concolor, glastifolius, verbascifolius*, and others ; *Gazania*, 2 spp. ; *Berkheya grandiflora ; Gerbera Wrightii*, and the curious fern-like-leaved *G. asplenifolia*. In ERICACEÆ, the Peninsular species of *Erica*, though so numerous (92), are not by any means the finer ones of the genus. The most attractive are *E. mammosa, alveiflora, purpurea, abietina, verticillata, pyramidalis, cerinthoides, baccans*. In BORAGINACEÆ, *Lobostemon argenteus* and *fruticosus*. In SELAGINACEÆ, *Selago serrata* and *spuria*. In VERBENACEÆ, *Stilbe ericoides*. In LABIATÆ, *Salvia aurea* and *nivea ; Leonotis Leonurus*. Of PROTEACEÆ the most abundant are, besides those already named, *Leucadendron Levisanus ; Protea Scolymus, cynaroides, incompta, Lepidocarpon, mellifera ; Serruriæ* are numerous both in species and individuals, but of little beauty ; *Mimetes hirta, decapitata, Hartogii, cucullata*, chiefly in the southern part of the Peninsula. In THYMELÆACEÆ, *Passerina filiformis*, abundant but insignificant ; *Chymococca empetroides* (a graceful shrub of the seashore, with small flowers, but bright scarlet berries which are often used for Christmas decorations) ; *Struthiola erecta ; Gnidia pinifolia ; Lachnæa capitata*. In PENÆACEÆ the following mountain species are pretty, and interesting as representatives of a purely South African Order : *Sarcocolla*, 2 or 3 spp., and *Brachysiphon imbricatus*.

Succulent plants, as a whole, do not make a great show. They are chiefly found in the Orders CRASSULACEÆ and FICOIDEÆ. The former includes the fine *Rochea coccinea*, so long cultivated in Europe ; of the latter the *Mesembrianthema* include a few brilliant species which sometimes form large masses of flowers.

Amongst the Monocotyledons Orchids are numerous in species, some few also in individuals. The well-known *Disa uniflora* heads the list, though now seldom seen in quantity ; and the beautiful blue species of different hues—*D. graminifolia, purpurascens*, and *longicornu*, the scarlet *D. ferruginea*, and the lovely white *D. fasciata*, occasionally occur in considerable numbers. Most of the species of other genera are scattered, and comparatively insignificant in effect, excepting *Satyrium coriifolium*, which is common, and of which the flowers, though not large nor growing in masses, are of so vivid a flame-colour as to attract the eye upon the sandy downs. In HÆMODORACEÆ, *Wachendorfia paniculata*, with tawny yellow flowers, is common. In Iridaceæ, Amaryllidaceæ, and Liliaceæ the number of genera and species with handsome, striking flowers, and occurring in quantities, is so great that to name them would be a repetition of the larger part of the list which follows. The most prominent genera are *Moræa*, *Bobartia*, *Aristea*, *Ixia*, *Watsonia*, *Babiana*, and *Gladiolus;* of Amaryllidaceæ, *Hypoxis*, *Amaryllis*, and *Nerine;* of Liliaceæ, *Agapanthus*, *Lachenalia*, *Ornithogalum*. *Typha capensis* (the Cape "Bulrush"), and *australis* occur along the streams on the Flats. Our only Aroid, the well-known *Richardia africana*, occurs in abundance in tolerably moist meadows, and excites the admiration of all visitors.

Of the glumaceous Orders, the Juncaceæ are chiefly remarkable for the monotypic genus *Prionium*, locally known as the "Palmiet" (*P. Palmita*), which occurs in the mountain streams, but scarcely attains the size which is seen in the rivers further northward and eastward. The most prominent position of all these is taken by the Restionaceæ, which form one of the chief features in the floral landscape. They grow in vast numbers on the sandy soil of the Flats and also on the mountains, several species of *Restio* and *Thamnochortus* acquiring a height of six feet or more, in large tufts, and having a somewhat mournful though imposing appearance; other species, as of *Elegia*, *Dovea*, *Hypodiscus*, &c., are more elegant, and are often gathered for ornamental purposes. Of Cyperaceæ the most abundant both in species and individuals are the genera *Scirpus*, *Ficinia*, and *Tetraria*. Some tall species of *Cyperus*, as *C. textilis*, *longus*, and *fastigiatus*, occur along the streams. *Carpha glomerata* is a striking large grass-like plant growing sparingly on the mountains and on the Flats. *Schœnus nigricans* is interesting as an additional evidence of the affinity of our Flora with that of Australia (see a recent most suggestive paper by Mr. C. B. Clarke, F.R.S., on the "Antarctic Origin of the tribe Schœneæ," Proc. of the Royal Society, v. 70, p. 496 *et seq.*); *Ecklonea*, and *Chrysithrix*, as endemic genera, of the latter of which a second species was quite lately discovered within our limits by Major Wolley-Dod. Of the vast genus *Carex*, only twenty-two species occur in the whole South African Flora, and of these seven species are found on the Peninsula.

Respecting the grasses, I have already mentioned their general habit of growing in scattered tufts. *Stenotaphrum glabrum* and *Cynodon dactylon*, both almost cosmopolitan, are much used for lawns and meadows, but do not appear to grow thus except in cultivation or where the ground is cleared for them. *Phragmites communis*, the common English "Reed," also a cosmopolitan species, occurs on the margins of "Vleis" or pools.

Amongst the Ferns may be mentioned the fine *Hemitelia capensis* or "Tree-fern," found in the ravines on the east side of Table Mountain, the stem or caudex of which attains a height of five or six feet. The European *Pteris aquilina*, or "Bracken" is common chiefly among the woods of the foot-hills. *Vittaria lineata*, a curious grass-like fern, seems now somewhat rare. *Osmunda regalis* is included on the authority of old collectors, but has not been recorded in recent years, and it may be feared is now extinct on the Peninsula. *Ophioglossum Bergianum* is singular as one of the smallest of the genus; not rare, yet perhaps on account of its tiny size generally overlooked by collectors.

Aquatic Plants.

Aquatic plants, though by no means wanting, are yet perhaps less abundant than in many other countries. Surface water is not abundant on the Peninsula, and much of it becomes dried up, or nearly so, before the end of the summer. The most common and abundant of the aquatics is perhaps *Aponogeton distachyon*, and the less common *A. angustifolium*. Besides these the following occur: *Ranunculus rigidus*, *Nymphæa stellata*, *Oxalis natans*, *Crassula natans*, *Cotula myriophylloides*, *Limnanthemum Ecklonianum*, *Hypoxis aquatica*, *Dipidax triquetra*, *Typha* 2 spp., *Potamogeton pusillus*, *Ruppia* 2 spp., *Zannichellia palustris;* and 6 Characeæ.

Sociable Plants.

Of sociable plants in the strict sense of the term, *i.e.*, of plants growing closely together to the exclusion of all others, there are none on the Cape Peninsula. Two species only have ever been seen by the writer, during a residence of twenty-seven years, growing in such quantity and proximity as to give, when in flower, a colour to the mountain-side when viewed at a distance of two to three miles. These are *Podalyria calyptrata*, and *Erica hirtiflora;* but it is not to be supposed that this occurs every year, or even frequently. These may be said to grow subsocially, and to them should perhaps be added *Leucadendron argenteum.*

Tree-Planting.

Finally, a few words may be said on the change in the floral landscape produced by tree-planting. On the mountain-sides, chiefly on the eastern slopes, large plantations have been made of the common Oak, of Pines, chiefly *Pinus pinea* and *P. pinaster* (the Stone and Cluster Pines), and some Australian *Eucalypti;* and on the Flats, of Australian *Acaciæ* or Wattles. These have been made mostly by the Government Forest Department, and are growing well. All over the suburbs eastward of Cape Town these trees have also been planted largely, and give to the country a forestal aspect which it certainly did not possess before the advent of Europeans, or even until comparatively recent years. Of these foreign trees, though several now produce seed and grow spontaneously, none seem to have established themselves so vigorously as the Cluster Pine, and perhaps some of the Australian *Acaciæ* (*A. decurrens* and *A. saligna*). The Pine is longer-lived than the *Acaciæ*, and moreover almost completely kills out the indigenous undergrowth, yet, when they are planted together, I have observed that the Pine appears to dislike and suffer from the contact more than does the *Acacia*.

If one may for a moment give the reins to imagination and suppose that man and his interference were withdrawn from the Peninsula for a few hundred years, it is easy to dream that a conflict might ensue between the trees last mentioned for the mastery of the vegetation of the whole area; and that whatever the result of this struggle the whole face of Nature would be changed, so far as the vegetation was concerned, to a monotonous and mournful character.

Vertical Range of Plants.

The great vertical range of certain plants on the mountains of the Peninsula should be noticed. The observations hitherto made are very scanty, and more complete investigation will doubtless show a much larger number of similar cases. I give the following list of plants, with a range of 1,000 feet or over, from records made at various times. The headings of the groups, it must be remembered, bear no reference to the actual height of the station of the plants above the level of the sea, but only to the extent of their range in altitude so far as observed or recorded. Thus, *Polygala bracteolata*, having been recorded at 100 feet and also at 1,800 feet of altitude, is placed in the first group of plants having a range of from 1,000 to 2,000 feet.

Having a range of from 1,000 to 2,000 feet.

Polygala bracteolata	*Liparis capensis*
Oxalis pentaphylla	*Eulophia tabularis*
Erica calycina	*Bartholina Ethelæ*
,, *pulchella*	*Satyrium saxicolum*
Simochilus fasciculatus	*Disa racemosa*
Olea capensis	,, *melaleuca*
Sarcocolla squamosa	,, *Richardiana*
Brachysiphon imbricatus	,, *porrecta*
Podocarpus Thunbergii	*Aristea spiralis*
Callitris cupressoides	

From 2,000 to 2,500 feet.

Psoralea aculeata	*Satyrium candidum*
Rhynchosia glandulosa	*Disa uniflora*
Hermas capitata	,, *ophrydea*
Helichrysum fruticans	,, *tenuifolia*
Alciope tabularis	,, *rosea*
Erica sebana	*Pterygodium acutifolium*
,, *glutinosa*	,, *carnosum*
,, *nudiflora*	*Ceratandra atrata*
Bellardia Trixago	*Watsonia Meriana*
Satyrium bicorne	,, *humilis*
,, *odorum*	*Richardia africana*

From 2,500 to 3,000 feet.

Helipterum speciosissimum	*Erica depressa*
Osmitopsis asteriscoides	*Disa graminifolia*
Crassula centauroides	*Bobartia filiformis*
Erica Halicacaba	

From 3,000 to 3,500 feet.

Psoralea aphylla	*Penæa mucronata*
Mairea taxifolia	*Disa micrantha*
Helichrysum sesamoides	,, *cornuta*
Senecio pubigerus	,, *patens*
Villarsia ovata	*Gladiolus arenarius*
Protea cynaroides	

Similar conditions of a high range, in a still greater degree, were observed and recorded by Philippi on Mount Etna in Sicily

(*Linnæa*, vol. vii. (1832), p. 727 and foll.). There, in a not very different latitude (37° 44′) and climate, similar circumstances of a high (in that case a much higher) mountain, surrounded by a warm sea, have produced, in a very different Flora, similar results. Hooker also, in his Introductory Essay to the Flora Indica (1855), p. 39, states that "almost every Himalayan plant has a vertical range of nearly 4,000 feet, and many of 8,000." These data stand in striking contrast to the observations recorded by Watson and others in Britain.

Systematic Elements of the Flora.

The structural or systematic character of the plants composing the Flora of the Peninsula may now be considered, with a view to enable us more readily to form a comparison with that of other Regions in South Africa, or elsewhere.

The proportion borne by the species of Monocotyledons (680) to those of Dicotyledons (1,437) is as 1 : 2·11. This is a high proportion for the former, and is doubtless due to what is regarded as the favouring circumstance of a moist coast climate. As we proceed inland the Monocotyledons appear to diminish; on the higher plateau of the Upper Region of the Cape Colony (Nieuwveld, Uitvlugt, and Winterveld) they rank, according to the observations of Drège, as 1 : 4·9. In England the proportion is about 1 : 3·3; in Greenland as 1 : 2; in Greece as 1 : 5·7. These two last are the extremes which I have been able to find recorded.

It has been aptly remarked by Ernst Meyer, in the work I have already cited, that "in the consideration of single families, two very different points of view present themselves, viz., their *absolute* and their *relative* numbers in our Flora in comparison with their numbers in other Floras. The same family may be equally important to a Flora in both respects, as, for example, Selagineæ and Mesembrianthemeæ in South Africa. But, as a matter of course, the most numerous family of any particular Flora may be one least peculiar to it; while one wholly peculiar [as, *e.g.*, Penæaceæ in South Africa] may be least numerously represented." The truth of this observation will be presently illustrated.

The following is a list of those Orders, twenty-four in number, arranged according to their numbers in indigenous species,* which form at least 1 per cent. of the total Flora :—

* In this and all subsequent statistical remarks indigenous species only are taken into account; *i.e.*, excluding all plants which there is reason to believe or suspect have been introduced by human agency.

	Species.	Per cent. of the whole native Phanerogamic Flora.
Compositæ	254	12·01
Leguminosæ	156	7·38
Iridaceæ	119	5·63
Orchidaceæ..................	117	5·53
Cyperaceæ	115	5·44
Ericaceæ......................	112	5·24
Gramineæ	95	4·49
Ficoideæ	91	4·30
Restionaceæ	89	4·21
Liliaceæ	83	3·92
Geraniaceæ..................	65	3·07
Scrophulariaceæ	60	2·84
Campanulaceæ	59	2·79
Proteaceæ	47	2·22
Crassulaceæ	40	1·89
Umbelliferæ	38	1·80
Rutaceæ	31	1·46
Cruciferæ	30	1·42
Thymelæaceæ	29	1·37
Polygalaceæ	29	1·37
Rosaceæ	29	1·37
Amaryllidaceæ	27	1·28
Selaginaceæ	26	1·23
Gentianaceæ	24	1·13
	1,765	83·39
69 Orders each with less than 1 per cent. ...	352	16·61
	2,117	100·0

Here, Compositæ head the list, but they are numerous in the Flora of all countries and occupy the first place in most. On the other hand, Bruniaceæ, Penæaceæ, and Grubbiaceæ, which are entirely confined to South Africa, are not sufficiently numerous in species to appear in the first list above cited; and Selaginaceæ which, with one single exception, are also all South African, only occupy a very low position in it.

Leguminosæ, Cyperaceæ, and Gramineæ, which occupy the second, fifth, and seventh places respectively, would also take a prominent place in the Flora of any similarly situated country.

But it is in the high rank which is taken by the Orders Iridaceæ, Orchidaceæ, Ericaceæ, Restionaceæ, Ficoideæ, Geraniaceæ, and Proteaceæ that the chief distinctive characters of the Peninsular Flora, taken as a whole, will be found. To these may be added, as a character of secondary importance, the presence of a considerable number of genera rich in species, of which some details will be now adduced.

The 2,117 species of native flowering plants enumerated in the "List" belong to 93 Orders and 485 genera. The average number of species to each genus is therefore 4·36.* This, from a comparison with other Floras of a similar size, is somewhat high, and seems to stand in opposition to the greatly diversified character which has been noted by previous writers as one of the most marked features of the South African Flora generally. It appears, however, to be chiefly due to the presence of a few genera very numerous in species. This is shown by the following list of the largest genera:—

	Species.
Erica	92
Mesembrianthemum	61
Aspalathus	50
Disa	47
Senecio	40
Ficinia	36
Oxalis	32
Pelargonium	30
Crassula	29
Helichrysum	29
Restio	29
Gladiolus	24
	499

We have, therefore, the first four genera with 250 species, or very nearly 12 per cent. of the whole; and twelve genera with 499 species, or 23·59 per cent. of the whole native Flora.

Most of these large genera are either exclusively South African or genera having their largest or at least a very large development in South Africa, the cosmopolitan *Senecio* being the only exception. But it is even more significant that, with two exceptions (*Mesembrianthemum crystallinum* and *Senecio vulgaris*), all the Peninsular species of these large genera are, so far as I have been able to

* In Mr. Wood's Catalogue of the Flora of Natal (a very much larger area) the average is 3·12 species to each genus.

ascertain, peculiar to Southern Africa, and the great majority to its South-western Region.

Besides the above there are twenty genera each containing 15 or more species, viz., *Cliffortia*, 23; *Heliophila*, 22; *Satyrium*, *Scirpus*, each 21; *Muraltia*, *Lobelia*, and *Thesium*, each 18; *Tetraria*, 17; *Hermannia*, *Phylica*, *Indigofera*, *Moræa*, and *Thamnochortus*, each 16; *Agathosma*, *Serruria*, *Gnidia*, *Pterygodium*, *Anthericum*, *Juncus*, and *Elegia*, each 15. The average is reduced by the very large number of 204 genera, which are represented by only one species each; of these, 42 are monotypic genera.

It would be interesting to adduce data of other similar Floras for the sake of comparison with that of the Cape Peninsula. Strictly speaking these should be of peninsulas, or islands near a continent, of nearly equal area, and in the same latitude. Unfortunately no observations bearing any near approach to these conditions are here available. I can only subjoin a few which may be suggestive to the reader:—

	Square miles. about	Genera.	Species.
Tasmania	22,633	394	1,063
Natal	21,150	756	2,360
Sicily	9,860	619	2,549
Madeira...............	300	366	710
Cape Peninsula ...	197	485	2,117
Isle of Wight	155	376	867
Hong Kong	29	566	1,056
Ischia	18	389	792

Remarkable Absence of Certain Orders.

It is not, however, merely by the vegetation actually present that the character of any particular Flora, as compared with others, is to be judged, but also by what is absent. In this respect that of the Cape Peninsula presents certain marked peculiarities.

In the first place it is a notable and somewhat unexpected circumstance that the large Orders Myrtaceæ, Apocynaceæ, and Acanthaceæ are wholly absent—not a single species having been hitherto detected within our limits. Yet of the first there are 9 or 10, of the second probably over 30, and of the last 195 enumerated species, dispersed throughout extra-tropical South Africa. It is true that these are chiefly eastern in their distribution (only a few occurring in the south-western districts), and belong to what I have elsewhere termed the Sub-tropical Region; nevertheless it is remark-

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able that not even a single outlier should have reached so far westward as the Cape Peninsula.

BIGNONIACEÆ and PEDALIACEÆ, less important Orders, yet both represented in the eastern and northern districts, are both entirely absent.

RUBIACEÆ, a vast Order, fifth in rank in the number of its species in the whole world, and the second in India, have but 15 species. Of these only two are trees; the rest small plants of the tribes Anthospermeæ and Galieæ. In Natal, however, this Order occupies a high rank, and probably reaches to about 3 per cent. of the whole Flora.

The following Orders also are very scantily represented here—those marked with an asterisk being also somewhat deficient throughout South Africa:—BIXACEÆ (2 species); MALVACEÆ (5); TILIACEÆ (1); SAPINDACEÆ (1); SAXIFRAGACEÆ* (1); ONAGRACEÆ* (1); CUCURBITACEÆ (2); PRIMULACEÆ* (2); CONVOLVULACEÆ (3)—the genus *Ipomœa* entirely absent; CONIFERÆ* (2).

Of CYCADACEÆ, a few species, and of PALMACEÆ 2 species, reach their southern limits in the Sub-tropical Region, but both are wholly wanting here.

Of the ORCHIDACEÆ so numerous on the Peninsula, it is noteworthy that of the 117 species enumerated, 109, or 93 per cent., belong to the tribe Ophrydeæ; 7 species only to the tribe Vandeæ; and 1 species to the Epidendreæ. All the species are terrestrial. Epiphytic orchids begin to appear only about the district of Knysna (in proceeding eastward) and become more abundant throughout the Sub-tropical Region.

RELATIONS OF THE PENINSULAR FLORA TO OTHERS.

A brief and very general statement only can be made on this subject. Even if space permitted, the data are as yet too incomplete to enable it to be treated as fully as its high importance demands. Excellent lists of the Flora of the Sub-tropical or South-eastern Region have been made by Mr. T. R. Sim for Kaffraria, and by Mr. Wood for Natal, which together give a satisfactory report of the Flora of that Region. But for that of the South-western Region a tabulated census is still wanting.

The general identity of the Peninsular Flora with that of the last-named Region has already been pointed out. On the eastern side there is a gradual transition (chiefly over the districts of Knysna, Humansdorp, and Uitenhage) to the Flora of the Sub-tropical Region. Some of the most striking contrasts between our Flora and that of the latter have been mentioned in the foregoing pages. It must suffice now to show both certain resemblances as well as differences by a tabulated list of the chief constituents of each.

For a comparison of mere richness of species in proportion to area it must be remembered that the enumerations following afford little aid. Natal has an area of 21,150 square miles, or very nearly the size of the island of Tasmania; while, as before stated, the Cape Peninsula has but 197. We can therefore use them as an aid to comparison of the constituent elements of the Flora of each of two neighbouring Regions only; and from that point of view they possess, incomplete as they are, considerable interest. Natal is very much less fully explored than the Cape Peninsula, a large part being mountainous and difficult of access, and large additions to the records of the Flora may be expected for many years to come.

Mr. Wood's Catalogue, after deduction of Cryptogams, varieties and introduced species, shows a total of Orders, 123; genera, 756; species, 2,360. Of these, there are 38 Orders and 460 genera which have not been found on the Cape Peninsula; while there are 6 Orders and 195 genera belonging to the latter which are not in Mr. Wood's list.

The following is a list of the larger Orders of each Flora arranged according to the number of species, to which have been added for convenience' sake the chief twelve Orders of the Karoo Region which will be mentioned presently:—

Cape Peninsula.	Sub-tropical Region Natal (Wood).	Karoo Region (Eastern part).
1. Compositæ	1. Compositæ	1. Compositæ
2. Leguminosæ	2. Leguminosæ	2. Gramineæ
3. Iridaceæ	3. Filices	3. Ficoideæ
4. Orchidaceæ	4. Gramineæ	4. Liliaceæ
5. Cyperaceæ	5. Orchidaceæ	5. Crassulaceæ
6. Ericaceæ	6. Liliaceæ	6. Leguminosæ
7. Gramineæ	7. Asclepiadaceæ	7. Geraniaceæ
8. Ficoideæ	8. Cyperaceæ	8. Scrophulariaceæ
9. Restionaceæ	9. Rubiaceæ	9. Asclepiadaceæ
10. Liliaceæ	10. Scrophulariaceæ	10. Sterculiaceæ
11. Geraniaceæ	11. Labiatæ	11. Solanaceæ
12. Scrophulariaceæ	12. Euphorbiaceæ	12. Cyperaceæ
13. Campanulaceæ	13. Iridaceæ	
14. Proteaceæ	14. Amaryllidaceæ	
15. Filices	15. Acanthaceæ	
16. Crassulaceæ	16. Campanulaceæ	

Cape Peninsula.	Sub-tropical Region Natal (Wood).
17. Umbelliferæ	17. Malvaceæ
18. Rutaceæ	18. Crassulaceæ
19. Cruciferæ	19. Anacardiaceæ
20. Thymelæaceæ	20. Umbelliferæ
21. Polygalaceæ	21. Celastraceæ
22. Rosaceæ	22. Geraniaceæ
23. Amaryllidaceæ	23. Cucurbitaceæ
24. Selaginaceæ	24. Thymelæaceæ

If the following list of the twelve largest genera of the Natal Flora (which I take as fairly representative of that of the Sub-tropical Region), be compared with that of the Peninsula, it will be seen how considerably they differ:—

Peninsula.	Species.	Natal.	Species.
Erica	92	Senecio	58
Mesembrianth'm	61	Helichrysum	56
Aspalathus	50	Indigofera	42
Disa	47	Cyperus	36
Senecio	40	Eulophia	30
Ficinia	36	Crassula	28
Oxalis	32	Rhus	26
Pelargonium	30	Gomphocarpus	26
Crassula	29	Panicum	26
Helichrysum	29	Ipomæa	24
Restio	29	Hibiscus	21
Gladiolus	24	Habenaria	21

Three genera only are identical in the list. The following will serve to show still more vivid divergences. The first column shows certain genera predominant in the Flora of the Peninsula, but wholly wanting or much less numerous in Wood's Natal Catalogue; the second column shows predominant Natal genera similarly deficient in the Cape Peninsula—

	C. Penins.	Natal.		Natal.	C. Penins.
Erica	92	13	Helichrysum	56	29
Mesembrianth'm	61	7	Indigofera	42	16
Aspalathus	50	4	Cyperus	36	9
Ficinia	36	3	Eulophia	30	2
Oxalis	32	7	Asclepias (incl. Gomphocarpus)	27	3
Pelargonium	30	9			

	C. Penins.	Natal.		Natal.	C. Penins.
Restio	29	0	Rhus	26	11
Cliffortia	23	3	Panicum	26	0
Heliophila.........	22	5	Ipomæa	24	0
Muraltia	18	2	Asplenium	22	5
Tetraria............	17	1	Hibiscus	21	3
Agathosma	15	0	Habenaria.........	21	0
Serruria............	15	0	Vitis	18	1
Gnidia	15	4	Vernonia	18	0
Elegia	15	0	Hypoxis	18	7
Ehrharta	14	2	Plectranthus ...	17	0
Geissorhiza	11	0	Argyrolobium ...	15	4
Lachenalia	11	0	Andropogon	15	3
Felicia	10	3	Kniphofia	12	1
Protea	10	4	Polypodium	12	1
Lobostemon	9	0	Angræcum	11	0
Leucadendron ...	9	0	Combretum	8	0
			Polystachya	8	0

The Karroo Region.

With regard to the Karroo Region which bounds the South-western Region upon the whole of its northern and north-eastern sides, a few words must suffice. The relations between the two Regions are considerably slighter than those between the South-western and Sub-tropical Region. A list of the twelve largest Orders of the eastern part of the Karroo has been given on p. 225. This has been compiled from the records of Drège, and of my own collections made during several years' residence at Graaff Reinet. It will be seen by it that the large succulent Orders Ficoideæ and Crassulaceæ occupy a much more prominent position than on the Peninsula; and to this it may be added that the dry climate of the Karroo has resulted in a much more frequent tendency to a succulent growth of stems, branches, and leaves in several other Orders, such as Zygophyllaceæ, Compositæ, and Liliaceæ (tribe Aloineæ). This is not merely the case as to systematic characters, but it has also strongly characterised the floral landscape, both by the character of the plant-forms as well as by the number of the individual plants in proportion to others. The Order Compositæ, which on our Peninsula constitutes about 12 per cent. of the Flora, reaches in the Karroo Region to 17 per cent.; the Ficoideæ reach nearly 7 per cent.; the Crassulaceæ, 5·3.

On the other hand, the seven Orders Rutaceæ, Bruniaceæ, Ericaceæ, Proteaceæ, Penæaceæ, and Orchidaceæ, which are either so markedly predominant, or so essentially characteristic of the Peninsula Flora that they constitute together 19·55 per cent. of its species, are so rare that only seven or eight species in all have been recorded in the Karroo; and most of these occur sparingly on the summits of the mountains which separate the Karroo Region from the other Regions of South Africa.

European Representatives.

The evidences of the connection of our Flora with that of Europe are but slight. They consist in the presence of a small number of genera common to both. Amongst these may be named *Anemone, Ranunculus, Lepidium, Geranium, Erodium, Dianthus, Silene, Linum, Trifolium, Alchemilla, Rubus, Hydrocotyle*, &c. They are almost all small genera, only one, the last, reaching to 13 species. Some include European species as well as species regarded as native, such as *Trifolium;* others, as *Anemone* and *Geranium*, have native species only. It is one of the most marked features of South African vegetation that European genera are not, as a rule, found upon the higher mountain summits, where they might have been expected, the only exceptions I can recall being a few *Ranunculi* and two *Alchemillas* in the north-eastern districts, but the species were all undoubtedly native. The naturalised species of European origin are mostly weeds of cultivation and roadside plants, and few are seen far from houses.

The only sign of any affinity with the South American Flora consists in the presence of many species of the genus *Oxalis*, which are numerous in both countries.

Affinities with the Australian Flora.

The relations of our Flora, and therefore that of the whole South-western Region, with that of Australia were first pointed out by Sir Joseph Hooker in his classical essay, "On the Flora of Australia. . . . An Introductory Essay to the Flora of Tasmania" (1859). They are very remarkable and curious. These affinities do not consist in the presence of identical species in either region; and scarcely even of genera common to both, for these are very few in number. But they are evidenced by the presence of certain identical, or closely related, Orders which are either peculiar to Australia and the South-western Region of South Africa or which there attain their maximum development.

"Two very distinct Orders—Proteaceæ and Restionaceæ—are abundant in both regions, and, except for a few outliers, do not occur in any other countries; yet they have no single species and only two or three genera, in common, out of many. . . . Diosmeæ, a large tribe of RUTACEÆ abundant in this Region, find a counterpart in Australia in the tribe Boronieæ of the same Order. The tribe Ericeæ, of the Order ERICACEÆ, has over 400 species in this Region alone; not one occurs in Australia, but the place of the tribe is taken by the large Order EPACRIDACEÆ, very closely allied to it, and which is almost confined to Australasia." * There is no genus of RUTACEÆ or PROTEACEÆ, and only three of RESTIONACEÆ, common to both Regions. In COMPOSITÆ, Bentham has pointed out several identical genera which are abundant in South Africa, notably *Helipterum* with 12 South African and 30 Australian species, and *Helichrysum* with 137 and 52 species respectively.

"The following Orders, characteristic of Australian vegetation, abound most, after Australia, in South Africa: THYMELÆACEÆ, HÆMODORACEÆ, DROSERACEÆ; and another point of approach is found in the remarkable deficiency in both countries of the widely-diffused Orders RUBIACEÆ, LAURACEÆ, and ARACEÆ."

There are certainly some remarkable divergences, of Orders rare or absent in either country and represented in the other, which Hooker has specified in detail. To these may be added that whereas in the ORCHIDACEÆ of Australia it is the tribes Vandeæ and Neottieæ which most largely prevail (Ophrydeæ being restricted to two species), in our Peninsular Flora the Vandeæ are few, the Neottieæ absent, while Ophrydeæ abound. Still, these divergences do not destroy the striking significance of the affinities before mentioned.

Sir J. Hooker conjectures the probability of a common origin of the Australian and South African (*i.e.*, the South-west African) Floras, derived from ancestors inhabiting a vast antarctic continent of which the greater part has been submerged; and that during the ages which have succeeded the severance of the continents the two Floras have become differentiated as we now know them.† The evidence, it should be added, is not merely South African, but is corroborated by the spread of some of the Australian Orders mentioned above (EPACRIDACEÆ, PROTEACEÆ, RESTIONACEÆ) northward towards

* This and the following quotations are taken, for the sake of brevity, from my "Sketch of the Flora of South Africa" in the Official Handbook of the Cape of Good Hope, 1886; the substance being derived from Hooker's Essay, above-mentioned.

† More recent discoveries have tended, as far as they go, to support this hypothesis: the presence, on the mountain-tops of South-west Africa, of *Nanolirion*, a small LILIACEA, a close ally of *Herpolirion*, found in similiar stations in S.E. Australia; and the facts and conclusions adduced in Mr. Clarke's paper on the Antarctic Origin of the tribe Schœneæ, cited above.

China, or north-westward to Patagonia and beyond, on the South American continent.

For a further and more detailed study of this deeply interesting subject the student is referred to the Essay of Sir J. Hooker, cited above.

The Effects of Bush Fires on the Vegetation.

In conclusion, some allusion may be made to the question whether any, and if so what, influence has been exercised upon the Flora of the Cape Peninsula and of South Africa generally by the widely-prevalent custom of burning the vegetation annually, in order, as it is said, that the young grass may grow more readily for the benefit of the live-stock. It may possibly be that this practice is of great antiquity; that it prevailed before the advent of Europeans; that it may have originated without the intervention of man, as from lightning or from heat produced by the impact of masses of falling rock during the dry seasons, causes which are said to be still in operation and to which the mountainous and precipitous character of the country lends an appearance of probability; that the results appearing beneficial, by the growth of more tender herbage, the aboriginal nomadic tribes imitated the processes of Nature, and produced artificial fires; and lastly that the early European colonists followed their example.

It has been observed here, as in other parts of the world, that the ground after a fire is often covered with a number of plants which had not been observed there previously, or at least for some considerable time, so as to appear (to a people who made no records of such facts), as if such plants were entirely new. Examples of such appearances are familiar to all South African observers, travellers, and collectors of plants, as well as of farmers; and vague ideas have been expressed that the great diversity of species exhibited here is due in part at least to the prevalence of bush fires.

This would probably be an erroneous supposition. The effect of burning would surely tend rather to destroy some species, especially annuals and hard-wooded plants, like heaths, which do not readily send up shoots from the caudex. It is noticeable that on mountain-sides where burning has been repeated plants with deeply-seated bulbs or rhizomes prevail to a considerable extent. Such are especially *Bobartia spathacea*, some *Watsonias* (*W. rosea*, &c.), and some of the stronger-growing RESTIONACEÆ. It is of course true that grasses and some other herbaceous plants fit for stock-food might more readily appear after burning in some localities, but in others this is doubtful. Burning is most resorted to where the natural vegetation is largely composed of coarse grasses, RESTIONACEÆ, Iridaceous, Amaryllidaceous, and Liliaceous plants. These form the so-called "Zuurveld" or Sour-veld of the colonists; and in some cases it seems probable that more harm than good is done to the veld by burning it, since the Orders mentioned above, while they are all least suitable for stock-food, are at the same time most difficult to eradicate by burning.

The subject requires further investigation; but on the whole it appears to me probable that the practice of burning is more harmful than beneficial from the economic point of view, and that from a botanical point of view it tends to the destruction of species and the consequent greater uniformity, not necessarily to the greater usefulness, of the vegetation.

The Flora of the whole South-western Region is undoubtedly an ancient one, as compared, for instance, with the European Flora, and the view has been expressed that it is probably becoming slowly and gradually extinct. If this be so, it seems not unreasonable to suppose that the process is being accelerated by a custom which is of questionable benefit, and which at least should be brought to the careful judgment of science.

THE FLORA.

RANUNCULACEÆ.

Clematis brachiata Thunb. Hedges, rare; 3–4. High Constantia; Rondebosch.

Anemone capensis Linn. Mountain slopes, frequent; 7–11.

Knowltonia vesicatoria Curt. Mountain and hill slopes, rather frequent; 7–11.

2. **K. rigida** Salisb. "Rocky mountain ground round Table Mountain," *Harvey*. Not found by us, but it appears likely to be mistaken for **K. vesicatoria.**

3. **K. gracilis** DC. "Near Constantia," *Eckl.* and *Zeyh.* Not found by us.

4. **K. hirsuta** DC. Mountain and hill slopes, rather frequent; 7–11.

Ranunculus rigidus Godr.? Vleys and rivers, rare; 10–12. In Vaarsche and Rapenburg Vleys.

2. **R. pinnatus** Poir. Damp grassy places on flats and hill slopes, frequent, flowers throughout the year, but chiefly 8–11. The fruit tubercles are sometimes very faint.

3. **R. capensis** Thunb. Grassy places, rare; 11. Rapenburg Vley; Green Point Common.

4. †**R. sceleratus** Linn. A single plant by shore at Woodstock; 10.

5. †**R. muricatus** Linn. By sluits throughout suburbs, rather frequent; 9–12. Also at Kamp's Bay and Black River.

6. †**R. trilobus** Desf. Grassy places, rare; 11. Rapenburg Vley, by the Observatory, *Wolley-Dod*, 3674.

MENISPERMACEÆ.

Cissampelos capensis Thunb. Bushy hillsides and flats, frequent; 2–5.

NYMPHÆACEÆ.

Nymphæa stellata Willd. Vleys, locally frequent; 12–5. Retreat and Princess Vleys.

PAPAVERACEÆ.

Corydalis vesicaria Pers. Bushy, sandy ground, chiefly near sea, frequent; 8–11.

2. **C. cracca** Schlecht. Bushy hill slopes, rather frequent; 8–11.

Fumaria Mundtii Spreng. Similar localities, but extending higher, occasional; 8–11. East slopes Devil's Peak and Table Mountain; "Kamp's Bay," *Harvey*.

2. †**F. muralis** Sond. Hedges and cultivation, very common; 7–11.

CRUCIFERÆ.

†**Nasturtium officinale** R. Br. Occasional, but very general; 9–10. Probably introduced, but, as is the case with many other doubtful natives, it is most difficult to speak with certainty.

†**Barbarea præcox** R. Br. Open woods and waste places, rather rare; 9–11. Retreat; Westerford Bridge; Klein Constantia; not uncommon above Groot Schuur.

Cardamine africana Linn. Stony shady kloofs, local; 10–11. East slopes of Devil's Peak and Table Mountain; Orange Kloof.

†**Alyssum maritimum** Lam. "Sandy places near Cape Town, not uncommon; April," *Sond.* Not seen by us.

†**Sisymbrium officinale** Linn. A very common weed of cultivation; 10–12.

2. **S.** sp. nov.? Hill slopes towards Smitswinkel Bay; 9. *Wolley-Dod*, 3199. Our material was insufficient to describe. The species seems near **S. capense**, but differs in style characters.

Heliophila dissecta Thunb. Sandy flats, common; 8–11. Very variable in foliage.

2. **H. sonchifolia** DC. "Stony places on mountains round Cape Town, *Masson*, &c., October," *Sond.* Not found by us.

3. **H. Ecklониana** Sond. Mountain slopes, rare; 10–11. Lion's Head, with whitish flowers; east slopes Twelve Apostles, with blue flowers.

4. **H. Dodii** Schltr. Mountain slopes, rare; 11. East slopes Devil's Peak, *Wolley-Dod*, No. 465.

5. **H. pusilla** Linn. f. Flats and hill slopes, very common; 7–10.

6. **H. coronopifolia** Linn. Damp places on hills and mountains, occasional; 10. Top of Skeleton Ravine; east slopes Devil's Peak; by swamp and west slopes in Orange Kloof.

7. **H. dentifera** Sond. Mountain slopes, rare; 10. East slopes Devil's Peak; Waai Vley; plentiful after a fire at top of Skeleton Ravine.

8. **H. diffusa** DC. Hill and mountain slopes, locally frequent; 8–10. Lion's Head and Signal Hill; eastern slopes of Devil's Peak.

9. **H. Peltaria** DC. Similar situations, but rarer; 8–10. With the last species on Lion's Head. "Among the Silver trees on Devil's Mountain," *Eckl.* and *Zeyh.*

10. **H. scabrida** Schltr. Mountain slopes, rare; 10–11. East slopes Devil's Peak, *Wolley-Dod*, No. 464, *Bolus*, 2703; *Herb. Norm Aust. Afr.*, 311.

11. **H. fœniculacea** R. Br. "Near Simon's Town," *Wright;* 8. "Kalk Bay," *Pappe*. Not found by us.

12. **H. tenuifolia** Sond. Mountain slopes, rare; 9. Muizenberg.

13. **H. refracta** Sond. Sandy flats, rare; 8–10. Chapman's Bay; about and beyond Camp Ground.

14. **H. trifurca** Burch. γ. **parviflora** Sond. "Table Mountain," *Eckl.* and *Zeyh.* Not found by us.

15. **H. tabularis** Wolley-Dod. Mountain slopes, rare; 10. Orange Kloof, west slopes, *Wolley-Dod*, 3338.

16. **H. pilosa** Lam. Sandy flats, very common; 8–1. Very variable in leaf-cutting and hispidity. The pods are occasionally strongly reflexed. A form with lilac flowers occurs at Buffel's Bay.

17. **H. abrotanifolia** Banks. "Mountains near Cape Town," *Sond.* Not found by us.

18. **H. elata** Sond. "Simon's Bay," *Wright* in Herb. Kew.

19. **H. subulata** Burch. Slopes near sea, very local; 9. Paulsberg; "near Simon's Town," *Eckl.* and *Zeyh.*

20. **H. linearifolia** Burch. Flats and dry hill slopes, rather common; 10–2.

21. **H. scoparia** Burch. Dry hillsides, rather locally frequent; 7–9. From Constantia Nek southward; rare in Orange Kloof.

22. **H. callosa** DC. Hill and mountain slopes, occasional; 10–2. East slopes Devil's Peak; Wynberg Hill; Orange Kloof.

Chamira cornuta Thunb. Rocky places among bushes, very rare; 9–10. Slopes near Smitswinkel Bay; Chapman's Bay.

†**Brassica Sinapistrum** Boiss. An occasional weed of cultivation; 9–10. Observatory, &c.

? †**B. alba** Boiss. Said to occur, but we have not found it. Perhaps confounded with **B. Sinapistrum.**

2. †**B. Sinapioides** Roth. (**B. nigra** Koch). A weed of waste places, here and there plentiful; 9–10.

†**Diplotaxis muralis** DC. Railway ballast; 9–10. Sea Point railway; Maitland.

†**Capsella Bursa-pastoris** Mœnch. Casual and rare, though widely dispersed; 8–12.

†**Senebiera didyma** Pers. A common garden weed, spreading to lower hill slopes; 8–12.

2. †**S. Coronopus** Poir. A weed of waste places, much less frequent than **S. didyma**; 8–12. About Woodstock and Maitland to Newlands; Kloof Road.

Brachycarpæa laxa Sond. Hill slopes, locally plentiful; 9–10. Lower slopes of Paulsberg.

Lepidium capense Thunb. ? Roadsides, grassy and waste places, apparently common; 6–12. Doubtfully distinct from the next two species, probably all three are forms of **L. ruderale** Linn., and should rank as aliens. Reaches 1,500 feet.

2. **L. africanum** DC. ? Appears rarer than **L. capense** and **L. pinnatum.**

3. **L. pinnatum** Thunb. ? Appears common; reaches 1,500 feet on Lion's Head.

†**Neslia paniculata** Desf. A single casual by the Kaffir location by Table Mountain reservoir, October.

†**Rapistrum rugosum** DC. A weed of waste places; 10–11. Three Anchor Bay; shore at Sea Point.

†**Raphanus Raphanistrum** Linn. An abundant weed of cultivation; 7–12.

Carponema filiforme Sond. Sandy flats, rare; 10. The Kommetjes, Chapman's Bay; "Doornhoogde," *Eckl.* and *Zeyh.*

†RESEDACEÆ.

†**Reseda** sp. Plants seen by roadside and railway near Muizenberg, but we never gathered it in flower.

2. †**R. odorata** Linn. By Rapenburg Vley; 8. *Wolley-Dod,* 3042. No doubt an escape, though far from gardens.

VIOLACEÆ.

Viola decumbens Linn. f. Mountain slopes, rare; "Nek between Klaver and Smitswinkel Vleys," *A. Bodkin.* Not seen by us.

2. †**V. tricolor** Linn. A casual of cultivation in several places; 8–11. Only the small-flowered form seen, which would be classified under **V. arvensis** Murr.

BIXACEÆ.

Scolopia (**Phoberos Mundtii** Arn.). "Table Mountain, rare; 4–5," *Pappe.* Not seen by us.

Kiggelaria africana Linn. Hedges and lower kloofs, frequent; 6–10. Leaves very variable both in dentition and tomentum.

POLYGALACEÆ.

Polygala myrtifolia Linn. Bushy places up to 1,200 feet, frequent; 8–1.

2. **P. bracteolata** Linn. Hill and mountain slopes, frequent up to 2,500 feet; 7–12. The var. **umbellata** Harv. about as common as type, but preferring higher elevations.

3. **P. virgata** Thunb. Bushy places, very rare; 9–10. Near Mostert's farm, Mowbray. Possibly introduced from the eastern districts.

4. **P. ericifolia** DC. Rough and grassy places, occasional; 7–10. Red Hill; Slangkop; Klaver Vley; Fish Hoek; Constantiaberg; between Retreat and Tokay.

5. **P. Garcini** DC. Similar situations to last, but common; 9–1.

6. **P. refracta** DC. Grassy places from flats to Lower Plateau, rather frequent; 7–2.

7. **P. macra** DC. Wet grassy places, very local; 1–3. Klaver Vley; frequent Orange Kloof swamp.

8. **P. Lehmanniana** E. and Z. Grassy hill slopes, rare; 9. Devil's Peak near Mostert's Glen (both glabrous and pubescent forms). "Round the Lion's Head," *Eckl.* and *Zeyh.*

9. **P. Dodii** Schltr. Grassy slopes near sea, rare; 1–2. Castle Rock, *Wolley-Dod,* Nos. 813 and 2272..

10. **P. Zahlbruckneri** Hayek. "Muizenberg, July," *Penther,* 1482. Unknown to us.

Muraltia serpylloides DC. Hill slopes and plateaux up to 1,500 feet, frequent; 6–9. Flowers usually pale, rarely deep rose.

2. **M. Heisteria** DC. Flats to at least 2,000 feet, common; 6–12, but occasionally flowers in any month. A white-flowered form occurs.

3. **M. brachypetala** Wolley-Dod. Locally frequent, on hill plateaux; 8–10. Hills west of Simon's Town, *Wolley-Dod,* 1426, 1871.

4. **M. macropetala** Harv. Sandy flats, locally plentiful; 5–9. Between Oude Molen and Uitvlugt.

5. **M. acipetala** Harv. Flats and hill slopes, rare, or mistaken for some other species; 8–12. Patrys Vley, *Wolley-Dod,* 1499. "Near path up Table Mountain," *MacGillivray*; "Simon's Bay," *Wright.*

6. **M. satureoides** Burch. Hills and mountains to about 2,000 feet, occasional; 3–11. Red Hill; west slopes of Devil's Peak; near Slangkop; Smitswinkel Bay.

7. **M. filiformis** DC. Flats and hills, common; 7–12. We think that **M. exilis** Schltr. is specifically inseparable from slender forms of this species, of which we regard it as an extreme variety. It occurs in a marsh near the source of the Silvermine River.

8. **M. demissa** Wolley-Dod. Flats and hills, frequent or common; 8–12.

9. **M. recurva** Wolley-Dod. Mountain slopes, rare? 7. Orange Kloof, *Wolley-Dod,* 2726.

10. **M. mixta** Linn. Damp places on flats and hills, local; 5–1. Common about Rapenburg and Uitvlugt; at 1,000 feet on Muizenberg.

11. **M. alopecuroides** DC. Mountain slopes, rare; 12. Constantiaberg.

12. **M. phylicoides** Thunb. Sandy flats and plateaux, very common; 7–12. Reaches 1,200 feet on Constantiaberg. **M. Dodii** Schltr., which was founded on a supposed absence of horns to the capsule, must be reduced to this species; we have found horns on the type specimen (*Wolley-Dod*, No. 941), they appear to be deciduous after the fruit has ripened.

13. **M. ciliaris** DC. Sandy flats, rare; 1. Near Kenilworth, *Schlechter !*

14. **M. diffusa** Burch. Flats to mountains, common; 7–1. Mr. N. E. Brown considers that **M. stipulacea** Burch (non "DC." *Harvey*, Fl. Cap. I. 103) and **M. tenuifolia** DC. var. **major** Harv. are synonyms of this species.

15. **M. dumosa** DC. "Lion's Mountain," *Eckl.* and *Zeyh.* Not found by us.

16. **M. thymifolia** Thunb. Flats and hill slopes, locally common; 6–11. From Signal Hill to Kamp's Bay; Retreat; Muizenberg; Steenberg; Simon's Town.

17. **M. pauciflora** DC. Rare; 6. Orange Kloof, at 1,200 feet. *Schlechter !*

18. **M. striata** DC. Flats, rare; 5–8. Doornhoogde; near Retreat; near Meyerhof.

Mundia spinosa DC. Sandy flats, very common; 5–10. Occasionally with white flowers.

FRANKENIACEÆ.

Frankenia lævis Linn. Shores and roadsides near sea, occasional; 10–11. Rapenburg Vley; Kalk Bay; Fort Knokke; Chapman's Bay.

2. **F. pulverulenta** Linn. Similar situations, but more local; 11. Green Point Common.

CARYOPHYLLACEÆ.

Dianthus incurvus Thunb. Flats and mountain slopes, frequent; 10–2. Reaches 1,500 feet.

? **Silene capensis** Otth. Though reported from the Peninsula, we think this wants confirmation. It is more distinct from **undulata** than the description shows. Its leaves are much narrower, the radical ones in a rosette, stems very erect, and inflorescence much more regularly cymose than that species. We have not found it.

1. **S. undulata** Ait. Shady rocky ground from sea-level to 1,500 feet, frequent; 9–10.

2. **S. ornata** Ait. "Sandy places near Doornhoogde," *Thunb.* Not seen by us.

3. †**S. gallica** Linn. Cultivated and waste ground, very common; 6–10. Reaches 2,500 feet on Devil's Peak. **S. quinquevulnera** Linn. occurs occasionally by roadsides.

4. **S. clandestina** Jacq. Sandy flats to mountains, frequent; 8–11. Though usually easily distinguished, some forms of this are superficially very like the next.

5. **S. Burchellii** Otth. Similar situations but more partial to mountains, frequent; 6–12. A very variable plant.

6. **S. crassifolia** Linn. Sandy places near sea, occasional; 9–1. From Muizenberg to Simon's Town; Slangkop; Chapman's Bay; Signal Hill. Probably **S. Thunbergiana** E. and Z., and **S. primuliflora** E. and Z., are only varietally distinct.

†**Lychnis dioica** Linn. Flats, rare; 8. *Schlechter!*

Cerastium Dregeanum Fenzl. Mountain slopes, local; 10–11. Above Tokay plantation; west slopes of Orange Kloof.

2. **C. capense** Sond. Flats to mountains, very common; 8–12.

3. †**C. glomeratum** Thuill. A single plant above Groot Schuur; 8. This is not synonymous with **C. viscosum** Linn., stated by Sonder to occur round Table Mountain (Fl. Cap. I. 131), and of which we have seen no specimens.

†**Stellaria media** Vill. Shady places on flats and hills, common; 5–12. Reaches 3,000 feet on Twelve Apostles, but very rarely seen above 600 feet.

†**Sagina ciliata** Fr. Roadsides and gravelly places, rare; 9–10. The Castle; Rondebosch Station; Kirstenbosch; Maitland; Ranger's Cottage.

†**Spergula arvensis** Linn. An abundant weed of cultivation; 7–10.

†**Spergularia rubra** Pers. Grassy and gravelly places near sea, frequent; 7–10.

2. †**S. media** Pers. (**S. marginata** DC.). Sea-shores and flats, common; 9–3.

†**Polycarpon tetraphyllum** Linn. f. A weed of cultivation and waste ground, common; 9–1.

†PORTULACEÆ.

†**Portulaca oleracea** Linn. A weed of cultivation, rare; 8–10. Rondebosch; near Kenilworth racecourse; Kalk Bay.

ELATINACEÆ.

Bergia glomerata Linn. f. Flats near Rondebosch; rare; flowers not seen.

MALVACEÆ.

†**Lavatera arborea** Linn. Waste places, rare; 9–11. Muizenberg; Kalk Bay; Sea Point; Maitland.

†**Malva parviflora** Linn. Cultivation and waste places, very common; 8–11.

2. †**M. verticillata** Linn. With the last, but much less common?; 9.

Malvastrum capense Gray and Harv. Hill and mountain slopes to 1,800 feet, frequent; 7–9.

? **M. calycinum** Gray and Harv. This has been confounded with **M. capense.** We have not been able to find an authentic record for the Peninsula, but admit it with doubt, since it is said to occur.

2. **M. albens** Harv. Flats, rare; 10. Beyond Rondebosch.

Hibiscus diversifolius Jacq. Very rare, only one locality known; 5. By Orange Kloof swamp.

2. **H. æthiopicus** Linn. Low hills, frequent; 12–3, but flowers occasionally throughout the year.

3. **H. Trionum** Linn. Grassy places and orchards, common; 12–3. The leaves vary greatly.

STERCULIACEÆ.

Hermannia althæifolia Linn. Hill slopes, frequent; 8–10.

2. **H. decumbens** Willd. Sandy flats, occasional; 8–9. Camp Ground; Uitvlugt; Maitland.

3. **H. procumbens** Cav. Sandy flats, rare; 8–10. Paarden Island and its vicinity.

4. **H. cuneifolia** Jacq. Low hill slopes, common; 8–10. A very variable plant, which sometimes runs very near, if it does not, as we suspect, hybridise with **H. decumbens** and **H. alnifolia.**

5. **H. alnifolia** Linn. Hill slopes, occasional; 8–10. West slopes Lion's Head; Kasteel Poort; Roodebloem; Farmer Peck's Valley; Miller's Point; Chapman's and Hout Bays.

6. **H. salvifolia** Linn. Hill slopes, rare; 9. Between Miller's Point and Smitswinkel Bay, *Wolley-Dod*, No. 3031. This is the var. **ovalis** Harv.

7. **H. scoparia** Harv. Among shrubs on flats, rare; 11. Vygeskraal River between Uitvlugt and Camp Ground.

8. **H. flammea** Jacq.? "Simon's Town," *Wright*. "Muizenberg and Simon's Bay," *Harvey*. We have not seen Harvey's specimens, but Wright's are almost certainly the next species.

9. **H. rudis** N. E. Brown. Stony slopes, locally frequent; 7–9. From Fish Hoek southward.

10. **H. hyssopifolia** Linn. Hill and mountain slopes, common, occasionally on the flats; 8–11.

11. **H. ternifolia** Presl. Hill slopes, very local; 9. Lower slopes Paulsberg, frequent, *Wolley-Dod*, 2873.

12. **H. lavandulifolia** Linn. "Flats near Salt River," *Eckl.* and *Zeyh.* Not found by us.

13. **H. verticillata** K. Schum. Sandy flats, very local; 9–11. Simon's Bay; abundant at Chapman's Bay.

14. **H. diffusa** K. Schum. Sandy and gravelly places; rather frequent; 8–11. Camp Ground; Chapman's Bay; Sea Point, abundant, &c.

15. **H. vesicaria** Cav. Hill slopes, rare; 8–9. Lion's Head; Signal Hill; near Blockhouse on Devil's Peak.

16. **H.** sp. (**Mahernia scabra** E. and Z.). Sandy flats, very rare; 8–9. Near Muizenberg Vley.

TILIACEÆ.

Grewia occidentalis Linn. Sheltered spots on hills and mountains, occasional; 6–11. East slopes of Devil's Peak; near Constantia; several places in Orange Kloof.

LINACEÆ.

Linum africanum Linn. Plains and hill slopes, frequent; 6–12.

2. **L. thesioides** Linn. Stony and sandy places, rare? 12–2. "Foot of Lion's Mountain, Wynberg," *Eckl.* and *Zeyh.* Not found by us, but likely to be passed by as a small state of **L. africanum.**

3. **L. Thunbergii** E. and Z. Plains and hill slopes, frequent; 6–12. Over 2,000 feet on Constantiaberg.

4. **L. quadrifolium** Linn. Bushy mountain slopes, rare; 9–11. East slopes Devil's Peak; slopes beyond Kirstenbosch.

ZYGOPHYLLACEÆ.

†**Tribulus terrestris** Linn. Waste gravelly places, locally frequent; 11–4. From the Castle to Woodstock; Rondebosch station; by Wynberg Garrison Church.

Zygophyllum spinosum Linn. Sandy flats and hills, frequent; 6–9.

2. **Z. sessilifolium** Linn. Sandy and gravelly hill slopes, frequent; 6–9.

3. **Z. fulvum** Linn. Sandy flats and hills, rather rare or local; 9–11; Paulsberg; Chapman's Bay; Battery Point, Hout Bay; near Muizenberg Vley (with decidedly rough-edged leaves).

4. **Z. flexuosum** E. and Z. Sandy and gravelly places, rare; 7–11. Between Retreat and Muizenberg Vleys (var. α); "at Constantia and about Cape Town, var. β," *Eckl.* and *Zeyh.*

5. **Z. Morgsana** Linn. Sandhills by sea, locally common; 7–11. Beyond Sea Point; Paarden Island; ? Fish Hoek.

6. **Z. debile** Cham. and Schl. Rare; 6. "Green Point," *Zeyher;* "near Cape Town," *Krauss.* Not found by us.

7. **Z. incrustatum** E. Mey. Sea-shores, rare; 6. "Hout Bay," *Schlechter !* 996.

8. **Z. Lichtensteinianum** Cham. and Schl. Rare; 5. "Kamp's Bay," *Krauss.* Not seen by us.

9. **Z. fœtidum** Schrad. and Wendl. Rare; 8. "Near Cape Town," *Krauss.* Not seen by us.

GERANIACEÆ.

Monsonia ovata Cav. Rough hill slopes, very local; 4–8. Foot of eastern slopes of Devil's Peak.

Geranium incanum Linn. Flats and hill slopes, common; 8–11.

2. **G. ornithopodum** E. and Z. Damp places near the sea, rare; 9. Hout Bay; Smitswinkel Bay.

3. †**G. dissectum** Linn. Fields and roadsides near houses, frequent; 10–12.

†**Erodium malachoides** Willd. Sandy places near sea, occasional; 9–11. Slangkop; St. James's; Chapman's Bay; beyond Sea Point; "near Green Point," *Harvey.*

2. †**E. moschatum** Willd. Cultivated and waste places, very common; 6–10.

? †**E. cicutarium** L'Hérit. Has been reported, probably in error. We have not seen specimens.

Pelargonium longifolium Jacq. Flats and dry hill slopes, frequent; 11–12. Every gradation of leaf, from entire to inciso-bipinnatifid, or both on the same plant, may be found at the foot of the slopes towards Sea Point. **P. ciliatum** Jacq. was gathered in Orange Kloof, *Wolley-Dod*, 2221.

2. **P. Meyeri** Harv. Rare; 3. "Near Constantia," *Eckl.* and *Zeyh.;* Kenilworth Flats, *Schlechter !*

3. **P. angustifolium** Thunb. "Gravelly places, Steenberg, between 500 and 1,000 feet, December," *Eckl.* and *Zeyh.* Unknown to us.

4. **P. barbatum** Jacq. This species has been so confounded with the next that we cannot say much of it. It has been gathered on Table Mountain by Ecklon.

5. **P. Leeanum** Sweet. Flats and low hill slopes, frequent; 10–11.

6. **P. hirsutum** Ait. Dry rough hills, locally frequent; 11. Near Sea Point (var. **melananthum** Harv.).

7. **P. astragalifolium** Pers. "About Cape Town and Wynberg," *Harvey.* We have not been able to distinguish this from the next species. A small plant with broad petals of a deep rose colour,

matches **Geranium astragalifolium** Cav., but is not Persoon's species. It was gathered at Kalk Bay, *Wolley-Dod*, 2160; Muizenberg, *Bolus*, 3063; also by *Pappe* on Table Mountain.

8. **P. pinnatum** Linn.? Hill and mountain slopes, frequent? 11–12. See note to last species. One or other, or some allied undescribed species is frequent.

9. **P. rapaceum** Jacq. Shrubby places, occasional; 12. About Rosebank and Rondebosch; "Table Mountain," *Ecklon*.

10. **P. dipetalum** L'Hérit? Dry sandy places, locally common; 12. Muizenberg; Herzog, near Retreat. It is probable that this is not L'Héritier's plant (Geraniologia, t. 43), and it may be a new species.

11. **P. lobatum** Willd. Rough hill slopes among bushes, locally frequent; 9–10. West slopes Signal Hill to Kamp's Bay.

12. **P. flavum** Ait. Judging by specimens at Kew, this species seems inseparable from **triste**. The decurrence, breadth, and degree of dissection of the leaf segments appear most variable. "Cape District," *Zeyher*.

13. **P. triste** Ait. Sandy and gravelly flats and low hills, frequent; 9–1.

14. **P. gibbosum** Willd. Rocks and slopes near sea, rather frequent; 12–4. Slangkop; Chapman's Bay; beyond Sea Point; Paarden Island; Kalk Bay; Smitswinkel Bay.

15. **P. hirtum** Jacq. Rocks and bushy hill slopes, locally common; 8–9. West slopes Signal Hill and Lion's Head up to 1,500 feet.

16. **P. myrrhifolium** Ait. Flats and mountains up to 1,500 feet, common; 7–2. Some of the varieties are very distinct, and on the Peninsula, at least, they do not run into one another. Var **betonicum** Harv. seems to be the commonest variety; var. **Synnoti** Harv. is plentiful beyond Miller's Point, and is the only one we have seen there.

17. **P. candicans** Spreng. Dry gravelly hill slopes, rare; 12–2. Castle Rock; near the Silver trees on Devil's Peak.

18. **P. senecioides** L'Hérit. Sandy flats, rare; 6–11. Fish Hoek; Chapman's Bay; between Groot and Klein Slangkop.

19. **P. grossularioides** Ait. Damp places, frequent; 5, 9–12. Most variable. The var. **anceps** Harv. inhabits the wettest places; var. **iocastum** Harv. is found at Groot Schuur and elsewhere on Devil's Peak.

20. **P. chamædryfolium** Jacq. Dry sandy places up to 1,500 feet. Rather less frequent than the last species, though more abundant locally; 9–1.

21. **P. saniculifolium** Willd. Mountain rocks, frequent; 7–12. It can hardly be called a "bush" as in Fl. Cap. I. 295.

22. **P. alchemilloides** Willd. Pine woods and dry shady places, rather frequent; 9–10.

23. **P. tabulare** L'Hérit. Similar situations, frequent; 7–11. Reaches 1,500 feet. We think Harvey's statement that it is "very like **P. alchemilloides**" is misleading.

24. **P. heterogamum** L'Hérit. Mountain slopes, locally frequent; 12–3. Near the Saddle, Devil's Peak, also north slopes; by the tunnel, Orange Kloof.

25. **P. zonale** Willd. "Simon's Bay," *Wright.* We have not gathered this.

26. **P. betulinum** Ait. Sandy or gravelly bushy ground, common; 9–10. Varies much in colour of flowers.

27. **P. cucullatum** Ait. Hill and mountain slopes, very common; 10–2.

28. **P. angulosum** Ait. Similar situations but less common; 9–2.

29. **P. capitatum** Ait. Flats and hill slopes, very common; 1–12.

30. **P. vitifolium** Ait. With difficulty distinguished from last, but perhaps frequent; 10–12. Wynberg Hill?; by waterfall, Devil's Peak; near Claremont station.

Oxalis monophylla Linn. Flats and low hill slopes, rather rare; 4–5. About Roodebloem; Camp Ground; Lion's Head.

2. **O. glabra** Thunb. Flats and low hills, partial to damp, very common; 4–8. A very variable plant, the usual form being var. **minor** Sond. or possibly var. **acuminata** Sond; var. **pusilla** is common on the Camp Ground and Sea Point Common.

3. **O. versicolor** Linn. Flats and hills, about the commonest species; 5–8. The peduncles are often glandular, and not always terminal.

4. **O. polyphylla** Jacq. Hill and mountain slopes, frequent; 3–6. We think **O. pentaphylla** Sims should be combined with this species as a five-leaved variety. There appears to be no other difference, except that **O. pentaphylla** usually flowers rather earlier and at higher altitudes.

5. **O. falcata** Sond. Sandy or gravelly flats and hills, frequent; 5–7. Liable to be mistaken for **versicolor,** the corolla being usually white with a pink edge, but seldom so deep red as in **versicolor.** Its inflorescence is sometimes axillary.

6. **O. tenuifolia** Jacq. Sandy flats, partial to damp, occasional; 6–7. About Roodebloem, Newlands, and Observatory; Kenilworth racecourse.

7. **O. minuta** Thunb. Grassy flats, rare; 6–7. Camp Ground to Kenilworth racecourse.

8. **O. multicaulis** E. and Z. Hill slopes, locally abundant; 5–6. East slopes of Devil's Peak.

9. **O. purpurea** Thunb. Flats and slopes to 1,000 feet, very common; 4–8.

10. **O. denticulata** Wolley-Dod. Marshy ground, frequent; 5–8.

11. **O. variabilis** Lindl. Flats and slopes to 1,000 feet, very common; 4–8. Flowers usually white or deep rose, rarely pink. This species has been unaccountably much confounded with **O. purpurea,** from which it differs constantly in its much more conical corolla tube, and the absence of translucent dots under the leaves, their place being taken (at least in most examples) by short black lines.

12. **O. convexula** Jacq. Flats to mountains, common; 3–8. One of the earliest to flower, and reaching the highest elevation (summit of Devil's Peak). We include **O. commutata** Sond. under this species, his type specimens are almost certainly not distinct, and Jacquin's name has priority. We have never seen specimens with the cellular face of the leaf uppermost, and think this supposed character due to an error in observation.

13. **O. punctata** Linn. Bushy flats and hill slopes up to 1,500 feet, frequent; 4–6.

14. **O. balsamifera** E. Mey. Sandy flats, rare; 6–7. North-west of Maitland. This species comes very near **O. luteola,** which has an equally sticky, but a smaller much narrower corm, its flowers also are brighter clearer yellow, on longer peduncles, and its calyx segments more obtuse.

15. **O. luteola** Jacq. Dry sandy places on flats, one of the commonest species; 5–8. A large-flowered form, probably var. **marginata** Sond., must not be confounded with the next species.

16. **O. Eckloniana** Presl. Sandy and gravelly flats, rare; 5–7. Green Point Common.

17. **O. obtusa** Jacq. Flats and hill slopes to 1,500 feet, common; 7–10. One of the latest to appear. Flowers very variable in colour, brick-red, salmon-pink, pale yellow, or nearly white.

18. **O. lanata** Linn. f. Clay soil on hill slopes, not seen on flats, common; 5–9. A pink-flowered form exists and is common behind Wynberg Camp.

19. **O. natans** Linn. f. Vleys and pools on flats, frequent; 8–11.

20. **O. incarnata** Linn. Woods and shady places, rather locally common; 8–12. East slopes Devil's Peak and Table Mountain up to 1,500 feet. Though usually the latest to flower, it has been found in April.

21. **O. bifida** Thunb. Hill and mountain slopes, especially in open woods, frequent; 3–7. Reaches 2,000 feet.

22. **O. hirta** Linn. Flats and hill slopes, common; 5–8. Occasionally with double flowers.

23. **O. brevicaulis** Sond. Gravelly lower slopes, locally frequent; 5–7. Green Point Common; north and west slopes Signal Hill and Lion's Head; Kamp's Bay; Twelve Apostles.

[**O. pentaphylla** Sims. See remarks under **O. polyphylla** Jacq.]

24. **O. tomentosa** Linn. Gravelly flats and hills, locally plentiful; 4–6. Signal Hill; Green Point Common; north slopes of Devil's Peak; Observatory and Camp Ground.

25. **O. flava** Linn. Sandy and gravelly flats, rare; 5–6. Rapenburg Vley; the Castle; Signal Hill; Green Point Common. Its nature is much less social than is usual in the genus.

26. **O. lupinifolia** Jacq. Rare; 5. "Hout Bay," *Schlechter*, 783!

27. **O. sericea** Linn. f. Gravelly and grassy lower slopes, rather frequent; 5–9. Plentiful about Groot Schuur and behind Mowbray cemetery, more rare elsewhere.

28. **O. compressa** Thunb. Gravelly and grassy places, locally common; 6–9. About Woodstock and Observatory; Green Point Common; Simon's Town.

29. **O. cernua** Thunb. Roadsides and grassy places, the commonest species; 5–10. Occasionally with double flowers.

30. **O. caprina** Linn. Shady and grassy flats or lower slopes, frequent; 3–5. Past flowering before most other species commence.

31. **O. livida** Jacq. Gravelly hill slopes, rather frequent; 3–5.

32. **O. corniculata** Linn. An abundant weed in gardens and by roadsides; 1–12. We think native.

RUTACEÆ.

Macrostylis villosa Sond. Flats and mountain slopes, frequent; 2–5. Reaches 2,800 feet on the Twelve Apostles. Var. **glabrata** Sond. is less common.

Diosma succulenta Berg. Flats and mountains, frequent; 11–7.

2. **D. cupressina** Linn. Flats, rare within our limits, more frequent beyond; 12–1. Doornhoogde.

3. **D. vulgaris** Schlecht. Flats to mountains, very common; 1–12. Reaches at least 2,500 feet.

? **D. virgata** G. F. W. Mey. "Stinkwater Ravine," *Rehmann*, 1339. Requires confirmation.

Coleonema album B. and W. Sea-shores to mountain-tops, preferring rocks, frequent; 1–12.

Adenandra obtusata Sond. "West side of Table Mountain, 10;" *Eckl.* and *Zeyh.* Not seen by us.

2. **A. viscida** E. and Z. "Near Hout Bay," 8–9; *Eckl.* and *Zeyh.* Not seen by us.

3. **A. cuspidata** Mey. Hill and mountain slopes, rather frequent; 7–11.

4. **A. umbellata** Willd. Hill and mountain slopes, rather frequent; 7–11. Reaches 3,500 feet.

5. **A. amœna** B. and W. "Foot of Devil's Mountain, 10," *Drège.* Not found by us.

6. **A. ciliata** Sond. "Muizenberg, 5," *von Ludwig*. We have not found it.

7. **A. uniflora** Willd. Flats to mountain slopes, common; 7–12. The commonest species, known from **A. umbellata** and **A. cuspidata** by the leaves being narrower in proportion to their length and more acute than in those species. Var. **pubescens** Sond. has been gathered at Smitswinkel Bay, *Wolley-Dod*, 1305.

? **A. biseriata** Meyer. It is not clear that Sonder's station, on the Cape Flats (Fl. Cap. I. 389) is within our limits, so its admission into our list is queried.

8. **A. coriacea** Licht. "Kasteelberg summit, October," *Eckl.* in Herb. Kew. Not found by us.

9. **A. brachyphylla** Schlecht. Hill slopes, rather locally frequent; 9–12. From Steenberg southwards, but not found to the north of it.

Barosma crenulata Hook. "Fissures of Table Mountain, October," *Thunberg*, &c. Not seen by us.

2. **B. pulchella** B. and W. "Table Mountain, November," *Eckl.* and *Zeyh.* Not seen by us.

Agathosma tabularis Sond. "Top of Table Mountain, November," *Eckl.* Not seen by us.

2. **A. hirta** B. and W. "Table Mountain at 2,000 feet, May," *Krauss*. Not seen by us.

3. **A. Hookeri** Sond. Dry sandy ground, rare; 9–11. Red Hill, &c. Patrys Vley.

4. **A. umbellata** Sond. "Near Simon's Town," *Wright* in Herb. Kew. Not found by us.

? **A. gracilicaulis** Sond. "Near Simon's Town," *Wright* in Herb. Kew. An incomplete specimen, named with doubt and never gathered by us, so requiring confirmation.

? **A. lycopodioides** B. and W. Authority doubtful, not seen by us.

5. **A. imbricata** Willd. Hills and mountains, frequent; 11–1.

6. **A. rugosa** Link. Hills and mountains, common; 4–9. The rugosity of the leaves is not apparent until they are dry.

7. **A. Wrightii** MacOwan. Mountain slopes, apparently local; 6–11. Near Simon's Town. We think this is perhaps only a form of **A. rugosa.**

8. **A. cerifolium** B. and W. Mountain slopes, rare; 3. Muizenberg, at 1,200 feet, *Bolus*, 4647.

9. **A. ciliata** Link. Mountain slopes, common; 3–9.

10. **A. ambigua** Sond. "Mountain sides, Lion's and Table Mountains, October, November," *Eckl.* and *Zeyh.* Not seen by us.

11. **A. Ventenatiana** B. and W. Flats and hills, rare or mistaken for next; 7–9. Little Lion's Head, over Hout Bay; Fish Hoek.

12. **A. villosa** Willd. Flats, locally frequent; 8–9. Beyond Uitvlugt, becoming more frequent beyond our limits. We have never found it "on the mountains round Cape Town" (Fl. Cap. I. 427).

13. **A. stricta** Wolley-Dod. Mountains, rare; 11. Constantiaberg, *Wolley-Dod*, 1935.

14. **A. erecta**, B. and W. Dry hills, apparently rare; 9–10. Klein Slangkop; hills west of Simon's Town; west slopes Lion's Head. Not easy to distinguish, when growing, from **A. glabrata**.

15. **A. glabrata** B. and W. Flats and hill plateaux, frequent; 10–11. Most common on hills west of Simon's Town and about Doornhoogde. **A. Gillivrayi** Sond. should be reduced to this species, we think.

AQUIFOLIACEÆ.

Ilex capensis Sond. and Harv. Kloofs at moderate elevations occasional; 12. Orange Kloof; shore beyond Kamp's Bay.

CELASTRACEÆ.

Gymnosporia acuminata Szysz. Kloofs and rocky places on hills and mountains, occasional; 6–10. Devil's Peak; Skeleton ravine; Orange Kloof.

2. **G. lucida** Loes. "Sides of Table Mountain," *Masson.* "Kamp's Bay," *Pappe.* Not found by us.

3. **G. buxifolia** Szysz. Bushy and rocky places on mountains, occasional; 11. East slopes Devil's Peak; Table Mountain.

4. **G. rhombifolia** (E. and Z. sub **Celastro**). "Devil's Peak, January," *Eckl.* and *Zeyh.* Not found by us, but it appears to be a mere variety of the preceding.

5. **G. maritima** Loes. Sea-shores, local; 8. Between Muizenberg and Fish Hoek.

6. **G. laurina** (Thunb. sub **Celastro**). Sea-shores and low hills. rather common; 1–6.

7. **G. Schlechteri** Loes. Mountains, rare; 1. Not seen by us.

8. **G. angustifolia** (Sond. sub **Scytophyllo**). "Mountains near Cape Town," *Eckl.* Not found by us.

Putterlickia pyracantha Loes. Near the sea, locally common, 1–2; Lion's Head; Kamp's Bay; Paarden Island; Miller's Point.

Pterocelastrus tricuspidatus Sond. Rocky hills, frequent; 9. In foliage most like **Gymnosporia laurina**.

2. **Pt. rostratus** Walp. "Ravines, east side of Table Mountain; 1–2," *Pappe.* Not found by us.

Cassine capensis Linn. Kloofs and stream sides at low elevation, occasional; 6. About Constantia Nek and Orange Kloof.

2. **C. barbara** Linn. Rocky places on hills, rare? ; 4. Hills near Simon's Town.

Maurocenia frangularia Mill. Rocks by the sea and on hills up to about 800 feet, rather common; 1–4.

2. **M. Schinziana** Loes. "Near Hout Bay, June." *Schlechter !*

Lauridia reticulata E. and Z. "Stinkwater, near Cape Town," *Rehmann.* Not found by us.

RHAMNACEÆ.

Scutia capensis Don. Mountain slopes, rare ?. Ravine above Kirstenbosch, *Bolus*, 4990.

Phylica stipularis Linn. Flats and hilltops, frequent; 5–7.

2. **P. buxifolia** Linn. At the foot of rocks on hills and mountains, frequent; 4–8.

3. **P. plumosa** Thunb. Hill slopes and flats, frequent; 6–8. Var. **Thunbergiana** is the usual, if not the only form on the Peninsula.

4. **P. reflexa** Lam. Mountain summits, rare; 10–1. Klaasjagersberg; Chapman's Peak; Constantiaberg; Twelve Apostles.

5. **P. Dodii** N. E. Br. Hill slopes, rare; 9. Lower slopes of Paulsberg, *Wolley-Dod*, 2872.

6. **P. capitata** Thunb. Hill slopes, common; 6–8.

7. **P. spicata** Linn. f. Flats, rather rare; 2. Claremont; near Simon's Bay.

8. **P. cuspidata** E. and Z. Flats, occasional; 9–3. Beyond Uitvlugt; Doornhoogde; Claremont.

9. **P. callosa** Thunb. Mountains, rare; 9–3. "Devil's Mountain," *Thunberg.* Not seen by us.

10. **P. acmæphylla** E. and Z. Mountains, rare; 11. "Mountains near Cape Town," *Schlechter.* Not found by us.

11. **P. bicolor** Linn. Hills and mountain slopes, rather frequent; 3–8. Reaches 3,000 feet on the Twelve Apostles.

12. **P. strigulosa** Sond. Flats and hill slopes, apparently rare, 1–3 ? "Near Cape Town," *Thunberg;* foot of Devil's Peak, near Rondebosch, *Bolus*, 4494 ?

13. **P. ericoides** Linn. Flats, rather rare? 5–6. By Retreat Vley; Smitswinkel Bay; "Kamp's Bay," *Eckl.*

14. **P. parviflora**, Linn. Flats, frequent; 3–6.

15. **P. selaginoides** Sond. "Muizenberg, January," *Penther.* Not found by us.

16. **P. eriophoros** Berg. Flats and mountains, frequent or common; 2–6.

Noltea africana Reichb. Lower mountain slopes, occasional; 10. Table Mountain; near Hout Bay.

AMPELIDACEÆ.

Vitis capensis Thunb. Kloofs and woods, very local. Below waterfall, Devil's Peak. Flowers not seen.

SAPINDACEÆ.

Melianthus major Linn. Hill slopes, occasional; 8–10. About Constantia; Miller's Point; Orange Kloof; Devil's Peak.

ANACARDIACEÆ.

Rhus rosmarinifolia Vahl. Hill and mountain slopes, common; 5–6. Reaches 1,800 feet on Vlaggeberg.

2. **R. stenophylla** E. and Z. Mountain slopes, rare or local?; 6–8. "East slopes Table Mountain," *Eckl.* and *Zeyh.* Devil's Peak (a glabrous form); locally frequent by path near Smitswinkel Bay.

3. **R. angustifolia** Linn. Hill slopes, occasional; 10–11. Chiefly on lower eastern slopes of Devil's Peak.

4. **R. tomentosa** Linn. Flats and hills, common, 6–12; var. **petiolaris** Sond., top of Red Hill.

5. **R. villosa** Linn f. Flats, rather frequent; 11.

6. **R. pyroides** Burch. "Hout Bay; near Cape Town," *Rehmann.* Not found by us, but seems very near the last.

7. **R. mucronata** Thunb. Mountain slopes, occasional; 12–1. Muizenberg; "Table Mountain," *Eckl.*; "Simon's Bay," *Mac-Gillivray;* "Lion's Back," *Eckl.*

? **R. Dregeana** Sond. "Stinkwater, Table Mountain; Devil's Peak," *Rehmann.* Not seen by us, and requires confirmation.

8. **R. glauca** Desf. Flats and hills, frequent or common; 6–9.

9. **R. lucida** Linn. Flats and hills, frequent; 7–10.

? **R. scytophylla** E. and Z. Reported to have been found in fruit, in October, but we have never been able to trace the authority.

10. **R. undulata** Jacq. "Constantia," *Eckl.* and *Zeyh.* We have not collected it.

11. **R.** n. sp. Hills near Fish Hoek, *Bolus*, 4912. Apparently very distinct, but found without flowers or fruit.

LEGUMINOSÆ.

Cyclopia latifolia DC. Mountains, rare; 10–11. Table Mountain; Constantiaberg.

2. **C. genistoides** R. Br. Bushy hills and mountain slopes, frequent; 7–11.

3. **C. galioides** DC. Similar situations, but less frequent; 2–5 (–9?). Hills west of Simon's Town; Klaasjagersberg; Paulsberg; Orange Kloof; Disa Gorge.

Podalyria calyptrata Willd. Kloofs and hill slopes, common; 7–9.

2. **P. argentea** Salisb. Hill slopes, rather frequent; 10–11. Devil's Peak; Wynberg Ranges. A white-flowered form may occasionally be found.

3. **P. biflora** Lam. Hill slopes, occasional; 9–12. Near Smitswinkel Bay; near Constantia Nek; Wynberg Park.

4. **P. cuneifolia** Vent. Flats and hill slopes, occasional; 8–9. Between Fish Hoek and Simon's Town; Devil's Peak; Alphen and Constantia; towards Doornhoogde.

5. **P. sericea** R. Br. Roadsides and low bushy places, frequent; 5–6.

Liparia sphærica Linn. Hill and mountain slopes, occasional; 7–11. Newlands; Wynberg ascent; Constantiaberg; Kalk Bay. A very conspicuous plant, so appearing more frequent than it really is.

2. **L. parva** Vogel. Rough hill slopes, locally occasional; 1–5 (flowers all the year). Several places south of Simon's Town and Klaver Vley.

Priestleya angustifolia E. and Z. "Cape Town range," *Harvey*. Not found by us.

2. **P. teres** DC. "Table Mountain, January," *Burchell*. Not found by us.

3. **P. capitata** DC. "Summit of Table Mountain," *Thunberg*. Not found by us.

4. **P. umbellifera** E. and Z. "East side of Table Mountain," *Eckl.* and *Zeyh.* Not found by us.

5. **P. villosa** DC. Mountain slopes, occasional; 3–9. Lower Plateau; Orange Kloof; east slopes Devil's Peak, Table Mountain and Constantiaberg.

6. **P. sericea** E. Mey. Gravelly hill slopes, frequent; 6–11.

Amphithalea densa E. and Z. Mountain slopes, occasional; 12–5. Devil's Peak; Lion's Head; Skeleton ravine; Table Mountain; Orange Kloof; Klaver Vley; Chapman's Peak.

2. **A. ericifolia** E. and Z. Flats and hill slopes, very common; 7–12.

3. **A. virgata** E. and Z. "Devil's Peak, 1,000 feet, June," *Krauss*. Not found by us.

4. **A. speciosa** Schltr. Hill slopes, rare; 7. "Slopes about 100 feet above the sea, Kamp's Bay," *N. Pillans*, 345.

Walpersia burtonioides Harv. "Klassenbosch, February–April," *Zeyher*. Not seen nor recorded by any other collector.

Borbonia cordata Linn. Flats and hill slopes, common; 7–12.

2. **B. barbata** Lam. Hill slopes, occasional; 11. Above Tokay; "between Devil's Peak and Table Mountain," *MacOwan;* "above Simon's Town, frequent," *Milne;* "foot of Table Mountain," *Alexander.*

3. **B. lanceolata** Linn. Damp places on low ground, frequent; 12–3.

4. **B. parviflora** Lam. Hill and mountain slopes, frequent; 10–1.

5. **B. perforata** Thunb. "Kamp's Bay," *Harvey.* Not found by us.

Rafnia triflora Thunb. Shrubby hillsides, occasional; 9–1. Groot Schuur; Orange Kloof; Lion's Head; frequent Wynberg Hill.

2. **R. crassifolia** Harv. Rather damp, sandy ground, local and rather rare; 10–1. Klaver Vley; Smitswinkel and Patrys Vleys.

3. **R. angulata** Thunb. Flats and mountain slopes, common; 9–3. Var. **angustifolia** is as common as the type.

4. **R. humilis** E. and Z. Flats and lower slopes, rare; 11–12. Beyond Uitvlugt; "near Constantia," *Eckl.* and *Zeyh.;* "near Paradise," *Harvey.*

5. **R. opposita** Thunb. Flats and hill slopes, frequent; 9–4.

6. **R. affinis** Harv. Hill slopes, apparently rather rare; 9 (–3 ?). Orange Kloof; Simon's Town hills.

7. **R. cuneifolia** Thunb. Hill slopes, rare; 9–3. Kamp's Bay; hills near Simon's Town.

Euchlora serpens E. and Z. Gravelly or sandy flats, rare; 8–9. Near Maitland.

Lotononis prostrata Benth. Gravelly and sandy hill slopes, occasional; 7–9. Signal Hill; Observatory; Oude Molen.

2. **L. varia** Steud. "Near Cape Town," *Dr. Alexander Prior.* Not seen by us.

3. **L. umbellata** Benth. Hill slopes to a considerable elevation, occasional; 8–9. Kasteel Poort; King's Blockhouse; Hout Bay; Slangkop.

4. **L. involucrata** Benth. Similar situations, but frequent; 8–11.

5. **L. peduncularis** Benth. "Round Cape Town," *Thunberg.* Not found by us.

6. **L. angustifolia** Steud. Sandy flats and hills, rare; 12. Near Tokay; Steenberg at 800 feet.

7. **L. perplexa** E. and Z. Hill slopes, rare. "Lion's Rump," *Alexander!* "mountain sides round Cape Town, common," *Harvey.* We have not found this, and can hardly believe it is "common."

8. **L. oxyptera** Benth. Hill slopes, rare; 9. Signal Hill over Three Anchor Bay (a quinate-leaved variety).

Lebeckia Plukenetiana E. Mey. Flats and hill slopes, frequent; 7–1.

2. **L. Meyeriana** E. and Z. Similar situations, occasional; 7–1. Kalk Bay hills; east slopes Table Mountain, 1,000 feet; "Kamp's Bay," *Pappe;* "near Constantia," *E.* and *Z.;* "near Simon's Bay," *MacGillivray.*

3. **L. Candolleana** Walp. Similar situations, common; 10–2.

4. **L. Simsiana** E. and Z. Sandy or gravelly flats, rare; 9–11. Fish Hoek Valley (always quite prostrate).

5. **L. sepiaria** Thunb. Hill slopes, rare; 9. Kamp's Bay; "west side of Lion's Mountain," *Thunberg.*

6. **L. inflata** Bolus. Bushy hill slopes, rare; 11. Near the waterfall, Devil's Peak, 1,000 feet, *Bolus,* 4826.

7. **L. Wrightii** Bolus (**Lotononis Wrightii** Harvey). Grassy mountain slopes, rare; 11. Above Kirstenbosch, at 1,200 feet, *Bolus,* 4671; "mountains near Simon's Town," *Wright.*

Viborgia obcordata Thunb. Sandy flats or roadsides, occasional; 8–12. Fish Hoek; Klein Slangkop; Hout Bay; Rapenburg Vley; Twelve Apostles; Muizenberg.

Aspalathus psoraleoides Benth. Mountains, rare; 11. Muizenberg at 1,500 feet, *Bolus,* 4621.

2. **A. anthylloides** Linn. Mountain slopes, rather rare; 10–11. Constantiaberg; hills west of Simon's Town; Muizenberg; "top of Table Mountain," *Hesse.*

3. **A. argyrella** MacOwan. Sandy plateaux, very local; 9–10. Red Hill; Slangkop. L. Wright's specimen of "**A. villosa** Thunb." from Simon's Bay hills (Fl. Cap. II. 106) is this species, which is quite distinct from Thunberg's plant.

4. **A. virgata** Thunb. "Tokay," *Eckl.* in Herb. Kew. Not found by us.

5. **A. jacobæa** E. Mey. "Cape Flats and hills round Cape Town," *Harvey.* Not found by us.

6. **A. elongata** E. and Z. Sandy ground, rare; 11. "Rapenburg," *F. Guthrie!*

7. **A. lotoides** Thunb. Low hill slopes, rather rare; 7–10. Between Constantia Nek and Hout Bay; Kamp's Bay.

8. **A. heterophylla** E. Mey. Flats and hill slopes, frequent; 11–1.

9. **A. tridentata** Linn. Flats and hill slopes, frequent; 10–1. Not seen by us north of Constantiaberg, but Dr. Pappe records it from "under Table Mountain."

10. **A. argentea** Linn. Sandy ground, rare; 12. "Rapenburg," *F. Guthrie!*

11. **A. chenopoda** Linn. Mountain slopes at moderate elevations, frequent; 8–12.

12. **A. araneosa** Linn. Low hill slopes, occasional; 10–11. Near Constantia; Wynberg Hill.

13. **A. ciliaris** Linn. Flats, rare; 12–1. Near Wynberg; "Rapenburg," *F. Guthrie!*; "northern slopes Table Mountain," *Ecklon.*

14. **A. Benthamii** Harv. Hill and mountain slopes, occasional; 12–1. Simonsberg; Vlaggeberg; Muizenberg; Devil's Peak.

15. **A. incurva** Thunb. Flats and hill slopes, occasional; 11–1. Above Fish Hoek; near Alphen; abundant at Kenilworth; "summit of Table Mountain and about Simon's Bay hills," *Milne.*

16. **A. uniflora** Linn. Hill and mountain slopes, rather frequent; 11–3.

17. **A. nigra** Linn. Flats, very local; 11–12. Between Retreat Vley and Muizenberg (var. **involucrata**, Pappe).

18. **A. Forbesii** Harv. Flats very local; 11–12. Between Retreat Vley and Muizenberg.

19. **A. spicata** Thunb. Flats and hill slopes, frequent; 10–12.

20. **A. ericifolia** Linn. Flats and hill slopes, rather common; 9–11.

21. **A. thymifolia** Linn. Flats, roadsides, and low hills, common; 11–1.

22. **A. rigescens** E. Mey. "Kamp's Bay, August," *Krauss.* Not found by us.

23. **A. laricifolia** Berg. Hills, rare; 10–11. Wynberg Hill, 300 feet, *Bolus*, 7983.

24. **A. canescens** Linn. Low hill slopes, rather rare; 10. Lion's Head; wood near Wynberg.

25. **A. Chamissonis** Vog. "Sides of Table Mountain, 1,000–2,000 feet, October," *Mund.* Not found by us.

26. **A. filicaulis** E. and Z. Flats and sandy plateaux, rare; 12–3. Klaver Vley; plentiful on Kenilworth racecourse.

27. **A. Willdenoviana** Benth. Hill slopes, rare; 9–10. Constantia Nek; "Hout Bay," *Alexander.*

28. **A. macrantha** Harv. Open woods on low hills, occasional; 10–11. Devil's Peak; Wynberg Hill; Orange Kloof.

29. **A. callosa** Linn. Flats and plateaux at low elevations, common; 11–1.

30. **A. variegata** E. and Z. Sandy flats, rare; 11. "Rapenburg," *F. Guthrie!*

31. **A. carnosa** Berg. Mountains, occasional; 11–1. Summit of Constantiaberg; Muizenberg, 1,200 feet; "Simon's Bay hills," *Thunberg.*

32. **A. Priori** Harv. "Table Mountain," *Dr. Alexander Prior.* Not found by us.

33. **A. humilis** Bolus. Mountain-tops, rare; 12. Summit of Table Mountain, *Bolus*, 3728.

34. **A. sarcodes** Vog. Hill slopes, locally frequent; 9–12. Klein Slangkop; Muizenberg; near Simon's Town; "Steenberg," *Thunberg*, &c.

35. **A. sarcantha** Vog. Hill slopes, locally frequent; 8–10. Slangkop; hills west and south-west of Simon's Town.

36. **A. capitata** Linn. Mountains at moderate elevations, rather rare; 2–3. Summit of Muizenberg, and of a kopje south of it; "Table Mountain," *Thunberg*, &c.

37. **A. arida** E. Mey. Flats and dry hillsides, occasional; 11–1. Steenberg; Smitswinkel Bay; Camp Ground; frequent near Maitland cemetery. Var. **grandiflora** Harv. looks very different from the type; we have found it on Red Hill and Klaasjagersberg.

38. **A. spinosa** Linn. Flats, roadsides, and low hills, rather common; 12–3.

39. **A. abietina** Thunb. Flats, rather rare; 10–11. Near Rosebank; Tokay; Fish Hoek; "Summit of Table Mountain," *Eckl.* and *Zeyh.*

40. **A. fornicata** Benth. Mountain plateaux, rare; 11. Klaver Vley; Muizenberg, 1,500 feet; "Table Mountain," *Mund*, &c.

41. **A. retroflexa** Linn. Flats and low plateaux, common; 9–1. Var. **bicolor** Harv. is common on the flats.

42. **A. galioides** Linn. Hill slopes, rather rare; 10–1. Devil's Peak; Simonsberg.

43. **A. astroites** Linn. Slopes to about 1,800 feet, rather common, and here and there abundant; 10–11.

44. **A. acuminata** Lam. Dry ground on flats and low hills, rather locally common; 9–1. About Rapenburg, &c.; Signal Hill.

45. **A. divaricata** Thunb. Flats to mountain slopes, rather common; 9–3.

46. **A. armata** Thunb. Sandy flats, rare; 10–11. Rapenburg; Fish Hoek.

47. **A. corymbosa** E. Mey. Hill and mountain slopes, frequent; 9–2.

48. **A. capillaris** Benth. Mountain slopes, rare; 12. Table Mountain northern slopes, 2,500 feet, *Bolus*, 3870; "Summit of Table Mountain," *Thunberg*, &c.

49. **A. bracteata** Thunb. Mountain slopes, rare; 2. King's Blockhouse, *Wolley-Dod*, 912; "Table Mountain," *Harvey*.

50. **A. suffruticosa** DC. Flats to mountain slopes, common; 1–3.

Melolobium cernuum E. and Z. Flats and hill slopes, rare; 8–10. Signal Hill and Lion's Head; foot of Muizenberg; Paarden Island; roadside Orange Kloof ?.

Crotalaria humilis E. and Z. Grassy flat and low hills, rather common; 8–10.

2. †**C. capensis** Jacq. Thickets and plantations, rather frequent; 8–10. Introduced as an ornamental plant from the Eastern district, but now naturalised.

Argyrolobium velutinum E. and Z. Sandy flats and hill slopes, rather rare; 9–12. Rapenburg; "Table Mountain," *Mund;* "Simon's Town," *E.* and *Z.*

2. **A. filiforme** E. and Z? "Hills round Cape Town," *Pappe;* "Doornhoogde," *Eckl.* and *Zeyh.* Not found by us, unless, as seems probable, it be identical with the next species.

3. **A. stenorrhizon** Oliv. Sandy flats, rather rare; 10–11. Klaver Vley; near Fish Hoek; near Rondebosch; and Doornhoogde. It is more frequent just beyond our limits at Vygeskraal Farm.

4. **A. lanceolatum** E. and Z. Flats and hill slopes, rather common; 9–12. Seen in Waai Vley (*Wolley-Dod,* 2245) and near the summit of Table Mountain, but very rarely so high.

†**Cytisus candicans** Lam. Roadsides, local; 11–12. Near Fernwood.

†**Medicago sativa** Linn. "Near Cape Town and Simon's Bay," *Eckl.* and *Zeyh.* Only seen by us in cultivation, but doubtless sometimes escaping.

2. †**M. denticulata** Willd. A weed of cultivation and grassy places, very common; 8–10. The very long-spined forms are probably **M. lappacea** DC., Kalk Bay; and the very short-spined, **M. apiculata** Willd., Signal Hill. A spineless-fruited plant from Rapenburg Vley and Green Point Common, probably belongs to the latter.

3. †**M. nigra** Willd.? "About Table Mountain," *Eckl.* and *Zeyh.* We have not identified this, but suspect it to be a variety of the preceding.

4. †**M. laciniata** All. Sandy flats and roadsides, chiefly near the sea, locally frequent; 9–10. Paarden Island; Chapman's Bay; Elsje Bay, &c.

†**Melilotus parviflora** Desf. Low hill slopes, especially near the sea, very common; 9–11.

2. †**M. messanensis** Desf. Grassy places, rare; 5. Muizenberg Vley.

Trifolium Burchellianum Ser. Damp grassy fields, locally frequent; 1. Muizenberg Vley; Rapenburg Vley; Vaarsche Vley.

2. †**T. tomentosum** Linn. Grassy places near the sea, common; 8–11.

3. †**T. angustifolium** Linn. Roadsides, railways, and low hill slopes, common; 9–12.

4. †**T. arvense** Linn. Fields and hedges, rare; 9–10. Groot Schuur; Camp Ground; Red Hill; about Simon's Town.

5. **T. stipulaceum** Thunb. Sandy flats, rare; 10. Paarden Island.

6. †**T. repens** Linn. Damp grassy places, rather rare; Vaarsche Vley; Black River; Claremont; Muizenberg Vley.

7. †**T. procumbens** Linn. Grassy fields and roadsides, very common; 9–11.

8. †**T. minus** Sm. (= **T. dubium** Sibth.). Similar situations, and equally common; 9–11. There is some confusion in the synonymy of **T. procumbens, T. minus,** and allied species. We have given the names usually accepted by British botanists.

9. †**T. suffocatum** Linn. Grassy places, rare; 10–11. By bridge on Camp Ground; by shore at Woodstock.

Psoralea pinnata Linn. Flats to mountain slopes, common; 10–1. Reaches Lower Plateau.

2. **P. aphylla** Linn. Flats to mountain slopes, partial to damp, frequent; 10–1. A very variable plant, dwarf specimens being liable to be mistaken for **P. restioides.**

3. **P. restioides** E. and Z. Marshy spots on hill and mountain plateaux, occasional; 9–2. Lower Plateau; Constantiaberg and Steenberg; Slangkop; Klaver Vley; Paulsberg.

4. **P. fascicularis** DC. Damp places, rare; 9–10. Between Orange Kloof farm and Constantia Nek.

5. **P. aculeata** Linn. Hill and mountain slopes to 2,500 feet, frequent; 10–11.

6. **P. repens** Linn. Sandy ground, frequent; 11–12.

7. **P. decumbens** Ait. Dry grassy and bushy flats and hill slopes, rather common; 9–11.

8. **P. capitata** Linn. f. Damp grassy places, rather frequent; 12–2. West of Lion's Head; Rapenburg Vley; towards Doornhoogde; Kenilworth, plentiful; Muizenberg Vley.

9. **P. hirta** Linn. Margins of plantations, rather rare; 11. Camp Ground; near Rosebank. "Lion's Mountain," *Harvey.*

10. **P. bracteata** Linn. Flats and hill slopes, frequent; 10–12.

11. **P. spicata** Linn. Similar places, but very local; 10–12. Wynberg Hill; near Bishop's Court.

Indigofera filifolia Thunb. By streams on hills or mountains, rather locally frequent; 9–4. From Orange Kloof to Kalk Bay.

2. **I. candicans** Ait. Rare? 10–11. We have only once gathered this, in the swamp by Orange Kloof farm. In the Fl. Cap. II. 172, it is recorded from "*dry* hills round Cape Town and Kamp's Bay," Harvey remarking that it appears to be a "variety of **I. psoraleoides** from *drier ground.*" Its habitat and rank as a species require further investigation

3. **I. psoraleoides** Linn. Dry sandy flats and hill slopes, occasional; 10–11. Roadside near Constantia; west slopes Lion's Head.

4. **I. gracilis** Spreng. Dry hill slopes, occasional; 7–11. Miller's Point; near the Blockhouse; west slopes Lion's Head.

5. **I. procumbens** Linn. Dry flats or low slopes, occasional; 6–9. Near Maitland; Lion's Head; Fish Hoek.

6. **I. incana** Thunb. Grassy and bushy hill slopes, rather frequent; 8–10.

7. **I. glomerata** E. Mey. Dry and rocky places, rather frequent; 8–11. Reaches summit of Constantiaberg and of Table Mountain.

8. **I. filicaulis** E. and Z. By streams on hills and mountains, frequent; 12–2.

9. **I. brachystachya** E. Mey. Mountain slopes, rare; 5. Fish Hoek, *Bolus*, 4881; "about Muizenberg and Simon's Bay," *Eckl.* and *Zeyh.*

10. **I. angustifolia** Linn. Flats and low plateaux, rather frequent; 8–12. Reaches 1,000 feet on Klaasjagersberg. The species would be as well placed in § Productæ as in § Pinnatæ.

11. **I. filiformis** Thunb. Hill and mountain slopes, frequent; 8–11. Reaches Lower Plateau.

12. **I. coriacea** Ait. From flats to summit of Table Mountain, common; 1–12.

13. **I. sarmentosa** Linn. f. By mountain streams, rather frequent; 11–3; reaches summit of Table Mountain.

14. **I. capillaris** Thunb. Flats and hill slopes, occasional; 9–10. Farmer Peck's Valley, Muizenberg.

15. **I. cytisoides** Thunb. Hill slopes, rather frequent; 3–5.

16. **I. humifusa** E. and Z. Flats, rare; 10. Near Rondebosch, *Bolus*, 4510.

Tephrosia capensis Pers. Hill slopes to about 1,500 feet, frequent; 7–1.

2. **T. grandiflora** Pers. Bushy places, rare; 3. "Near Newlands Avenue," *Bodkin!* Possibly introduced.

Sutherlandia frutescens R. Br. Hill slopes to about 1,500 feet, rather common; 9–11.

Lessertia spinescens E. Mey. Sandy flats, rare; 10. "Rapenburg," *F. Guthrie!*

2. **L. linearis** DC. Flats and low hill slopes, near the sea, rather frequent; 9–12.

3. **L. pulchra** Sims. Hill slopes up to 1,200 feet, frequent; 9–11.

4. **L. excisa** DC. Hill slopes, rare? 9–10. Signal Hill; west slopes Lion's Head; "Kamp's Bay," *Harvey.*

5. **L. tomentosa** DC. Sandy flats, occasional; 9–10. Near Retreat station; Chapman's Bay; Slangkop; Paarden Island.

6. **L. argentea** Harv. Flats and hill slopes, rare; 9–10. Red Hill; "near Green Point," *Pappe;* "Simon's Bay," *Eckl.* and *Zeyh.*

Hallia alata Thunb. Apparently rare; 2. "Kloof between Table Mountain and Lion's Head," *Eckl.;* "Cape Town," *Pappe.*

2. **H. virgata** Thunb. Flats and hill slopes, very common; 10–3. Occasionally with white flowers.

3. **H. cordata** Thunb. Flats and hill slopes, very common; 10–3.

4. **H. asarina** Thunb. Hill slopes, rare or overlooked? 10–3. Groot Schuur; "Cape Town," *Alexander.* Hardly more than a broad-leaved variety of the last.

5. **H. imbricata** Thunb. Flats and low plateaux, occasional; 11. Flats near Rondebosch and Kenilworth; Steenberg; Orange Kloof; Kirstenbosch.

†**Vicia angustifolia** Roth. (**V. sativa** Linn.). Flats and hill slopes to about 1,200 feet, frequent; 8–11.

2. †**V. atropurpurea** Desf. Grassy fields, rare; 10–11. By Maitland Bridge; "near the Observatory," *Zeyh.*

3. †**V. hirsuta** Koch. Gardens, hedges, and roadsides, frequent; 8–10.

4. †**V. tetrasperma** Mœnch. Similar places, occasional; 8–11. From Claremont to Kenilworth; Retreat; plentiful in a meadow below Klein Constantia.

Dolichos gibbosus Thunb. Hill and mountain slopes, very common; 1–12. Reaches nearly to summit of Devil's Peak. This plant forms long, twining, ropy stems in woods.

2. **D. decumbens** Thunb. Hill slopes, apparently very local; 6–8. Lion's Back.

Fagelia bituminosa DC. Hill and mountain slopes, very common; 1–12. Reaches almost to the summit of Table Mountain. Forms large ropy stems in woods.

Rhynchosia ferulifolia Benth. Sandy flats, occasional; 8–11. By Retreat station; Chapman's Bay; beyond Uitvlugt.

2. **R. viscidula** Steud. "Amongst shrubs on Table Mountain summit, September," *Eckl.* and *Zeyh.* Not found by us.

3. **R. glandulosa** DC. Flats to mountain slopes, frequent; 9–1. Reaches Lower Plateau.

Virgilia capensis Lam. Kloofs and thickets, rather frequent; 8–3, but chiefly 2–3.

†**Cassia tomentosa** Lam. Roadsides, &c., frequent; 11–1.

†**Acacia horrida** Willd. Hillsides, rare; 12–1. Lion's Head. An outlier from the Karroo, and we think doubtfully native.

ROSACEÆ.

Rubus rosifolius Sm. Lower slopes, very local? "Sides of Table Mountain facing the town," *Eckl.* and *Zeyh.* Not found by us.

2. **R. pinnatus** Willd. Hill slopes, common; 8–10. Reaches almost to summit of Constantiaberg, but rarely exceeds 1,200 feet.

3. **R. rigidus** Sm. Hill slopes, rare. Kloof west of Lion's Head, October. Not seen in flower.

4. **R. fruticosus** Linn (sp. agg.). Hill slopes, common; 9–12. Much more constant than in Europe. A plant as common as the type, but with septenate-pinnate leaves and constantly abortive fruit, may be a hybrid with **R. pinnatus,** but it bears little resemblance to that species.

Alchemilla capensis Thunb. Damp or shady slopes up to 1,000 feet, rather frequent; 8–10.

†**Poterium Sanguisorba** Linn. A roadside casual; 9–10. Beyond Sea Point; "about Simon's Bay," *Wright.*

Cliffortia ilicifolia Linn. Hill slopes, very rare. Near swamp, Orange Kloof, not seen in flower.

2. **C. intermedia** E. and Z. We do not understand this species, but plants which have glabrous tridentate leaves occur near Maclear's Beacon (? **C. tabularis**); behind Wynberg ranges and Lower Plateau above; about Constantiaberg, farm, and Nek; summit of Twelve Apostles; near Miller's Point.

3. **C. ruscifolia** Linn. From flats to highest summits, very common; 6–12. A most variable plant in pubescence, length, width, and dentition of leaves. Var. **tridentata** Harv. occurs in the Disa Gorge. A plant from above Klassenbosch with glabrous leaves 6–8 lines long and $\frac{1}{2}$ line wide may belong to this species.

4. **C. tabularis** Diels *MS.* Near Maclear's Beacon, *Bolus*, 7994.

5. **C. graminea** Linn. f. Wet places, flats to mountain slopes, occasional; 12–3. Retreat Vley; Smitswinkel Vley; near top of Vlaggeberg; Orange Kloof swamp.

6. **C. odorata** Linn. f. Mountain slopes, frequent; 9–11. Often forms dense matted masses and reaches nearly to summit of Table Mountain.

7. **C. ferruginea** Linn. f. Flats, common; 9–12.

8. **C. cuneata** Ait. Flats, rare; 6. "Near Claremont," *Schlechter*, 798!

9. **C. obcordata** Linn. f. Flats and hill slopes to at least 1,000 feet, common; 9–11.

10. **C. marginata** E. and Z. Hill slopes, rare; 4. "Smitswinkel Bay," *Schlechter*, 670!

11. **C. polygonifolia** Linn. Flats and hill slopes to 1,500 feet, common; 7–10. Var. **ternata** and var. **trifoliata** about equally common.

12. **C. octandra** Ch. and Sch. Flats and hill slopes, rare, but perhaps mistaken for the last species; 4–5. Near Kirstenbosch: Constantia; "near Salt River," *Eckl.* and *Zeyh.*

13. **C. dentata** Willd. Rocky ledges on mountains, very local; 6–7. East slopes Devil's Peak and Table Mountain; near Miller's Point (an erect narrow-leaved form).

14. **C. strobilifera** Linn. Wet places on flats, common; 3–4.

15. **C. falcata** Linn. f. Low dry slopes and flats, locally frequent; 4–7. Beyond Simon's Town; Muizenberg Vley; "bases of Table and Devil's Mountains," *Drège* (? overlooked elsewhere).

16. **C. pedunculata** Schltr. Bushy places by mountain streams, rare. Orange Kloof (past flowering in December).

17. **C. ericifolia** Linn. f. Flats, rather rare; 3. Kenilworth; "between Cape Town and False Bay," *Thunberg;* "near Doornhoogde," *Eckl.* and *Zeyh.*

18. **C. eriocephalina** Ch. and Schl. Mountain-tops, rare; 2. Near Maclear's Beacon, *Bolus,* 7995.

19. **C. sarmentosa** Linn. Dry flats and low hill slopes, frequent; 5–8.

20. **C. juniperina** Linn. f. Flats and hill slopes to 1,500 feet, rather common; 6–11.

21. **C. filifolia** Linn. f. Flats and hill slopes, rather frequent; 5–8. Nordhoek; Slangkop; Tokay; Wynberg ranges; "flats and about Table Mountain," *Eckl.* and *Zeyh.*

22. **C. subsetacea** Diels *M.S.* Hill slopes, rare; 8. Smitswinkel Bay, *Wolley-Dod,* 1500.

23. **C. teretifolia** Thunb. Flats, rare; 3. "Near Wynberg," *Schlechter,* 1146!

Grielum tenuifolium Linn. Sandy flats, very local; 10–11. Paarden Island (probably the same as Harvey's "Salt River" station). More common beyond our limits.

SAXIFRAGACEÆ.

Cunonia capensis Linn. Kloofs and bushy places to above 1,500 feet, frequent; 3–4.

CRASSULACEÆ.

Dinacria filiformis Harv. Sandy plains, locally frequent; 9–11. Chapman's Bay; Muizenberg.

Crassula (Helophytum) natans Thunb. Pools and ditches on flats, very common; 5–10. A most variable species. Harvey's var. **filiformis** is probably a distinct species. We have it from near Maitland, and Black River (*teste* Schönland).

2. **C. (Bulliarda) Vaillantii** Roth. Gravelly pools, rare; 10. Near Maitland station, *Wolley-Dod,* 3065.

3. **C. Zeyheriana** Schön. (**C. decumbens** E. and Z. non Thunb.). Damp sandy flats, common, unless confounded with **C. glomerata** Linn.; 8–10. Flats about Rondebosch!

4. **C. decumbens** Thunb. non E. and Z. **(Bull. trichotoma** E. and Z.). Flats, in damp sandy places, rather frequent; 7–10. A variety or possibly new species (*teste* Schönland) grows in dense cushion-shaped masses on rocks on Lion's Head at 1,500 feet, *Wolley-Dod*, 3676.

5. **C. (Bulliarda brevifolia** E. and Z.). Damp flats, especially near the sea, common; 9–10.

6. **C. alpina** Endl. Sandy flats and ledges of rocks on mountains, rather rare or overlooked; 9–10. Patrys Vley; Red Hill; Muizenberg; Orange Kloof.

7. **C. perfossa** Lam. Stony places, rare; 2. Muizenberg, *Guthrie !*; "west side of Table Mountain," *Eckl.* and *Zeyh.*

8. **C. densifolia** Harv. Flats and stony places, local; 3–4. Near Salt River; foot of Devil's Peak.

9. **C. cymosa** Linn. Sandy flats, rather common; 12–1.

10. **C. flava** Linn. Flats and gravelly hill slopes, frequent; 12.

11. **C. undulata** Harv. Sandy and gravelly flats, rather common; 10–1.

12. **C. scabra** Linn. f. About dry rocks, &c., rather common; 12–1. From sea-level at Kamp's Bay to 2,500 feet or more on Constantiaberg. **C. scabrella** Harv. does not seem worth separating, even as a variety.

13. **C. lycopodioides** Lam. Dry gravelly soil, rare; 3. Near Rapenburg.

14. **C. muscosa** Linn. Dry rocks, rather rare; 3–8. Kenilworth; Muizenberg.

15. **C. pharnaceoides** (Hochst.) Schön. (**C. campestris** E. and Z.) Mountain slopes, rare; 8. "Above Orange Kloof," *Schlechter*, 1321!; "Simon's Bay," *Wright.*

16. **C. glomerata** Linn. Damp sandy and gravelly flats and hills, very common; 10–1.

17. **C. glabra** Harv. Sandy places, rare; 12. Kenilworth racecourse, *Bolus*, 7962.

18. **C. Dodii** Schön. and Baker f.? "Simon's Bay," *Wright*, 549 (*vide* Journ. of Bot., 1898, p. 372).

19. **C. tenuis** Wolley-Dod. Sands by shore, rare; 9–10. North of Kamp's Bay, *Wolley-Dod*, 3369; "Signal Hill," *Wilms*, 3232.

20. **C. centauroides** Linn. By mountain watercourses, frequent; 10–1. Occasionally met with on the flats, as at Black River village.

21. **C. Sarcolipes** Harv. Grassy damp places on flats and mountains, frequent; 9–10.

?**C. dentata** Thunb. "Table Mountain," *Harvey* in Fl. Cap. II. 356, and a specimen so named by Wright in the Kew Herbarium from Simon's Town are the only evidence we have seen of this plant, but we question the occurrence of the true species on the Peninsula, in consideration of Dr. Schönland's remarks in Journ. of Bot., 1898, p. 366.

22. **C. Promontorii** Schön. and Baker f. Damp ledges under rocks, rather rare; 10–12. Railside beyond Kalk Bay; Slangkop; Kasteel Poort; Lion's Head.

23. **C. Saxifraga** Harv. Hill slopes in damp places, rare?; 5. Orange Kloof near swamp; Muizenberg, 600 feet; "Steenberg," *Eckl.* and *Zeyh.*

24. **C. Septas** Thunb. Hill slopes in damp places, frequent; 5–8.

25. **C. muricata** Thunb. (**C. Sphæritis** Harv.). Rocky places on mountains, rare; 7–9. "Simon's Town," *Schlechter*, 1076!; "Devil's Peak," *Eckl.* and *Zeyh.*

26. **C. ciliata** Linn. Shrubby flats and hills, rare; 1. Rosebank, *Bolus*, 7032; "hills round Cape Town," *Eckl.* and *Zeyh.*

27. **C. tomentosa** Linn. Rocky mountain sides, rare; 4. "Muizenberg," *Eckl.* and *Zeyh.* Not found by us.

28 **C. interrupta** E. Mey. Rocky places or mountains, rare; 2. "Near Simon's Town," *Schlechter*, 331!

29. **C. nudicaulis** Linn. Dry hill and mountain slopes, occasional, rarely on flats; 11–12. Kalk Bay hills; Orange Kloof; Vlaggeberg; Lion's Head.

Grammanthes gentianoides DC. Dry sandy places on flats and low hills, rather common; 9–11.

Rochea coccinea DC. Dry sunny rocks, frequent from 1,500 feet to summit of Table Mountain; 1–2.

2. **R. versicolor** DC. Dry hill and mountain slopes; rare. "Table Mountain," *Burchell;* "Paradise," *Dr. Wallich;* "Noord Hoek Mt., 11," *G. Sichel!* Not found by us.

3. **R. jasminea** DC. Dry places on mountain plateaux, local; 11–1. Lower Plateau; Skeleton Ravine; Waai Vley.

4. **R. odoratissima** DC. Dry slopes from about 500 feet to 3,500 feet, rather common; 8–1. A pale yellow and a pure white form occur; the former appears the commoner and flowers 8–11, succeeded by the white one at higher elevations. We can see no specific difference.

Cotyledon orbiculata Linn. Among bushes from sea-level to at least 1,500 feet, common; 1.

2. **C. purpurea** Thunb. "Common on hills and mountains about Cape Town and elsewhere," *Thunberg*. Apparently not found by any other collector.

3. **C. fascicularis** Ait. Rocky bushy slopes, locally rather frequent; 11–12. From Kalk Bay to Paulsberg; Klein Slangkop; rocky knoll in Chapman's Bay.

4. **C. tuberculosa** Lam. Rocky bushy slopes, rather rare; 1–2. West slopes Lion's Head; Miller's Point and towards Smitswinkel; Slangkop and Klein Slangkop.

5. **C. hemisphærica** Linn. Dry rocks on mountains, very local; 1. Lion's Head.

DROSERACEÆ.

Drosera trinervia Spreng. Flats and mountain slopes in damp places, common; 8–11.

2. **D. cuneifolia** Thunb. Damp hill and mountain slopes, frequent; 12–2. Both these species reach the Lower Plateau. A very slender small-flowered form grows with the type below Vlaggeberg; it may be a distinct species (*Wolley-Dod*, 457).

3. **D. capensis** Linn. Damp places on flats and hills, rare; 12. Camp Ground; near Vlaggeberg; near Klein Slangkop.

4. **D. hilaris** Ch. and Schl. Damp spots on hills and mountains, rather rare; 10–11. Devil's Peak; Orange Kloof; hills west of Simon's Town; "east side of Table Mountain and near Constantia," *Berg.*, &c.

5. **D. ramentacea** Burch. Mountain tops, rare; 2. "Slopes of Table Mountain at 3,000 feet," *Schlechter*, 269!; "summit of Table Mountain, eastern side," *Ecklon*, &c.

6. **D. pauciflora** Banks. Damp sandy places on hills, locally frequent; 8–10. Red Hill; Klaver Vley. Only var. **minor** Harv. has been found by us.

7. **D. cistiflora** Linn. Flats and hill slopes, rather common; 8–10.

BRUNIACEÆ.

Berzelia lanuginosa Brongn. Mountain streams, rather common; 7–11. Descends to 300 feet in Schoester's Kraal.

2. **B. abrotanoides** Brongn. Similar situations but at lower elevations; frequent; 10–12.

Brunia nodiflora Linn. Hill and mountain slopes, common; 5–12.

2. **B. pinifolia** Linn. f. Mountain slopes, rare; 11. "Orange Kloof," *Marloth*, 2751. Not found by us, but we believe it was found by some old collector, and the record mislaid.

Staavia glutinosa Thunb. Mountain slopes and plateaux, rather rare; 1–4, but gathered in flower also in July and September. Skeleton Ravine; Lower Plateau; Waai Vley.

2. **S. Dodii** Bolus. Dry rocky hills, very local; 5–7. Ridge between Smitswinkel and Patrys Vleys, *Wolley-Dod*, 2641.

3. **S. radiata** Thunb. Flats and hill slopes to moderate elevations, rather common; 7–2.

4. **S. capitella** Sond. Mountain tops, rare; 11. Table Mountain summit, 3,400 feet, *Bolus*, 4490.

Audouinia capitata Brongn. Dry hill slopes, locally rather frequent; 5–9. From Kalk Bay to Smitswinkel Vley; Klein Slangkop.

HALORRHAGIDACEÆ.

Serpicula repens Linn. By water on flats and hills, rather common; 11–3.

Gunnera perpensa Linn. Wet places on flats, occasional; 11. Kirstenbosch; Orange Kloof; Constantia; Tokay.

LYTHRACEÆ

†**Lythrum hyssopifolium** Linn. Damp places on flats, rather common; 11–1.

Olinia cymosa Thunb. Kloofs and by rocks, occasional; 10. Table Mountain, 1,500–2,000 feet.

ONAGRACEÆ.

†**Epilobium hirsutum** Linn. Wet places, rather rare; 11–1. Beyond Sea Point; towards Kirstenbosch; Muizenberg Vley; Fish Hoek; Hout Bay.

2. †**E. tetragonum** Linn. Wet places, rare; 12–1; Vley near Retreat. It is possible that both species of **Epilobium** are native.

†**Œnothera odorata** Jacq.? About houses and waste places, frequent; 12. We are uncertain whether the plants we have seen belong to this species or to **Œ. biennis** Linn., as we never gathered any.

2. †**Œ. nocturna** Jacq. "Naturalised in fields and waste places near Rondebosch," *Eckl.* and *Zeyh.* Not seen by us.

Montinia acris Linn. f. Flats and mountain slopes to about 1,500 feet; very common; 5–10.

CUCURBITACEÆ.

†**Cucumis africanus** Linn. f. "Garden near Cape Town," *Eckl.* and *Zeyh.* Not found by us.

2. †**C. myriocarpus** Naud. Recorded also by Eckl. and Zeyh. in a garden, but doubtless introduced.

Melothria punctata Cogn. Climbing on hedges and on bushes, frequent; 12–1.

Kedrostis nana Cogn. Similar habitats, occasional; 5–1. Lion's Head (var. β); Cape Flats; Orange Kloof; Kalk Bay (var. α); Chapman's Bay; Miller's Point (var. α).

FICOIDEÆ.

The difficulty in the genus **Mesembrianthemum** lies in the almost entire loss of colour and form of leaf section in dried specimens. These points, as well as the characters of the stamens and styles should be carefully observed before drying. A considerable number of the species we believe we have identified are unrepresented in the Kew Herbarium. Consequently we submit the subjoined names with caution, the notes referring to the specimens we have gathered, and not being intended for revised descriptions of the species. We have in this genus used the ? after the name only in cases of more than ordinary doubt.

Mesembrianthemum reptans Ait. Dry sandy ground on flats, common; 7–9. Flowers as commonly white as yellow, rarely pale rose. "Rocks on Lion's Mountain" sounds a most improbable habitat for this species (see Fl. Cap. II. 407). It has sometimes most unaccountably been confounded with **M. filicaule.**

2. **M. diversifolium** Haw. "Sandy places near Green Point, July," *Eckl.* and *Zeyh.* Not seen by us.

3. **M. læve** Thunb. Dry sandy ground, local? 9–10. Below Slangkop; Hout Bay; hills west of Simon's Town. Seems to differ from **M. validum** mainly in number of styles.

4. **M. validum** Haw. Sand-dunes, occasional; 5–7. Muizenberg; Fish Hoek.

5. **M. pugioniforme** Linn. Sandy places in the flats, common; 9–12. We include **M. capitatum** Haw. as an inseparable form.

6. **M. Schollii** Salm Dyck. "Rocky places on the west side of Table Mountain, February," *Eckl.* and *Zeyh.* Not found by us, but seems very near the next species.

7. **M. sarmentosum** Haw. Sandy hill slopes, locally frequent; 7–9. About Red Hill and Smitswinkel Bay; beyond Sea Point, &c.

8. **M. geminiflorum** Haw. Dry sandy ground, locally frequent; 8–9. About the washhouses by the Camp Ground.

9. **M. crassifolium** Linn. Muddy and sandy creeks and flats, local; 9–10. On and about Paarden Island; Rapenburg Vley; Kenilworth.

10. **M. dunense** Sond. Muddy and sandy creeks, very local; 9–10. Paarden Island, *Wolley-Dod*, 3370. "Shore near Cape Town," *Eckl.* Leaves very smooth, shining green, but very closely resembling the fig. in Dillenius' tab. 201, fig. 257.

11. **M. acinaciforme** Linn. Sandy and bushy ground, rather uncommon; 9–11. Chiefly from Hout Bay and Fish Hoek southwards.

12. **M. edule** Linn. Dry sandy places, very common; 7–12. Flowers pale yellow fading to pale rose, but only very occasionally pale rose from the first. Very distinct from the last species as a rule,

but rarely a form possessing exactly intermediate characters may be found which we think probably a hybrid, *e.g.*, near Miller's Point; on Red Hill, &c.

13. **M. filamentosum** Linn. Hill slopes on gravelly or rocky soil, locally frequent; 8–9. Between Sea Point and Kamp's Bay.

14. **M. mutabile** Haw. Rocks from 1,500 feet upwards, frequent; 8–11. At the foot of the precipices around Devil's Peak and Table Mountain, much rarer near the summit. Petals sometimes dirty white.

The following 6 species belong to the §Bracteata, which is a well-marked one, known by its very slender petals, the inner rows of which are much shorter and often of different colour to the outer, and so strongly incurved as to invert the outer stamens over the styles. The species, however, except **M. bracteatum** and **M. asperum,** are most difficult to separate, confusion having arisen from the upper leaves often being mistaken for bracts.

15. **M. gracile** Haw.? In rough places; 1. Near Wynberg ranges. An erect, but not rigid plant, with smooth leaves; intermediate between **M. asperum** and **M. bracteatum.**

16. **M. anceps** Haw.? Dry low ground, occasional; 12–2. Near Miller's Point; Retreat; Constantia Nek; Mowbray cutting. A decumbent, pale, glaucous plant. Leaves shorter and broader than usual in the section. Petals often reflexed and twisted. We doubt if this is distinct from **M. radiatum.**

17. **M. asperum** Haw. Sandy flats and roadsides, frequent; 4–8. Flats about Wynberg, Kenilworth, and Retreat. A rather stiffly erect plant, with longish very slender petals and leaves. According to Salm Dyck, and in our specimens, the calyx is not punctate-scabrous, nor is it in the least like **M. scabrum** (*vide* Fl. Cap. II. 415) though often so named in herbaria.

18. **M. compressum** Haw.? Flats; 4. By Camp Ground road. Near the preceding but decumbent, with smooth leaves.

19. **M. bracteatum** Ait. Mountain plateaux, frequent; 12–1. Stiffly erect, usually reddish with dark green foliage. Leaves stout, strongly compressed and sharply keeled. The purplish lines on the petals, mentioned by Sonder, do not appear till they are dry; moreover, they occur in most of the species in this group.

20. **M. radiatum** Haw.? In shrubby places, rare; 3. Near Rosebank, *Bolus*, 7946. We doubt whether **M. patulum** should be kept distinct from this, but have never gathered it.

21. **M. glaucum** Linn. Dry sandy places, appears locally frequent; 8–9. Camp Ground; Oude Molen; beyond Uitvlugt; Kenilworth. Flowers very showy. Leaves shorter and broader than in the next species, sometimes resembling those of §Falcata.

22. **M. aurantiacum** Harv. Sandy or gravelly flats to mountains, rather frequent; 6–9. Rondebosch and Kenilworth flats; common at Patrys and Smitswinkel Vleys; Steenberg; Vlaggeberg. Flowers much smaller and duller yellow than in the last species.

? **M. formosum** Haw. We enter this because some of the plants beyond Sea Point run very near it, though equally near **M. sarmentosum,** which differs from this in having slightly rough-keeled, vaginate leaves, smaller flowers, and connivent styles.

23. **M. falciforme** Haw. Chiefly on dry mountain rocks, common; 11–1. A well-marked plant, ascending to the summit of Table Mountain. Sonder is misleading in saying the leaves have "angles acute;" the keel is quite rounded throughout.

24. **M. falcatum** Linn. Similar situations, occasional; 11–1. Farmer Peck's valley; Kalk Bay; Vlaggeberg; Miller's Point. Keel of leaves more angular, flowers smaller, but chiefly recognisable by its much slenderer leaves.

25. **M. roseum** Willd. Gravelly hill slopes, locally common; 10. Beyond Sea Point. A most showy plant, quite covered with large pale, rarely deep, rose flowers. Styles very short and remarkably stout. Its leaves are quite those of this section, yet it has been placed to various others in herbaria.

26. **M. aristulatum** Sond. Dry hill slopes and on rocks, locally frequent; 8–9. Signal Hill and Lion's Head to 1,500 feet; rocks by shore at Sea Point; by Kenilworth racecourse. Quite distinct from any other Peninsular species.

27. **M. tumidulum** Haw. Sands by sea-shore, not very common though locally abundant; 8–9. Beyond Sea Point; Kalk Bay; Miller's Point; Smitswinkel Bay; below Paulsberg; Chapman's Bay; Slangkop; Hout Bay. Plant prostrate, in dense masses. Leaves more subterete than subtriquetrous, and often longer than internodes. Our specimens may possibly belong to the next species, but in habit, stature, length of leaves and inflorescence, they differ more widely from its description than the gathering we have so named.

28. **M. umbellatum** Linn. ? *Wolley-Dod,* 3661 (November), near Retreat Station, is nearest this, but leaves are shorter and bracts longer than in its description.

29. **M. veruculoides** Sond. Rocks, very local; 10–1. Lion's Head, 1,500 feet. "North side Table Mountain," *Marloth,* 2581. Leaves quite terete, very glaucous, hardly mealy. Stamens erect or spreading. Styles longer than stamens, curved out.

30. **M. productum** Haw. ? Sandy ground, very local; 1. Muizenberg Vley. Leaves terete, very pale and glaucous. Petals pale rose or whitish. Styles short, thick, very spreading. Seems to be var. **lepidum** Salm Dyck.

31. **M. Zeyheri** Salm Dyck. Dry sandy ground, local; 10–11. Hills west of Simon's Town; Chapman's Bay, frequent. Stem decumbent, branches very erect. Leaves subcylindrical. Flowers large and showy. Petals bright deep rose. Styles very short and obtuse.

32. **M. flexuosum** Haw. Gravelly hill slopes, appears very local; 10. Behind Lion Battery, *Wolley-Dod,* 3420. Leaves semiterete or bluntly trigonous. Calyx finely warted, limb suddenly contracted into

tube. Petals rosy. Plant slender and weak in dense tufts. Evidently the same as Dr. Pappe's plant, so named from "Lion's Mountain," but both seem equally near **M. umbelliflorum** Jacq.

33. **M. micranthum** Haw. Dry gravelly flats, appears very local; 12. Plentiful about Fort Knokke, Woodstock.

34. **M. variabile** Haw. Dry sandy flats, apparently rare; 10–11. Near Retreat Station. Leaves semiterete, punctate, not warted, glaucous. Calyx tube elongate. Petals yellow, very broad, obtuse. Styles 5, short, thick. There is reason to suppose that **M. coccineum** Haw., **M. variabile** Haw., **M. bicolorum** Linn., and **M. inæquale** Haw., are all varieties of **M. tenuifolium** Linn.

35. **M. bicolorum** Linn. Sandy places, rare; 10. Kenilworth Flats, *Bolus*, 8022.

36. **M. tenuifolium** Linn. Sandy flats, rare; 3. Cape Flats, *Bolus*, 3924. Petals mauve.

37. **M. stenum** Haw. Sandy flats, rare? 11–12. Among bushes on Camp Ground. A slender rather straggling plant, with rather crowded shortly peduncled flowers, the demarcation between peduncle and calyx tube obscure.

38. **M. spiniforme** Haw.? Dry slopes, appear rare; 6–7. West slopes Lion's Head; near Hout Bay, *Wolley-Dod*, 1469, 2732. Differs from **M. aduncum** chiefly in its larger size and longer leaves.

39. **M. aduncum** Haw. Dry gravelly soil on flats, frequent and general; 6–10. A rather small ragged plant. Leaves subterete, with hooked acuminate points. Calyx truncate below lobes. Petals obtuse, dull rose. Styles subulate equalling stamens. Near **M. scabrum,** but distinguished by non-warted leaves with hooked tips.

40. **M. filicaule** Haw. In short grass at low elevations, frequent; 5–9. Stem slender, creeping, leaves subulate acuminate, usually not hooked at apex, peduncles long, slender, red.

41. **M. calcaratum** Wolley-Dod. Sandy flats, locally frequent; 7–9. About Claremont and Kenilworth. The leaves being spurred or gibbous at base distinguish this species.

42. **M. glomeratum** Linn. Dry gravelly soil, apparently rare; 11. Kloof west of Lion's Head, *Wolley-Dod*, 3660. "Near Cape Town on flats, and on Table and Lion's Mountains," *Sonder*.

43. **M. polyanthum** Haw.? Sandy ground, rare?; 11–1. Klaver Vley; roadside near Oatlands. Plants from these two localities differ considerably in size and colour of flower but agree in leaves, and some of them may possibly belong to **M. elegans.**

44. **M. elegans** Jacq. "Sandy places and rocks, Table and Lion's Mountains," *Sonder*. Not found by us.

45. **M. scabrum** Linn. Gravelly flats, rather frequent; 8–10. Especially plentiful about Observatory. A small rather ragged bush, very like **M. aduncum** but with glaucous, warted, obtuse leaves.

46. **M. asperulum** Salm Dyck. Dry gravelly places, apparently rare; 9–10. Railway near Maitland Bridge; Signal Hill, *Wolley-Dod*, 3140, 1524A.

47. **M. striatum** Haw. "Simon's Bay," *Wright* in Herb. Kew. Not found by us.

48. **M. attenuatum** Haw. On rocks, rather rare; 8–9. Slangkop; beyond Sea Point; east slopes Table Mountain. Usually a compact cæspitose plant, with numerous shortly peduncled flowers. Leaves only 2 to 3 lines long in Peninsular specimens.

49. **M. candens** Haw. Sandy and rocky ground near sea, frequent?; 9–11. Kalk Bay; Paarden Island; beyond Sea Point, &c. Very like **M. floribundum** but much less woody, branches long, diffuse, usually rooting, peduncles very short, calyx tube obconical.

50. **M. floribundum** Haw. Similar places to and as frequent as last; 9–10. Paarden Island; near Kamp's Bay; Rapenburg Vley, &c. Stem often very woody, branches sometimes prostrate but never rooting, peduncles long (1 to 2 inches), calyx tube hemispherical.

51. **M. longispinulum** Haw. Dry sandy ground, rather locally frequent; 10–11. Chapman's Bay; about Retreat and Muizenberg; hills west of Simon's Town. The leaves are half clasping at the base. The species is well described in Fl. Cap. II. 449.

52. **M. nodiflorum** Linn. Dry gravelly soil, rare; 11. Green Point Common, *Wolley-Dod*, 3666. Leaves often with 2 to 3 strong pectines on each side of base. Flowers sessile with a bract on or at base of calyx tube. Calyx lobes usually spurred. Petals very short.

53. **M. pyropæum** Haw. Dry sandy places, apparently rare; 9–10. Shore near Oatlands; Paarden Island, *Wolley-Dod*, 1796. Perhaps this should be reduced to a variety of the next.

54. **M. criniflorum** Houtt. Dry sandy places, very common; 7–10.

55. **M. crystallinum** Linn. Dry sandy places, locally frequent; 11–12. About Sea Point; and Maitland. Very distinct by its large leaves, and the whole plant being covered with large glittering papulæ, but the leaves have usually withered before the flowering period is well advanced.

56. **M. sessiliflorum** Ait.? Dry sandy places, rare; 8–9. By shore beyond Sea Point, *Wolley-Dod*, 2864. Annual. Peduncles axillary, $\frac{1}{2}$ to 1 inch. Three of the calyx lobes twice as long as petals, the other two much longer. Petals short, erect, yellow, uniseriate. Stamens few. Styles short recurved. Capsule with 5 horns.

57. **M. pinnatifidum** Linn. Damp sandy ground on hills and mountains, rather locally frequent; 7–8. Below Wynberg Reservoir; Farmer Peck's Valley; hills west of Simon's Town; Smitswinkel Vley. Flowers pale rose, very inconspicuous.

58. †**M. cordifolium** Linn. Is a frequent garden weed, but is probably introduced from the eastern districts.

59. **M. pallens** Ait. Dry ground, banks and walls, rather locally common; 11–12. From Fort Knokke to Sea Point. A coarse straggling dull glaucous plant, the papulæ on the leaves very inconspicuous. Pappe's specimen labelled **M. geniculiflorum** Linn. from Papendorp (Woodstock) in Herb. Kew, is this species, and as we know of no other evidence for the occurrence of **M. geniculiflorum** on the Peninsula, we have omitted it.

60. **M. Tripolium** Linn. Damp bushy places, local and rare; 10–11. Several places in the Orange Kloof.

61. **M. pomeridianum** Linn. Dry sandy places, common; 9–12. Abundant in Chapman's Bay.

62. **M. glabrum** Ait.? A plant from the Kommetje, Chapman's Bay (*Wolley-Dod*, 1755 and 3142) may be this species. It closely resembles very large specimens of **Hymenogyne glabra,** but has 10 styles, which are more or less connate below, not united into a tube throughout. We much doubt the synonymy of the two species; moreover, "stigmas united into a tube *at the base*" is a description which could not by any possibility be applied to **Hymenogyne glabra.** The same plant is common beyond our limits, near the shore towards Riet Vley. It may possibly be **M. pomeridianum** Linn., var. **glabrum** Haw., but differs considerably from the true species.

Hymenogyne glabra Haw. Dry sandy ground, rare; 9–10. "Rapenburg," *Guthrie;* roadside beyond Simon's Town, *Bolus*, 7092, *Wolley-Dod*, 2851.

Tetragonia echinata Ait.? Sandy ground, rare; 7. Near Retreat Station, *Bolus*, 7206.

2. **T. herbacea** Linn. Grassy and sandy places on low hills, frequent; 6.

3. **T. portulacoides** Fenzl. Dry sandy flats, rare; 8–9. Between Retreat and Muizenberg, *Bolus*, 7207.

4. **T. decumbens** Mill. Waste and sandy ground, rather rare; 10–12. Paarden Island; Railway about Muizenberg; Castle ditch and grounds.

5. **T. spicata** Linn. f. "Rondebosch," *Eckl.* and *Zeyh.* Not found by us.

6. **T. fruticosa** Linn. Waste bushy and rocky ground, frequent; 10–3. Reaches at least 1,000 feet.

Aizoon paniculatum Linn. Dry sandy ground, rare; 9–10. Klein Slangkop; Chapman's Bay; Muizenberg; "Simon's Bay," *Wright.*

2. **A. sarmentosum** Linn. f. Sandy and gravelly places; frequent; 7–10.

Galenia secunda Sond. "Near Amsterdam Battery," *Pappe.* Not found by us.

2. **G. herniariifolia** Fenzl. Sandy flats, frequent; 11–1.

3. **G. pruinosa** Sond.? Sandy ground, very local; 10. Frequent Paarden Island, *Wolley-Dod*, 3127.

4. **G. africana** Linn. Flats, rare; 2. Meadow near Salt River, *Schlechter*, 285.

Acrosanthes teretifolia E. and Z. Dry hills, rare?; 11–12 Steenberg plateau, *Bolus*, 4851, *Wolley-Dod*, 3581.

Pharnaceum lanatum Benth. Dry sandy ground, rather rare; 7–9. About Diep River and Retreat; Hout Bay; Chapman's Bay; Camp Ground.

2. **P. incanum** Linn. Similar places, very common; 7–10. Reaches 2,500 feet in Kasteel Poort.

3. **P. reflexum** E. and Z. "Clayey soil near the town"; 9. *Krauss*. Not found by us.

4. **P. lineare** Linn. f. Dry sandy ground, occasional; 10–12. About Rapenburg; Chapman's Bay; about Retreat Station.

5. **P. dichotomum** Linn. f.? "Mountain plateaux above Simon's Town, Feb.," *Schlechter*, 332.

6. **P. subtile** E. Mey. Sandy ground near sea, frequent, but easily overlooked; 9–10.

7. **P. pusillum** Schltr. Dry sandy ground, rare; 9. Beyond Simon's Town, *Wolley-Dod*, 2906.

8. **P. cordifolium**, Linn., var. **obovatum** Bolus (as a species). Sands near sea, locally frequent; 9–11. From Muizenberg to Oatlands; shore below Slangkop. We believe **P. obovatum** Bolus is a variety of this species, specimens of which exist in Herb. Brit. Mus., gathered by Masson and by Harvey (No. 243) without exact locality. Var. **obovatum** differs from typical **P. cordifolium** in the leaves being longer, more numerous in the whorl, more tapering to the base, generally acute and only very rarely slightly retuse.

9. **P. (Hypertelis arenicola** Sond.) "Moist sandy places at Green Point; 1–3." *Zeyher*, 619. Not found by us.

Cœlanthium parviflorum Fenzl. Dry sandy flats, rather rare; 9–12. Muizenberg; Chapman's Bay; Camp Ground. Much more frequent on flats beyond our limits.

Polpoda capensis Presl. Foot of Table Mountain near Cape Town, occasional; 6–12.

Adenogramma rigida Sond. Stony hill slopes, rare; 10–11. Fish Hoek Valley, *Wolley-Dod*, 3415.

2. **A. diffusa** Fenzl. Mountain slopes, occasional; 8–11, 2. North side of Table Mountain; Simonsberg; above Kamp's Bay; "east slopes," *Eckl.* and *Zeyh.*

3. **A. galioides** Fenzl. Sandy flats and low hill slopes, very common; 8–10.

4. **A. Mollugo** Reich. Sandy flats, &c., frequent; 8–10. Known from the last species when in flower by its stiffer more erect habit.

Limeum africanum Burm. Gravelly slopes and roadsides, rare; 8–9. Hout Bay; beyond Sea Point.

UMBELLIFERÆ.

Hydrocotyle verticillata Thunb. Bogs and by vleys, locally frequent; 10–6. From Retreat to Oatlands; Hout Bay.

2. **H. asiatica** Linn. Similar places, but also in drier soil, frequent; 11–4.

3. **H. eriantha** Rich. Bushy mountain slopes, rather rare; 10–3. Orange Kloof; south slopes of Table Mountain 3,100 feet. Var. **glabrata**, Sond. Lower Plateau, 2,400 feet, *Bolus*, 4855.

4. **H. hederifolia** Burch. Dry rocky mountains, rare; 9–1. Over Miller's Point; Lower Plateau.

5. **H. villosa** Linn. f. Dry mountain slopes; rather rare; 10–1. Lion's Head; Table Mountain, 1,400 feet.

6. **H. Solandra** Linn. f. Dry hill slopes, locally frequent; 6–10. West slopes Lion's Head and Table Mountain; near Observatory.

7. **H. triloba** Thunb. Rocky mountain slopes, rare; 9–1. Muizenberg; "Table Mountain," *Eckl.* and *Zeyh.*

8. **H. montana** Ch. and Schl. Mountains, rare; 1. "Muizenberg," *Schlechter.* Not found by us.

9. **H. tridentata** Linn. f. Sandy flats, rather frequent; 8–2. Flats near Rondebosch; from Retreat southward.

10. **H. Centella** Ch. and Schl. Dry hill and mountain slopes, common; 9–3. Very variable in leaf.

11. **H. virgata** Linn. f. Flats to mountains, very common; 11–1.

12. **H. heterophylla** Schinz. "Muizenberg, March," *Schlechter*, 619.

13. **H. septemloba** Schinz. "Constantiaberg, 2,800 feet, May," *Schlechter*, 878.

Hermas gigantea Linn. f. "Mountains near Cape Town," *Sonder.* Not found by us.

2. **H. villosa** Thunb. Hill and mountain slopes, frequent; 12–3.

3. **H. capitata** Linn. f. Damp rocks on mountains, occasional; 12–1. Waai Vley; Steenberg; Constantiaberg; Klaasjagersberg.

4. **H. quinquedentata** Linn. f. "Top of Table Mountain," *Thunberg.* Not found by us.

Arctopus echinatus Linn. Flats and lower hill slopes, very common; 6–8.

†**Sanicula europæa** Linn. Shady woods, rare; 12–1. Skeleton Ravine, 1,500 feet; between Alphen and Constantia. We are not sure as to the nativity of this species. It has not the look of an introduced plant.

Lichtensteinia lacera Ch. and Schl. Sandy flats and low hills, rather frequent; 12–3. Frequently met with in pine woods, but rarely flowering except in open places.

2. **L. Beiliana** E. and Z. Shrubby places, rare; 11–3. Rosebank; Oude Kraal, by the sea.

†**Apium graveolens** Linn. Wet grassy places, rare; 12–1. Muizenberg Vley; Vaarsche Vley. An erect plant.

2. †**A. australe** Thon. Wet grassy places, very locally frequent; 3. Muizenberg Vley. A small prostrate plant, with much thicker ribs on fruit than in **A. graveolens.**

3. †**A. inundatum** Reich. f. In water, locally frequent; 10–12. Salt River Junction; Rapenburg Vley, and up the rivers; vley near Retreat.

Carum capense Sond. Dry hill slopes, common; 2–3.

2. **C. hispidum** Benth. and Hook. (**Ptychotis hispida** Sond.). Flat and low hills, frequent; 10–11.

Sium Thunbergii DC. In or by water, rather rare; 2–3. Muizenberg Vley; Chapman's Bay; Rapenburg Vley.

Seseli asperum Sond. "Sea-shore near Cape Town, March," *Thunberg*. Not found by us.

†**Fœniculum officinale** All. Hedges and waste places, rather frequent.

Œnanthe filiformis Lam. Flats to mountain tops, common; 1–4.

Capnophyllum africanum Koch. Sandy flats and lower slopes near sea, common; 6–1.

Anesorhiza capensis Ch. and Schl. "Mountains near Cape Town," *Mund* and *Maire*. Not found by us.

2. **A. montana** E. and Z. Somewhat shady places on flats and hill slopes, rather frequent; 2–3.

3. **A. macrocarpa** E. and Z. Sandy ground chiefly near sea, occasional; 12–2. Retreat; Kalk Bay; Miller's Point and beyond; Chapman's and Hout Bays; Klein Slangkop.

4. **A. elata** E. and Z. Mountains, rare; 12–2. "Table Mountain near Tokay, 500–2,000 feet," *Eckl.* and *Zeyh.* A plant in flower and fruit, gathered in February at 1,600 feet behind Simon's Town, by *Schlechter*, 331, is probably this species. Leaves gathered by *Wolley-Dod*, 3428, in November on the summit of Constantiaberg may also belong here.

5. **A. hirsuta** E. and Z. Shrubby hills and flats, locally occasional; 11. About Roodebloom and Observatory; Rosebank; Camp Ground; Claremont Flats.

6. **A.** (**Glia gummifera** Sond.). Hill and mountain slopes, rather common; 12–1. A broad-leaved form with a thinly floccose stem is common on the bushy slopes towards Smitswinkel Bay.

Peucedanum abbreviatum E. Mey. "Mountain tops of the Peninsula, 2,000–3,000 feet; March," *Krauss*, 1179. Not found by us.

2. **P. ferulaceum** Thunb. Hill slopes, rather rare; 9. Farmer Peck's Valley; east slopes Devil's Peak; "Table Mountain," *Sonder.*

3. **P. Galbanum** Benth. and Hook. Bushy hill and mountain slopes, common; 10–12. A form (*Wolley-Dod*, 2368), with remarkably narrow leaf-segments from near Constantia Nek, may be the same as the next species.

4. **P. tenuifolium** Thunb. "Waterfall, Devil's Peak," *Pappe.*

5. **P. Sieberianum** Sond. Dry hill and mountain slopes, frequent; 12–2.

†**Daucus Carota** Linn. A weed in cultivated ground, scarcely naturalised.

Caucalis africana Thunb. Hedge-banks and cultivated ground, common; 9–11.

ARALIACEÆ.

Cussonia thyrsiflora Thunb. Mountains, rare; 11. Muizenberg, 1,500 feet, *Bolus*, 4622; "Hout Bay," *Sond.*

CORNACEÆ.

Curtisia faginea Ait. Hillsides and kloofs, occasional: 1–2. Orange Kloof; ravine above Kirstenbosch.

RUBIACEÆ.

Oldenlandia capensis Thunb. Moist places on flats, rare; 1. Camp Ground.

Plectronia ventosa Linn. Hill slopes, rare; 9. Foot of Table Mountain below Platteklip, *Bolus*, 3896.

2. **P. Mundiana** Pappe. Mountain slopes, partial to kloofs, rather frequent; 11–12.

Anthospermum æthiopicum Linn. From flats to summit of Table Mountain, very common; 5–8.

2. **A. prostratum** Sond. Sandy flats near sea, apparently rare; 6–10. Near Paarden Island, *Wolley-Dod*, 3312.

3. **A. ciliare** Linn. Hill slopes and flats, frequent; 5–7.

4. **A. Bergianum** Cruse. Dry hills and flats, frequent; 7–8.

5. **A. hirtum** Cruse. Open places in kloofs, frequent; 9–1. Abundant above Groot Schuur.

? **A. Lichtensteinii** Cruse. "Sandy places near Cape Town," *Lichtenstein.* Not found by us, and it is not certain whether this station is within our limits.

Nenax acerosa Gaertn. Cape Flats, occasional; 2. *Bolus*, 4997.

2. **N. hirta** Cruse. Hill slopes, occasional; 7. Near Sea Point, *Bolus*, 4998; "Devil's Mountain," *Berg.*

Carpacoce scabra Sond. "Simon's Bay," *Wright.* Not found by us.

2. **C. spermacocea** Sond. Shrubby places on hill and mountain slopes, frequent; 9–1. Reaches the Lower Plateau.

Galium monticolum Sond. "Mountains near Cape Town," *Ecklon.* Not found by us.

2. †**G. Aparine** Linn. An occasional garden weed.

3. **G. asperum** Thunb. Sandy bushy places near sea, locally rather frequent; 9–2. Fish Hoek and Chapman's Bay southward.

4. **G. tomentosum** Thunb. Sandy bushy places, rare; 11. Between Retreat and Muizenberg, *Wolley-Dod*, 3680.

DIPSACEÆ.

Cephalaria rigida Schrad. Hill and mountain slopes to about 2,000 feet, occasional; 1–2. Devil's Peak; Orange Kloof; Constantia Nek; Steenberg Farm.

Scabiosa Columbaria Linn. Flats and hill slopes, frequent; 8–12. A very variable plant.

2. **S. africana** Linn. Hill slopes, frequent; 7–11.

COMPOSITÆ.

Corymbium nervosum Thunb. Hill and mountain slopes, common; 11–1. Reaches Lower Plateau.

2. **C. glabrum** Thunb. "Simon's Bay," *MacGillivray.* "Wynberg," *Dr. Wallich.* Not found by us.

3. **C. scabrum** Linn. f. Chiefly on flats, but also hill and mountain slopes, rather common; 11–1. Reaches Lower Plateau.

Pteronia hirsuta Linn. f. Dry ground northern and western foot of Table Mountain, rare; 11–12. *Bolus*, 4500.

2. **P. camphorata** Linn. Sandy flats, rare; 8–10. Klassenbosch; Chapman's Bay; "Simon's Bay," *Wright.*

Amellus Lychnitis Linn. Sandy flats, locally common; 10–11. Hout and Chapman's Bays.

Charieis heterophylla Cass. Sandy flats, occasional; 9–10. Camp Ground; about Maitland and Paarden Islands; Farmer Peck's Valley; Chapman's Bay. All the examples we have seen have the disc florets bright deep blue.

Mairea crenata Nees. Mountain plateaux, locally frequent; 9–12. Lower Plateau and summit of Table Mountain; near Wynberg reservoir.

2. **M. taxifolia** DC. Mountain slopes and plateaux, common; 2–3, also 6–8, probably flowers the whole year. Reaches summit of Table Mountain.

3. **M. lasiocarpa** DC. Mountain slopes, rare; 5. "Above Orange Kloof, 2,000 feet," *Schlechter*, 732.

Aster fruticosus Linn. Low hill slopes, common; 9–11.

Felicia tenella Nees. From flats to mountain tops, very common; 10–2. Reaches Lower Plateau. A most variable plant.

2. **F. reflexa** DC. Mountain slopes and sides of kloofs, common; 7–8. Reaches summit of Twelve Apostles.

3. **F. maritima** Bolus. Sandy flats, rare; 1. Near Maitland, *Bolus*, 6265.

4. **F.** (**Aster Bergerianus** Harv.). Flats and hill slopes, local; 9–10. Signal Hill; Green Point Common?; "Lion's Mountain," *Ecklon*.

5. **F. adfinis** Nees. "Lion's Mountain," *Ecklon*. Not found by us.

6. **F.** (**A. Pappei** Harv.). Sandy flats, apparently frequent; 9–12. Hout, Chapman's, and Buffel's Bays; Camp Ground, &c. Very different-looking from the form of **Charieis heterophylla** with blue disc florets (the only form we have seen of that species), but very like and has been confounded with **A. elongatus** Thunb. var. **spathulifolius** Harv. The latter species has, however, a biseriate involucre and a ligneous stem, though plants flowering the first year might be mistaken for the present species.

7. **F.** (**A. Cymbalariæ** Thunb.). Shady rocks, rather rare; 12–3. Waterfall, Devil's Peak; rocks over Tokay; Table Mountain, 3,000 feet; "above Simon's Bay," *Milne*.

8. **F.** (**A. Candollei** Harv.). Damp kloofs, rare; 11–12. Orange Kloof River; waterfall, Devil's Peak, very rare or extinct in the latter station.

? **F.** (**A. elongatus** Thunb.). "Devil's Peak," *Schinz*. Not found by us. (See remarks under **A. Pappei.**) Failing better evidence, we question its existence on the Peninsula.

9. **F.** (**A. capensis** Less.). Hill slopes, rare; 10. West slopes of Slangkop; "Table Mountain," *Thunb.*

10. **F.** (**A. æthiopicus** Burm.). Bushy places, frequent; flowers the whole year and reaches 3,000 feet.

†**Erigeron canadense** Linn. Frequent about gardens and orchards; 8–11. Also on Lower Plateau.

Nidorella foliosa Cass. Sandy places, rare; 10–3. By the Kommetje, Chapman's Bay; near Muizenberg; "dry hills round Cape Town and Kamp's Bay," *Wallich*.

†**Conyza ambigua** DC. Waste places and railway banks, common; 7–12. Often misnamed **Erigeron canadense,** but quite different from that species in its purplish tubular ray florets, and in being twice the size in all its parts, and with dark, not pale yellowish-green foliage.

2. **C. pinnatilobata** DC. By streams and vleys, rare; 12–5. Several places in Orange Kloof; Rapenburg Vley.

3. **C. pinnatifida** Less. Similar situations, rather rare; 2–4. Muizenberg, Retreat, and Rapenburg Vleys.

4. **C. ivifolia** Less. Bushy swampy places, frequent; 1–4.

Chrysocoma Coma-aurea Linn. Flats and hill slopes, very common; 9–11.

Brachylæna neriifolia R. Br. Mountain sides, rare. Muizenberg. Never seen by us in flower on the Peninsula.

Tarchonanthus camphoratus Linn. Slopes near the sea, rather locally common; 1–2. Foot of Twelve Apostles; Kalk Bay; from Miller's Point southward.

Ifloga (**Trichogyne reflexa** Less.). Sandy flats, common; 9–10.

2. **I.** (**T. seriphioides** Less.). Sandy flats, locally abundant; 9–3. Chapman's Bay; more rarely on Camp Ground; "Wynberg," *Burchell*, 893; "Table Mountain and above Simon's Bay," *Milne.*

3. **I.** (**T. laricifolia** Less.). Clayey flats and slopes, locally frequent; 3–5. Pastures at Observatory; about Lion Battery; Cape Flats.

4. **I. polycnemoides** Fenzl.? Sands near sea, rare; 4. "Near Muizenberg," *Schlechter*, 629.

Gnaphalium undulatum Linn. Hill and mountain slopes, rare? 10–11. Kirstenbosch; "Devil's Peak," *Berg;* "above Kirstenbosch," *Lessing.*

2. **G. candidissimum** Lamk. Dry flats and low hill slopes, common; 10–11.

3. **G. repens** Linn. "Sea-shore near Cape Town," *Thunberg.* Not found by us.

4. †**G. purpureum** Linn. Waste places, frequent; 9–10. A plant from ditches in Vaarsche Vley, *Wolley-Dod*, 3201, looks very different from the usual form of dry places, in having dark-green subglabrous foliage, and dark brown involucral scales, but it corresponds exactly with North American specimens at Kew.

5. †**G. luteo-album** Linn. A frequent plant of waste places; 9–11. A cosmopolitan species, very likely native.

6. **G. pauciflorum** DC. Bare rocks and dry open spots, rare; 9–10. Oatlands Point; summit Twelve Apostles. The latter plant approaches **G. glomerulatum** Sond. in its subuniseriate, truncate involucral scales, and perhaps really is that species.

7. **G. parvulum** Harv. Under shrublets on hill slopes, occasional; 9–10. Lion's Head; Kirstenbosch; Devil's Peak; Slangkop.

Helipterum speciosissimum DC. Hills and mountains to about 3,000 feet, frequent; 7–12.

2. **H. variegatum** DC. Flats, rare; 8–9. Fish Hoek Valley; "Simon's Bay," *Wright.*

3. **H. canescens** DC. Flats to mountain slopes, frequent; 11–7. Above 2,000 feet on Chapman's Peak and Constantiaberg.

4. **H. gnaphaloides** DC. Flats to mountain slopes, frequent and locally abundant; 9–12. Reaches 3,000 feet in Kasteel Poort.

Helichrysum capillaceum Less. Bushy slopes, rare; 9–10. Near Smitswinkel Bay, *Wolley-Dod*, 2975.

2. **H. expansum** Less. Dry sandy and waste places, very common; 10–5. Reaches 1,000 feet in Orange Kloof.

3. **H. ericifolium** Less. Dry gravelly soil and path-sides, frequent; 9–5. Leaves frequently strongly reflexed.

4. **H. declinatum** Less. Rare; 9–2. Simon's Town; "Orange Kloof," *Schlechter.*

5. **H. serpyllifolium** Less. Grassy or bushy places, frequent; 11–5. Reaches summit of Table Mountain, though rare over 500 feet.

6. **H. cylindricum** Less. Hill slopes, rare; 10. "Behind Kamp's Bay," *MacOwan*, Herb. Norm. 104.

? **H. imbricatum** Less. Sandy flats, rare; 10. Said to have been found within our limits, but we know of no authentic record nearer than Duinefontein sandhills, *Wolley-Dod*, 1854, which is well beyond them.

7. **H. crassifolium** Less. Sandy ground at low elevations, frequent; 11–12.

8. **H. rotundifolium** Less. Mountain rocks, rare; 12–5. Constantiaberg; "Orange Kloof," *Schlechter.*

9. **H. grandiflorum** Less. Mountain rocks, frequent; 12.

10. **H. fruticans** Less. Shady rocks on mountains, occasional; 9–12. Skeleton ravine; Constantiaberg; Kasteel Poort; near summit of Table Mountain.

11. **H. paniculatum** Thunb. "Devil's Peak," *Mund.* Not found by us.

12. **H. retortum** Thunb. Sandhills near sea, local; 9–12. Near Simon's Town; Fish Hoek, up to 500 feet; Kamp's Bay.

13. **H. marifolium** DC. "Table Mountain," *Drège.* Not found by us.

14. **H. fœtidum** Cass. Bushy hill slopes, frequent; 12–1. The dull yellow form is the commonest.

15. **H. rutilans** Less. Dry sandy flats, local; 11–2. Beyond Uitvlugt; abundant on Kenilworth Racecourse.

16. **H. nudifolium** Less. Open hill slopes, occasional; 3–6. Devil's Peak; Orange Kloof; Constantia Nek; Steenberg.

17. **H. gymnocomum** DC. "Between Newlands and Paradise," *Burchell.* Not found by us.

18. **H. odoratissimum** Less. Hill and mountain slopes, very common; 8–11. Reaches 2,500 feet.

19. **H. cymosum** Less. Bushy flats and hill slopes, common; 9–2.

20. **H. parviflorum** DC. Hill and mountain slopes, common; 9–2.

21. **H. maritimum** Less. Slopes near sea, locally common; 9–11. About and beyond Simon's Town; beyond Sea Point; Hout Bay; Devil's Peak at 700 feet.

22. **H. teretifolium** Less. Flats and slopes to 2,500 feet, common; 9–10.

23. **H. capitellatum** Less. Bushy mountain slopes, locally common; 1–3. Eastern slopes Devil's Peak; "Table Mountain sides," *Berg.*

24. **H. revolutum** Less. Hill slopes, rare; 9–10. Beyond Sea Point; "between Constantiaberg and Hout Bay," *Schlechter;* "about Table Mountain," *Berg.*

25. **H. crispum** Less. Hill slopes, frequent; 12–1.

26. **H. auriculatum** Less. Mountain slopes, frequent; 12–1.

27. **H. vestitum** Less. Mountain slopes and plateaux, common; 12.

28. **H. humile** Andr. Mountain slopes and rocks, occasional; 9–11. Waai Vley; Kasteel Poort; Kalk Bay Mountains; plentiful on Constantiaberg.

29. **H. sesamoides** Thunb. Flats to mountain slopes, common; 8–12.

Leontonyx squarrosus DC. Flats to mountain slopes up to 2,000 feet, occasional; 11–2. Constantiaberg; Orange Kloof; Devil's Peak; beyond Uitvlugt.

2. **L. glomeratus** DC. Mountain slopes, occasional; 12. Summit of Table Mountain; "low ground at Simon's Bay," *Milne;* "Lion's Head," *Pappe.*

3. **L. angustifolius** DC. "About Cape Town," *Eckl.* and *Zeyh.;* "Flats near Kenilworth," *Schlechter.* Not found by us.

4. **L. spathulatus** Less. Flats and mountain plateaux, rare; 11–12. Railway near Maitland Bridge; path near summit of Table Mountain. A plant with dense greenish-yellow tomentum, from beyond Sea Point (*Wolley-Dod,* 3649), probably belongs here.

Phœnocoma prolifera Don. Slopes and plateaux, rare; 9–12. Muizenberg; Klaasjagersberg; Simonsberg; Patrys Vley.

Anaxeton arborescens Cass. Mountain slopes, common; 5–8.

2. **A. nycthemerum** Less. "Southern slopes of Devil's Mountain," *Berg.* Not found by us.

3. **A. asperum** DC. Hill slopes and plateaux, locally frequent; 5–8. From Steenberg to Smitswinkel. Var. **læve** Harv. is the only form we have noticed.

Petalacte coronata Don. Flats and hill slopes, frequent; 6–10.

Perotriche tortilis Cass. Flats and hill slopes, rare; 3. "East slopes Devil's Peak," *Guthrie*, 973.

Stœbe rosea Wolley-Dod. Hill and mountain slopes, locally frequent; 1–3. From Muizenberg southwards.

2. **S. æthiopica** Linn. Mountain slopes, frequent; 11–1

3. **S. prostrata** Linn. Mountain rocks, rare; 2. Summit of Table Mountain.

4. **S. fusca** Thunb. Dry hill slopes, rare?; 3–4. Hout Bay; hills west of Simon's Town.

5. **S. incana** Thunb. Mountain slopes, frequent; 1–3.

6. **S. capitata** Berg. Flats and mountain slopes, locally frequent; 12–3. Near Rondebosch; east slopes Constantiaberg.

7. **S. alopecuroides** Less. "Devil's Peak," *Mund* and *Maire*. Not found by us.

8. **S. cinerea** Thunb. Dry flats to mountain slopes, common; 11–6. Reaches 2,500 feet.

Disparago laxifolia DC. "Near Simon s Bay," *Wright*, 353. Not found by us.

2. **D. seriphioides** DC. "Flats near Rondebosch and Salt River," *Burchell*, 706, 829. Not found by us.

3. **D. lasiocarpa** Cass. Mountain slopes, occasional; 1, 7. Steenberg; near Chapman's Peak; Muizenberg; Kenilworth; "Hout Bay," *Harvey*.

4. **D. anomala** Schltr. Dry flats, rare; 1–2. Smitswinkel Vley, *Wolley-Dod*, 766.

Elytropappus glandulosus Less. Flats and hill slopes, common; 3.

2. **E. canescens** DC.? "Near Hout Bay," *Schlechter*. Identification doubtful.

3. **E. Rhinocerotis** Less. Foot of mountain slopes, occasional; 7–8. Rosebank; Mowbray, &c.

Bryomorphe Zeyheri Harv. Mountain tops, rare; 11–1. "Summit of Table Mountain," *Schlechter*.

Metalasia imbricata Harv. Flats, apparently rare; 1–2. Near Rapenburg.

2. **M. umbellata** Linn. Mountain slopes, rare; 1–2. "Simons Town," *A. Bodkin*.

3. **M. Cephalotes** Less. Flats and dry hill slopes, frequent; 7–1. A very variable plant. The name perhaps covers more than one species.

4. **M. depressa** Harv. "Summit of Table Mountain," *Ecklon*, *Pappe*, &c. Not found by us.

5. **M. divergens** Don. Similar places to **M. Cephalotes,** but extends higher, rather frequent; 7–3. Reaches summit of Table Mountain.

6. **M. adunca** Less. "Near Constantia," *Mund.* Not found by us.

7. **M. muricata** Less. Flats, hills, and mountains; very common; 6–9.

8. **M. fasciculata** Don. Mountain slopes, rare; 11. Muizenberg? *Bolus*, 7293; "About Cape Town," *Harvey.*

Relhania ericoides Cass. Hill slopes, locally frequent; 9–10. Slopes and summit of Signal Hill.

2. **R. genistifolia** L'Hérit. Flats and hill slopes, occasional; 8–9. Lion's Head; Signal Hill; Kasteel Poort; north slopes Devil's Peak; Observatory.

3. **R. sessiliflora** Thunb. Gravelly fields, rare; 11. Sea Point.

Leyssera gnaphaloides Linn. Hill slopes, local; 9–10. Near Groot Schuur; frequent west slopes Lion's Head.

? **L. incana** Thunb. "Round Cape Town," *Eckl.* Not found by us, and a doubtful species.

Athrixia heterophylla Less. Mountain slopes, locally frequent; 8–9. Above Klassenbosch and in Orange Kloof.

2. **A. capensis** Ker. Similar situations, but rarer?; 8–9. Above Kirstenbosch; Steenberg.

Printzia Bergii Cass. Hill slopes, rare; 8–9. By the silver-trees on Devil's Peak.

2. **P. aromatica** Less. Mountain slopes, rather rare; 12–1. Table Mountain; Muizenberg; north slopes Constantiaberg.

Pulicaria capensis DC. Vleys and damp places, frequent; 1–2. Reaches 800 feet on west slopes of Lion's Head.

Osmites dentata Thunb. Hill and mountain slopes, especially by damp rocks, common; 10–2. Reaches 3,200 feet in Waai Vley.

2. **O. hirsuta** Less. "Table Mountain," *Mund.* Not found by us.

Osmitopsis asteriscoides Cass. By streams and vleys on hills and mountains, very common; 8–11. Reaches over 3,000 feet.

†**Xanthium spinosum** Linn. Waste places, casual; 3–6. Alphen Bridge; Observatory; about Simon's Town; frequent near Mowbray Station.

2. †**X. strumarium** Linn. Waste places, casual. Near Cape Town.

†**Ambrosia artemisiifolia** Linn.? Waste places, rather rare; 4–5. Round the Castle; Observatory; Maitland Bridge; railside beyond Wynberg. The species may be **A. tenuifolia** Spreng.

Bidens pilosa Linn. Wet places, rare; 11. Roadside, Newlands; Orange Kloof Farm; above Klein Constantia.

Eriocephalus septulifer DC. Mountain slopes, rare ; 8–9. By King's Blockhouse.

? **E. sericeus** Gaudich. " Not uncommon round Cape Town," *De Cand.* Not found by us, but we suggest its identity with the last species, the phyllaries of which are as often septiferous as not so in the same head.

2. **E. umbellulatus** DC. Dry slopes on hills and mountains, common ; 6–9.

3. **E. racemosus** Linn. Dry sandy ground, local ; 9–10. Plentiful in Chapman's Bay.

Athanasia parviflora Linn. Hill slopes to about 1,500 feet, frequent ; 11–12.

2. **A. capitata** Linn. Dry flats and hill slopes, occasional ; 11–3. Green Point Common ; east slopes and foot of Devil's Peak ; Constantia Nek ; " Lion's Back," *Eckl.*

3. **A. flexuosa** Thunb. " Signal Hill, December," *Schlechter.*

4. **A. trifurcata** Linn. Dry roadsides, rather rare ; 11–1. Near Hout Bay Nek ; east of Maitland Cemetery ; roadside beyond Simon's Town.

5. **A. crithmifolia** Linn. Common and general ; 11–12.

6. **A. linifolia** Harv. " Camp Ground," *Harvey.* Not found by us.

7. **A. dentata** Linn. Dry places on flats and low hill slopes, frequent ; 11–1.

Œdera latifolia Less. Hills and mountain slopes, rather frequent ; 8–10. Devil's Peak ; several places from Constantia Nek to Simon's Town.

2. **Œ. prolifera** Linn. f. Flats and hills, frequent ; 7–10. Reaches Kasteel Poort, but rarely exceeds 1,500 feet.

†**Chrysanthemum segetum** Linn. Waste ground, rare ; 12. Herschel Lane, Claremont.

2. †**C. coronarium** Linn. Waste ground, occasional ; 9–11. Klein Constantia ; Orange Street ; Kirstenbosch ; Three Anchor Bay, &c.

Matricaria capensis Linn. Sandy places, rare ; 11–12. Hillocks in Vaarsche Vley, *Wolley-Dod*, 3646.

2. **M. hirta** DC. " Wet places near Cape Town," *Thunberg ;* " Marshes near Salt River," *Harvey.* Not found by us, but we much doubt its distinctness from **M. capensis.**

3. **M. multiflora** Fenzl. Sandy places near the shore, locally abundant ; 9–11. Sea Point ; Paarden Island ; Simon's Town ; Miller's Point ; rare in Chapman's Bay.

4. **M. sabulosa** Wolley-Dod. Sandy shores, rare ; 11. Shore beyond Sea Point, *Wolley-Dod*, 3421.

Otochlamys Eckloniana DC Gravelly flats, rare. " Green Point," *Schlechter*, 9022. Not found by us.

Cotula myriophylloides Harv. In water, very local; 10–11. Effluent from the Kommetje; Muizenberg Vley; Green Point Common.

2. **C. coronopifolia** Linn. By sluits and muddy places, common; 7–11. Seen on Lower Plateau, but rarely so high.

3. **C. pusilla** Thunb. Damp spots on the flats, frequent; 7–10.

4. **C. filifolia** Thunb. Similar places to the last, and often mixed with it, common; 7–10. The strong form, which grows in water, var. **decumbens** Harv., is not always associated with broader leaves nor more bearded sheaths, and it looks perennial.

5. **C. bracteolata** E. Mey. "Paarden Island," *Burchell, Drège.* Not found by us.

6. **C. (Cenia) turbinata** Linn. Flats to mountain slopes, very common; 7–12. The two colour forms do not seem to amalgamate. The one with white rays, purplish beneath, and a dull greyish-yellow disc, rarely or never ascends above a few hundred feet. That with both disc and ray bright golden-yellow (not discoloured beneath) is found chiefly on the slopes, as far as the Lower Plateau. Except in colour, we see no difference between them.

Hippia gracilis Less. Mountain slopes, under shrublets, common; 8–10. Reaches nearly to the summit of Table Mountain.

Alciope tabularis DC. Hill and mountain slopes in rather damp places, frequent; 1–4. This is one of those species which flower most abundantly after a fire, independent of the season.

Cineraria geifolia Linn. Flats to mountain slopes, common; 9–10. Very variable in leaf-cutting and pubescence. Reaches 2,500 feet.

†**Senecio vulgaris** Linn. An occasional weed of cultivation; 7–12.

2. **S. maritimus** Linn. Sandy sea-shores, very common; 9–3.

3. **S. littoreus** Thunb. Sandy and cultivated ground, very common; 9–10.

4. **S. abruptus** Thunb. Flats and hill slopes, partial to damp places, frequent; 8–10.

5. **S. repandus** Thunb. Shady spots under rocks, at moderate elevations, rare; 9–10. Lion's Head; slopes near Smitswinkel Bay (with glabrous involucral scales). The latter is probably Wright's "Simon's Town" station, Fl. Cap. III. 356.

6. **S. lævigatus** Thunb. Mountain slopes, occasional; 10–1. Devil's Peak; Muizenberg; Red Hill; "Simon's Bay," *Wright.*

7. **S. glutinarius** DC. Sandy ground near sea, rare; 9–10. Hout Bay; Chapman's Bay.

8. **S. glutinosus** Thunb. "Table Mountain and round Cape Town," *Thunberg.* Not found by us, but see remark under **S. hastulatus.**

9. **S. elegans** Linn. Low sandy ground, frequent; 7–10. Reaches 1,000 feet over Newlands.

10. **S. arenarius** Thunb. Flats and slopes to 2,000 feet, common; 8–10. With white rays in Chapman's Bay.

11. **S. speciosus** Willd. Hill and mountain slopes, partial to damp shade, frequent; 7–11. Reaches 3,200 feet in Waai Vley. This is the plant which Harvey puts under **S. concolor** DC., a Chinese species which occurs in Natal and the Katberg, and is the plant referred to as "DC.'s typical form" in Fl. Cap. III. 363.

12. **S. erubescens** Ait. Hill slopes, rarely over 1,000 feet, frequent; 7–10. With white flowers near Wynberg Reservoir, and on summit of Twelve Apostles.

13. **S. purpureus** Linn. Hill slopes, partial to damp kloofs, occasional; 7–10. Orange Kloof swamp; frequent behind Groot Schuur.

14. **S. erosus** Linn. Dry sandy ground and hill slopes, occasional, or locally frequent; 8–10. West slopes Lion's Head and Kamp's Bay; Klein Slangkop; summit of Elsje Peak; frequent Chapman's Bay and beyond Simon's Town.

15. **S. hastulatus** Linn. Hill slopes, frequent; 7–10. Reaches 2,000 feet on Devil's Peak. Without the root or radical leaves this is almost indistinguishable from **S. glutinosus.**

16. **S. crispus** Thunb. Mountain plateaux, locally common; 12–2. Lower Plateau of Table Mountain; Waai Vley.

17. **S. crenulatus** DC. Apparently very rare; 6. Two plants gathered beyond Miller's Point, *Wolley-Dod,* 2620.

18. **S. cordifolius** Linn. f. Mountain slopes at foot of rocks, frequent; 2–5. Reaches summit of Devil's Peak.

19. **S. cymbalariifolius** Less. Mountain slopes, usually above 1,000 feet, frequent; 8–12. An extraordinarily variable plant. Most of the Peninsula specimens are var. **purpureus,** but forms near var. **rotundifolius** may be found in Waai Vley, and var. **hastifolius** (with whitish rays) on the Steenberg; Slangkop; and in Patrys Vley.

20. **S. diversifolius** Harv. Sandy ground near sea, locally frequent; 9–10. Hout Bay; Chápman's Bay. Only var. **integrifolius** seen.

21. **S. verbascifolius** Burm. At the foot of mountain rocks, rare; 9–12. Kloof beyond Kirstenbosch; Constantiaberg; Waai Vley, at 3,000 feet.

22. **S. pubigerus** Linn. Flats and slopes to over 3,000 feet, very common, flowering all the year.

23. **S. lyratus** Linn. f. Mountain slopes and plateaux, local; 10–2. Slangkop (type); top of Skeleton Ravine (var. **lacerus**).

24. **S. rigidus** Linn. Flats and hill slopes to at least 1,000 feet, common; 9–12. A stunted form is found on the summit of Table Mountain.

25. **S. arniciflorus** DC. Low sandy ground, rather rare; 9–10. Hout Bay; Fish Hoek; Dido Valley; Paulsberg.

26. **S. lanceus** Ait. By vleys on flats, rare; 1–4. Muizenberg and Retreat Vleys (both var. **subinteger**).

27. **S. halimifolius** Linn. Damp sandy flats, occasional; 11–12. Muizenberg and Retreat Vleys; Wynberg Hill; Maitland; between Alphen and Tokay.

28. **S. glastifolius** Linn. f. "Summit of Table Mountain, January, February," *Thunberg*. Not found by us.

29. **S. lineatus** DC. Hill and mountain slopes, frequent; 3–5.

30. **S. umbellatus** Linn. Flats and dry hill slopes, occasional; 10–11. Retreat; Steenberg; Klaver Vley; near Slangkop; south of Uitvlugt; "Table Mountain," *Mudd*. **S. linoides** DC. (Fl. Cap. III. 407) appears to be this species, or very near it.

31. **S. grandiflorus** Berg. Hill and mountain slopes, frequent; 10–12. Reaches 3,000 feet in Waai Vley.

32. **S. pinnulatus** Thunb. Rare; 7. Vineyards near Wynberg; "about Table Mountain," *Drège*.

33. **S. fœniculoides** Harv. Sandy ground, rare; 1–2. Cape Flats; Camp Ground.

34. **S. bipinnatus** Less. Mountain slopes and plateaux, locally frequent; 11–2. Lower Plateau; east slopes Table Mountain.

35. **S. paniculatus** Berg. Mountain slopes and tops, rather frequent; 11–1. Muizenberg; Lower Plateau; Silvermine Valley.

36. **S. rosmarinifolius** Linn. f. Roadsides and dry places on flats, frequent; 11–12.

37. **S. Burchellii** DC. Flats and hill slopes to about 1,000 feet, very common; 8–4.

38. **S. pinifolius** Lam. Hill slopes, frequent, especially after fires; 1–6.

39. **S. triqueter** Less. Hill slopes, occasional; 12–3. Kalk Bay hills; Klaver Vley.

40. **S.** (**Kleinia radicans** DC.). "Simon's Town Mountains, 500 feet," *Schlechter*. Not seen by us.

41. **S.** (**K. crassulifolia** DC.?). Dry rocks, very local, flowers not seen. Lion's Head; Klein Slangkop. Leaves subterete, decidedly tapering to base. Possibly **K. repens** or **ficoides.**

Euryops pectinatus Cass. Rocky places on mountains, occasional; 10–12. North side Table Mountain; Twelve Apostles; Constantiaberg; Klaasjagersberg; Lion's Head; Devil's Peak.

2. **E. abrotanifolius** DC. Hill and mountain slopes to at least 2,800 feet, common; 7–9.

Gamolepis annua Less. Sandy flats and lower slopes, frequent; 8–9. Reaches 1,000 feet in Orange Kloof.

Gymnodiscus capillaris Less. Sandy flats and low hills, very common; 6–9.

Othonna digitata Linn. f. Sandy flats, frequent; 7–9.

2. **O.** (**Doria perfoliata** Thunb.). Sandy places among rocks or bushes, rather rare; 8–9. Kasteel Poort; Hout Bay; Klein Slangkop; occasional from Dido Valley to Paulsberg.

3. **O. Lingua** Linn. f. Sandy flats, common; 6–8. We are not sure that both this and the last species are found on the Peninsula, if they are really distinct, which seems doubtful. We have applied the former name to slender, rampant, large-leaved plants, the latter to small, erect ones, but there is no difference in the pappus nor in the pubescence of the achenes.

4. **O. coronopifolia** Linn. Dry ground on flats or low slopes, usually near the sea, locally frequent; 10–1. From Retreat, southward; "Salt River," *Harvey.*

5. **O. ciliata** Linn. f. Hill slopes, locally frequent; 7–10. Signal Hill to Kamp's Bay.

6. **O. parviflora** Linn. From flats to summit of Table Mountain, rather common; 1–7.

7. **O. amplexicaulis** Thunb. Mountain slopes, rare; 5. "Orange Kloof," *Schlechter*, 730. Not found by us. Wright's 296 from Simon's Town is **O. dentata.**

8. **O. dentata** Linn. Mountain rocks, occasional; 6–11. Lower Plateau; from Vlaggeberg to Kalk Bay; Slangkop; Miller's Point.

9. **O. arborescens** Linn. Mountain rocks, frequent; 6–9. Never seen below 500 feet. Drège's plant from "Cape Flats" must have been a casual.

10. **O. linifolia** Linn. f. In damp places on flats or low hills, frequent; 6–8.

11. **O. tuberosa** Thunb. Sandy flats, frequent; 5–10.

12. **O. heterophylla** Linn. f. Gravelly flats, rather frequent; 5–8. Uitvlugt; Rondebosch; Kenilworth; Orange Kloof; reaches 1,000 feet on Devil's Peak.

13. **O. pinnata** Linn. f. Gravelly hills, locally frequent; 5–9. Lion's Back; beyond Kamp's Bay; Orange Kloof; behind Mowbray.

Dimorphotheca pluvialis Moench. Flats and low hills, very common; 8–9.

2. **D. nudicaulis** DC. Hill and mountain slopes, rarely on flats, frequent; 7–9. Reaches 2,600 feet on Lower Plateau, where we have seen it in flower in February.

3. **D. fruticosa** Less. Rocky and bushy places by the shore, local; 9–11. Kalk Bay to Miller's Point; Hout Bay; "Kamp's Bay," *Harvey.*

Tripteris rigida Harv. "Roadside between Wynberg and Constantia," *Wallich.* Not found by us.

2. **T. dentata** Harv. Dry sandy ground at foot of hills, frequent; 8–12. We include **T. arborescens** Less. and **T. amplectens** Harv. as synonyms.

3. **T. clandestina** Less. Roadsides and railway banks, especially on freshly turned soil, very common; 8–9.

4. **T. tomentosa** Less. Mountain slopes, rare; 6. "Near Hout Bay, 800 feet," *Schlechter*, 954.

Osteospermum moniliferum Linn. Bushy places on flats and mountains, frequent; 6–9.

2. **O. ciliatum** Berg. Rather damp places on hills or mountains, common; 11–1. Often in dense tangled masses.

3. **O. spinosum** Linn. Low hill slopes, locally frequent; 5–6? About Signal Hill and west slopes Lion's Head. This is one of those species which appears to flower at any time of the year. We have gathered it both in flower and fruit in January, May, June, and September.

4. **O. ilicifolium** Linn. Mountain slopes and plateaux, frequent; 8–2.

? **O. polygaloides** Linn. We doubt this being distinct from the next, having never seen the smooth fruit attributed to it. It is recorded from "Devil's Peak," *Pappe;* "Table Mountain," *Eckl.;* and "near Cape Town," *Harvey*.

5. **O. imbricatum** Linn. Flats to mountain slopes, frequent; 8–1.

Ursinia anthemoides Poir. Roadsides to mountain slopes, very common; 9–12. Reaches Lower Plateau. Sometimes mistaken for **U. annua** Less.

2. **U. dentata** Poir. Hill and mountain slopes, common; 7–4, but principally 9–11.

3. **U. nudicaulis** N. E. Br. Wet places on mountains, locally common; 12–2. From Waai Vley to summit.

4. **U. anethifolia** N. E. Br. Hill and mountain slopes, frequent?; 7–4.

5. **U. crithmifolia** Spreng. Flats to mountain summits, common; 7–2.

6. **U. trifurca** N. E. Br. Sandy ground, rare; 9. Lower slopes of Paulsberg, *Wolley-Dod*, 3027. Mr. Brown thinks **U. ciliaris** N. E. Br. probably synonymous.

7. **U. tenuifolia** Poir. Flats and hill slopes, frequent; 6–3. Partial to damp.

8. **U. filicaulis** DC. (**U. chrysanthemoides** Harv.) Sandy flats, rare; 9. Elsje Bay; near Retreat Station; between Groot and Klein Slangkop. The stems creep horizontally some 15 to 18 inches.

Haplocarpha lanata Less. Hill and mountain slopes, frequent, especially after fires; 3–5.

Arctotheca repens Wendl. Flats and hill slopes, rather rare; 6–12. Devil's Peak; near Rapenburg Vley; lower part of Orange Kloof; Sea Point; "Platteklip," *MacGillivray;* "Green Point, near Lighthouse," *Pappe.*

Cryptostemma calendulaceum R. Br. Roadsides and waste places, very common and very variable; 8–11. Seen on Lower Plateau, but imported with material for reservoir.

2. **C. Forbesianum** Harv. Flats, rare; 7–8. Rapenburg; beyond Uitvlugt. The primary leaf-lobes are often irregularly incised.

3. **C. niveum** Nicholls. Sandy sea-shores, rare; 8–9. Fish Hoek station.

Arctotis acaulis Linn. Flats and hill slopes, common; 7–9.

2. **A. leptorhiza** DC.? Sandy flats, locally frequent; 9–12. About Diep River, Retreat and Muizenberg. What we take for this species has pale orange ray florets, scarcely darker on backs, leaves scarcely paler beneath, thin, and somewhat sinuate-pinnatifid, and the whole plant viscous, with fibrous roots. But a plant to which this name is often given is frequently found on hill slopes, and might be taken for a small first year flowering state of **A. acaulis,** of which it has the deep yellow or orange ray florets, much darker on back, thick lyrate pinnatifid leaves, thickly white felted beneath, and the plant not clammy, with a hard wiry root. It is probably a distinct species.

3. **A. angustifolia** Linn. Flats and low hill slopes, frequent; 1–3.

4. **A. glandulosa** Thunb. Sandy flats, rare; 11. "Rapenburg," *Guthrie,* 232.

5. **A. aspera** Linn. Slopes and kloofs, from sea-level to 2,800 feet, frequent; 8–1.

6. **A. stœchadifolia** Berg. Sandy slopes near sea, rare; 9–10. Slangkop; hills west of Simon's Town; Chapman's Bay; Buffel's Bay.

Venidium hirsutum Harv. Sandy flats, rare; 9–12. Paarden Island; Three Anchor Bay.

Gorteria calendulacea DC. "Lion's Mountain," *Drège.* Not found by us.

2. **G. personata** L. Flats and hill slopes, frequent; 8–10.

Gazania pinnata Less. Gravelly flats and lower slopes, frequent; 9–10. Very variable. A more decumbent, dwarfer plant, with very scabrous leaves, often bipinnate, which we have seen near Hout Bay Nek and Chapman's Bay, may be a distinct species.

2. **G. Pavonia** R. Br. "Near Cape Town," *Thunberg;* "Green Point," *Wilms.* Not found by us.

Cullumia decumbens Less. "Muizenberg," *Eckl.* and *Zeyh.* Not found by us.

2. **C. squarrosa** R. Br. Sandy slopes by sea, locally common; 7–9. From Muizenberg to Miller's Point; Klein Slangkop; Hout Bay.

3. **C. ciliaris** R. Br. Mountain slopes, frequent; 8–10.

4. **C. setosa** R. Br. Low hill slopes, frequent; 7–9. Also seen in flower in April and December.

Berkheya carthamoides Willd. Open gravelly spots on flats and hill slopes, frequent; 12–1.

2. **B. carlinoides** Willd. "Devil's Mountain," *Thunberg;* "Lion's Mountain," *Mund.* Not found by us.

3. **B. grandiflora** Willd. Hill and mountain slopes, frequent; 10–1.

4. **B.** (**Stobæa pinnatifida** Thunb.). Hill slopes, rare; 10–11. Signal Hill and west slopes Lion's Head.

5. **B.** (**S. rigida** Thunb.). Roadsides and dry waste places, frequent; 8–2.

6. **B.** (**S. atractyloides** Thunb.). "Roadsides at foot of Table Mountain," *Eckl.;* "Muizenberg," *Burke.* Not found by us.

†**Silybum Marianum** Gærtn. Roadsides and waste places, occasional; 9–11. Beyond Kamp's Bay; Westerford; about Simon's Town; between Maitland and junction.

†**Carbenia benedicta** Adans. "About Cape Town," *Harvey.* Not found by us.

†**Carthamus lanatus** Linn. "About Cape Town," *Eckl.* and *Zeyh.* Not found by us.

†**Centaurea melitensis** Linn. About houses and orchards, occasional; 11–12. Klein Constantia; Kirstenbosch; Orange Kloof Farm; Maitland; Claremont.

2. †**C. Calcitrapa** Linn.? Waste ground, rare; 1–2. Green Point Common; Craig's Battery. We have seen, but not gathered this species.

Gerbera asplenifolia Spreng. Gravelly hills and mountain slopes, frequent, but rather local; 10–11. North slopes Devil's Peak; many places south of Constantia Nek.

2. **G. integralis** Sond. Mountains, very local; 2. Lower Plateau.

3. **G. Wrightii** Harv. Sandy hills, usually among rocks, local; 9–1. Muizenberg; Elsje Peak; Red Hill; Slangkop.

4. **G. Burmannii** Cass. Flats to mountain slopes, rather frequent; 9–1.

5. **G. piloselloides** Cass. Low hill slopes, frequent; 1–4.

Hieracium capense Linn. Hill slopes, rare; 12–3. Constantiaberg; Vlaggeberg; Orange Kloof; behind Wynberg Ranges.

†**Hypochoeris radicata** Linn. Flats, roadsides, and newly turned ground, occasional; 6–8. About Rondebosch and Groot Schuur; Wynberg Park; Orange Kloof.

2. †**H. glabra** Linn. Roadsides and cultivated fields, frequent; 8–10.

Lactuca capensis Thunb. Roadsides and banks, occasional; 11–2. West slopes Lion's Head; towards Constantia Nek; near Camp Ground; Groot Schuur and Newlands Woods.

Sonchus Ecklonianus DC. Hill slopes, occasional; 2–6. Signal Hill; Groot Schuur; Orange Kloof; towards Constantia Nek. We think **S. Dregeanus** DC. synonymous.

2. †**S. asper** Gærtn. Roadsides and waste places, frequent; 9–4.

3. †**S. oleraceus** Linn. Similar places, common; 9–4.

†**Urospermum picroides** Desf. Waste ground and low hills, very common; 7–11.

CAMPANULACEÆ.

Laurentia repens Benth. and Hook. Damp grassy hollows on flats, frequent; 11–3.

2. **L. arabidea** A. DC. Wet rocks and shallow streams, rare; 11–1. Orange Kloof River; between Vlaggeberg and Constantiaberg.

? **L. bifida** Sond. Wet places; 7. On path up Steenberg slopes. Perhaps a dwarf form of last.

Lobelia erinoides Thunb. Wet places on flats, frequent; 12–1.

2. **L. depressa** Linn. f. Damp hollows, inundated in winter, on flats and mountains, occasional; 11–2. Rapenburg Vley; roadsides beyond Camp Ground; Waai Vley and near summit.

3. **L.** (**Metzleria filicaulis** Presl.). "Table Mountain," *Schinz;* "near Cape Town, October," *Harvey.* Not found by us.

4. **L.** (**M. humifusa** A. DC.). Damp rocks on mountains, occasional; 11–1. Table Mountain at 3,000 feet over Lower Plateau; Constantiaberg; Muizenberg. This species may be the same as **L. alsinoides** Lam.

5. **L. debilis** Linn. f. Damp places on flats and low hills, frequent; 9–12.

6. **L. corymbosus** Grah. Mountain tops, rare; 12. Muizenberg, 1,200 feet, *Bolus*, 3858B.

7. **L. Eckloniana** A. DC. "Simon's Bay," *Wright;* "Table Mountain," *Eckl.* and *Zeyh.* Not found by us.

8. **L. lutea** Linn. Flats and hill slopes, common; 10–3. Not confined to wet places. Reaches 800 feet over Tokay.

9. **L. linearis** Thunb. "Near Maitland," *MacOwan;* "near Doornhoogde," *Eckl.* and *Zeyh.* Not found by us.

10. **L. setacea** Thunb. Dry flats to mountain slopes, common; 12–3.

11. **L. pinifolia** Linn. Similar places, common; 7–11.

12. **L. coronopifolia** Linn. Similar places, frequent; 7–4.

13. **L. Erinus** Linn. Dry banks, fields, and roadsides, very common; 7–4. Exceeds 1,000 feet on Table Mountain.

14. **L. triquetra** Linn. Flats to mountains, common; 8–3.

15. **L. Boivinii** Sond. Low hill slopes, rare; 6–9. Path to Smitswinkel Bay; shore below Slangkop.

16. **L. pubescens** Ait. Hills and mountain slopes, partial to rocky places, frequent; 10–2. Flowers usually white, rarely blue.

17. **L. anceps** Thunb. Wet places on flats, frequent; 12–4.

18. **L. aspera** Spreng. "Near the lesser waterfall on north side of Devil's Peak," *Ecklon;* "valley on the Muizenberg, April," *Schlechter*, 563! Not found by us.

Cyphia Phyteuma Willd. Flats to mountain slopes, occasional; 10–11. Wynberg Hill.

2. **C. incisa** Willd. Flats and hill slopes, rare; 9. Kamp's Bay; Signal Hill?

3. **C. Cardamines** Willd. Flats and hill slopes, locally frequent; 8–9. Camp Ground; Signal Hill; Green Point Common.

4. **C. campestris** E. and Z. "Sandy slopes, Constantiaberg, behind Hout Bay, May," *Schlechter*, 762! Not found by us.

5. **C. bulbosa** Berg. Flats and hill slopes, common; 8–10.

6. **C. crenata** Sond. "Simon's Bay," *Eckl.* and *Zeyh.* Not found by us.

7. **C. dentariifolia** Presl. "Side of Table Mountain near Constantia," *Eckl.* and *Zeyh.* Not found by us.

8. **C. digitata** Willd. Flats and hill slopes, frequent; 8–9.

9. **C. volubilis** Willd. Flats and hill slopes, frequent; 8–9.

10. **C. Zeyheriana** Presl. Hill and mountain slopes, occasional; 8–9. East slopes Devil's Peak; Wynberg Hill; Orange Kloof.

Lightfootia subulata L'Hérit. Flats to mountains, frequent; 11–12.

2. **L. rubens** Buek. "Near Cape Town, *Harvey*," *Sonder*. Not found by us.

3. **L. longifolia** DC. Flats and hills, rather frequent; 11–1. Beyond Uitvlugt; Muizenberg Vley; Klaver Vley.

4. **L. Thunbergiana** Buek. "Between Hout Bay and Wynberg, November–December, *Drège*," *Sonder*. Not found by us.

5. **L. oxycoccoides** L'Hérit. Flats to mountain tops, occasional; 11–4. Silvermine River; summits of Devil's Peak and Table Mountain; Muizenberg.

6. **L. fasciculata** Spreng (**L. tenella** A. DC.). Flats, frequent; 10–12.

7. **L. oppositifolia** A. DC. Flats and hills, frequent; 11–1.

Wahlenbergia capensis A. DC. Flats and hills, frequent; 10–11.

2. **W. depressa** Wolley-Dod. Mountain slopes, rare; 11. North slopes Lion's Head, *Wolley-Dod*, 3516.

3. **W. procumbens** A. DC. Damp grassy places, common; 10–4.

4. **W. paniculata** A. DC. Sandy flats, rather frequent; 9–12.

5. **W. exilis** A. DC. Dry roadsides and gravelly places, occasional; 10–11. Retreat Flats; above Kirstenbosch.

6. **W. cernua** A. DC. Dry hill slopes and roadsides, locally frequent; 12–1. From Devil's Peak to Constantia Nek.

7. **W. arenaria** A. DC. Sandy flats, occasional; 11–12. Paarden Island; Camp Ground; Hout Bay.

Microcodon glomeratum A. DC. Dry roadsides and waste places, common; 10–1.

2. **M. sparsiflorum** A. DC. "North slopes Table Mountain, October," *Ecklon*. Not found by us.

3. **M. hispidulum** Sond. Dry mountain slopes, rare; 9–11. North slopes Lion's Head, *Wolley-Dod*, 3093, 3530. "Table Mountain," *Eckl.* and *Zeyh.*

Roella ciliata Linn. Flats to mountains, common; 7–4; var. **Dregeana** *Sond.* is a well-marked variety; we have gathered it on Muizenberg.

2. **R. reticulata** A. DC. Flats to mountains, frequent; 12–4. Extend above Lower Plateau.

3. **R. amplexicaule** Wolley-Dod. Hill slopes, rare? 12–1. Silvermine River, *Wolley-Dod*, 808; "Simon's Bay," *MacGillivray*, 659; "hills above Simon's Town," *Milne*, 154.

4. **R. squarrosa** Berg. Hills and mountains, occasional; 12–2. Lower Plateau; summit of Twelve Apostles; hills about Simon's Town.

5. **R. muscosa** Thunb. Mountain rocks, very local; 12–2. Near Maclear's Beacon; top of Stinkwater Ravine, Table Mountain.

6. **R. decurrens** L'Hérit. "Near the plantation on Lower Plateau, March," *H. G. Flanagan* (7966! of herb. Bolus).

Prismatocarpus subulatus A. DC. Flats and hill slopes, frequent; 11–3.

2. **P. fruticosus** L'Hérit. "Table Mountain," *Eckl.* and *Zeyh.* Not found by us.

3. **P. nitidus** L'Hérit. Mountains, frequent; 11–2.

4. **P. sessilis** Eckl. Flats and mountains, frequent; 11–3.

5. **P. acerosus** Schinz. Summit of Table Mountain, rare; 12. *Bolus*, 7087!

Treichelia longibracteata Vatke. Hills, rare; 11. Wynberg Hill, near Claremont, *Wolley-Dod*, 1887!

ERICACEÆ.

§ Gigandra.

Erica Petiveri Linn. Mountain slopes, frequent; 8–4.

2. **E. penicillata** Benth. "Muizenberg," *Harvey*, in Herb. Trin. Coll. Dublin. Not found by us.

3. **E. Plukenetii** Linn. Mountain slopes, common; 8–4.

§ Didymanthera.

4. **E. monadelphia** Andr. "Simon's Bay, Dec.," *MacGillivray*, 441. Not found by us.

§ Pleurocallis.

5. **E. mammosa** Linn. Flats and mountains, common; 10–2.

6. **E. alveiflora** Salisb. Mountains, rather rare; 4, 11–12. Table Mountain; Devil's Peak.

7. **E. sessiliflora** Linn. f. Mountains, occasional; 5, 8–9.

8. **E. purpurea** Andr. Mountain slopes, occasional; 11–5. Eastern slopes.

9. **E. coccinea** Berg. Mountain slopes, occasional; 9–7. (Appears to flower all the year.)

10. **E. conica** Lodd. Mountain slopes, occasional; 7–8.

11. **E. annectens** Guth. and Bolus. "Kalk Bay," *Guthrie*, 1002!

12. **E. onosmiflora** Salisb. "Camp Ground, February," *Admiral Grey*. Not found by us.

§ Evanthe.

13. **E. abietina** Linn. Hills and flats beyond Simon's Town: locally frequent; 7–8.

14. **E. curviflora** Linn. By mountain streams and vleys, frequent; 8–11.

15. **E. verticillata** Berg. Flats, by low damp gullies, locally frequent; 1–3.

16. **E. brachialis** Salisb. Sea-shore, local and rather rare; 2. Beyond Kamp's Bay; Chapman's Bay.

§ Dasyanthes.

17. **E. cerinthoides** Linn. Flats to mountain slopes, frequent; 7–4.

§ Callista.

18. **E. fastigiata** Linn. "Table Mountain, Orange Kloof, 800 feet, June," *Schlechter*, 933! Not found by us.

19. **E. transparens** Berg. Mountains, occasional, 1–2. Table Mountain, various places to the summit.

§ Myra.

20. **E. glutinosa** Berg. Mountains, occasional; 12–2. Frequent on Lower Plateau.

§ Ephebus.

21. **E. pubescens** Linn. Mountain slopes, rather rare; 1–4. Devil's Peak; Lion's Head.

22. **E. pyramidalis** Soland. Flats, occasional; 4, 10. Wynberg.

23. **E. pusilla** Salisb. Chiefly on flats, more rarely on mountain slopes, occasional; 2, 4, 5, 8. Kenilworth, Wynberg, &c.

24. **E. distorta** Bartl. Rocky mountain slopes, rare; 6. Table Mountain.

25. **E. caterviflora** Salisb. Mountain sides, rare; 2. "Table Mountain, Hout Bay Stream," *Marloth*, 348!

26. **E. parviflora** Linn. Mountain slopes and tops, occasional; 5–10.

27. **E. intervallaris** Salisb. "Flats near Wynberg," *Niven*, 27. Not found by us.

28. **E. cyrilliflora** Salisb. "Marshy plain near Simon's Bay," *Niven*, 28, *Admiral Grey*. Not found by us.

29. **E. turgida** Salisb. Flats, occasional; 11–12. Wynberg.

30. **E. hirtiflora** Curt. Mountain slopes, frequent; 8–2. Abundant on Devil's Peak.

31. **E. mollis** Andr. Mountain slopes and tops, occasional; 11–12. Table Mountain.

32. **E. caffra** Linn. Mountain slopes and summits, rare; 8. Platteklip Gorge.

33. **E. marifolia** Soland. Mountain slopes, rare; 1–3. Table Mountain; Devil's Peak.

§ Ceramia.

34. **E. planifolia** Linn. Mountain slopes, occasional; 7–2. Various places on Table Mountain.

35. **E. oxycoccifolia** Salisb. Moist shady places on mountains, rare; 12. Table Mountain, 3,000 feet.

36. **E. thymifolia** Andr. Hill slopes, frequent; 10–12.

37. **E. strigosa** Soland.. Mountain slopes, rather rare; 6–10.

§ Desmia.

38. **E. obtusata** Klotzsch. Mountains, rare; 10. Head of Waai Vley, *Wolley-Dod*, 3257.

§ Gypsocallis.

39. **E. capillaris** Bartl. Flats and mountains, occasional; 10–1.

40. **E. nudiflora** Linn. Mountain slopes, frequent; 2–5.

§ Pyronium.

41. **E. paniculata** Linn. Hill and mountain slopes, frequent; 8–9.

§ Orophanes.

42. **E. pilulifera** Linn. Mountains, local; 8. Lower Plateau of Table Mountain.

43. **E. Bergiana** Linn. "Table Mountain near the waterfall," Coll. unknown, in Cape Gov. Herb. Not found by us.

44. **E. laeta** Bartl. Grassy hill and mountain slopes, occasional; 12–2. From Muizenberg southward.

45. **E. viridipurpurea** Linn. Flats and hill slopes, frequent; 8.

46. **E. subdivaricata** Berg. Flats and mountains, frequent; 10–5.

47. **E. margaritacea** Soland. Flats, frequent; 10–3.

48. **E. curvirostris** Salisb. Mountains, rare; 2–3. Lower Plateau, *Bolus*, 4480; "summit of Table Mountain," *Schoennberg*, (4907 of herb. Galpin).

§ Pachysa.

49. **E. multumbellifera** Berg. Flats and hills, common; 8, 11–5.

50. **E. mucosa** Linn. Flats and mountain slopes, occasional; 9, 12–3. From Rondebosch to Cape Point.

51. **E. physodes** Linn. Mountain tops, occasional; 5–9. Table Mountain to Simon's Bay. var. **urna-viridis** Bolus. Mountains, occasional and local; 7, 9, 12–3. Muizenberg.

52. **E. Fairi** Bolus. Mountains, occasional and local; 5–6. Mountains west of Simon's Town.

53. **E. obliqua** Thunb. Mountain slopes and tops, occasional; 1–5. Table Mountain; Muizenberg.

§ Hermes.

54. **E. empetrifolia** Linn. Mountains, occasional; 10–12. Table Mountain to Simon's Bay.

55. **E. pyxidiflora** Salisb. (**E. empetroides** Andr.). Mountains, occasional; 8–12. Table Mountain to Simon's Bay.

56. **E. amœna** Wendl. (**E. plumosa** Andr.). Moist places on mountains, rather rare; 11. Muizenberg to Cape Point.

57. **E. Dodii** Guth. and Bolus. Mountains, rare; 10–11. Head of Waai Vley, *Wolley-Dod*, 3333! *Galpin*, 3647!

58. **E. pulchella** Houtt. Flats and mountains, common; 12–3.

59. **E. viscaria** Linn. Flats and mountains, frequent; 3–4, 7–10, 12.

§ Arsace.

60. **E. hispidula** Linn. Mountains, frequent; 2–11 (flowers the whole year?).

61. **E. inops** Bolus. Mountains, occasional; 4, 7–8. Table Mountain to Muizenberg.

62. **E. tenuis** Salisb. Rocky places on mountains, rather rare; 11. Table Mountain; Constantiaberg.

§ Pseuderemia.

63. **E. sphærocephala** Wendl. "Rocky slopes of Constantiaberg, 2,000 feet, May," *Schlechter*, 784! Not found by us.

64. **E. clavisepala** Guth. and Bolus. "Shore below Slangkop, February," *Guthrie*, 1304.

§ Oxyloma.

65. **E. genistifolia** Salisb. Mountains, rare; 10–11. Table Mountain to Simon's Bay.

§ Eriodesmia.

66. **E. bruniades** Linn. Flats and hill slopes, common; 7–1.

67. **E. capitata** Linn. Flats, occasional; 10–2. Cape Town to Simon's Bay.

§ Amphodea.

68. **E. sexfaria** Bauer. Rocky mountain tops, rare; 12. Summit of Table Mountain.

69. **E. spumosa** Linn. Rocky places on mountains, occasional; 9–11. Table Mountain to Simon's Town.

§ Geissostegia.

70. **E. placentiflora** Salisb. "Slopes of Table Mountain near Hout Bay, June," *Schlechter*, 932!

71. **E. imbricata** Linn. Flats and mountains, very common; 4–10.

§ Elytrostegia.

72. **E. lasciva** Salisb. Flats, occasional; 2–3. Rondebosch to Wynberg.

73. **E. diosmifolia** Salisb. Rocky places on mountains, rare; 8–12. Summit of Table Mountain.

§ Platyspora.

74. **E. albens** Linn. "Summit of Table Mountain; 4," *Thunberg*. Not found by others nor by us, and now probably extinct.

§ Lamprotis.

75. **E. lutea** Berg. Mountains, frequent; 8–2. Reaches summit of Table Mountain.

76. **E. tenuifolia** Linn. Mountain slopes, occasional; 10–12. Table Mountain; Devil's Peak.

77. **E. chlamydiflora** Salisb. "Eastern slopes Table Mountain above Constantia" (in Cape Government Herb., collector unknown, but probably *Ecklon* and *Zeyher*). Not found by us. It has also been collected near Stellenbosch.

78. **E. gnaphaloides** Linn. Flats and mountains, occasional; 8–11.

79. **E. articularis** Linn. Mountain slopes, occasional; 11–5. Table Mountain.

80. **E. corifolia** Linn. Flats and lower mountain slopes, common; 12–4.

81. **E. palliiflora** Salisb. Lower mountain slopes, occasional; 8–11.

§ Eurystegia.

82. **E. Halicacaba** Linn. Rocky ledges, occasional; 10–3. Table Mountain to Elsje Peak.

§ Trigemma.

83. **E. plumigera** Bartl. " Amongst bushes on the eastern side of Devil's Peak, between 1,000 and 2,000 feet, *Eckl.* and *Zeyh.*," *Bartl.* Not found by us.

84. **E. baccans** Linn. Lower mountain slopes, frequent; 8–12.

85. **E. triflora** Linn. Lower mountain slopes, occasional; 7–11.

86. **E. depressa** Linn. In crevices of rocks, rare; 11–2. Summit of Table Mountain; Muizenberg.

87. **E. petiolaris** Lam. Rocky places on mountains, rare; 10–11. Table Mountain; Constantiaberg.

88. **E. brevifolia** Salisb. Mountain tops, occasional; 8–12. Table Mountain to Muizenberg.

§ Eurystoma.

89. **E. nivea** Forbes. Mountains, rare; 8–9. Lower Plateau mountains west of Simon's Town.

90. **E. calycina** Linn. Rocky places on mountains, frequent; 8–12.

91. **E. lucida** Salisb. Mountains, occasional; 8. Table Mountain; Devil's Peak.

§ Melastemon.

92. **E. cristiflora** Salisb. Mountain slopes, occasional; 8–9, 2. Table Mountain, 2,000 feet; Devil's Peak.

Philippia Chamissonis Klotzsch. Flats and hills, occasional; 2–4. Muizenberg; Fish Hoek.

Blaeria purpurea Linn. f. Mountains, occasional; 12. Table Mountain.

2. **B. ericoides** Linn. Dry places on flats or mountain rocks, common; 1–3.

Grisebachia (**Acrostemon hirsutus** Kl.). Mountains, rare; 7; " Simon's Town, 800 feet," *Schlechter*, 1074. Not found by us.

Simocheilus bicolor Benth. Flats and mountains, rare; 5. " Simon's Town Mountains," *Guthrie*, 1402; " Cape Flats, *Krauss*," *fide Klotzsch*. Not found by us.

2. **S. glabellus** Benth. Flats to mountain slopes, frequent; 6–10.

3. **S. depressus** Benth. Mountains, rare; 5. Near Simon's Town, *Bolus*, 4993.

4. **S.** (**Syndesmanthus articulatus** Klotzsch.). Flats, common; 2–3.

5. **S.** (**Syn. scaber** Klotzsch.). Mountain slopes, rare; 4–9. Near summit Twelve Apostles.

6. **S. (Syn. glaucus** Klotzsch.). Flats, rare; 1–2. "Near Salt River, *Burchell*, 705." Not found by us.

7. **S. (Syn. fasciculatus** Klotzsch.). Mountains, rare. *Fide Bentham,* but without exact locality. Not found by us.

Sympieza capitellata Licht. Mountains, rare; 5. Simon's Town, 800 feet, *Bolus*, 7005.

2. **S. brachyphylla** Benth. Flats and rocky places at low elevations, rare; 7–10. Rocky ridge by Smitswinkel Vley, *Wolley-Dod*, 1501; "flats near Claremont," *Guthrie*, 1012.

Scyphogyne urceolata Benth. Mountains, occasional; 1. Devil's Peak, 1,500 feet, *Bolus*, 4496.

2. **Sc. inconspicua** Brongn. Flats to mountain slopes, common; 9–3.

Salaxis axillaris Salisb. Flats to mountain slopes, frequent; 8–3.

2. **S. flexuosa** Klotzsch. Flats, rare; 5. Near Rondebosch, *Bolus*, 4010.

? S. ciliata Benth. We have this noted, and have little doubt, correctly; but the authority has been accidentally omitted. It was probably among Schlechter's collection.

3. **S. hexandra** Klotzsch. "Mountains near Cape Town," *Bentham.* Not found by us.

4. **S. rugosa** Benth. "Near Cape Town, *Zeyher*," *fide Bentham.* Not found by us.

5. **S. Sieberi** Benth. Mountain slopes and plateaux, rare; 2–8. Steenberg Plateau; Wynberg; Victoria Road, west slopes.

PLUMBAGINACEÆ.

Statice linifolia Thunb. Very similar to **S. equisetina** and **scabra**. There is some doubt as to which is the prevailing species.

2. **S. equisetina** Boiss. Flats where water has stood in winter, and sea-shores, frequent?; 12–2.

3. **S. corymbulosa** Boiss. "Kamp's Bay, May, *Krauss*," *fide Boissier.* Not found by us.

4. **S. scabra** Thunb. Similar situations to **S. equisetina**; 5. Near Retreat station; "Simon's Bay near to Nordhoek," *Milne.*

PRIMULACEÆ.

†**Anagallis arvensis** Linn. Hill slopes to at least 1,000 feet, common and general; 8–12. The form with pink flowers is much less frequent than that with blue.

Samolus campanuloides R. Br. By vleys and wet places on flats, frequent; 9–1.

2. **S. Valerandi** Linn. Similar situations, and as generally, though more thinly, distributed; 9–12. Reaches 500 feet on Lion's Head. It appears native, and extends into the interior of the Colony.

MYRSINACEÆ.

Myrsine africana Linn. Hill and mountain slopes, frequent; 9–10. Very common on Devil's Peak.

2. **M. melanophlæos** R. Br. Mountain slopes, occasional; 5–7. Eastern slopes, Table Mountain to Simon's Town.

EBENACEÆ.

Royena lucida Linn. Mountain slopes and kloofs, occasional; 11. Frequent at 1,500 feet over Groot Schuur, also in Skeleton Ravine, perhaps general.

2. **R. glabra** Linn. Hill and mountain slopes, frequent; 11–12. Descends below 100 feet at Claremont and Retreat.

Euclea racemosa Linn. Flats, rare; 2–3. Sandy downs towards False Bay.

SAPOTACEÆ.

Sideroxylon inerme Linn. Near shores, rare; 12. Chapman's Bay; "Van Kamp's Bay," *Burchell.*

OLEACEÆ.

Olea verrucosa Link. Flats and hill slopes, occasional, or perhaps frequent; 8–9. Hout Bay; Chapman's Bay; hills west of Simon's Town.

2. **O. capensis** Linn. Similar situations and more frequent; 11–2.

ASCLEPIADACEÆ.

Secamone Thunbergii E. Mey. Mountains, occasional; 11. Orange Kloof; "Table Mountain," *Harvey.*

Microloma lineare R. Br. Flats and hill slopes, rare; 7–8. Near Hout Bay Nek; Platteklip.

2. **M. sagittatum** R. Br. Similar situations, occasional; 7–8. Hout Bay; "Kamp's Bay; Uitvlugt," *Fair;* Chapman's Bay (a hairy form).

Astephanus neglectus Schltr. Slopes near the sea, rare; 5–6. Top of Red Hill road, Simon's Town; near Muizenberg.

Schizoglossum lamellatum Schltr. "Sandy slopes near False Bay, April," *Schlechter*, 605. Not found by us.

2. **S. Guthriei** Schltr. Hill slopes, rare; 11. "Tokay," *Fair*, *Guthrie*, 316.

3. **S. restioides** Schltr. Grassy flats, rare; 5. "Camp Ground," *Schlechter*, 740. Not found by us.

4. **S. pedunculatum** Schltr. Sandy flats, rare; 2. "Between Claremont and Kenilworth," *Schlechter*, 351, *Bodkin!* Not found by us.

5. **S. Aschersonianum** Schltr. Flats and hill slopes, rare; 12–4. Near Sandown Road, Rondebosch; Claremont; Kalk Bay Hills.

6. **S. Schinzianum** Schltr. Flats and hill slopes, rare; 9–2. Simonsberg; Orange Kloof.

Asclepias undulata Jacq. Hill slopes, rare; 1. Orange Kloof, *Bolus*, 7117.

2. **A. crispa** Berg. Flats and hill slopes, thinly scattered but general; 11–5.

3. **A. arborescens** Linn. Flats and slopes to over 1,000 feet, rather frequent; 4–8.

4. †**A. fruticosa** Linn. Roadsides, rare; 2–4. Mowbray station; near Simon's Town; by Victoria Bridge, Orange Kloof. Probably a colonist from the Eastern Province.

Cynanchum Zeyheri Schltr. Slopes near the sea, rare; 6–10. By Lion Battery; shore north of Kamp's Bay.

2. **C. africanum** Hoffmgg. Climbing on shrubs in sandy ground, frequent; 9–11.

3. **C. obtusifolium** Linn. f. Similar situations, occasional; 11–2. Bosky Dell, Simon's Town; Kalk Bay; Mount Road, Rondebosch; north of Muizenberg station, plentiful.

Eustegia lonchitis E. Mey. Sandy flats, rare; 9–10. Beyond Maitland station.

2. **E. filiformis** R. and S. Dry hill slopes, rare; 1–2. Simonsberg, *Wolley-Dod*, 282.

Brachystelmaria occidentalis Schltr. Dry hill slopes, rare; 4. "Rocky hill beyond Smitswinkel Bay," *Schlechter*, 650. Not found by us.

Stapelia variegata Linn. Hill slopes, occasional; 5–8. Signal Hill; by shore at Oatlands; Klein Slangkop; at 1,500 feet, beyond Kamp's Bay.

GENTIANACEÆ.

Sebæa ambigua Cham. Damp roadsides and flats, occasional?; 9–11. Near Simon's Town; near Little Lion's Head; between Maitland and the sea.

2. **S. minutiflora** Schinz. Similar situations, rare; 9. By the shore at Slangkop, *Wolley-Dod*, 3253.

3. **S. albens** R. Br. Similar situations, occasional?; 9–12. Fish Hoek valley; creek by Paarden Island; "Green Point," *MacGillivray.*

This species appears to have been confounded with **S. ambigua,** though the calyces are quite different. One or other is certainly more frequent than we have indicated, but we have been obliged to confine ourselves to identified specimens.

4. **S. capitata** Ch. and Schl. Mountains, very rare; 1. Near mouth of Waai Vley, *Wolley-Dod*, 2122. Only a single specimen was gathered. It appears to have been seldom found before.

5. **S. pallida** E. Mey. Flats in rather damp places, frequent; 9–11.

6. **S. ochroleuca** Wolley-Dod. Hill slopes, especially in open spots, frequent, at least locally; 9–10. Hout Bay and from Fish Hoek southward.

7. **S. aurea** R. Br. Flats and hill slopes, common; 9–11. A form with white flowers occurs all over Signal Hill.

8. **S. sulphurea** Ch. and Schl. Mountains, local; 10–11. Top of Twelve Apostles over the tunnel; southern slopes to summit of Constantiaberg.

9. **S. Zeyheri** Schinz. Similar situations to **S. ochroleuca,** with which it often grows mixed, frequent; 9–10.

10. **S. gibbosa** Wolley-Dod. Flats, rare or overlooked; 1. By railway by Muizenberg Vley, *Wolley-Dod*, 2332. Liable to be passed over as **S. aurea.**

11. **S. rara** Wolley-Dod. Sandy flats, apparently rare; 11. South of Uitvlugt towards Black River, *Wolley-Dod*, 3413.

12. **S. sclerosepala** Gilg. in Schinz Versuch. (1903) p. 23. "Table Mountain, rare, Jan.," *Schlechter*, 170. Not found by us.

? S. Grisebachiana Schinz. We admit this with a query. We do not understand the species, and its occurrence within our limits requires confirmation.

Belmontia cordata E. Mey. Flats and hill slopes, common; 8–10.

2. **B. intermedia** Knobl. Sandy flats, very local; 9–10. Frequent on Paarden Island, *Wolley-Dod*, 3255.

3. **B. micrantha** Gilg. Hill slopes, frequent; 8–10. Chiefly from Constantia Nek southwards; "Devil's Peak," *Wilms*.

Lagenias pusilla E. Mey. Moist places on flats, occasional; 10–11. Rondebosch; Kenilworth; "Simon's Bay," *Wright;* "Table Mountain, north slopes," *Ecklon*.

Chironia nudicaulis Linn. By streams and vleys, occasional; 6–11. Table Mountain; Smitswinkel Bay; stream south of Constantiaberg.

2. **C. maritima** Eckl. Similar situations, but rare; 12–2. Fish Hoek.

3. **C. jasminoides** Linn. Flats, rare; 12–1. Near Cape Town, *Bolus*, 2877. Unfortunately the specimen was lost after the record was noted.

4. **C. linoides** Linn. Dry places, rather frequent; 11–1. Tokay; Uitvlugt; near Rondebosch. This species is very variable in the length of its calyx segments.

5. **C. baccifera** Linn. Dry slopes and flats, frequent; 11–2. The seaside form differs greatly from the more inland one in its leaves being shorter, broader, more rigid, and with recurved points.

Orphium frutescens E. Mey. Flats and sea-shores, common; 11–1.

Villarsia ovata Vent. Swampy places from flats to the summit of Table Mountain, frequent; 10–2. Varies greatly in stature.

Limnanthemum Ecklonianum Griseb. In pools, rare; 1. St. Mary's Lake, Newlands.

BORAGINACEÆ.

Heliotropium ambiguum DC. "Green Point," *Ecklon;* "Table Mountain," *MacGillivray.* Not found by us.

†**Lithospermum arvense** Linn. Waste and cultivated places, casual; 8–11. Kirstenbosch; Maitland; Uitvlugt.

Cynoglossum enerve Turcz. Bushy places, rare; 4–5. Between Wynberg Ranges and Klassenbosch.

Lobostemon glaber Buek. Bushy hills, occasional; 7–11. Wynberg Hill.

2. **L. glaucophyllus** Buek. Similar places, frequent; 7–11. Reaches 2,500 feet.

3. **L. Swartzii** Buek. Similar places, occasional; 10–12. Ladies' Mile, near Alphen. Perhaps not distinct from **L. glaber.**

4. **L. fruticosus** Buek. Flats and hill slopes, rather common; 7–10. Reaches 2,500 feet.

5. **L. argenteus** Buek. Bushy hill slopes, locally frequent; 10–1. West slopes Signal Hill and Lion's Hill to 1,200 feet; "Kamp's Bay," *MacOwan!*

6. **L. ferocissimus** Buek. Dry places on flats, rare; 11–12. Railway near Maitland Bridge, and path thence to Observatory.

7. **L. verrucosus** Buek. Dry hill slopes, rare; 9. Slopes south of road in Orange Kloof.

8. **L. capitatus** Buek. Sandy flats, rare; 3. Kenilworth, *Schlechter,* 535. Not found by us.

9. **L. montanus** Buek. Bushy hill and mountain slopes, frequent; 7–9. A form with longer leaves reaches 2,700 feet on Lower Plateau.

†**Echium plantagineum** Linn. Roadsides and waste places, locally frequent; 10–1. Wynberg; between Mowbray and Rapenburg; roadside beyond Retreat.

CONVOLVULACEÆ.

†**Convolvulus arvensis** Linn. A casual; 12. Railway near Mowbray.

Dichondra repens Forst. Flats and mountain slopes, rare; 5. "North slopes Table Mountain," *Ecklon;* "Flats between Rondebosch and Newlands; above Klassenbosch," *Schlechter.*

Falkia repens Thunb. Grassy plains, frequent; 11–2.

Cuscuta africana Thunb. Hill slopes, rare; 1–3. Miller's Point; Little Lion's Head.

SOLANACEÆ.

†**Solanum nigrum** Linn. Flats and hill slopes, common, flowers all the year. The usual lowland form has leaves entire, not deeply lobed, as on mountains.

2. **S. quadrangulare** Thunb. Roadsides on low ground, occasional; 3–5. Retreat; Hout Bay; near Elsje Bay; Simon's Town.

3. †**S. pseudo-Capsicum** Linn. Bushy places, rare; 11. Wynberg Ranges.

4. **S. aggregatum** Jacq. Amongst shrubs, rare; 5. Near Rosebank.

5. **S. giganteum** Jacq. Similar situations, frequent, and, we believe, native, but often planted.

6. †**S. auriculatum** Linn. Similar situations, but not native, also frequently planted.

7. **S. tomentosum** Linn. Dry places, rare; 5. At foot of rocks on Lion's Head.

8. **S. sodomæum** Linn. Flats and hill slopes, chiefly roadsides and sluits, very common; 1–12.

9. †**S. aculeastrum** Dunal. Waste ground, occasional; 9–10. Between Rondebosch and Newlands; above Maitland Bridge; Newlands Avenue. Introduced from Eastern Province.

†**Physalis peruviana** Linn. Woods and bushy places, occasional; 11–12. About Rondebosch, Newlands, and Constantia.

Withania somnifera Dun. Waste places, rare; 10–11. Gravel-pit on Signal Hill.

Lycium horridum Thunb. Waste places and hedges, occasional; 11. Kalk Bay; Rapenburg.

2. **L. tetrandrum** Linn. f. "Between Lion's Rump and the sea-shore, June," *Thunberg.* Not found by us.

3. **L. afrum** Linn. Dry fields and waste places, locally frequent; 5–8. About Observatory, Rapenburg, Salt River, and the Castle.

4. **L. carnosum** Poir. Sandy flats, occasional; 5–8. Rapenburg.

†**Datura Stramonium** Linn. Waste places, casual; 10–11 Kirstenbosch.

†**Nicotiana glauca** Grah. Waste places and railway banks, occasional; 1–12. Sea Point; Docks; Muizenberg to Simon's Town.

SCROPHULARIACEÆ.

†**Verbascum virgatum** With. A casual near houses; 12. Klein Constantia; Groot Schuur; Kirstenbosch.

Hemimeris Bergiana Hiern. (**Diascia Bergiana** Benth.). Sandy places, rare; 8. Sea Point, *Bolus*, 4770.

2. **H. bonæ-spei** Linn. (**D. nemophiloides** Benth.). Sandy places, frequent?; 7–10.

3. **H. Benthami** Hiern. (**D. diffusa** Benth.). Sandy places, frequent?; 7–10. We fear there has been confusion in the past of this and the last-named species, consequently we are in doubt as to their relative frequency.

4. **H. diffusa** Linn. f. (**D. elongata** Benth.). Sandy places, frequent; 7–10.

Alonsoa peduncularis Wettst. "Near Cape Town," *Harvey*. Not found by us.

Diascia montana Spreng. (**Hemimeris montana** Linn. f.). Flats and hill slopes, frequent; 7–9.

2. **D. sabulosa** Hiern. (**H. sabulosa** Linn. f.). Sandy flats, frequent, though less so than the last species; 8–10.

Nemesia lucida Benth. Hill slopes in rather damp places, frequent; 8–10.

2. **N. barbata** Benth. Dry sandy places, frequent; 8–9.

3. **N. Guthriei** Hiern. Dry sandy places, rare; 9. Rapenburg, *Guthrie*, 1221!

4. **N. parviflora** Benth. Hill slopes, occasional; 8–10. "Cape Town," *Alexander;* "Stinkwater," *Rehmann;* "Table Mountain," *Ecklon*. Not found by us for certain, but specimens from the Silvermine River (*Wolley-Dod*, 277), and Slangkop may belong here.

5. **N. pinnata** E. Mey. Flats and slopes, partial to damp sandy places, common; 7–9. Reaches 2,000 feet.

6. **N. bicornis** Pers. Sandy flats, common; 7–10.

7. **N. micrantha** Hiern. Sandy ground, only once found; 10. Hout Bay Fisheries, *Wolley-Dod*, 3068.

8. **N. affinis** Benth. Hill or mountain slopes, occasional; 9–11. "Above Kamp's Bay," *Galpin*, *Wilms.*; "Constantia," *Ecklon*; "Simon's Bay," *Wright*. Not found by us.

9. **N. fœtens** Vent. "Nord Hoek Forest," *Milne*. Not found by us.

10. **N. divergens** Benth. "Neighbourhood of Cape Town," *Ecklon*, 144. Not found by us.

11. **N. chamædrifolia** Vent. Slopes, chiefly in stony water-courses, frequent; 11–2.

†**Antirrhinum Orontium** Linn. Casual near habitations; 8–9. Orchard at Kirstenbosch.

†**Cymbalaria spuria** Gärtn. A weed of cultivation; 2–5. Near Constantia Nek; railway beyond Wynberg.

Halleria lucida Linn. In kloofs, frequent up to 2,500 feet; 5–8.

2. **H. elliptica** Thunb. "Table Mountain," *Thunberg*. Not found by us.

Teedia lucida Rud. Shady places on mountains, rare; 10–11. Summit of Constantiaberg; "Table Mountain," *Pappe*.

Zaluzianskya maritima Walp. (**Z. coriacea** Walp.). Sandy flats, rare. "Princess Vley," *MacOwan*, Herb. Norm., 1932! "Mountains near Cape Town," *Ecklon* and *Zeyher*. Not gathered by us.

2. **Z. lychnidea** Walp. "Near Cape Town," *Harvey*. Not found by us.

3. **Z. capensis** Walp. Flats and hill slopes, frequent; 6–11. Possibly the next species has sometimes been taken for this.

4. **Z. dentata** Walp. Hill and mountain slopes, frequent; 7–11

5. **Z. villosa** F. W. Schmidt (**Nycterinia selaginoides** Benth.). Sandy ground, frequent; 6–10.

6. **Z. divaricata** Walp. Hill and mountain slopes to 1,500 feet, frequent; 8–9.

7. **Z. ramosa** Schinz. "Near Hout Bay," *Schlechter*, 968. Not found by us.

8. **Z. africana** Hiern. (**Nycterinia africana** Benth.). "Lion's Head," *Thunberg*; "Sides of Table and Devil's Mountains, 1,000 feet," *Krauss*. Not found by us.

Polycarena silenoides Harv. Hill slopes, locally common; 8–10. North and west slopes Lion's Head.

2. **P. capillaris** Benth. Dry roadsides and sandy places, occasional; 7–10. Camp Ground; Chapman's Bay; Rapenburg Vley.

Phyllopodium capitatum Benth. Near Cape Town, *Bolus*, 2799 partly; "Slopes near Wynberg," *Drège*; "South side of Table Mountain, September," *Krauss*.

2. **P. heterophyllum** Benth. Dry plains, frequent; 8–9.

Sutera brachiata Roth (**Chœnostoma hispidum** Benth.). Hill and mountain slopes, common; 7–3. A dwarf form with sub-orbicular densely pubescent leaves and pink flowers is found near the sea-shore, and a luxuriant, very large-leaved form on the slopes towards Smitswinkel Bay.

2. **S. linifolia** O. Kuntze (**C. linifolia** Benth.). Gathered somewhere within our limits by Schlechter (716), but we have no record of the exact locality.

3. **S. lychnoidea** Hiern. (**Lyperia fragrans** Benth.). Sandy ground, locally frequent; 8–12. Hout Bay and from Fish Hoek southward.

4. **S. tristis** Hiern. (**L. tristis** Benth.). Sandy flats, frequent; 9–11.

5. **S. antirrhinoides** Hiern. (**L. violacea** Benth.). Hill slopes, very rare; 9. Devil's Peak over Mostert's Kloof.

6. **S. æthiopica** O. Kuntze (**Chœn. æthiopicum** Benth.). "Kamp's Bay," *Burchell.* Not found by us.

7. **S. cœrulea** Hiern. (**Sphenandra viscosa** Benth.). Sand-dunes at Black River near Rondebosch, *Bolus,* 8035.

Nemia rubra Berg. (**Manulea rubra** Linn. f.). Sandy flats and hills, frequent; 7–10.

2. **N. tomentosa** Hiern. (**M. tomentosa** Linn.). Similar places, frequent; 9–12.

3. **N. Cheiranthus** Berg. (**M. Cheiranthus** Linn.). Hill and mountain slopes, common; 7–2.

4. **N. stellata** Hiern. (**M. stellata** Benth.). "Hills near Cape Town," *Ecklon,* 356. Not found by us.

Ilysanthes riparia Rafin. "In spots that have been inundated in winter, near Wynberg; 12–1," *Harvey.* "Between Cape Town and Table Mountain," *Burchell,* 679. Not seen by us.

Limosella capensis Thunb. Shallow pools, occasional; 8–11. Beyond Camp Ground; above Rapenburg Vley; Kommetje effluent.

2. **L. aquatica** Linn. Shallow pools, rare; 8–11. Vaarsche Vley; near Kenilworth racecourse.

†**Veronica Tournefortii** C. Gmel. Casual near houses, *Bolus,* 4774; 8–9.

2. †**V. Anagallis** Linn. "Streams near Cape Town," *Thunb.*; "Simon's Bay," *MacGillivray,* 670. Not found by us, perhaps now extinct.

Melasma scabrum Berg. Rather damp places on mountains and flats, occasional; 11–1. Vlaggeberg; Silvermine River; Orange Kloof; Tokay Flats.

2. **M. luridum** Hiern. (**Alectra lurida** Harv.). Hills and mountains, rare; 9–12. Old road to Constantia Nek, *Wolley-Dod,* 1521; "Wynberg," *Harvey;* "Rocks at top of Table Mountain," *Schlechter.*

3. **M. sessiliflorum** Hiern. (**A. melampyroides** Benth.). Road-sides and rough ground, occasional; 11–2. Newlands; Black River; Tokay Plantation; Vlaggeberg.

Harveya coccinea Schlecht. Bushy slopes, frequent; 11–2.

2. **H. capensis** Hook. Rather open places on slopes, frequent; 11-2.

3. **H. purpurea** Harv. Mountain slopes, rare; 11. Muizenberg, *Bolus*, Herb. Norm. Aust. Afr., 378; "Stony places on Table Mountain," *Masson;* "Wynberg," *Wallich.*

4. **H. laxiflora** Hiern. Similar places, rare; 12–1. Muizenberg Mountain, *Wolley-Dod*, 584, *Bolus*, 3381.

5. **H. tubulosa** Harv. Similar places, rare; 12–1. Devil's Peak, *Bolus*, 3380. "Table Mountain," *Burchell.*

6. **H. squamosa** Steud. Sandy places, rare; 11. "Near Smitswinkel Bay, 400 feet," *Bodkin* (8041! of herb. Bolus).

7. **H. Bolusii** O. Kuntze (**Aulaya capensis** Harv.). Mountain tops, rare; 11–12. Lower Plateau and summit of Table Mountain.

Hyobanche sanguinea Thunb. Sandy grounds, occasional; 7–9. Uitvlugt; more frequent from Fish Hoek southward.

2. **H. atropurpurea** Bolus. Rocky mountain slopes, rare; 12. Over Klassenbosch. (Subsequently found on Winterhoeksberg, Tulbagh.)

Buchnera glabrata Benth. Damp rough ground, rare; 3–4. By swamp in Orange Kloof; "Moist places on flats near Wynberg," *Sonder*; "Near Rondebosch," *Ecklon.*

†**Bellardia Trixago** All. Hills and mountains, frequent, or common; 11–1. Reaches summit of Table Mountain.

OROBANCHACEÆ.

Orobanche ramosa Linn. Sandy places near sea, occasional; 9–10. Hout Bay; Rapenburg Vley; Fish Hoek to Oatlands; Paulsberg; Paarden Island; Kamp's Bay; Chapman's Bay. Usually found in single plants.

LENTIBULARIACEÆ.

Utricularia capensis Spreng. Damp spots from flats to mountain tops, very common; 11–3.

2. **U. livida** E. Mey. Mountain slopes, rare; 3. "Constantiaberg, 1,500 feet," *Schlechter*, 500. Not found by us.

MYOPORACEÆ.

Oftia Jasminum Wettst. Hill and mountain slopes, common; 7–4.

SELAGINACEÆ.

Hebenstreitia dentata Linn. Flats and hill slopes, occasional; 6–7. Devil's Peak; "Hout Bay," *Ecklon* and *Zeyher;* "Kamp's Bay," *Alexander.*

2. **H. parviflora** E. Mey. Sandy places, rare; 8–9. Hills west of Simon's Town. Possibly often mistaken for the next species.

3. **H. fastigiosa** Jarosz. Sandy plains, locally common ; 9–10. Abundant between Red Hill and Slangkop ; Chapman's Bay.

4. **H. repens** Jarosz. Dry flats and hill slopes, frequent ; 8–10.

5. **H. cordata** Linn. Sandhills near sea, common ; 11–12.

Dischisma arenarium E. Mey. Dry places near sea, rare ; 9–11. Fish Hoek valley ; Oatlands Point ; near Retreat station ; Green Point Common.

2. **D. capitatum** Chois. Sandy flats, occasional ; 9–10. Camp Ground ; between Maitland and sea ; Hout Bay ; north slopes Lion's Head ; "Simon's Bay," *Wright.*

3. **D. erinoides** Sweet. Hill slopes, rare ; 9–10. Path towards Smitswinkel Bay ; slopes of Paulsberg.

4. **D. ciliatum** Chois. Flats and hill slopes, common ; 7–11.

Walafrida pubescens Rolfe. "Simon's Town," *Schlechter*, 663. Not found by us.

Selago adpressa Chois. Bushy hill slopes, rare ; 11–12. Signal Hill above Sea Point.

2. **S. scabrida** Thunb. Dry flats to mountain slopes, frequent ; 12–3, 6–7.

3. **S. Dregei** Rolfe. "Near Cape Town," *Harvey.* Not found by us.

4. **S. corymbosa** Linn. Flats and hill slopes, very common ; 12–5.

5. **S. stricta** Berg. "Table Mountain, 3,000 feet," *Schlechter*, 126. Not found by us.

6. **S. herbacea** Chois. (**S. lobeliacea** Hochst.). "West side of Table Mountain, June," *Krauss.* Not seen by us.

7. **S. cephalophora** Thunb. Sandy flats near the shore, occasional ; 10–12. Hout Bay ; Muizenberg ; Chapman's Bay.

8. **S. serrata** Berg. Rocky places on mountains, frequent ; 9–1.

9. **S. quadrangularis** Chois. Shady rocks at high elevations, occasional ; 9–12. Devil's Peak ; Waai Vley, frequent ; Constantiaberg ; west slopes Orange Kloof.

10. **S. spuria** Linn. Flats to mountain slopes, very common ; 11–1. A large-flowered state is sometimes found, apparently resulting from an injury to the stem.

11. **S. fruticulosa** Rolfe. Dry hill slopes, rare ; 10. West slopes Lion's Head. A form with flowers one-quarter the normal size occurs towards Kamp's Bay.

12. **S. ramosissima** Rolfe. "Table Mountain, 500 feet," *Schlechter.* Not found by us.

13. **S. cinerascens** E. Mey. "On the side of the Devil's Peak," *Krauss.* Not seen by us. (See Fl. Cap. V. 122.)

Microdon ovatus Chois. Flats and mountains, rare; 8–9. "Cape Flats," *Harvey*. "Mountains at Muizenberg," *Wallich*. Not found by us.

Agathelpis angustifolia Chois. Flats to mountains, common; 5–12. Reaches over 3,000 feet on Table Mountain.

2. **A. nitida** E. Mey. Hill slopes, locally frequent; 7–10. About the waterfall, Devil's Peak.

VERBENACEÆ.

Campylostachys cernua Thunb. Hill and mountain slopes, occasional; 2–3, 7, 12. Devil's Peak; Vlaggeberg; "Kamp's Bay," *Burchell*.

Stilbe ericoides Linn. Dry flats, common; 5–8.

2. **S. vestita** Berg. Mountains, occasional; 8–12. Table Mountain; Muizenberg. Mountain sides between Constantia and Hout Bay; Table Mountain above Slang Kuil.

†**Lantana camara** Linn. "Devil's Mountain near Rondebosch," *Wilms*, 3530. Not seen by us.

†**Lippia reptans** H. B. and K. Damp flats, rare. Rapenburg Vley, *Wolley-Dod*, 3522.

Bouchea cernua Schauer. Low hill slopes near the sea, occasional; 7–9. Smitswinkel Bay; near Oatlands Point; near Fish Hoek; Paulsberg.

†**Verbena bonariensis** Linn. Waste places, roadsides, &c., frequent; 11–4.

2. †**V. officinalis** Linn. Similar places, frequent; 10–4.

LABIATÆ.

Mentha lavandulacea Willd. By streams, rare; 1–3. Lion's Head; Constantia.

2. †**M. viridis** Linn. By streams, rare; 3. Constantia, apparently an escape.

3. †**M. hirsuta** Huds. (**M. aquatica** Linn.). Reedy vleys, frequent; 3–5. This species has every appearance of a native, though we believe it not to be so. It is quite unlike any British form of the species known to us.

Salvia aurea Linn. Flats and slopes, especially in rocky places up to 1,500 feet, frequent; 9.

2. **S. nivea** Thunb. Flats near the sea, rare; 12. Rapenburg.

3. **S. africana** Linn. Hill slopes, common; 8–10.

4. **S. paniculata** Thunb. Similar places, common; 11–2.

†**Cedronella triphylla** Mœnch. Bushy slopes, locally common; 11. East slopes Devil's Peak.

Ballota africana Benth. Rocky places, rare; 10. Chapman's Bay; Lion's Head at 1,500 feet.

Stachys æthiopica Linn. Bushy hill and mountain slopes, common; 1–12. A form with smaller and purplish flowers, differing slightly in other respects, is frequent on Signal Hill.

2. †**S. arvensis** Linn. Cultivated fields, rare; 8–10. Mowbray Farm.

3. **S. Thunbergii** Benth. Mountain slopes, rare; 11–12. By the waterfall, Devil's Peak.

Leonotis Leonurus R. Br. Sandy slopes near sea, frequent; 12–1. Reaches over 1,500 feet on Twelve Apostles.

PLANTAGINACEÆ.

Plantago carnosa Lam. Flats, &c., near the sea, common; 12.

2. †**P. major** Linn. Waste places, casual; 9–12. Newlands; Rondebosch, &c.

3. **P. remota** Lam. Hill and mountain slopes, frequent; 11–2.

4. †**P. lanceolata** Linn. Roadsides and railway banks, occasional; 8–11. About the southern suburbs.

5. **P. hirsuta** Thunb. Dry grassy places, locally abundant; 9–10. Green Point Common; near Lion Battery.

†PARONYCHIACEÆ.

†**Herniaria hirsuta** Linn. Sandy flats, rare; 10–11. Fish Hoek; Chapman's Bay; between Retreat and Muizenberg Vley.

†**Corrigiola littoralis** Linn. Waste places, especially railways, occasional; 2–6. Railway at Claremont, Retreat, and Muizenberg.

2. †**C. telephifolia** Poir. Dry waste places; 8–9. Near Simon's Town cemetery.

†**Scleranthus annuus** Linn. Roadsides, rare; 8–9. Maitland; Red Hill.

AMARANTACEÆ.

†**Amarantus Blitum** Linn. A common weed in gardens at Rondebosch.

2. **A. Thunbergii** Moq. Cultivated and waste ground, frequent; 5–11. Especially common about Retreat and Diep River.

Achyranthes argentea Lam. Woods and bushes, occasional; 10–1. About Groot Schuur, Newlands Avenue and Westerford Bridge.

CHENOPODIACEÆ.

†**Chenopodium ambrosioides** Linn. Roadsides, cultivated and waste places, common; 11–4. Very variable in stature and leaf-cutting.

2. †**C. album** Linn. Cultivated fields, occasional; 5–12. Chiefly about Diep River.

3. †**C. murale** Linn. Cultivated and waste places, very common; 7–1.

4. †**C. rubrum** Linn. var. **pseudo-botryodes** Wats. Dry stream-beds on flats, rare; 4. Near Kenilworth racecourse; Rapenburg and Muizenberg Vleys. Very closely resembling **C. botryodes** Sm.

5. †**C.** (**Roubiera multifida** Moq.). Roadsides, casual; 4. Between Newlands Bridge and village.

†**Atriplex patula** Linn. var **angustifolia** Sm. Dry vleys, rare; 11–4. Near Kenilworth racecourse; Rapenburg Vley.

Exomis axyrioides Fenzl. Waste places, especially near houses, frequent; 4.

Chenolea diffusa Thunb. Sea-shores, especially rocky ones, frequent; 4.

Salicornia fruticosa Linn. Muddy flats, common; 10–1. A closely branched erect form with woody stem sometimes 1½ inches thick, which probably belongs here, occurs near Kamp's Bay, Paarden Island, and at Paulsberg.

2. **S. natalensis** Bunge. Similar situations, frequent; 10–1.

Suæda cæspitosa Wolley-Dod. Sandy ground, very local; 10. Paarden Island, *Wolley-Dod*, 3396.

Salsola Kali Linn. Sandy sea-shores, occasional; 1. From Woodstock to Sea Point.

†PHYTOLACCACEÆ.

†**Phytolacca decandra** Linn. Rubbish heaps and waste places, frequent; 1–12.

POLYGONACEÆ.

Polygonum atraphaxoides Thunb. Dry hills, rare; 2. Near Kamp's Bay.

2. **P. serrulatum** Lej. Wet ditches and by vleys, common; 6–2.

3. †**P. lapathifolium** Linn. Similar places, locally common; 5–11. Retreat, Diep River, and Muizenberg.

4. †**P. Convolvulus** Linn. Waste places, casual; 5–6. In two or three places about Rondebosch Camp Ground.

5. **P. tomentosum** Willd. Marshy ground, rare; 11–1. Vaarsche Vley; Klein Constantia; near Muizenberg Vley.

6. †**P. aviculare** Linn. Waste and cultivated ground, very common; 1–12.

7. **P. maritimum** Linn. Sandy sea-shores, rare; 8. Kamp's Bay. We believe that Schlechter gathered this at Chapman's Bay.

†**Rumex Acetosella** Linn. An abundant weed of cultivation; 7–12.

2. †**R. conglomeratus** Murr. Damp roadsides and woods, occasional; 5–12. Newlands Woods; roadsides near Newlands and Kenilworth stations; Constantia Nek; Black River.

3. †**R. crispus** Linn. Damp roadsides and fields, occasional; 10–12. Constantia Nek; Vaarsche Vley; between Retreat and Muizenberg Vley.

4. **R. Ecklonii** Meisn. By vleys, frequent; 10–12.

5. **R. cordatus** Desf. Flats and hill slopes, common; 5–11.

6. †**R. pulcher** Linn. Waste places and roadsides, very common; 10–2.

7. **R. sagittatus** Linn. Bushy roadsides and hedges, locally frequent; 10–12. Several places about Constantia.

Emex Centropodium Meisn. Manure heaps, roadsides and grassy flats, very common; 9–1.

CYTINACEÆ.

Cytinus dioicus Juss. Mountain slopes, rare; 8. Devil's Peak, 1,800 feet, on **Agathosma.** Said also to have been found on the Flats.

Hydnora africana Thunb. "Hout Bay, on **Cotyledon orbiculata** Linn.," *Mund fide Harvey.* Not found by us.

PIPERACEÆ.

Peperomia retusa A. Dietr. Damp rocks in shady kloofs, common; 1–3.

LAURACEÆ.

Ocotea bullata E. Mey. "Ravines of Table Mountain," *Pappe.* "Hout Bay," *Mally* (*teste Marloth*). Not seen by us.

Cassytha capensis Meisn. Amongst shrubs, common; 4.

2. **C. ciliolata** Nees. "Table Mountain, December," *Burchell.* Not found by us.

PROTEACEÆ.

Aulax pinifolia Berg. "Table Mountain, December," *Burchell.* Not found by us.

Leucadendron argenteum R. Br. Flats and hill slopes, frequent; 9–10. Except on the Devil's Peak, this tree appears to be getting less common, being much sought after for fuel.

2. **L. plumosum** R. Br. "Near the Blockhouse above Kamp's Bay, July," *Zeyher*, 4687. Not found by us.

3. **L. Levisanus** Berg. Flats, common; 9–11.

4. **L. decorum** R. Br. Flats to mountain slopes, frequent; 6–9. Reaches 3,000 feet on Table Mountain.

5. **L. grandiflorum** R. Br. Mountain slopes, rare ; 9. Vlaggeberg ; east slopes Table Mountain and near the summit.

6. **L. virgatum** R. Br. Flats and mountain slopes, rare ? ; 9–10. West slopes Devil's Peak, over 2,000 feet ; flats near Wynberg.

7. **L. adscendens** R. Br. Flats and hill slopes, perhaps the commonest species ; 5–7. Reaches 1,500 feet in Orange Kloof.

8. **L. salignum** R. Br. Hill and mountain slopes, frequent ; 9–10. Reaches nearly to summit of Devil's Peak.

9. **L. uliginosum** R. Br. Swampy places, chiefly on flats, occasional ; 6–10. Camp Ground ; Smitswinkel Bay ; between Groot and Klein Slangkop.

Protea coccinea R. Br. Flats and mountain slopes, rare ; 4. "Claremont Flats ; Steenberg," *Fair ;* "Devil's Peak," *Zeyher.*

2. **P. incompta** R. Br. Flats and hill slopes, common ; 6–8.

3. **P. Lepidocarpon** R. Br. Similar situations and about equally common ; 6–8.

4. **P. acaulis** Thunb. Open spots from flats to mountain slopes, occasional ; 7–9.

5. **P. calocephala** Meisn. "Hills, rare," *Marloth.* Not found by us.

6. **P. cynaroides** Linn. Flats and eastern slopes to summit of Table Mountain, frequent, but seldom flowering ; 6–8, 1.

7. **P. grandiflora** Thunb. Mountain slopes, occasional ; 5–6. Orange Kloof ; Devil's Peak ; Constantiaberg.

8. **P. mellifera** Thunb. Flats and hill slopes, frequent ; 6–8.

9. **P. Scolymus** Thunb. Flats, frequent ; 6–11. Abundant in Fish Hoek valley and near Retreat.

10. **P. speciosa** Linn. Mountain slopes, rare, apparently more frequent formerly ; 11. Table Mountain.

Leucospermum Conocarpum R. Br. Hill and mountain slopes, frequent ; 8–1.

2. **L. ellipticum** R. Br. Hillsides, rare ; 10. Lion's Head, *Bolus*, 7036.

3. **L. Hypophyllum** R. Br. Sandy flats, frequent ; 7–11.

Serruria glaberrima R. Br. Hills, rare ; 7–10. Rocky kopje south-west of Slangkop ; mountains behind Simon's Town.

2. **S. fœniculacea** R. Br. Hills, rare ; 7–9. Smitswinkel Bay ; near Simon's Town.

3. **S. cyanoides** R. Br. Flats and hill slopes, occasional ; 7–9. Elsje Peak ; Orange Kloof below farm.

4. **S. arenaria** R. Br. Dry sandy flats, occasional ; 9–10. Near Plumstead ; near Rapenburg. Flowers duller rose and leaves less divided than in last species.

5. **S. hirsuta** R. Br. Hill slopes, occasional?; 7–10. Above and beyond Simonstown.

6. **S. Nivenii** R. Br. "Muizenberg," Herb. Gub. Cap. Not found by us.

7. **S. plumosa** Meisn. Hill slopes, locally frequent; 6–7. Kalk Bay Hills; ridge beyond Smitswinkel Vley. The yellowish inflorescence appears to be the best mark of this species, though in dried specimens it is difficult to distinguish it from the last two or the next.

8. **S. villosa** R. Br. "Simon's Bay," *Thunberg;* "Constantia," *Niven.* Not found by us.

9. **S. ciliata** R. Br. Flats, rare; 10–2. About Doornhoogde. It becomes common on Vygeskraal farm, beyond our limits.

10. **S. glomerata** R. Br. Flats, frequent or common; 8–11.

11. **S. flagellaris** R. Br. Dry sandy slopes, locally frequent; 9–11. Muizenberg; Elsje Peak and Dido Valley. Leaves, apparently of this species, were seen on the rocky ridge beyond Smitswinkel Bay.

12. **S. decumbens** R. Br. "Rocky mountains about Simon's and False Bays," *Meisner. Bolus,* 7287, from this neighbourhood, may belong here, if not to the last species.

13. **S. decipiens** R. Br. Sandy flats, occasional; 10. About Rondebosch, &c. Seems to differ little from **S. glomerata** except in the more hairy outer bracts.

14. **S. Burmannii** R. Br. Flats and hill slopes, frequent; 8–2. This species sometimes forms a bush 4 feet high; for instance, behind Wynberg Butts.

15. **S. sp.** An undetermined species, differing from any of the above-named, was gathered by Schlechter (No. 1225) on Constantiaberg in July, 1892, also by Miss E. M. Kensit at Nordhoek in the same month (No. 8063 of Herb. Bolus).

Mimetes hirta R. Br. Mountain slopes, rare; 8–9. Table Mountain; near Simon's Bay.

2. **M. decapitata** Meisn. Sandy flats, rare; 5–9. Patrys Vley.

3. **M. cucullata** R. Br. Mountain slopes, local; 8–9. Simonsberg, on both sides of nek over Oatlands.

4. **M. Hartogii** R. Br. Mountain slopes, rare; 9. Near Slangkop.

5. **M. divaricata** R. Br. Sandy and rushy places, frequent from Constantiaberg southwards; 1–12.

6. **M. intermedia** Buek. Hill slopes, occasional; 1–12. Muizenberg; near Simon's Town.

7. **M. purpurea** R. Br. Rushy flats, common; 1–12.

Spatalla curvifolia Knight. Mountains, rare; 1. *Schlechter,* 180A. Not found by us.

Brabejum stellatifolium Linn. Woods and thickets; 1 Groot Schuur to Wynberg at 200 feet to 500 feet, seldom flowering.

THYMELÆACEÆ.

Arthrosolen laxus C. A. Meyer. Roadsides and hill slopes, frequent; 1–12.

2. **A. spicatus** C. A. Meyer. Flats near vleys, more local than last, but frequent; 1–12.

Passerina filiformis Linn. Flats and hill slopes to at least 1,000 feet, very common; 9–12.

Chymococca empetroides Meisn. Sandy downs by the sea, locally frequent; 9. Kalk Bay; Muizenberg.

Cryptadenia breviflora Meisn. "Table Mountain," *Meisner*. Not found by us unless confounded with one of the two following.

2. **C. grandiflora** Meisn. Flats, frequent; 12–5.

3. **C. uniflora** Meisn. Flats, common; 9–12.

Lachnæa capitata Meisn. Flats, common; 9–5.

2. **L. densiflora** Meisn. Flats, frequent, and rather local; 8–11. Abundant near Claremont Sanatorium.

? **L. macrantha** Meisn. Authority mislaid, so we mark it with doubt. We never gathered it.

3. **L. funicaulis** Schinz. "In a valley, in sandy soil, at 3,000 feet, January," *Schlechter*, 401. Precise locality not stated. Not found by us.

Struthiola longiflora Lam. Flats and hillsides, probably very common. The species of this genus are so very much alike that we are unable to state positively as to their relative frequency. One or two certainly are very common, and they appear to flower all the year round.

2. **S. lucens** Poir. Apparently less common than last or next.

3. **S. erecta** Linn. Flats and hillsides, apparently very common.

? **S. virgata** Linn. This has been recorded, but we mark it with doubt, as we believe one of the first two species has been mistaken for it.

4. **S. striata** Lam. Sandy flats, locally frequent; 10–1. Maitland; Rapenburg Vley; Tokay; Miller's Point. A distinct species.

Gnidia anomala Meisn. Dry mountain slopes, locally frequent; 6–10. Simon's Town to Cape Point; more rare on Table Mountain.

2. **G. scabrida** Meisn. "Summit of Devil's Peak," *Ecklon*. Not found by us.

3. **G. pubescens.** Mountain slopes, frequent from Constantiaberg southwards; 1–12. Also in Orange Kloof.

4. **G. penicillata** Licht. Damp sandy ground, locally frequent; 1–12. Schoester's Kraal; Klaver Vley; Smitswinkel Vley.

5. **G. linoides** Wikstr. Reedy ground, rare; 3-5. By Orange Kloof swamp.

6. **G. sericea** Linn. Hill and mountain slopes, occasional; 6–10. East slopes Devil's Peak; Signal Hill. **Arthrosolen laxus** is often mistaken for this species, though very unlike it.

7. **G. Burmanni** Eckl. "Lion's Mountain," *Eckl.*, 85, *Sieber*, 63. Not found by us.

8. **G. albicans** Meisn. Flats and mountains, occasional, or locally frequent; 10. Constantiaberg; Claremont Flats.

9. **G. oppositifolia** Linn. By streams or mountains, common; 11–12. Reaches summit of Table Mountain.

10. **G. humilis** Meisn. Hill and mountain slopes, frequent; 11–3.

? **G. juniperifolia** Lam. This has been recorded, but we fear the next species has been taken for it. There is no plant so named from the Peninsula at Kew.

11. **G. subulata** Lam. Flats and hill slopes, common; 12–2.

12. **G. decurrens** Meisn. Flats and hill slopes, common; 9–11.

13. **G. carinata** Thunb. Hillsides, rare; 2. "Bosky Dell, Simon's Town," *Bodkin*.

14. **G. parvula** Wolley-Dod. Hill slopes, apparently rare or overlooked; 8. Near the Signal Station, *Wolley-Dod*, 2928.

15. **G. pinifolia** Linn. Flats to summit of Table Mountain, very common; 8–11.

PENÆACEÆ.

Penæa fruticulosa Linn f. Flats and hill slopes, frequent; 3–8.

2. **P. mucronata** Linn. Hill and mountain slopes, common; 3–10.

Sarcocolla squamosa Endl. Among rocks on mountains, frequent; 10–1.

2. **S. fucata** A. DC. We have not found this, if indeed it be distinct from the last. It is, however, said to grow on the Peninsula.

3. **S. minor** A. DC. Rocks on mountains, occasional; 11–1. Descends to 100 feet at Miller's Point.

4. **S. formosa** A. Juss. Stony places on hill and mountain slopes, locally frequent; 7–8. Beyond Simon's Town; nek of Klaver Vley; below 100 feet at Kamp's Bay.

Brachysiphon fucata Gilg. Damp, shady rocks on mountains, rare; 7–10. Above Klassenbosch; below saddle between Devil's Peak and Table Mountain.

LORANTHACEÆ.

Viscum obscurum Thunb. Rare; 12. Tokay plantation, on **Olea**.

2. **V. capense** Thunb. Common; 1–12. On various low shrubs, chiefly **Rhus**, often at ground level.

SANTALACEÆ.

Thesium spinosum Linn. Flats, rare; 3. "Beyond Claremont," *Schlechter*. Not found by us.

2. **T. strictum** Berg. Hill and mountain slopes, frequent; 1–12. Easily recognised by its great height.

3. **T. paniculatum** Linn. Locally common; 4–6. Wynberg Ranges.

4. **T. Schumannianum** Schltr. Locally frequent; 1–6. Northern slopes of Orange Kloof; Vlaggeberg.

5. **T. juncifolium** A. DC. Devil's Peak above Mostert's Ravine; 9.

6. **T. commutatum** Sond. Upper slopes of Simonsberg; 9.

7. **T. carinatum** A. DC. Grassy places, 6–10. Either this species or the next is common; perhaps both are, but they have been much confounded. We have it from Klaver Vley and Smitswinkel Vley.

8. **T. capitatum** Linn. See last. We have specimens from Red Hill.

9. **T. pubescens** A. DC. Sandy ground, rare; 9–10. Miller's Point; Chapman's Bay; between Retreat and Muizenberg Vleys.

10. **T. capitellatum** Sond. Mountain sides, rare; 8. Muizenberg, 1,000 feet, *Bolus*, 8040.

11. **T. capituliflorum** Sond. Flats and stony mountain sides, appears common; 7–9. Steenberg; Slangkop, &c.

12. **T. tenue** Bernh. Hill and mountain slopes, locally frequent; 8–11. Constantiaberg; over Klassenbosch and Fernwood.

13. **T. Frisea** Linn. Above Noah's Ark Battery, Simon's Town; 9.

14. **T. polyanthum** Schltr. Roadside near the Kommetjes, Chapman's Bay, *Wolley-Dod*, 1551.

15. **T. debile** R. Br. (**T. amblystachyon** A. DC.). Damp grassy places, frequent; 6–10.

16. **T. spicatum** Linn. Flats and low hills, appears frequent; 6–3.

17. **T. funale** Linn. (**T. adpressifolium** Sond.). Flats and hillsides, appears frequent; 7–3.

18. **T. Ecklonianum** Sond. Sandy flats, rare; 3. Rondebosch, *Bolus*, 3920.

We give the relative frequency and months of flowering in the above genus with diffidence.

The following have at various times been reported from the Peninsula. We do not include them because the authority is wholly insufficient: **T. euphorbioides** Linn., **T. euphrasioides** DC., **T. scabrum** Linn., **T. triflorum** Thunb.

Thesidium fragile Sond.? Sandy flats and hill slopes, rare; 9–11. Retreat; beyond Paulsberg; north slopes, Slangkop.

2. **T. strigulosum** Sond. ? Mountains, rare; 10. Near Simon's Town at 1,200 feet, *Bolus*, 4689.

Colpoon compressum Berg. Bushy hillsides, frequent, here and there very common; 12–4.

GRUBBIACEÆ.

Grubbia rosmarinifolia Berg. Upper slopes and summits, locally common; 8–12. Platteklip; summit of Table Mountain; Lower Plateau; Silvermine River, &c.

2. **G. stricta** DC. Rocky hill slopes, locally frequent; 3–6. Klaasjagersberg; Red Hill; ridge beyond Smitswinkel Vley; Batsata Rock.

EUPHORBIACEAÆ.

Euphorbia tuberculata Jacq "Table Bay," *Drège*, 8202. Not found by us, unless it be a plant closely resembling the next species, found on Paarden Island and also, beyond our limits, on the sandhills towards Durban Road.

2. **E. Caput-Medusæ** Linn. Flats and hill slopes, occasional; 6–9. Smitswinkel Bay; Paulsberg; frequent from Three Anchor Bay along Western slopes to Hout Bay Nek.

3. **E. tuberosa** Lam. Flats and hill slopes, common; 4–9.

4. **E. elliptica** Thunb. Hillsides, local, or passed over as the last species; 6–9. Over Kamp's Bay; above Mowbray; frequent on Signal Hill.

5. **E. mauritanica** Linn. Near the shore locally plentiful; 9–10. Paarden Island; Kalk Bay; Kamp's Bay.

6. **E. sp.** (§**Arthrothamnus**). An undetermined species of this section was gathered by *Wolley-Dod* (1777) above road beyond Sea Point.

7. †**E. Helioscopia** Linn. A common weed on roadsides and cultivation; 5–12.

8. †**E. Peplus** Linn. More common than last, and reaching 1,500 feet on the mountain slopes; 5–12.

9. **E. Meyeri** Boiss. "Mountains near Cape Town," *Ecklon* and *Zeyher*. Not found by us, but it somewhat resembles the next species, and a specimen gathered on the Lion's Back (*Wolley-Dod*, 3104) may belong to it.

10. **E. genistoides** Linn. Low hills, rather frequent; 8–11. Appears to have been frequently confounded with the next species, from which it is totally distinct, and may be readily distinguished by its more branched and shrubby growth, and its stem always, and fruit and leaves often finely densely pubescent.

11. **E. erythrina** Link. Flats and bushy hill slopes, frequent; 7–10.

12. **E. striata** Thunb. Shrubby hill slopes, rare; 12. "Kamp's Bay," *Schlechter*, 79. Much resembling the last species.

13. **E. platyphyllos** Linn., var. **literata** Koch. Locally plentiful, 9–11. Vaarsche Vley, *Wolley-Dod*, 3202.

Cluytia pulchella Linn. Damp kloofs and stream sides, frequent; 2–9. Reaches at least 2,000 feet.

2. **C. alaternoides** Muell-Arg. Hill and mountain slopes, more rarely on flats, common; 5–11. Reaches 2,000 feet. Leaf-edges callous and smooth.

3. **C. pterogona** Muell-Arg. Bushy hill slopes, occasional; 7–11. Eastern slopes from Devil's Peak to Klassenbosch.

4. **C. pubescens** Thunb. Bushy hill slopes, rare; 5. Wynberg Hill; "Lion's Head and Devil's Peak," *Pappe*.

5. **C. polygonoides** Linn. Hill and mountain slopes, apparently frequent; 6–11. Liable to be mistaken for **C. alaternoides,** but distinguishable by the subscabrous membranous leaf-edges, and the absence of an apiculus at their tips.

6. **C. ericoides** Thunb. Hill and mountain slopes, rare; 5–6. Orange Kloof; Devil's Peak. Rather near narrow-leaved forms of the last, but leaves flat or concave, more acute and often apiculate.

Leidesia capensis Muell-Arg. Damp places in woods, locally frequent; 7–12. Newlands Woods and Groot Schuur.

2. **L. obtusa** Muell-Arg. Under bushes, rare?; 9. Near shore in Smitswinkel Bay, *Wolley-Dod*, 3302.

Adenocline pauciflora Muell-Arg. Sandy and grassy flats, occasional; 8–10. Hout Bay; about Oatlands Point; Buffel's Bay.

Paradenocline procumbens Muell-Arg. Similar places, locally frequent; 9–10. Chapman's Bay; Oatlands to Smitswinkel Bay.

†**Mercurialis annua** Linn. Roadsides, rare; 6–12. Path to Lion Battery; road to Platteklip; Kloof Road; Klein Constantia; casual at Rondebosch.

URTICACEÆ.

?† **Urtica dioica** Linn. Has been recorded, but, we suspect, in error for next.

†**U. urens** Linn. A very common weed of cultivation and waste places; 5–12.

Australina capensis Wedd. Damp shady ground and under bushes, frequent; 7–4.

Celtis rhamnifolia Presl. Mountain kloofs, rare; 9. Skeleton Ravine (not seen in flower). "Ravines on the east side of Table Mountain," *Krauss*, 1776.

†**Cannabis sativa** Linn. A casual at Black River.

MYRICACEÆ.

Myrica æthiopica Linn. Flats and lower slopes, frequent; 11–1.

2. **M. cordifolia** Linn. Flats, locally frequent; 5–6. About Uitvlugt and Maitland; shores of False Bay near Muizenberg.

3. **M. humilis** Cham. and Schl.? Mountains, rare; 9. Above Simon's Town, *Bolus*, 4948.

4. **M. Kraussiana** Buek. "Amongst rocks, Steenberg," *Krauss*. Not found by us.

5. **M. quercifolia** Linn. Flats and slopes to a considerable elevation, common; 6–11.

SALICACEÆ.

Salix capensis Thunb. "Streams near Constantia, September," *Krauss*. Not found by us.

CONIFERÆ.

Callitris cupressoides Schrad. Mountain slopes, frequent; 1–5.

Podocarpus Thunbergii Hook. Woods and kloofs to a considerable elevation, usually on the eastern slopes.

ORCHIDACEÆ.

Liparis capensis Lindl. Sandy flats and slopes to about 2,500 feet, occasional; 4–8. Near Claremont Sanatorium; north slopes Orange Kloof; Red Hill and Klaver Vley; Smitswinkel Vley and beyond.

Acrolophia sphærocarpa Schltr. and Bolus. "Cape Flats near Wynberg, February," *Ecklon* and *Zeyher*. Not found by us.

2. **A. tristis** Schltr. and Bolus. Flats and mountain slopes, frequent; 11–2.

3. **A. lamellata** Schltr. and Bolus. Similar situations; 10–12. Frequent on flats from Rondebosch to Wynberg, occasional elsewhere, reaching 1,400 feet.

4. **A. cochlearis** Schltr. and Bolus. Similar situations up to 1,200 feet, but chiefly on the flats, frequent; 10–2.

5. **A. ustulata** Schltr. and Bolus. Open sandy valleys, very rare and uncertain; 12. Farmer Peck's Valley.

Eulophia tabularis Bolus. Among low shrublets on mountains, occasional; 12–1. Near Wynberg Reservoir; Muizenberg.

2. **E. capensis** Bolus (**E. aculeata** Spreng.). From Flats to summit of Table Mountain, common; 12–2. Occurs sparingly on the Flats.

Bartholina pectinata R. Br. Sheltered spots on lower slopes, usually rare but uncertain, sometimes abundant; 9–10. Orange Kloof; Muizenberg; Kamp's Bay; Kenilworth racecourse.

2. **B. Ethelæ** Bolus. Hills, generally near the sea, 100–1,000 feet, rare; 11–2. Simonsberg; Fish Hoek; Muizenberg.

Holothrix Mundii Sond. Dry ground on flats and mountains, very rare; 9–10. Rondebosch Flats; Wynberg Hill; Orange Kloof rocks at 1,200 ft.

2. **H. squamulosa** Lindl. Low sandy ground, common; 10–1. Also at 2,500 feet on Table Mountain.

3. **H. condensata** Sond. Damp rocky ledges on mountains, frequent; 12–2. Descends to 800 feet in Orange Kloof.

4. **H. hispidula** Dur. and Schinz. (**H. parvifolia** Lindl.). Sandy places on mountains, rather rare; 12–4. Lower Plateau over Klassenbosch; Farmer Peck's Valley; frequent in Waai Vley.

5. **H. exilis** Lindl. var. **brachylabris** Bolus. Sandy ground, very rare; 11–2. Table Mountain (near tunnel intake); by railway near Muizenberg Vley.

6. **H. villosa** Lindl. Sandy ground, frequent, especially on flats; 9–11.

7. **H. gracilis** Lindl. "Table Mountain," *Drège*. Not found by us.

Satyrium carneum R. Br. Sandy flats and low hills, partial to damp places, rather frequent; 9–11. Especially abundant about Retreat and False Bay; reaches over 2,000 feet on Constantiaberg.

2. **S. candidum** Lindl. Flats and lower slopes, frequent; 9–10. Abundant near Orange Kloof swamp after a fire. Reaches 2,400 feet.

3. **S. Guthriei** Bolus? Flats, very rare; 10. "Towards Tokay," *F. Guthrie, junr.*, 7095 of Herb. Bolus. This may be a hybrid between **S. candidum** and **S. bicallosum,** but the evidence is inconclusive.

4. **S. emarcidum** Bolus. Low ground, rare; 9–10. Fish Hoek near Kalk Bay.

5. **S. ligulatum** Lindl. Wet ground on flats and low hills, frequent; 9–12. Abundant at Muizenberg Vley. Though seldom seen over 500 feet, this species reaches the Lower Plateau (2,500 feet).

6. **S. bicorne** Thunb. Sandy ground, chiefly at low elevations, but reaches 2,300 feet above Klassenbosch, common; 7–10.

7. **S. ochroleucum** Bolus. Mountain slopes, rare; 10. Crags above Klassenbosch; Devil's Peak. There is some doubt whether this may not be the same as **S. humile** Lindl., a point we have been unable to determine.

8. **S. coriifolium** Swtz. Sandy flats and hills to about 1,000 feet, common; 7–11.

9. **S. odorum** Sond. Shady places on flats and slopes to about 2,500 feet, frequent; 9–11.

10. **S. foliosum** Swtz. Damp ground at high elevations, rare; 12–2. Near Maclear's Beacon.

11. **S. lupulinum** Lindl. Damp sandy flats and hills, occasional: 8–10. Slangkop; Red Hill; Fish Hoek; eastern slopes Devil's Peak and Table Mountain.

12. **S. stenopetalum** Lindl., var. **brevicalcaratum** (**S. marginatum** Bolus). Swampy ground on flats and hills, occasional; 10–11. Klein Constantia; Klaver Vley; top of Silvermine Valley; plentiful by Orange Kloof swamp.

13. **S. Hallackii** Bolus. Sandy flats, rare; 12. Hout Bay; Cape Flats.

14. **S. bicallosum** Thunb. Slopes from 500 to 2,500 feet, frequent; 9–11.

15. **S. Lindleianum** Bolus. Mountain slopes, occasional; 9–12. Klaver Vley; Constantiaberg; north slopes Table Mountain; rocks over Waai Vley.

16. **S. bracteatum** Thunb. Damp flats and mountain rocks, frequent; 8–12. Reaches summit of Table Mountain. Var. **nanum** Bolus is found in Klaver Vley, and plentifully in a swamp near source of Slangkop River.

17. **S. saxicolum** Bolus. Damp mountain rocks, rare; 9–11. Constantiaberg near Waterfall; Devil's Peak. Possibly a var. of the preceding.

18. **S. striatum** Thunb. Sandy slopes, rare; 9–10. Steenberg.

19. **S. erectum** Swtz. "Slopes above Orange Kloof, 2,200 feet, December," *Schlechter*. Not found by us.

20. **S. retusum** Lindl. "Slopes of Table Mountain at 3,500 feet, February," *Schlechter*. Not found by us.

21. **S. rhynchanthum** Bolus. Mountain swamps, rare; 12. Waai Vley; by the reservoir on Lower Plateau; Steenberg.

Pachites Bodkinii Bolus. Mountain slopes, very rare; 1. Muizenberg Mountain, *Bodkin*, 7071 of Herb. Bolus. This was founded on a single specimen, but it was subsequently refound.

Disa multiflora Bolus. Flats and mountain slopes, occasional; 9–10. Claremont; near Hout Bay; slopes over Wynberg; reaches 2,000 feet in Orange Kloof.

2. **D. pygmæa** Bolus. Plateaux at moderate elevations, rare; 10–11. Along the Silvermine Valley and extending to foot of Constantiaberg.

3. **D. conferta** Bolus. Sandy flats, very rare; 10. Rapenburg, *Guthrie*, 7097 of Herb. Bolus.

4. **D. cernua** Swtz. Lower slopes and swampy flats, rather rare; 10–11. Lion's Head; by the Kommetjes; Wynberg Flats; between Retreat and Muizenberg.

5. **D. micrantha** Bolus. Flats and mountain slopes, common; 9–11. Much resembling **D. multiflora** but appears much commoner. Reaches 3,500 feet.

6. **D. ophrydea** Bolus. Damp plateaux and slopes, locally common; 10–11. South of plantation on Lower Plateau; marsh at source of Slangkop River; Muizenberg; Constantiaberg.

7. **D. affinis** N. E. Brown. Mountain slopes and damp rocky ledges, rather rare; 8–10. Near Wynberg Reservoir.

8. **D. reticulata** Bolus. Mountain plateaux, rare; 11–12. Steenberg; Table Mountain.

9. **D. rufescens** Swtz. Similar situations to **D. ophrydea** which it superficially much resembles, occasional; 8–10. Near Wynberg Reservoir; Silvermine Valley; Klaver Vley; Kenilworth Flats.

10. **D. Bolusiana** Schltr. Mountain tops, very rare; 1. Near Maclear's Beacon, *Bolus*, 4903.

11. **D. sabulosa** Bolus. Sandy flats, locally frequent, but of uncertain appearance; 10. Kenilworth racecourse, *Bolus*, 7104.

12. **D. auriculata** Bolus. Mountains, rare; 10. Steenberg, 1,200 feet, *F. Guthrie, junr.*, 7096 of Herb. Bolus.

13. **D. longicornu** Linn. f. Mossy krantzes, locally common; 12–1. Table Mountain at 3,000 feet; rare elsewhere, as in Orange Kloof, and near Kalk Bay.

14. **D. maculata** Linn. f. Ledges of rocks at moderate elevations, locally common; 11. Muizenberg; Constantiaberg.

15. **D. uniflora** Berg. Wet krantzes and by mountain streams, locally common; 1–4. Especially common on Lower Plateau and in Waai Vley, &c., also in kloofs on west slopes of Orange Kloof; above Tokay; Silvermine River.

16. **D. ocellata** Bolus. Grassy spots at high elevations, very rare; 11–12. Near Maclear's Beacon.

17. **D. uncinata** Bolus. Damp spots and by streams on mountains, very rare; 11–12. By Orange Kloof River; Lower Plateau over Skeleton Ravine.

18. **D. cornuta** Swtz. Among shrublets from flats to highest summits, frequent; 10–1.

19. **D. æmula** Bolus. Similar spots on flats, very rare, but liable to be mistaken for last; 10. Near Salt River. Also gathered just beyond our limits on Vygeskraal farm.

20. **D. tenuicornis** Bolus. Rocky ledges on mountains, rare or not appearing at all some years, frequent in others; 9–11. Near Wynberg Reservoir; Constantiaberg.

21. **D. tenella** Thunb. Flats, rare; 8–9. Kenilworth racecourse, *Bolus*, 7204.

22. **D. tabularis** Sond. Mountain slopes in moist places, rare; 9–12. Table Mountain; Constantiaberg.

23. **D. obtusa** Lindl. By streams and wet rocks on mountains, occasional, but locally abundant; 9–12. Lower Plateau; marsh near source of Slangkop River.

24. **D. cylindrica** Swtz. Plateaux and upper slopes, frequent; 10–1.

25. **D. lineata** Bolus. Mountain slopes, rare; 10–11. Constantiaberg; Lower Plateau at top of Skeleton Ravine.

26. **D. racemosa** Linn. f. Open damp places on mountains, occasional; 11–2. Lower Plateau; top of Silvermine Valley.

27. **D. venosa** Swtz. Moist grassy places, occasional; 12. Lower Plateau.

28. **D. tenuifolia** Swtz. Open sandy spots on mountains, frequent; 11–2.

29. **D. patens** Swtz. Flats and lower slopes, occasional; 10–1. Simonsberg; Muizenberg; Claremont Flats.

30. **D. Harveiana** Lindl. Rocky places on mountains, locally frequent; 12–1. Nek between Constantiaberg and Hout Bay; kopjes round the Lower Plateau.

31. **D. Draconis** Swtz. Mountain slopes and flats, very rare; 11–12. "Table Mountain above Orange Kloof, 2,400 feet," *Schlechter* 90*b*. Also reported from Princess Vley. Not seen by us.

32. **D. glandulosa** Burch. Mountain tops, occasional; 12–1. Muizenberg; Table Mountain.

33. **D. vaginata** Harv. Among shrublets and in open spots at high elevations, frequent; 11–1. All over the higher parts of Table Mountain and Constantiaberg.

34. **D. rosea** Lindl. Damp shady rocks on mountains, frequent; 10–12.

35. **D. Richardiana** Lehm. Damp mountain rocks, frequent; 9–11. Below 1,000 feet on Steenberg.

36. **D. oligantha** Reichb. Similar places, rare or overlooked; 11–12. It was frequent all over the upper plateau of Table Mountain in 1896, *Wolley-Dod*, 2338.

37. **D. Bodkinii** Bolus. Moist mountain ravines, very rare; 11 Table Mountain above Klassenbosch, 2,400 feet, *Bodkin*, 4968 of Herb. Bolus. Also in Waai Vley.

38. **D. melaleuca** Thunb. Open spots on hills and mountains, occasional; 11–1. Muizenberg; Lower Plateau; hills west of Simon's Town.

39. **D. atricapilla** Bolus. Similar situations to last, from which it is with difficulty distinguished, rather rare; 12–1. Lower Plateau; Muizenberg; Simonsberg.

40. **D. fasciata** Lindl. Stony places and moist rocks, rather rare and uncertain; 10–11. Sometimes abundant on the top of Constantiaberg and down the Silvermine Valley; mountains south of Simon's Town; summit of Table Mountain.

41. **D. graminifolia** Ker. Dry sunny spots on mountains, common; 2–3.

42. **D. purpurascens** Bolus. Dry places on mountains, frequent; 11. From Muizenberg nearly to Cape Point, most frequent about Klaver and Smitswinkel Vleys.

43. **D. barbata** Swtz. Among Restiones on the flats, occasional; 9–11. Flats beyond Black River; Kenilworth racecourse.

44. **D. lacera** Swtz. var. **venusta** Bolus. Similar situations, but more frequent and reaching higher elevations; 11–12. Flats near Claremont Sanatorium; Steenberg; Tokay; Kenilworth and Wynberg flats.

45. **D. lugens** Bolus. Among Restiones on the flats, rare; 10–11. Near Rondebosch and Claremont. It becomes more frequent beyond our limits.

46. **D. ferruginea** Swtz. Dry open spots on high mountains, frequent; 2–4. Extends from Devil's Peak to Klaasjagersberg.

47. **D. tenuis** Lindl. Damp slopes at medium elevations, rather rare or overlooked; 4–7. Claremont and Kenilworth Flats; Orange Kloof; near source of Silvermine River; between Red Hill and Slangkop; Devil's Peak.

Schizodium flexuosum Lindl. Flats, very rare and sporadic; 9–10. "Near Rondebosch," *Bodkin.*

2. **S. biflorum** Dur. and Schinz (**S. arcuatum** Lindl.). "On the summit of a mountain near Constantia, 2,000 feet, September," *Krauss.* Not found by us.

3. **S. inflexum** Lindl. Damp sandy plateaux at high elevations rare; 11–12. Lower Plateau and near summit of Table Mountain.

4. **S. bifidum** Reichb. f. (**S. obliquum** and **S. clavigerum** Lindl.). Damp sandy plateaux and flats, frequent; 7–9.

5. **S. rigidum** Lindl. Damp sandy flats, occasional; 8–9. Rondebosch; Constantia, &c.

6. **S. Gueinzii** Reich. f.? "Flats near Constantia, about 200 feet, September," *Bodkin*, 7019! of Herb. Bolus.

Pterygodium Volucris Swtz. Sandy plains and gentle slopes, frequent; 9–10. Plentiful about Muizenberg Vley.

2. **P. alatum** Swtz. Hill slopes and tops, occasional; 9. Lion's Back; above Mowbray; Silvermine Valley.

3. **P. alare** Dur. and Schinz (**P. platypetalum** Lindl.). Mountain slopes 1,000 to 1,800 feet, occasional; 8–9. Near Hout Bay; Vlaggeberg; Devil's Peak.

4. **P. cruciferum** Sond. Sandy flats, rare; 9–10. Near Kamp's Bay; Fish Hoek; Kenilworth.

5. **P. caffrum** Swtz. Among shrublets on flats and hills, frequent; 9–12.

6. **P. catholicum** Swtz. Similar places, common; 8–11.

7. **P. acutifolium** Lindl. Mountain slopes, occasional; 10–12. Lower Plateau; Waai Vley; Muizenberg.

8. **P. carnosum** Lindl. By mountain streams, frequent; 11–12.

9. **P. rubiginosum** Sond. Mountain tops, very rare; 1. "Constantiaberg," *Bodkin*, 7048 of Herb. Bolus.

10. **P. (Corycium) orobanchoides** Schltr. Grassy or sandy flats and low hill slopes, common; 9–10.

11. **P. (Cor.) crispum** Schltr. Sandy flats, rare; 9–10. Towards Tokay and Steenberg; Rapenburg. This species is frequent on the Duinefontein sandhills beyond our limits.

12. **P. (Cor.) bicolorum** Schltr. Hill slopes, rare; 10–12. Lion's Mountain; Steenberg; above Klassenbosch.

13. **P. (Cor.) excisum** Schltr. Sandy flats, occasional; 10–12. Muizenberg; Wynberg and Rondebosch Flats; near Tokay on burnt spots.

14. **P. (Cor.) microglossum** Schltr. Sandy flats, rare; 11–12. Wynberg, Retreat, and Tokay Flats.

15. **P. (Cor.) bifidum** Schltr. "Mountains near Cape Town," *Ecklon* and *Zeyher*. Not found by us.

Ceratandra bicolor Sond. Mountains, rare; 12–1. Lower Plateau; Muizenberg.

2. **C. Harveyana** Lindl. Mountains, very rare; 12. Lower Plateau, by the plantation and near Wynberg reservoir. It appeared in some quantity with the last species on some ground freshly dug for planting in 1896.

3. **C. atrata** Dur. and Schinz. (**C. chloroleuca** Mund). Hill and mountain slopes, frequent; 10–12.

4. **C. globosa** Lindl. (**C. parviflora** Lindl.). Mountain tops, very rare; 12. Table Mountain; summit of Constantiaberg.

Disperis capensis Swtz. Flats and slopes to a considerable elevation, common; 7–9. Reaches Waai Vley. The yellowish-flowered variety looks a distinct species, and is distinct from the much rarer albino form of the type, but we cannot separate it by definite characters. It is frequent on the lower slopes of the Devil's Peak, where it flowers at a different period from the type.

2. **D. paludosa** Harv. Marshy ground on mountains, usually rare; 11. Waai Vley; near Ranger's cottage and Wynberg reservoir; Silvermine Valley. In some years abundant on the Lower Plateau.

3. **D. secunda** Swtz. Flats and hill slopes, rare; 8–9. Table Mountain above the city; Vlaggeberg; Devil's Peak above Mowbray.

4. **D. cucullata** Swtz. Flats and lower slopes, rare; 8–9. Lion's Head; Steenberg; Rondebosch.

5. **D. villosa** Swtz. Sandy places on flats, frequent; 8–10.

6. **D. Bodkinii** Bolus. Flats, very rare; 8. "Under bushes on Claremont Flats," *Bodkin*, 7970 of Herb. Bolus. Only found in one spot in one year.

HÆMODORACEÆ.

Wachendorfia thyrsiflora Linn. Swamps and streams on low ground, occasional; 10–11. Orange Kloof swamp to Hout Bay; near Westerford Bridge; above Klein Constantia.

2. **W. paniculata** Linn. Grassy and sandy flats, common; 7–10. A variety with narrow cylindrical panicle, small pale flowers, and narrow leaves is frequent on the hills west of Simon's Town, and occasional elsewhere. It is probably var. **tenella** Baker.

Dilatris corymbosa Berg. Dry stony hills and flats, frequent; 8–12.

2. **D. viscosa** Thunb. Dry mountains, occasional; 11–1. Constantiaberg; near summit of Table Mountain.

Cyanella capensis Linn. Flats and hill slopes, frequent; 10–11.

IRIDACEÆ.

Moræa ciliata Ker. Hill slopes, local; 8–9. About the Signal station and towards Kamp's Bay. A form with white flowers and almost glabrous yellowish leaves, from near the Kommetjes, Chapman's Bay, *Wolley-Dod*, 1657, may be a distinct species.

2. **M. papilionacea** Ker. Sandy slopes and flats, frequent, 8–10. Flowers orange-yellow or brick-red; we have never seen them lilac.

3. **M. angusta** Ker. Sandy plains, rarely on mountains, occasional; 8–10. Near Rondebosch; Diep River; towards Chapman's Bay; Lower Plateau (December). A form with pale dull purplish flowers occurs near Kamp's Bay toll-bar, and a variety with paler yellow scentless flowers, (the type is strongly scented), with the inner perianth segments recurved instead of erect, grows with the type beyond Constantia Nek, *Wolley-Dod*, 3268, and near Kenilworth station.

4. **M. viscaria** Ker. From roadsides on flats to mountain plateaux, frequent; 11–1.

5. **M. crispa** Ker. Flats and hills, frequent; 7–9. The type on Signal Hill and beyond Simon's Town; var. **rectifolia** elsewhere. We have only seen it with pale yellow flowers.

6. **M. iriopetala** Linn. f. Flats, rare; 8–9. Wynberg; "Devil's Mountain," *Thunberg*.

7. **M. mira** Klatt. Flats, locally common; 8–9. Rondebosch and Newlands; Oude Molen; above Kamp's Bay; Patrys Vley. Flowers deep blue, not violet, extremely fugitive.

8. **M. tristis** Ker. Shady and grassy places, frequent; 8–9.

9. **M. ramosa** Ker. Damp places from flats to high mountains, frequent and locally abundant; 10–12. Reaches Waai Vley.

10. **M. edulis** Ker. Dry sandy flats and low hills, common and very variable; 8–11. The yellow-flowered var. **longifolia** Sweet, with leaves sometimes 5 feet long, nearly as common as the mauve-flowered type.

11. **M. xerospatha** MacOwan. Gravelly flats, locally common; 9–10. From the Grand Parade to Salt River.

12. **M. tripetala** Ker. Flats and low hills, common; 8–9. Var. **mutila** Baker is common above Observatory, and in the kloof on west slopes Lion's Head; the leaf, besides being pilose, is usually broader, and the inner perianth segments are much longer. Forms of the type with leaf broad but glabrous do not appear to have the long inner perianth segments of the variety.

13. **M. Jacquiniana** Schltr. Mountain slopes and plateaux, occasional; 10–1. Waai Vley, and near the summit of Table Mountain; summit of Twelve Apostles; Vlaggeberg; Constantiaberg; Steenberg.

14. **M. glaucopis** Drap. Lower hill slopes, frequent; 9–11. By this we understand the species with white outer perianth segments having a dark patch at the base of the lamina, the lateral lobes of the inner segments being erect, narrow, and subacute, but we admit our inability to distinguish between this and the two following species, and varieties of **M. Pavonia** Ker.

15. **M. tricuspis** Jacq. Similar situations, but appears much more local; 9–11. Frequent on lower slopes beyond Simon's Town. Closely resembles the last, but the outer perianth segments are pale yellow. It agrees with figures of both **M. tricuspis** Ker. in Bot. Mag. t. 696, and **M. tricuspis** var. **lutea** Ker. *ib.* t. 772, but Baker places the latter as a variety of **M. Pavonia.**

16. **M. tenuis** Ker. Lower slopes, locally frequent; 9–10. West slopes Signal Hill and Lion's Head. Very like the last, with the same coloured flowers but much taller, sometimes 4 feet high, and with the lateral lobes of the inner perianth segments broader, much more obtuse, and spreading.

Homeria collina Vent. Flats and hills to moderate elevations, very common; 7–10. A very variable plant. The prevalent mountain form, *Wolley-Dod*, 594, is a much stouter plant, with much firmer perianth, which is deep yellow instead of the fragile pale red of that from the flats. A dwarf small-flowered form from Red Hill, Klein Slangkop and Salt River, *Wolley-Dod*, 3010 and 3304, may be **H. miniata** Sweet.

2. **H. simulans** Baker. Sandy flats, occasional; 11. Kenilworth Flats and racecourse; Retreat. Probably often passed by as **Moræa viscaria.**

Ferraria undulata Linn. Sandy places, near the sea, frequent; 9–10. Reaches 1,500 feet on Lion's Head.

Hexaglottis longifolia Vent. Flats and hill slopes, common; 10–11. Very variable in stature. The form of marshy ground which we have only seen in Orange Kloof swamp, by Constantia Nek, and at Groot Schuur, is 4 feet high with leaves ½ inch broad, and is probably the type. The much commoner form of dry ground is 6 to 12 inches high, with very narrow (flat) leaves, and may be **H. virgata** Sweet, but that is said to have terete leaves, though throughout the order flat leaves have often been described as terete.

Galaxia ovata Thunb. Flats and hill slopes, frequent; 6–9. Especially common on Lion's Head. Flowers usually bright deep rose, occasionally yellow; we have never seen them lilac.

2. **G. graminea** Thunb. Flats, frequent; 6–9. Only the yellow-flowered form seen.

In the following genus it is almost impossible to diagnose species from descriptions. We have therefore arranged the Peninsular species which we have found, and those noted for the district in the Flora Capensis, in accordance with the following short descriptions. We do not intend this to be in any way a revision of the genus, but only to indicate our interpretation of the species.

Romulea sublutea Baker. Corm flat-bottomed. Peduncles long, with several spreading-ascending glabrous pedicels. Flowers bright deep yellow, concolorous on back. Sandy flats, locally common; 8–9. From Fish Hoek southward.

2. **R. bulbocodioides** Baker. Corm ovoid. Basal leaf one, broader than in most other species, much overtopping floral leaves and inflorescence. Peduncles short, with spreading recurved pedicels which are scabrous-pubescent on angles, usually densely so, rarely subglabrous. Flowers bright saffron-yellow, usually green externally. Sandy and gravelly flats, rather rare; 6–10. Camp Ground; fields at Observatory.

3. **R. latifolia** Baker. This seems to be a broad-leaved form of **R. chloroleuca;** we see no other difference. Similar situations, occasional; 6–10.

4. **R. chloroleuca** Baker appears to differ in no respect from **R. bulbocodioides** except in the colour of the flowers, which are typically white, with green or lilac backs, rarely pale lilac within, but it is connected by insensible gradations of yellow with **R. bulbocodioides.** It is one of the commonest species; 6–10.

5. **R. similis** Eckl. "Lion Mountain and Devil's Mountain," *Thunberg;* "Kamp's Bay," *Ecklon;* sandy flats, Camp Ground, *Bolus*, 3734, partly. We do not understand this species, so follow Baker in Flora Capensis.

6. **R. minutiflora** Klatt. Differs from **R. rosea** only in having very small pale purple or rosy flowers, but in no technical character. It is locally frequent in dry gravelly soil; 9. Green Point Common; Grand Parade, and on the common by the shore to Woodstock.

7. **R. hirsuta** Eckl. Corm flat-bottomed. Basal leaves two to four, very slender, about equalling inflorescence, usually very finely pubescent. Peduncles with close erect-ascending pedicels, which are glabrous or pubescent on angles. Flowers bright rose, varying to reddish- or coppery-orange, not particoloured externally as in **R.**

rosea. Gravelly flats and hill slopes, common; 8–9. A form with very small pale flowers from Vlaggeberg, *Wolley-Dod*, 1645, probably belongs here. Another form with corm of this species, and densely pubescent but broad leaves, otherwise just as in **R. chloroleuca,** we suppose to be a hybrid. It was gathered above Observatory gravel fields, and above Sea Point, *Wolley-Dod*, 2659 and 1160.

8. **R. rosea** Eckl. Corm globose. Leaves two to several, rigid, glabrous, much overtopping inflorescence, as do the floral leaves. Peduncles with erect glabrous or rarely (and only in varieties) finely scabrous pedicels. Flowers various shades of purple, violet, blue, or rose, rarely white, very generally with green bands externally. Appears to be the commonest species; 6–11.

Var. **R. pudica** Baker is unknown to us, but appears to be only a colour form.

Var. **R. speciosa** Baker has the green bands on the backs of the perianth segments more strongly marked and pinnately branched. It is the common mountain form.

Var. **R. parviflora** Baker is the small-flowered form, common by roadsides or even on roads, and in waste gravelly places.

Var. **R. dichotoma** Baker. Peduncles 10 to 12 inches, with 2–4 divaricate finely scabrous pedicels and small blue flowers, green externally. Only seen in water in Rapenburg Vley in October, *Wolley-Dod*, 3631, but a very similar plant, though much dwarfer and with less divaricate pedicels, is frequent in damp sandy places on the flats, especially north of Maitland, *Wolley-Dod*, 3276 and 1795.

A rarer form, very similar to the dwarf form of **R. dichotoma** but with glabrous pedicels, and pale orange or ochreous flowers, red or red-striped externally, is found occasionally in dry sandy ground, as in Chapman's Bay; and flats near Wynberg, Rondebosch, and Maitland, *Wolley-Dod*, 1672, 1589, 3275.

9. **R. arenaria** Eckl. is unknown to us except from Baker's quotation, "Wynberg, *Ecklon.*"

10. **R. papyracea** Wolley-Dod. Very local; 10. Lower Plateau. The corm of this species has very *thin*, not *thick*, papyraceous tunics, as described in Journ. Bot. xxxviii. p. 170.

Two other species, **R. filifolia** Eckl. and **R. longifolia** Baker, are said to have been found on the Peninsula, but we cannot trace good authority, nor do we know either species, unless *Wolley-Dod*, 1489, from Wynberg Park, with leaves 2 feet long, is referable to **R. longifolia.**

Bobartia filiformis Ker. Flats to mountain tops, usually in damp places, occasional; 10–2. Frequent on the Flats; Lower Plateau; Waai Vley; summit of Table Mountain.

2. **B. gladiata** Ker. Hill and mountain slopes to 1,500 feet, frequent; 10–11.

3. **B. spathacea** Ker. Hill slopes, common; 11–3.

Aristea racemosa Baker. Flats, rare; 11. Kenilworth.

2. **A. pauciflora** Wolley-Dod. Hills and mountains, rare; 10–12. Near Wynberg reservoir, *Bolus*, 7056; Maclear's Beacon; Lower Plateau and Orange Kloof, *Wolley-Dod*, 2157, 2161, 3507.

3. **A. juncifolia** Baker. Damp places on mountains, rare; 11. Stream south of Constantiaberg; top of Farmer Peck's Valley.

4. **A. dichotoma** Ker. Flats and lower slopes, frequent; 12–2.

5. **A. cyanea** Soland. Sandy flats, frequent, more rarely on hill slopes; 8–9. We have also seen it in flower in February.

6. **A. capitata** Ker. Mountains, frequent, less so on lower slopes; 11–1. This has been gathered in flower in July.

7. **A. spiralis** Ker. Damp spots on hills and mountains, frequent; 9–12.

Witsenia maura Thunb. Among **Osmitopsis,** &c., on low ground, rare; 4–6. Patrys Vley; Silvermine Valley below waterfall; Smitswinkel Vley.

Hesperantha cinnamomea Ker. Flats and hill slopes, occasional; 8–9. Lion's Back; above Mowbray; Kenilworth and Claremont Flats.

2. **H. falcata** Ker. Among shrublets on flats and hills, frequent; 7–10.

3. **H. graminifolia** D. Don.? Sandy flats, rare; 9. Rondebosch Camp Ground near bridge, *Wolley-Dod*, 524.

4. **H. pilosa** Ker. Flats to mountain slopes, frequent; 8–9.

5. **H. radiata** Ker. Flats to high mountains, frequent, though rather local; 9–12. Especially common on Signal Hill. Reaches nearly to summit of Table Mountain.

Geissorhiza humilis Ker. Sandy places from flats to mountains, frequent; 8–9. Var. **grandiflora** Baker is especially frequent in Fish Hoek Valley. A plant differing somewhat in habit, with pubescent leaves, longer perianth tube, and white, very brittle corm tunics, from the marsh near source of Slangkop River, *Wolley-Dod*. 3190, is placed here provisionally. A plant with similarly pubescent leaves, but otherwise typical, occurs between Groot and Klein Slangkop, *Wolley-Dod*, 3189.

2. **G. Wrightii** Baker. Mountain slopes, rare; 12. Rocks over Waai Vley, *Wolley-Dod*, 2146. Nearest this species, but spathe valves membranous at the tips, and bearing some resemblance to **G. setifolia** Eckl.

3. **G. secunda** Ker. Hill slopes and sandy flats, very common; 8–12. As we understand this species, its corm tunics are just as in **G. imbricata,** its stem is densely finely pubescent, leaves narrowed into a pseudo-petiole, not with ventricose sheaths, and deep purplish blue flowers. Mr. Baker's description in Flor. Cap. vi. p. 69, closely fits what we understand by **G. setifolia** Eckl., an absolutely distinct species, though placed as a variety of **G. secunda** by him.

4. **G. pubescens** Wolley-Dod. Hill slopes, locally abundant; 9–11. West slopes Lion's Head and Signal Hill, *Wolley-Dod*, 1246 and 1602; much rarer near the Blockhouse on Devil's Peak, 583.

5. **G. setifolia** Eckl. Hill and mountain slopes, frequent; 9–11. See note under **G. secunda.** The present species has bright brown crustaceous corm tunics, erect glabrous stem, 8 to 12 inches high, abruptly flexed at lower nodes, terete, glabrous leaves, and small whitish or pale yellow flowers, reddish on back.

6. **G. graminifolia** Baker. Hill slopes, apparently rare, but we do not understand the species; 9. Signal Hill, *Wolley-Dod*, 521. We have seen similar plants labelled **G. quinquangularis** Eckl., but that is a species having flowers twice the size of **G. graminifolia.**

7. **G. hirta** Ker. var. **quinquangularis** Eckl. This is quoted by Baker, "Lion Mt., *Ecklon*, 312," but has not been seen by us.

8. **G. imbricata** Ker. Damp spots on flats and hills, and a lax elongated form on wet rocks on high mountains, common; 8–11.

9. **G. setacea** Baker. We think this has been confused with **G. Bolusii;** at any rate, *Bolus*, 4803 is the latter species. We have not seen Thunberg's plant from "near Cape Town."

10. **G. Bolusii** Baker. Wet rocks on mountains, frequent, but chiefly restricted to a belt between 1,200 and 1,600 feet; 10–11.

11. **G. excisa** Ker. Hill and mountain plateaux and rocks, frequent; 9–10. Descends below 500 feet in Patrys Vley.

Ixia polystachya Linn. Hill and mountain slopes, partial to damp places, frequent; 10–12. This appears to be a most variable species. Some forms seem indistinguishable from **I. leucantha** Jacq.; others with yellow flowers (**I. flavescens** Eckl.) differ from **I. maculata** Linn. only in the absence of the dark throat, not a very trustworthy character.

2. **I. hybrida** Ker. "Kamp's Bay," *Pappe.* Not found by us.

3. **I. maculata** Linn. Plains and low hills in dry places, requent; 10–12.

4. **I. columellaris** Ker.? Plants agreeing with the description of this species were gathered on the Steenberg slopes, *Wolley-Dod*, 1943 and 3638. The filaments were quite free, but the plants were otherwise just like **I. monadelpha.** The figure in Bot. Mag. t. 630 looks so different, however, that we query the name.

5. **I. monadelpha** Delar. Flats and hills, occasional; 9–11. North of Kamp's Bay; Camp Ground; west slopes Lion's Head; Orange Kloof up to 2,000 feet.

6. **I. paniculata** Delar. Damp spots on flats and hills, occasional; 11–12. Near Diocesan College ranges; Klaver Vley; Muizenberg Vley.

Lapeyrousia corymbosa Ker. Sandy flats and hills, locally frequent; 11–12. Camp Ground and Claremont Flats; Red Hill; Lion's Back; Kamp's Bay.

2. **L. Fabricii** Ker. Sandy flats, locally frequent; 10–12. Maitland to Rondebosch; Chapman's Bay.

Micranthus plantagineus Eckl. Flats to mountains, in dry places, very common; 10–1. The var. **junceus** appears nearly as common as the type.

2. **M. fistulosus** Eckl. Flats and hill slopes, common; 11–12. Especially abundant on the west slopes of Lion's Head. The leaves are fistular, and are very much greater in diameter than in var. **junceus** of the last species.

Watsonia Meriana Mill. Hill and mountain slopes, partial to damp places, common; 11–2. Reaches summit of Table Mountain.

2. **W. coccinea** Herb. Hills, rare; 10–11. "Constantia," *Zeyher*. What appears to be this species grows abundantly near Malherbe's farm in Klaver Vley.

3 **W. humilis** Mill. Sandy plains from flats to mountains, frequent; 10–11. Especially common on Rondebosch Flats and the Lower Plateau.

4. **W. rosea** Ker. Flats and mountains, rather common; 11–12.

5. **W. punctata.** Hills and mountains, frequent; 12–1.

Babiana tubiflora Ker. In deep sand on flats, rare; 8–9. Hout Bay; Chapman's Bay. It becomes more frequent beyond our limits.

2. **B. plicata** Ker. Sandy places up to about 800 feet, common; 6–9.

3. **B. disticha** Ker. Similar places, and nearly as common; 5–7. This species is certainly distinct from the last, differing in its shorter and broader leaves, perianth with a much longer tube, its segments usually purplish, subequal, connivent at tips, so that the flowers, which are quite scentless, appear regular. In **B. plicata** the flowers are usually pink, but sometimes deep violet, the perianth very oblique, segments unequal, almost always with broad white blotches on one or three of the lowest. The flowers also are very strongly sweet-scented.

4. **B. stricta** Ker. Flats and hills to about 1,000 feet, frequent; 7–10. A very variable plant, and perhaps an aggregate species, but we have not been able to distinguish more than one. A small-flowered variety is common along the Victoria Road towards Hout Bay Nek.

5. **B. ringens** Ker. Sandy places to 800 feet, frequent; 8–9.

Melasphærula graminea Ker. Damp, shady kloofs, frequent; 7–9.

Sparaxis grandiflora Ker. Grassy places up to 800 feet, common; 7–9. The forms **S. Liliago** and **S. anemoniflora** are about equally common.

Tritonia scillaris Baker. Lower hill slopes, frequent, and locally common; 9–11.

2. **T. crispa** Ker. Mountain slopes, rare; 10-11. North slopes Lion's Head at about 1,200 feet. Var. **grandiflora,** Kasteel Poort. Var. **parviflora,** "Lion's Rump," *Pappe;* "foot of Table Mountain," *MacOwan.*

Acidanthera tubulosa Baker. Hills at about 800 feet, rare; 10–11. Hills west of Simon's Town, *Wolley-Dod*, 2036.

2. **A. pauciflora** Benth. Damp places on flats and low hills, rare; 11. Near Muizenberg Vley, *Wolley-Dod*, 3655. Liable to be mistaken for **Gladiolus angustus** or **hastatus.** We think No. 946 of *MacOwan* and *Bolus*, Herb. Norm., to belong here, as Baker first placed it, rather than to the last species.

3. **A. sabulosa** Schltr. Sandy flats, rare; 10. Camp Ground, *Wolley-Dod*, 3419.

4. **A. rosea** Schinz. "Summit of Devil's Peak," *Schlechter*, 75. Not seen by us.

Synnotia bicolor Sweet. Dry grassy fields and hillsides, rare; 8–10. About Observatory; Lion's Head.

Gladiolus grandis Thunb. Among shrubs on hill slopes, rather rare; 5–11. Devil's Peak; Silvermine Valley; Muizenberg; Constantia.

2. **G. tristis** Linn. Mountain slopes, rare; 9–10. West slopes Devil's Peak at 2,500 feet, *Wolley-Dod*, 1761. Appears to be var. **concolor.**

3. **G. recurvus** Linn. Flats to mountain slopes, common; 5–9. Very variable in colour, and perhaps not specifically distinct from the last. An obvious hybrid with **G. Watsonius** was gathered by Mr. Bodkin on the Steenberg, growing with both parents.

?**G. angustus** Linn. Wet places, rare?; 9–11. We are doubtful of the occurrence of this plant within our limits, though it is frequent about Vygeskraal Farm, just beyond them. *Bolus*, 2824 is much more like **G. blandus;** *MacOwan* and *Bolus*, 284 is probably some other species, and we have not seen *MacOwan*, 2605. (*Vide* Fl. Cap. vi. p. 140.)

4. **G. hastatus** Thunb. Marshy places on flats and hills, locally frequent; 9–1. The Kommetjes; marsh north of Constantiaberg. The leaves are quite flat, not subterete, and the flowers are cream-coloured, with mauve or crimson blotches. *Burchell*, 8414 and 8506 are most probably **G. Watsonius.** *Bolus*, 3883, is certainly **G. Pappei.** *Wright*, 251, has no flowers in Herb. Kew. (*ib.* p. 141).

5. **G. gracilis** Jacq. Flats and slopes to 800 feet, frequent; 7–9.

6. **G. tenellus** Jacq. Hill slopes, locally frequent; 7–9. Devil's Peak; Lion's Head. A small well-marked species, with dark brown flowers inclining to purplish, but translucent and very rigid. *Zeyher*, 1628 is not this species (*ib.* p. 141).

7. **G. aureus** Baker. Sandy flats, very local; 8–9. Chapman's Bay.

8. **G. vomerculus** Ker. We only know this from Baker's citation, "Eastern declivity of Table Mountain, *Ecklon*, 158," and it appears to us hardly distinct from **G. blandus.**

9. **G. brevifolius** Jacq. Flats and hill slopes, frequent; 3–5. The leaves are often produced in later flowering plants; they are often pubescent. We think **G. jonquilliodorus** Eckl. quite a distinct species. Its corm has loose, thin, brown, papery tunics, stem 30 inches high or more, leafless. Leaves subterete, glabrous, withered at the time of flowering. Flowers 9 to 15, crowded, small, pale, dull yellow. *Burchell*, 748, "from the gardens at Cape Town," is the latter species, and *Wolley-Dod*, 2392, Vygeskraal, just beyond our limits, is the same, but we have not found it on the Peninsula.

10. **G. tabularis** Eckl. High mountains, locally frequent; 1–3. Table Mountain and Devil's Peak.

11. **G. debilis** Ker. Hill slopes, locally frequent; 8–10. Not seen north of Steenberg. Pappe's plant from Cape Flats is certainly **G. biflorus** (*ib.* p. 145).

12. **G. biflorus** Klatt. Damp places on the flats, occasional; 6–9. Fish Hoek; Uitvlugt; Doornhoogde; more frequent near Wynberg. Very variable in size of flowers.

13. **G. cochleatus** Sweet. "Lion's Mountain," *Drège.* Not found by us.

14. **G. Pappei** Baker. Bogs on high mountains, rare; 12. Lower Plateau, and by path towards Maclear's Beacon. Specimens from these stations appear to be always one-flowered, but a deep-coloured, two-flowered plant from Orange Kloof (*Wolley-Dod*, 3363) may be this species, or possibly **G. Rogersii** Baker. *Bolus*, 3883, placed by Baker under **G. hastatus,** belongs here.

15. **G. inflatus** Thunb. Plateaux and plains, frequent; 8–9. Especially abundant at Fish Hoek and south of Constantiaberg.

16. **G. suaveolens** Eckl. (**G. involutus** Delar.) "Eastern side of Table Mountain," *Ecklon* and *Zeyher.* Not found by us.

17. **G. vittatus** Hornem. "Cape Flats near Wynberg," *MacOwan* and *Bolus*, Herb. Norm., 287. We do not understand this species, which seems too near **G. blandus.** Perhaps *Wolley-Dod*, 388, from Vlaggeberg, belongs here.

18. **G. villosus** Ker. Flats and hill slopes, frequent; 7–9. Especially frequent in Orange Kloof after a fire.

19. **G. scaphochlamys** Baker. "Flats near Cape Town," *MacOwan*, 2553. Looks rather near **G. blandus,** but that is a mountain plant. Unless *Wolley-Dod*, 398 and 399, from Devil's Peak belong here, we have not gathered it.

20. **G. blandus** Ait. Mountain slopes, frequent; 11–1. Abundant in Waai Vley after a fire. Rarely below 1,000 feet, but gathered at 300 feet at Steenberg Farm.

21. **G. alatus** Linn. Sandy flats and hill slopes, occasional; 8–9. About Maitland and Mowbray; west slopes Lion's Head: Tokai.

22. **G. arenarius** Baker. Flats, locally frequent; 10–12. About Claremont and Kenilworth; Retreat. We have not seen it on mountains, as Baker records it.

23. **G. montanus** Baker. Hill and mountain slopes; frequent; 12–4. Extends nearly to summit of Table Mountain.

24. **G. Watsonius** Thunb. Mountain slopes, locally frequent; 5–6. Steenberg Rocks; lower slopes Lion's Head near Tamboer's Kloof. We are convinced that there are two species combined under **Antholyza revoluta** Burm., and though they are certainly not generically distinct we have preferred to leave names as they are, giving the leading characters which distinguish them. They appear to connect the genera **Gladiolus** and **Antholyza,** and on the whole both species are nearer the latter. The Steenberg plant, which we believe to be **Gladiolus Watsonius** Thunb., has corm globose, ½ inch diameter with thin pale brown striate papery tunics; stem slender, glabrous, about 1 line in diameter; three lowest leaf-sheaths without laminæ, the fourth with lamina ½ to 1 line wide, 6 to 9 inches long, two or three upper shorter, ribs 3 to 5 moderate; rachis flexuose; flowers 1–3, rarely 4, bright rather pale red, tube of perianth narrow cylindrical for about 8 lines, then gradually expanded into a curved portion 8 to 10 lines long, 2 to 2½ lines wide, segments distinctly acuminate, 10 to 12 lines long; spathe valves 12 to 16 lines long; stamens nearly equalling lower perianth segments.

Figures of these species are not conclusive, as one of the most distinctive characters, the corm, is never shown.

Antholyza præalta Delar. (in Red. Lil. t. 387). Damp places below rocks at about 1,500 feet, frequent; 8–10. Distinguished from the next species as follows: Leaves rigid; stem 2 to 3 feet, considerably overtopping leaves, inflorescence strictly distichous; lower portion of perianth tube gradually expanded into upper portion. Flowers later, and at higher elevations.

2. **A. æthiopica** Linn. (in Red. Lil. t. 110, and Bot. Reg. t. 1159). Shady woods, common; 5–7. Leaves flaccid, sheathing stem up to inflorescence, which is distinctly but irregularly unilateral; stem 1½ to 2 feet; lower portion of perianth tube abruptly expanded into upper portion.

3. **A. Cunonia** Linn. Sandy ground, chiefly near the shore, occasional; 9. Fish Hoek; Hout Bay; Simon's Town; Paulsberg.

4. **A. revoluta** Burm. Grassy fields and low hill slopes, locally frequent; 7–8. Several places below Prince of Wales' Blockhouse on the Devil's Peak. See remarks under **Gladiolus Watsonius.** The present species has corm 1 inch in diameter with chocolate-brown tunics, sliced from below into rigid, horny, narrow subulate laminæ, which usually cover numerous bulbils; stem stout and rigid, about 2 lines in diameter, 1½ to 2 feet high; lowest one or two sheaths without laminæ, the third with lamina 18 to 30 inches long, 1 to 1½ lines wide, very strongly ribbed, one or two upper leaves much shorter; rachis straight and rigid; flowers 5 to 6,

larger than in **Glad. Watsonius,** deep scarlet, segments of perianth acute, often narrow, but hardly acuminate; spathe valves about 2 inches long; stamens as in **G. Watsonius.**

5. **A. Merianella** Linn. Hill plateaux and flats, locally common; 6–9. From Steenberg southwards. Flowers brilliant orange and red, rarely yellow.

6. **A. Lucidor** Linn. f. Hill and mountain slopes, locally frequent; 12–3. From Steenberg southwards; "Devil's Peak," *Ecklon.*

7. **A. nervosa** Thunb. Hill and mountain slopes, occasional, though here and there frequent; 1–3. Orange Kloof; Simonsberg; Smitswinkel Vley; Devil's Peak.

AMARYLLIDACEÆ.

Pauridia hypoxidioides Harv. Sandy flats, locally common; 5–6. Camp Ground; Rapenburg; Maitland.

Curculigo plicata Ait. Pine woods and hill slopes to over 1,000 feet, common; 4–6.

Hypoxis minuta Linn. f. Sandy flats, locally common; 5–6. Camp Ground.

2. **H. alba** Linn. f. Damp flats and low hill slopes, common; 5–7.

3. **H. curculigoides** Bolus. Sandy flats, rare; 4–5. Near Kenilworth; Wynberg; "Hout Bay Valley," *Schlechter*, 627! also Herb. Norm. Austr. Afr., 1383!

4. **H. Schlechteri** Bolus. Flats and hill slopes, common and general; 6–8. This appears in Flor. Cap. as a var. of the preceding. It is, however, quite distinct by its terete leaves and ovate, not flattened, corm.

5. **H. serrata** Linn. f. Flats and low hill slopes, common, sometimes abundant; 5–10. Usually readily distinguished from **H. stellata** by its smaller redder paler flowers, pale green, or very rarely red on backs. What appears to be a slender elongated form grows on wet rocks in Orange Kloof River.

6. **H. aquatica** Linn. f. Pools on flats, dry in summer, frequent, often abundant; 7–8.

7. **H. stellata** Linn. f. Flats and hills, very common; 7–10. The white-flowered form is rather rare. All our gatherings of this species have reflexed hispidity on the leaf-margins just as in **H. serrata,** so that the most important specific distinction fails. The colour and size of flowers is much less important, still we believe the two species are distinct. One or other species, probably **stellata,** was gathered on Lower Plateau.

Hessea stellaris Herb. Sandy flats, frequent but rather local; 4–6.

2. **H. filifolia** Ait. Sandy flats in damp places, rare; 5–6. Camp Ground; Wynberg; "rarely on Table Mountain summit in December," *Schlechter*, 84.

Carpolyza spiralis Salisb. Sandy flats and hill slopes, locally common; 6–7. Signal Hill; Fish Hoek; beyond Kamp's Bay.

Gethyllis spiralis Linn. f. We have not gathered this in flower, but leaves which probably belong to it are to be found abundantly at the foot of Signal Hill behind Sea Point.

2. **G. afra** Linn. Shrubby places or open fields, rare; 12. Near Rosebank, *Bolus*, 3819.

3. **G. ciliaris** Linn. f. "Sandy places near Cape Town," *Thunberg*. Not found by us.

4. **G. undulata** Herb. Flats, rare; 12–3. "Zeekoe Valley, March," *Masson*. Specimens apparently of this species have been found by us on the Camp Ground and by Kenilworth station in December.

5. **G. pusilla** Baker. Flats, rare; 1. Kenilworth racecourse, *Bolus*, 7981.

Crinum longifolium Thunb. "Between the foot of Lion Mountain and the sea-shore," *Thunb.* Not found by us, and probably now extinct on the Cape Peninsula.

Amaryllis Belladonna Linn. Bushy places on flats and hills to about 1,000 feet, frequent, and locally plentiful after a fire; 3–4.

Brunsvigia gigantea Heist. Sandy places at the foot of the mountains, occasional; 2–3. Constantia; Muizenberg; Zeekoe Vley; Orange Kloof.

Ammocharis falcata Herb. "Near Cape Town," *Thunberg*. Not found by us.

Nerine sarniensis Herb. Mountain slopes from 700 to 1,500 feet, frequent, though rather local; 3–4. Varies from pink to scarlet or deep crimson.

2. **N. undulata** Herb. "Hills below Table Mountain, towards the east; Wynberg, &c.; 3–5," *Thunberg*.

3. **N. humilis** Herb. "Table Mountain," *Drège*. Neither of these found by us.

Cyrtanthus angustifolius. Mountains, occasional; 2. Lower Plateau, only flowering after a fire.

Hæmanthus coccineus Linn. Flats and slopes to at least a 1,000 feet, very common, though not always flowering; 2–3.

Buphane ciliaris Herb. Flats and slopes, frequent, but very seldom flowering and usually only after fires; 3–4.

LILIACEÆ.

Asparagus crispus Lam. Ledges and crevices of rocks at 1,000 to 2,000 feet, occasional; 8–9. Devil's Peak; Lion's Head; Muizenberg; Slangkop; towards Smitswinkel Bay.

2. **A. Thunbergianus** Schult. Flats to mountain slopes, apparently common, but we have no confidence in our ability to distinguish this species from **A. africanus ;** 3–6.

3. **A. capensis** Linn. Flats and lower slopes, frequent; 5–6. Common on the Camp Ground and about Observatory, thinly scattered elsewhere.

4. **A. africanus** Lam. Similar situations to **A. Thunbergianus,** apparently common; 3–6. One or other of these species varies greatly in habit, perhaps both do.

5. **A. scandens** Thunb. Shady woods in damp places, common up to 2,000 feet; 9.

6. **A. æthiopicus** Linn. Dry kloofs at low elevations, rare; 3–4. South of Hout Bay; above road in Orange Kloof; Skeleton Ravine; Devil's Peak. Our specimens agree best with the description of this species, but specimens of **A. sarmentosus** Linn. look no different.

7. **A. Kraussii** Baker. Climbing in kloofs and woods, rare? Not seen in flower. Near Constantia; Klassenbosch; Orange Kloof. Liable to be mistaken for **A. medeoloides,** var. **angustifolius.**

8. **A. medeoloides** Thunb. Bushes and kloofs, occasional; 9. Slopes towards Smitswinkel Bay; between Wynberg and Alphen; railway between Diep River and Muizenberg; Wynberg Park.

9. **A. undulatus** Thunb. Sandy fields and roadsides, rare; 8–9. About Hurley House on the Camp Ground.

Kniphofia aloides Mœnch. Marshy ground to about 1,000 feet, occasional, and flowering irregularly throughout the year. Orange Kloof; Devil's Peak; Nordhoek; Patrys Vley.

Aloe gracilis Haw. Rocky ground, rare; 9–10. Ridge beyond Smitswinkel Vley; near Slangkop.

Bulbinella robusta Kunth. Swamps from 1,500 to 3,000 feet frequent, and abundant where it does occur; 7–10.

2. **B. triquetra** Kunth. Sandy plains, rare; 9. Field at northern end of Camp Ground.

Bulbine favosa Roem. et Schult. Flats and mountains, common; 2–5. There appear to be two species included under this name. The stouter form, as found by roadside near Claremont, has a yellow digitate corm and seems to agree with Thunberg's **Anthericum favosum.** The more slender mountain form has fewer flowers, and a globose black-skinned corm. We have, however, noticed intermediates, and so hesitate to split the species.

2. **B. asphodeloides** Roem. et Schult. Flats to mountain slopes, frequent; 8–9. Racemes very dense; pedicels slender, usually reflexed after flowering.

3. **B. præmorsa** Roem. et Schult. Shrubby places near the coast, rare; 6. "Hout Bay," *Schlechter*, 963!

4. **B. pugioniformis** Link. Plateaux and slopes to about 1,000 feet, rare; 3–4. Hills west of Simon's Town; west slopes Orange Kloof; Steenberg rocks.

5. **B. annua** Willd. Sandy plains, occasional; 9. Beyond Paulsberg; Chapman's Bay. Perhaps frequent, but liable to be mistaken for **B. asphodeloides,** from which it differs in its much laxer raceme on a stouter less erect scape, with longer stouter pedicels not reflexed after flowering. Its leaves are usually broader and more fleshy.

6. **B. alooides** Willd. Damp rocky ledges and shallow kloofs from about 1,500 to 2,500 feet, frequent; 3, 6–8. We omit **B. nutans** Roem. et Schult., as *Bolus*, 3709, belongs, we believe, to the present species.

Eriospermum cernuum Baker. Flats and hills, rare; 2–3. Kenilworth; Claremont; near Hout Bay.

2. **E. lanceifolium** Jacq. Pine woods and bushy places at low elevations, occasional, but general; 3–4. Cape Flats, &c.

3. **E. pubescens** Jacq. Flats to mountain slopes, rare; 3. Near summit Lion's Head; Rondebosch Flats.

4. **E. spirale** Berg. Flats, in clefts of granite rocks, rare; 4. Kenilworth racecourse, *MacOwan* and *Bolus*, 1388. Flowers only in wet years.

Anthericum triflorum Ait. Hill and mountain slopes, locally requent; 8–11. Slopes of Lion's Head at and beyond Sea Point to about 1,500 feet.

2. **A. serpentinum** Baker. Hill slopes, locally occasional; 10. Lower slopes Lion's Head towards Kamp's Bay and behind the village, *Wolley-Dod*, 2331. The leaves are not spirally twisted but are strongly flexuose, so as to appear spiral when pressed.

3. **A. chlamydophyllum** Baker. Sandy places on low hill slopes, rare; 9–10. Behind Kamp's Bay, *Wolley-Dod*, 3358; between Groot and Klein Slangkop, with slightly scabrous leaves, *Wolley-Dod*, 3251. Scape bent strongly outwards just above base. Flowers very sweet-scented.

4. **A. brachypodum** Baker. Common on flats, rarely on mountains; 11–4. Devil's Peak at 1,800 feet. Clearly marked by its subsimple panicle, with shortly pedicelled or subsessile flowers.

5. **A. elongatum** Willd. (**A. Jacquinianum** Roem. et Schult.). Flats and low hills, common; 10–4. Extreme forms approach the last species.

6. **A. longepedunculatum** Steud. Wet places on flats, apparently common; 8–10. We do not fully understand this species, but it appears to be usually a small plant with large flowers. The fruits, though usually globose, are sometimes quite twice as long as broad.

7. **A. tabulare** Baker. Damp plateaux and dripping rocks at high elevations, locally frequent; 10–2. Plentiful on Lower Plateau, also along Twelve Apostles, and above Waai Vley.

8. **A. canaliculatum** Ait. Sandy flats and hills, frequent; 7–10. Especially frequent on Tokai Flats and the hills west of Simon's Town.

9. **A. hispidulum** Linn. Flats and low hills, especially in grassy places and in pine woods, frequent; 6–9. Sometimes subglabrous. A plant with leaves 1 to 2 feet long, 1 to 1½ lines wide, often glabrous, and scape 12 inches, may belong to a new species. It is occasional in pine woods about Rondebosch, *Wolley-Dod*, 533, 534, 535.

10. **A. revolutum** Linn. Sandy flats near the sea, common; 3–9.

11. **A. longifolium** Jacq. Flats and mountain slopes, rare; 10. East slope Devil's Peak at 600 feet, *Bolus*, 3809; "sandy places near Cape Town," *Thunberg*. Seems too near the last; the murications on the leaf-margins are very slight.

12. **A. hirsutum** Thunb. Stony flats and slopes to about 1,500 feet, common; 9–10.

13. **A. muricatum** Linn. f. "Hills and stony places below Table Mountain, on Devil's Mountain, and on Lion Mountain near Green Point," *Thunberg*, *Ecklon*, and *Zeyher*. Not found by us. The hispidity of the stem in the specimens at Kew is confined to the base.

14. **A. Gerrardii** Baker. Sandy flats, rare; 10. About the Kommetjes; Rapenburg.

15. **A. ciliatum** Linn. f. Flats, rare; 8. A single plant by Rapenburg Vley, with leaves not ciliate, as appears to be frequently the case. "Kalk Bay," *Pappe;* "Simon's Bay," *Wright*, 225; "Lion Mountain," *Thunberg*.

Chlorophytum comosum Baker. Woods and shady places, rare; 1. Behind Groot Schuur (without the comose tuft of leaves), *Wolley-Dod*, 844.

Cæsia Eckloniana Roem. et Schult. Mountain slopes, rare; 10–11. Swamp at head of Silvermine Valley, *Wolley-Dod*, 3430; behind Simon's Town, *Bolus*, 4692.

2. **C. Dregeana** Kunth. Sandy and grassy flats, frequent; 11–1.

Agapanthus umbellatus L'Hérit. Dry hill and mountain slopes, common, but not always flowering; 12–2.

Tulbaghia acutiloba Harv. "Table Mountain," *Ecklon*. Not found by us.

2. **T. alliacea** Thunb. Sandy places from flats to mountains, frequent, especially after fires; 2–3.

Lachenalia pendula Ait. Sandy flats, rare; 7–8. Near Retreat station; near Hout Bay.

2. **L. rubida** Jacq. Sandy flats and hills, occasional, but local; 5. About Diep River and Retreat; top of Red Hill; Muizenberg.

3. **L. tricolor** Thunb. Sandy hills, usually by rocks, locally common; 9. Near Simon's Town; Klein Slangkop. Flowers bright yellow, fading to deep red.

4. **L. reflexa** Thunb. Sandy flats and hills, locally frequent; 6–8. Common on the Camp Ground, more thinly towards Wynberg; top of Red Hill.

5. **L. orchioides** Ait. Flats and slopes to about 1,000 feet, common; 8–10. Very variable in colour, usually pale yellowish-white. Beyond Simon's Town a white-flowered form only is found. A slate-grey form is common in woods about Wynberg, and a deep purplish-blue rarely on Devil's Peak. A bright deep yellow form at Smitswinkel Bay may be distinct. In all colours, one-leaved forms are frequently found.

6. **L. glaucina** Jacq. Heathy downs and under shrubs, occasional; 8–9. Claremont; near Wynberg. Possibly mistaken elsewhere for **L. orchioides,** from which it is chiefly distinguished by its larger more ringent perianth.

7. **L. contaminata** Ait. Damp sandy flats, rare; 9–10. Fish Hoek; Rondebosch.

8. **L. pustulata** Jacq. Dry sandy places near the sea, locally common; 9–10. Sea Point; Kamp's Bay.

9. **L. unifolia** Jacq. Dry sandy places, locally frequent; 9–10. From Fish Hoek southward. The broad-leaved var. **Rogersii** is occasional, near Maitland; "Simon's Bay," *Wright;* "Kamp's Bay," *Ecklon* and *Zeyher.* A white-flowered form with pedicels about 1 line long and broad leaves (*Wolley-Dod,* 3634) is frequent at about 2,000 feet on west slopes of Orange Kloof.

10. **L. isopetala** Jacq. Damp sandy flats, rare; 12–1. "Nord Hoek," *Milne.* Found by us at Vygeskraal, but not seen within our limits.

11. **L. mediana** Jacq. Shrubby places and open flats, rare; 10. Near Rondebosch, *Bolus,* 4829; "Yzer Plaat, near Salt River," *Zeyher.*

Drimia media Jacq. Dry hill and mountain slopes, frequent; 2–3.

2. **D. pusilla** Jacq. Flats, rare; 3. Rapenburg; Rosebank, *Bolus,* 3923.

3. **D. elata** Jacq. Flats and dry mountains, rare; 3–4. Hills west of Simon's Town; near Rosebank.

Dipcadi hyacinthoides Baker. Hillsides, locally common; 8–10. Three Anchor Bay; Signal Hill.

Albuca major Linn. Hills and sandy flats, frequent; 9–12.

2. **A. minor** Linn. Similar situations and apparently somewhat commoner, but we cannot draw a line between the two; 9–12. A bright yellow-flowered plant with 6 perfect stamens, and sweet-scented, occurs on Kalk Bay hills (*Wolley-Dod,* 2372), and at Lion Battery. It is no doubt a distinct species, but our material is insufficient to describe from.

3. **A. Cooperi** Baker. "Sides of Table Mountain," *Pappe.* Not found by us.

4. **A. spiralis** Linn. f. Sandy flats and slopes to 1,500 feet, occasional but general; 8–9. Common about Sea Point.

Urginea filifolia Steinh. Sandy hills and flats, appears rare, but liable to be mistaken for the next species; 9. Fish Hoek; Kamp's Bay; "hills near Cape Town," *Thunberg;* "Hout Bay," *MacOwan.*

2. **U. exuviata** Steinh. Similar situations, frequent; 9–3.

3. **U. Dregei** Baker. Dry sandy places, occasional; 12–2. Vlaggeberg; Orange Kloof.

4. **U. altissima** Baker. Mountain slopes, locally frequent; 1. Signal Hill to Hout Bay Nek; Orange Kloof. Seldom flowering.

Hyacinthus corymbosus Linn. Maritime sandy places, occasional; 8. From Kamp's Bay to Sea Point.

Ornithogalum thyrsoides Jacq. Sandy grassy places near the sea, rare; 10. "Kamp's Bay," *MacOwan;* "Table Mountain and Devil's Mountain," *Ecklon.*

2. **O. Schlechterianum** Schinz. Wet rocks on mountains, locally frequent; 12–2. Devil's Peak; Skeleton Ravine; Lower Plateau; Orange Kloof River.

3. **O. pilosum** Linn. "Devil's Mountain," *Pappe;* "Simon's Town," *Schlechter*, 338. Not found by us.

4. **O. hispidum** Hornem. Damp mountain slopes, occasional; 10–1. Muizenberg; above Kirstenbosch; upper western slopes of Orange Kloof, frequent.

5. **O. tenellum** Jacq. Flats to mountain slopes, frequent; 10–2. We include **O. lacteum** Jacq. under this, the older name. The slenderest states we have seen were gathered at the Kommetjes and by Muizenberg Vley, but were connected by insensible gradations with typical **O. lacteum.**

6. **O. barbatum** Jacq. Mountain slopes, rare; 11. "Lion's Head," *MacOwan.*

? **O. suaveolens** Jacq. We include this with doubt, as we believe that *Bolus*, 3298, is either **Albuca major** or **A. minor,** and we have no other Peninsular record. (*Vide* Fl. Cap. vi. p. 507.)

7. **O. graminifolium** Thunb. Flats and low hill slopes in dry sandy places, occasional; 12–2. About Doornhoogde.

8. **O. Bergii** Schlecht. Low hill slopes, occasional; 12–3. Lane side near Klein Constantia; Constantiaberg; Sea Point.

Androcymbium leucanthum Willd. Plains and hill slopes; 6–9. Lion's Rump; near Salt River.

2. **A. eucomoides** Willd. Similar situations; 7–9. Devil's Peak; hills west of Simon's Town. One or other of these two species is common, perhaps both. We only quote stations from which we have identified specimens.

Wurmbea capensis Thunb. Plains and hill slopes, usually in sandy places, common; 6–10.

Bæometra columellaris Salisb. Grassy shady places, frequent; 8–10.

Dipidax ciliata Baker. Damp places on flats and hills, frequent; 7–9.

2. **D. triquetra** Baker. In shallow vleys, locally frequent; 9. Kenilworth to Diep River.

Ornithoglossum glaucum Salisb. Dry sandy plains and low hills, frequent, but thinly distributed; 7–8.

XYRIDACEÆ.

Xyris capensis Thunb. "About Wynberg, &c.," *Harvey*. Not found by us.

COMMELINACEÆ.

Commelina africana Linn. Under bushes and rocks at all elevations and seasons, frequent; 1–12.

JUNCACEÆ.

Juncus effusus Linn. By streams and vleys, occasional; 10–12. Tokai; Kenilworth station; rail beyond Wynberg; between Retreat and Muizenberg. Only seen in single specimens except in the last station.

2. **J. maritimus** Lam. Damp places all over the flats, frequent; 11–12.

3. **J. acutus** Linn. "Between Claremont and Kenilworth, January," *Schlechter*. Not found by us.

4. **J. punctorius** Linn. f. Wet fields, local; 11–12. Observatory; Vaarsche Vley; Rapenburg Vley; lower part of Vygeskraal River.

5. **J. oxycarpus** E. Mey. Vleys and wet ditches, frequent but thinly scattered; 11–12.

6. **J. rupestris** Kunth. Damp gravelly places, rare; 10–11. Fish Hoek Valley; "Simon's Bay," *Wright*.

7. **J. scabriusculus** Kunth. Damp sandy flats, frequent; 10–11. Some of our gatherings seem almost as near **J. diaphanus** Buchen.

8. **J. bufonius** Linn. In cultivated and waste ground, common; 9–1. Seen in Waai Vley, but rarely at so high an elevation.

9. **J. cephalotes** Thunb. In damp sandy ground, locally abundant; 9–10. Camp Ground; Fish Hoek Valley; Maitland station; Table Mountain, &c. This species runs very near the next, but we think our identifications are correct.

10. **J. Sprengelii** Nees. "Kamp's Bay," *Ecklon* and *Zeyher*. Not found by us.

11. **J. inequalis** Buchen. Granite rocks, &c., rare; 9. "Wynberg," *Schlechter*. "Kamp's Bay," *Ecklon*. Not found by us.

12. **J. Dregeanus** Kunth. "Geele Kley (*sic*) on Devil's Mountain, December," *Ecklon*.

13. **J. capensis** Thunb. Flats to mountains, common; 10–2. A very variable species.

14. **J. acutangulus** Buchen. Flats, rare?; 11–12. "Cape Flats," *Ecklon*; Sea Point, *Wolley-Dod*, 3328; between Claremont and Kenilworth, *Wolley-Dod*, 3656. The two latter may be stout, angular-stemmed forms of **J. capensis**.

15. **J. lomatophyllus** Spreng. Muddy streamlets and marshes, common, and reaches a considerable elevation; 11–12.

Prionium Palmita E. Mey. Swamps and rivers, locally abundant; 12–2. Orange Kloof swamp, and northern slopes at 2,000 feet; Silvermine Valley.

TYPHACEÆ.

Typha australis Schum. Vleys and damp places, frequent; 12–1.

2. **T. capensis** Rohrb. Similar situations, rather less frequent; 12–1.

ARACEÆ.

Richardia africana Kunth. Damp shady woods and bushes, very common; 7–10.

NAIADACEÆ.

Triglochin bulbosum Linn. Sandy places, not always in damp ground, common; flowers all the year. A slender form, which may prove to be a distinct species, is frequently found at various elevations.

2. **T. laxiflorum** Guss. Similar places, occasional. Near Muizenberg Vley.

3. **T. striatum** Ruiz and Pav. Wet places, usually saline, frequent; 12–3. Easily distinguished by its orbicular fruits.

Aponogeton angustifolium Ait. Vleys on flats, frequent; 7–10.

2. **A. distachyon** Linn. f. Similar places, common; 6–10.

Potamogeton pusillus Linn. Vleys, very local; 11. One or two vleys by railway near Salt River; near Muizenberg Vley. We believe this is native.

Ruppia rostellata Koch. Salt vleys and pools, rare; 11. By Maitland Bridge.

2. **R. spiralis** Hartm. Similar places, rare; 10–11. Kommetje effluent; "Green Point," *Harvey*.

Zannichellia palustris Linn. Similar situations, locally common; 11. Pools about Vaarsche Vley; Kommetje effluent, the latter a one-fruited form, but which Dr. Rendle thinks hardly separable from the type.

RESTIONACEÆ.

The difficulty of identifying most of the species in this order without dissection, principally accounts for our poor account of its distribution. Most of our specimens have been certified or named by Dr. Masters.

Restio cuspidatus Thunb. Dry hill slopes, frequent; 9–11.

2. **R. ferruginosus** Link. Mountain slopes, rare; 5. Devil's Peak, *Bolus*, 7219.

3. **R. Sieberi** Kunth. "Table Mountain," *Burchell*, 536. Not found by us.

4. **R. triflorus** Rottb. Mountain slopes; 2–4. Devil's Peak; Lion's Head; Kamp's Bay.

5. **R. Ecklonii** Mast. "Near Cape Town," *Burchell*, 456. Not found by us, nor the four following species.

6. **R. curviramis** Kunth. "Kloof between Table Mountain and Lion's Head, May," *Krauss*.

7. **R. capillaris** Kunth. "Table Mountain," *Schlechter*, 348.

8. **R. cincinnatus** Mast. "Mountains near Simon's Town, 1,000–2,000 feet," *Ecklon* and *Zeyher*.

9. **R. Ludwigii** Steud. "Mountains near Simon's Town," *Zeyher*.

10. **R. Eleocharis** Mast. Flats in rather damp spots, frequent; 2–6.

11. **R. tetragonus** Thunb. Flats to mountain slopes, frequent; 7–8.

12. **R. quinquefarius** Nees. Flats, common; 5–7.

13. **R. furcatus** Nees. Flats and hill slopes, common; 6–8. Abundant at Smitswinkel Vley.

14. **R. triticeus** Rottb. Hill slopes, occasional; 3–8. Orange Kloof; below Wynberg reservoir; Devil's Peak; Smitswinkel Vley.

15. **R. pannosus** Mast. "False Bay," *Robertson*. Not found by us.

16. **R. multiflorus** Spreng. Mountain slopes, locally frequent; 7–11. Devil's Peak below Saddle; Table Mountain; "Lion Mountain," *Mund*.

17. **R. filiformis** Poir. Mountain slopes, occasional; 9. Simonsberg; Table Mountain.

18. **R. bifidus** Thunb. Mountains, occasional; 11. Table Mountain, *Bolus*, 4439, 4440.

19. **R. perplexus** Kunth. Mountains, rare; 10. Table Mountain, *Bolus*, 2886.

20. **R. Harveii** Mast. "Near Cape Town," *Harvey*. Not found by us.

21. **R. bigeminus** Nees. Flats, rare; 7–11. Near Cape Town, *Bolus*, 4448.

22. **R. egregius** Hochst. Dry hill slopes, locally frequent; 3–4. Klaasjagersberg; Smitswinkel Vley.

23. **R. obtusissimus** Steud. Mountains, rare. "Table Mountain," *MacOwan*, 1673.

24. **R. sarocIados** Mast. Mountains, rare; 12. "Table Mountain," *Burchell*, 572, 605.

25. **R. compressus** Rottb. var. **major** Mast. Wet places on mountains, locally common; 6–11. Lower Plateau; below Wynberg reservoir.

26. **R. quadratus** Mast. Mountains, rare; 12. "Table Mountain," *Burchell*, 408. Not found by us, unless *Bolus*, 7220, belongs here, but it is liable to be confounded with **Leptocarpus paniculatus** Mast.

27. **R. Scopula** Mast. Mountain slopes, rare; 10. East slopes Table Mountain, *Bolus*, 4095B.

28. **R. protractus** Mast. Mountains, rare; 11. Valley behind Table Mountain, *Bolus*, 4443.

29. **R. micans** Nees. "Cape Flats near Wynberg." Collector unknown.

Dovea tectorum Mast. Flats, very common; 5.

2. **D. cylindrostachya** Mast. Flats, rare or mistaken for last; 5–7. Railside between Plumstead and Diep River; Schœster's Kraal.

3. **D. Hookeriana** Mast. Flats; 5. Railside between Plumstead and Diep River.

4. **D. aggregata** Mast. "Near Cape Town," *Zeyher*. Not gathered by us.

5. **D. macrocarpa** Kunth. Flats; 5. Uitvlugt. Resembling tall, large specimens of **D. tectorum.**

6. **D. ebracteata** Kunth. Mountains, locally frequent; 11–12. From the Lower Plateau to summit of Table Mountain.

7. **D. Bolusii** Mast. Rocky places on mountains, rare; 1. Muizenberg, *Bolus*, 3909, 3910.

8. **D. racemosa** Mast. "Table Mountain, December," *Burchell*. Not found by us.

9. **D. mucronata** Mast. Wet places on mountains, locally common; 9–11. From the Lower Plateau to summit of Table Mountain.

? **D. rigens** Mast. "Sandy ground, Zeekoe Vlei," *Zeyher*. Not found by us, nor are we sure that the station is within our limits.

Elegia equisetacea Mast. "Table Mountain and Devil's Mountain under 1,000 feet," *Drège*. Not found by us.

2. **E. coleura** Nees. "Near Rondebosch and on Table Mountain," *Burchell.* Not found by us.

3. **E. acuminata** Mast. Hill and mountain slopes; 12–1. Lower slopes towards Kirstenbosch, and above it; above reservoir on Lower Plateau.

4. **E. membranacea** Kunth. "Table Mountain," *Ecklon*, &c.; "Cape Town," *Harvey.* Not found by us.

5. **E. propinqua** Kunth. Hill and mountain slopes, apparently frequent, but liable to be confounded with next; 7–9.

6. **E. juncea** Linn. Hill and mountain slopes, common ; 7–9.

7. **E. cuspidata** Mast. Wet places or in water ; 9–10. Patrys Vley; streamlet on Red Hill; "Table Mountain," *Milne.*

8. **E. asperiflora** Kunth. Flats and hill slopes; 10–11. Steenberg Farm.

9. **E. fistulosa** Kunth. Wet places on flats, frequent; 7–10.

10. **E. squamosa** Mast. Flats and mountains, rare ?; 7–10. Fish Hoek Valley; "Devil's Peak," *Wilms.*

11. **E. deusta** Kunth. Mountains, occasional; 11–12. Table Mountain.

12. **E. stipularis** Mast. Flats, locally abundant; 6–8. Patrys and Smitswinkel Vleys.

13. **E. parviflora** Kunth. Flats and mountains, occasional; 11–5. Uitvlugt; Retreat; Smitswinkel Vley; by Wynberg reservoir.

? **E. rigida** Mast. Flats, rare ; 4. Damp hollows on Kenilworth racecourse. The specimen has either been mislaid or the name altered, so we query it.

14. **E. nuda** Kunth. "Salt River Flats," *Wilms.*, 3804.

15. **E. elongata** Mast. "Between Wynberg and Devil's Mountain," *Drège.* Not found by us.

? **E. Rehmannii** Mast. "Cape Flats," *Rehmann*, 1806. Probably within our limits, but not found by us.

Lamprocaulos Neesii Mast. Mountains, rare; 11–12. Table Mountain, *Bolus*, 4141.

Leptocarpus paniculatus Mast. Flats and mountains, occasional; 12. Table Mountain; Cape Flats. Liable to be confused with **Restio quadratus** Mast.

2. **L. incurvatus** Mast. Flats and mountain slopes, frequent ; 8–12.

3. **L. modestus** Mast. "Table Mountain or Devil's Peak, below 1,000 feet," *Drège.* Not found by us.

Thamnochortus spicigerus R. Br. Flats, occasional; 6–8, 11. Beyond Uitvlugt; Chapman's Bay; near Rondebosch; "Salt River," *Drège.*

2. **T. scirpiformis** Mast. "Sand - dunes near Cape Town," *Ecklon* and *Zeyher*. Not found by us.

3. **T. fruticosus** Berg. Flats, occasional; 7–9. Smitswinkel Vley; near Wynberg; foot of Devil's Peak; "near Constantia," *Zeyher*.

4. **T. argenteus** Kunth. "Hills below Table Mountain," *Thunberg*.

5. **T. elongatus** Mast. Flats and mountains, occasional; 10–4. Near Rondebosch; summit of Table Mountain; Fish Hoek; "Devil's Mountain," *Rehmann*.

6. **T. consanguineus** Kunth. "Table Mountain," *Burch.*, 525. Not found by us unless *Bolus*, 2883, be it.

7. **T. dichotomus** R. Br. Flats and hill slopes, frequent; 5–8.

8. **T. Bachmannii** Mast. Hill slopes, rare; 4. Woods above Newlands, *Wolley-Dod*, 2446.

9. **T. dumosus** Mast. Hill and mountain slopes, rare; 6–8. Kasteel Poort, *Wolley-Dod*, 1367; slopes over Miller's Point (a young state, so determination uncertain).

10. **T. erectus** Mast. Flats, locally frequent; 5–7. Maitland; Uitvlugt; Black River village; Steenberg Rocks.

11. **T. Burchellii** Mast. Flats, locally frequent; 5–7. Maitland; Black River village; "Kommetjes," *Galpin*. This species is liable to be confounded with the last. One or other is frequent towards Hout Bay and by roadside towards Muizenberg.

12. **T. umbellatus** Kunth. Flats and mountains, frequent; 10–11.

13. **T. imbricatus** Mast. Flats and mountain slopes, frequent; 6–7, 10.

14. **T. cernuus** Kunth. Flats and hill slopes, common; 7–9.

15. **T. distichus** Mast. Flats and mountains, occasional; 2. Table Mountain; flats near Rondebosch.

16. **T. caricinus** Mast. "Simon's Bay," *Wright*. Not found by us.

Hypolæna membranacea Mast. Flats, locally frequent; 6–7. Schoester's Kraal; Smitswinkel and Patrys Vleys. Easily recognised by its pale straw-coloured inflorescence.

2. **H. foliosa** Mast. Mountains, locally abundant; 11. Lower Plateau over Skeleton Ravine, *Wolley-Dod*, 3403. A remarkably slender and distinct species with flat leaves.

3. **H. Eckloniana** Mast. Hill and mountain slopes, frequent, at least locally; 5–7. Steenberg; Miller's Point; Smitswinkel Bay.

4. **H. laxiflora** Nees. "Table Mountain in fissures towards the top," *Ecklon*. Not found by us.

5. **H. gracilis** Mast. Similar places to and often mixed with **H. Eckloniana** but less frequent; 6–9.

Hypodiscus Dodii Mast. Hill plateaux, rare ; 7. Steenberg Plateau. This plant has the appearance of **H. Willdenovia** but the stems are terete.

2. **H. Willdenovia** Mast. Flats and hill slopes, occasional; 7. Steenberg Plateau; Orange Kloof; Black River; Smitswinkel Vley; Muizenberg.

3. **H. aristatus** Nees. Flats to mountains, frequent; 6–7. Reaches Lower Plateau.

4. **H. capitatus** Mast. Flats, locally frequent; 6–7. Roadside towards Hout Bay, *Wolley-Dod*, 2644, 2645. Externally very like **H. albo-aristatus**.

5. **H. albo-aristatus** Mast. Flats and hill slopes, frequent; 5–7.

6. **H. tristachyus** Mast. "Near Constantia," *Zeyher*. Not found by us.

Willdenovia humilis Mast. Flats, very local; 5–6. Retreat; "near Doornhoogde," *Eckl.* and *Zeyh.*

2. **W. striata** Thunb. Flats and hills, occasional; 8–9. Between Wynberg and Constantia; Muizenberg.

3. **W. sulcata** Mast. Flats, occasional; 5–6. Between Retreat station and Vley; Camp Ground.

4. **W. Lucæana** Kunth. Flats and hill slopes, occasional; 4–6. Steenberg Rocks; Muizenberg.

5. **W. peninsularis** N. E. Br. "Hills near Kommetjes, September–October," *Galpin*, 4832, 4822.

CYPERACEÆ.

Pycreus Mundii Nees. Wet grassy places, locally abundant; 11–12. Vaarsche Vley; stream between Retreat and Muizenberg Vley.

2. **P. polystachyus** Beauv. Damp grassy banks, occasional; 11–12. Shore beyond Sea Point; Camp Ground and roadside beyond; Muizenberg Vley.

3. **P. umbrosus** Nees. Damp grassy fields, frequent; 10–12.

Juncellus lævigatus C. B. Clarke. "Near Cape Town," *Thunberg*, &c. Not found by us.

Cyperus tenellus Linn. f. Rather damp sandy places, common; 10–12. Reaches over 2,500 feet, but rare on mountains.

2. **C. micromegas** Nees. Similar places but apparently rare, unless mistaken for the last species; 10–12. Flats beyond Maitland; Camp Ground; "Table Mountain," *Nees*.

3. **C. rupestris** Kunth. Mountain slopes, rare; 2. "Table Mountain above Klassenbosch," *Schlechter*, 421. Not found by us.

4. **C. sphærospermus** Schrad. Grassy banks, frequent; 10–4.

5. **C. denudatus** Linn. f. Swampy ground, occasional; 10–1. Orange Kloof farm and marsh; farm below Steenberg; Stinkwater stream by Kamp's Bay.

6. **C. textilis** Thunb. In and by vleys, locally common; 10–12. From Black River village to Maitland Bridge; railside beyond Wynberg.

7. **C. subchoristachys** C. B. Clarke. "Cape Town," *Spilhaus*. Not found by us.

8. **C. longus** Linn., var. **tenuiflorus** Boeck. Wet places, frequent; 11–1.

9. **C. fastigiatus** Rottb. In water, locally very common; 11–1. Rapenburg Vley.

Mariscus congestus C. B. Clarke. Damp roadsides and open woods, common; 11–2.

2. **M. riparius** Schrad. By or near streams, frequent; 6–8.

3. **M. tabularis** C. B. Clarke. "Table Mountain," *Hesse*. Not found by us.

Eleocharis limosa Schultz. Wet places, rare; 11. Vaarsche Vley and near Observatory, *Wolley-Dod*, 3542.

2. **E. Lepta** C. B. Clarke. Wet, grassy places, rare; 11. Vaarsche Vley, *Wolley-Dod*, 3541.

Bulbostylis humilis Kunth. "Simon's Bay," *Wright*. Not found by us.

? Scirpus fluitans Linn. Streams and pools; 8–12. By Claremont station; Kenilworth Racecourse; near Newlands. These were all gathered in a young state and may belong to the next species. The present species is not otherwise recorded from the Cape Peninsula.

1. **S. capillifolius** Parl. Similar places; 8–12. Table Mountain above Wynberg, *Bolus*, 4731. One or other of these two species is common and reaches Waai Vley.

2. **S. Ludwigii** Boeckl. By gravelly or peaty pools, occasional; 9–11. Near Maitland station; Rapenburg Vley; Camp Ground; Green Point Common; Fish Hoek valley.

3. **S. tenuissimus** Boeckl. Shallow pools, rare; 11–12. Muizenberg Vley, *Wolley-Dod*, 3551.

4. **S. verrucosulus** Steud. Muddy places, frequent; 10–12. Var. **pterocaryon** C. B. Clarke. Fish Hoek valley, roadside and in a vley, *Wolley Dod*, 3382A and 3383.

5. **S. diabolicus** Steud. Pools and wet ditches, occasional; 10–11. Vaarsche Vley; roadside beyond Camp Ground; near Mowbray station.

6. **S. venustulus** Boeckl. Sandy and muddy places near sea, frequent; 9–12.

7. **S. bulbiferus** Boeckl. "Sand-dunes near Cape Town," *Zeyher*. Not found by us.

8. **S. tenuis** Spreng. Wet sandy ground, locally frequent; 10–12. Maitland and Camp Ground. A much slenderer form occurs at Muizenberg Vley and in Fish Hoek valley.

9. **S. cernuus** Vahl. Muddy places, locally abundant; 11. Vaarsche and Rapenburg Vleys (var. **subtilis** C. B. Clarke), *Wolley-Dod*, 3544; "Lion Mountain," *Mund.*

10. **S. rivularis** Boeckl. Wet muddy places, frequent and locally abundant; 10–11.

11. **S. incomtulus** Boeckl. Damp sandy and muddy places, common at least from Camp Ground to Paarden Island, and observed elsewhere; 10–11.

12. **S. antarcticus** Linn. Sandy flats, very common; 7–12. The type **Isolepis seslerioides** Kunth, seems far less common than the variety **S. Bergianus** Spreng.

13. **S. Dregeanus** C. B. Clarke. Hill slopes, common? or the last species mistaken for it; 8–9. Abundant on slopes at 500 feet above Klassenbosch after a fire!

14. **S. membranaceus** Thunb. Sandy places, occasional; 9–11. Hills north of Simon's Town; Muizenberg Mountain and between the Vley and Retreat; Hout Bay; Slangkop.

15. **S. nodosus** Rottb. Sandy and wet ground, frequent; 12–2.

16. **S. prolifer** Rottb. Shallow pools and by vleys, common; 9–11.

17. **S. triqueter** Linn. Muddy ground, locally abundant; 11–1. Muizenberg Vley; Kommetjes.

18. **S. littoralis** Schrad. In vleys, locally abundant; 12–1. Muizenberg Vley.

19. **S. maritimus** Linn. Pools and vleys, common all over the flats; 11–12.

20. **S. Isolepis** Boeckl. "Table Mountain," *Hesse.* Not found by us.

21. **S. Hystrix** Thunb. Damp sandy ground, common; 10–11.

Ficinia radiata Kunth. Damp places from flats to mountains, frequent; 10–11.

2. **F. ixioides** Nees. Wet ground on mountains, rare; 8–10. Wynberg Reservoir; Waai Vley.

3. **F. scariosa** Nees. Flats and low hills, frequent; 3–4.

4. **F. Zeyheri** Boeckl. Hill and mountain slopes, rare; 9–10. Waai Vley; slopes beyond Simon's Town.

5. **F. pusilla** C. B. Clarke. "Near Cape Town," *Rehmann.* Not found by us.

6. **F. micrantha** C. B. Clarke. "Table Mountain," *Rehmann.* Not found by us.

7. **F. aphylla** Nees. "Near Cape Town," *Harvey;* "Boggy places above Simon's Bay," *Milne.* Not found by us.

8. **F. filiformis** Schrad. Woods and shady places to 3,000 feet, frequent; 7–12.

9. **F. Bergiana** Kunth. Hill slopes, occasional; 6–7. Behind Steenberg; Muizenberg; Smitswinkel Bay; between Cape Town and Newlands.

10. **F. stolonifera** Boeckl. "Simon's Bay," *Wright*. Not found by us.

11. **F. tristachya** Nees. "Mountains near Cape Town," *Thunberg;* "Table Mountain," *Ecklon;* "Cape Flats at Doornhoogde," *Zeyher*. Not found by us.

12. **F. albicans** Nees. Mountain slopes and flats, occasional; 6–11. Orange Kloof; slopes over Sea Point; "Devil's Peak," *Kuntze;* "Flats near Rondebosch," *Burchell.*

13. **F. tribracteata** Boeckl. Hill slopes, occasional; 5–7. Behind Steenberg; west slopes Orange Kloof; Smitswinkel Bay; behind Groot Schuur.

14. **F. acuminata** Nees. Mountain slopes, rare; 11. Table Mountain, *Bolus*, 4768.

15. **F. tenuifolia** Kunth. Mountain slopes, rare?; 8–10. Top of Skeleton Ravine; upper slopes Twelve Apostles.

16. **F. paradoxa** Nees. Sandy flats, frequent; 5–7.

17. **F. laciniata** Nees. "Near Cape Town," *Zeyher*. Not found by us.

18. **F. Ecklonea** Nees. Dry places on mountains, occasional; 4–9. Flats near Claremont; slopes beyond Simon's Town, over 1,000 feet; "Table Mountain," *Ecklon*.

19. **F. lævis** Nees. "Doornhoogde," *Zeyher;* "Table Mountain," *Fleck*. Not found by us.

20. **F. brevifolia** Nees. Wet rocks on mountains, occasional; 8–9. Near summit of Lion's Head; east slopes Orange Kloof; Miller's Point; Devil's Peak.

21. **F. acrostachys** C. B. Clarke. "Table Mountain," *Ecklon*. Not found by us.

22. **F. gracilis** Schrad. Mountain slopes, rare; 3–7. Steenberg Valley; Table Mountain.

23. **F. setiformis** Schrad. In sandy or muddy soil, common; 6–11. A very variable plant, sometimes 2 feet high, then resembling **F. brevifolia.** The var. **Capitellum** appears less frequent than the type, but is abundant on the flats between Rondebosch and Claremont.

24. **F. lithosperma** Boeckl. Sandy ground, occasional; 5–6. Retreat Flats; near Hout Bay Nek; Muizenberg.

25. **F. lucida** C. B. Clarke. Sandy flats, rare?; 8. Cultivated field beyond Uitvlugt. We may have mistaken this for **F. Capitellum** elsewhere.

26. **F. pinguior** C. B. Clarke. Mountains, rare; 8. Muizenberg; "False Bay," *Robertson.*

27. **F. bracteata** Boeckl. Flats to mountains, frequent; 6–10.

28. **F. fastigiata** Nees. Woods or damp slopes, frequent; 6–7.

29. **F. anceps** Nees. Rocky mountains, rare; 9. Klein Slangkop; Muizenberg; "Simon's Town," *Ecklon.*

30. **F. bulbosa** Nees. Dry sandy plains and low hills, frequent; 7–10.

31. **F. secunda** Kunth. Sandy flats and hills, frequent; 5–10. Var. **maxima** C. B. Clarke has only been found by the path north-east of Slangkop, *Wolley-Dod*, 3231.

32. **F. trichodes** Benth. "Between Cape Town and Newlands," *Burchell;* "Table Mountain," *Hesse.* Not found by us but perhaps mistaken for next.

33. **F. ramosissima** Kunth. Mountain slopes, frequent; 8–10.

34. **F. angustifolia** C. B. Clarke. Wet rocks, locally common; 12. Orange Kloof River above Wynberg intake.

35. **F. longifolia** C. B. Clarke. Mountains, rare; 11. Table Mountain at 3,000 feet, *Bolus*, 4736.

36. **F. capillifolia** C. B. Clarke. "Table Mountain," *Hesse.* Not found by us.

Fuirena pubescens Kunth. Flats, rare; 3. "Claremont Flats," *Schlechter*, 511.

2. **F. cœrulescens** Steud. Damp places on flats, rare; 11. Shore beyond Sea Point; "near Cape Town," *Harvey.*

3. **F. hirta** Vahl. Marshy ground and by streams, common; 11–2. A glabrous state closely resembling **F. cœrulescens** was gathered on west slopes Lion's Head.

Rhynchospora glauca Vahl. "Table Mountain," *Ecklon.* Not found by us.

Carpha glomerata Nees. By streams on hills and mountains, frequent; 11–12.

Ecklonea capensis Steud. Damp sandy and peaty ground, frequent; 9–10.

2. **E. solitaria** C. B. Clarke. Muddy ground, rare; 10. Sluit behind Mowbray washhouses, *Wolley-Dod*, 3348.

Schœnus nigricans Linn. Wet places, occasional; 6–10. Hout Bay; Uitvlugt; Muizenberg Vley.

Epischœnus quadrangularis C. B. Clarke. "Table Mountain," *Burchell.* Not found by us.

Tetraria cuspidata C. B. Clarke. Woods and bushy places, common; 7–12. A very variable plant.

2. **T. Bolusii** C. B. Clarke. "Devil's Mountain," *Rehmann.* Not found by us.

3. **T. sylvatica** C. B. Clarke. Hill slopes in gravelly or peaty places, frequent; 6–9.

4. **T. Wallichiana** C. B. Clarke. "Near Cape Town," *Harvey.* Not found by us.

5. **T. fimbriolata** C. B. Clarke. Dry hill slopes, rare; 9. Beacon Hill, Simon's Town, *Wolley-Dod*, 2801.

6. **T. fasciata** C. B. Clarke. Flats and lower slopes, locally frequent; 5–8. Retreat Flats; over Kamp's Bay; Smitswinkel Vley.

7. **T. circinalis** C. B. Clarke. Flats to mountains, frequent; 5–6.

8. **T. flexuosa** C. B. Clarke. "Table Mountain," *Thunberg*, &c. Not found by us.

9. **T. thermalis** C. B. Clarke. Hill and mountain slopes, frequent; 6–9. A small form, 12 to 18 inches high, is frequent in Smitswinkel Vley, *Wolley-Dod*, 2603.

10. **T. eximia** C. B. Clarke. "False Bay," *Robertson.* Not found by us.

11. **T. triangularis** C. B. Clarke. "Table Mountain," *Burchell.* Not found by us.

12. **T. Rottbœllii** C. B. Clarke. Hill and mountain slopes, frequent; 11–12.

13. **T. rottbœllioides** C. B. Clarke. "Constantia," *Zeyher;* "False Bay," *Robertson;* "Near Cape Town," *Rehmann.* Not found by us.

14. **T. involucrata** C. B. Clarke. "Between Rondebosch and Hout Bay," *Drège.* Not found by us.

15. **T. ustulata** C. B. Clarke. Hills and mountain slopes, occasional; 3–6 Above Simon's Town; roadside Orange Kloof; roadside Devil's Peak; Kamp's Bay.

16. **T. compar** Lestib. Dry flats and mountain slopes, common; 1, 4–6, 10.

17. **T. punctoria** C. B. Clarke. Swampy places, frequent; 3–5.

Macrochætium Dregei Steud. Wet places at low elevations, occasional; 7–10. Steenberg slopes and plateau; Schoester's Kraal; Patrys Vley; frequent.

Cladium Mariscus R. Br. Vleys, rare; 12–1. Retreat Vley.

Chrysithrix capensis Linn. Damp plateaux at all elevations, locally common; 7–11. Beyond Kenilworth Racecourse; Smitswinkel and Patrys Vleys; Lower and Upper Plateaux of Table Mountain. Var. **subteres** C. B. Clarke, was found at 2,000 feet over Nord Hoek, *Wolley-Dod*, 2703, and in Silvermine Valley, especially the upper part, *Wolley-Dod*, 3547.

2. **C. Dodii** C. B. Clarke. Wet places on mountains, rare; 10–11. Upper part of Silvermine River, *Wolley-Dod*, 3549; Lower Plateau over Skeleton Ravine, *Wolley-Dod*, 3550.

Schœnoxiphium capense Nees. Shady mountain kloofs, occasional; 6–10. Above Wynberg Ranges; Newlands Woods: "Table Mountain, 2,000–3,000 feet," *Drège.*

2. **S. Sickmannianum** Kunth. Shady kloofs, occasional? Table Mountain, 1,200–1,800 feet. Either this species or the last grows at the Waterfall, Devil's Peak, and in two or three kloofs in Orange Kloof.

Carex glomerata Thunb. Wet grassy places, rare; 8–10. Rapenburg Vley, *Wolley-Dod*, 2748, 3492.

2. **C. bisexualis** C. B. Clarke. Gravelly hill slopes, frequent; 6–9.

3. **C. Zeyheri** C. B. Clarke. Damp hill slopes, rare; 10. Between Victoria Road and Hout Bay, *Wolley-Dod*, 3206.

4. **C. Dregeana** Kunth. Hill slopes, occasional?; 5–9. West slopes Orange Kloof; Smitswinkel Bay. Superficially very like **C. bisexualis,** and we are not sure which is the prevailing species.

5. **C. extensa** Good. Wet spots on flats, occasional; 10–11. Sea Point; Fish Hoek; Kommetjes; frequent at Muizenberg Vley.

6. **C. æthiopica** Schkuhr. Damp places and kloofs, apparently rare; 8–11. Devil's Peak, 1,200 feet, *Bolus*, 3848.

7. **C. clavata** Thunb. Similar places, common; 8–11. Externally very like the last species.

GRAMINEÆ.

Imperata arundinacea Cyr. var. **Thunbergii** Hack. Damp low ground, rare; 11–3. Near Muizenberg Vley; Orange Kloof swamp.

Rottbœllia compressa Linn. f. var. **fasciculata** Hack. Damp sandy ground, rare; 1–3. Claremont; Muizenberg Vley; "Between Constantia and Wynberg; by Salt River," *Burchell.*

Andropogon eucomus Nees. Sandy flats, occasional; 12–3. Orange Kloof; roadside beyond Camp Ground.

2. **A. Nardus** Linn. var. **marginatus** Hack. Roadsides and hill slopes, frequent; 9–12.

3. **A. hirtus** Linn. Similar situations, common; 7–12.

Anthistiria imberbis Retz. Flats to mountain slopes, frequent; 6–11.

†**Paspalum Digitaria** Poir. Wet ditches, rare; 1–2. By Claremont station; roadside near High Constantia.

2. **P. distichum** Linn. var. **nanum** Doell. Damp sandy ground, rare; 1. Shore at Kamp's Bay, *Wolley-Dod*, 2343. Apparently native.

Digitaria sanguinalis Scop. Damp sandy places and roadsides, frequent; 12–4.

†**Panicum Crus-galli** Linn. Damp sluits and sandy ground, rare; 4. Near Claremont; near Constantia Nek; "Lion Mountain," *Ecklon.*

2. †**P. repens** Linn. Sandy ground, very local; 5–6. Vygeskraal river-bed at Uitvlugt.

Pennisetum macrourum Trin. Waste ground, partial to damp, occasional; 10–11. Klein Constantia; Kamp's Bay; between Rondebosch and Claremont.

2. **P. Thunbergii** Kunth. Damp hill slopes, rare; 6–10. Orange Kloof swamp; "Foot of Devil's Mountain," *Ecklon;* var. **Galpinii** Stapf, near King's Blockhouse, *Wolley-Dod*, 2668.

Stenotaphrum glabrum Trin. Roadsides, fields, and waste places, very common; 8–1. The "Coarse Quick," commonly used as a turf or lawn grass.

Prionanthium pholiuroides Stapf. Damp sandy flats, rare; 11. Fish Hoek Valley, *Wolley-Dod*, 3394.

Achneria Ecklonii Dur. and Schz. Sandy heathy flats, rare; 3. Kenilworth racecourse, *Bolus*, 7967.

2. **A. aurea** Dur. and Schz. Mountains, rare; 12. "Table Mountain summit," *Ecklon.* Var. **virens** Stapf, "Table Mountain," *Spilhaus.* Not found by us.

3. **A. capensis** Dur. and Schz. Mountain slopes and summits, rare; 11–12. Orange Kloof, *Wolley-Dod*, 2124; "Top of Table Mountain," *Ecklon.*

4. **A. ampla** Dur. and Schz. Flats and hill slopes, occasional; 12–1. Lower slopes above Protea; Muizenberg Vley; Tokay; Orange Kloof farm; "Between Wynberg and Constantia," *Burchell.* A handsome strongly scented grass.

Poagrostis pusilla Stapf. "Table Mountain, in shady rocky places, 3,000 feet," *Drège;* "marshy places at the same altitude," *Schlechter.* Not found by us.

†**Aira caryophyllea** Linn. Dry hill slopes, frequent; 9–10. Reaches Lower Plateau, but evidently conveyed there with building material.

Holcus setiger Nees. Low hill slopes and marshy ground, occasional; 10–12. Kalk Bay; west slopes Lion's Head; Kamp's Bay; Chapman's Bay; Retreat and Muizenberg Vley.

2. †**H. lanatus** Linn. Dry waste places, rare; 11–12. Near Herzog; near Westerford Bridge. Scarcely more than a casual in either locality.

Anthoxanthum Dregeanum Stapf. Flats, rare; 9–11. Railside between Claremont and Kenilworth; by Rapenburg Vley.

2. **A. Tongo** Stapf. Clefts of rocks on mountains, occasional; 9–10. Devil's Peak, near waterfall; summit of Twelve Apostles; rocks over Klassenbosch; above Miller's Point.

Kœleria cristata Pers. Dry hill slopes and flats, locally frequent; 11–12. Sandhills near Muizenberg Vley; Constantia Nek; Orange Kloof; Devil's Peak; "Lion Mountain," *Ecklon.*

2. **K. phleoides** Pers. Dry flats, rare; 11. Green Point Common, *Wolley-Dod*, 3576.

Avenastrum longum Stapf. Hill slopes and flats, occasional; 9–11. Klein Slangkop; Lion's Head; "Flats near Doornhoogde," *Ecklon* and *Zeyher;* var. **grande** Stapf, appears more frequent, especially on the slopes beyond Sea Point.

2. **A. quinquesetum** Stapf. "Table Mountain," *Ecklon.* Not found by us.

3. **A. Dodii** Stapf. Wet places, rare; 10. Hout Bay fisheries; below road near Oatlands Point, *Wolley-Dod*, 2775.

4. **A. antarcticum** Stapf. Dry hill slopes, frequent; 8–10.

†**Avena sativa** Linn. An escape from cultivation in various places.

2. †**A. fatua** Linn. A weed of waste places and railway banks, very common; 10–11.

3. †**A. barbata** Brot. Similar situations, common; 10–11.

Pentaschistis aristidoides Stapf. Flats and hill plateaux, frequent; 9–10.

2. **P. pallescens** Stapf. By rocks on mountains, occasional; 10–11. South slopes Constantiaberg; east slopes Devil's Peak; "Table Mountain," *Ecklon*, &c.

3. **P. argentea** Stapf. Mountain slopes, rare or locally frequent; 10. Slopes over Orange Kloof farm; "pastures above Simon's Bay, frequent," *Milne.*

4. **P. tortuosa** Stapf. By rocks on mountains, rare; 9–11. Devil's Peak, above Groot Schuur; slopes beyond Miller's Point.

5. **P. colorata** Stapf. Dry mountain slopes, occasional; 9–11. West slopes of Slangkop; "Kamp's Bay," *Wilms.;* var. **polytricha** Stapf, Silvermine Valley; about Batsata Rock and Paulsberg.

6. **P. curvifolia** Stapf. Hill and mountain slopes, frequent; 10–11.

7. **P. capensis** Stapf. Wet spots on mountains, rare; 10–11. Orange Kloof river, *Wolley-Dod*, 2122; "Table Mountain," *Spilhaus.*

8. **P. subulifolia** Stapf. Hill and mountain slopes, occasional; 9–10. Near Paulsberg; south slopes Slangkop; "North slopes of Table Mountain," *MacOwan.*

9. **P. leucopogon** Stapf. Dry sandy ground, rare; 9. Between Groot and Klein Slangkop, *Wolley-Dod*, 3228.

10. **P. aspera** Stapf. Below rocks on mountains, frequent; 9–11.

11. **P. angustifolia** Stapf, var. **albescens** Stapf. Sandy hills, rare; 10. Near Upper North Battery, Simon's Town, *Wolley-Dod*, 2064.

12. **P. imperfecta** Stapf. Mountain slopes, rare; 12. Dry rocks on eastern slopes of Constantiaberg, *Wolley-Dod*, 407; Constantia Nek.

13. **P. Thunbergii** Stapf. Dry flats and hill slopes, common; 10–12. Var. **bulbothrix** Stapf, "eastern side of Lion's Rump," *Burchell.*

14. **P. airoides** Stapf. Dry hill slopes, rare or overlooked; 10. North slopes Lion's Head, *Wolley-Dod*, 3095.

Pentameris longiglumis Stapf. "Table Mountain," *Burchell*, &c. Not found by us.

2. **P. speciosa** Stapf. Dry hill and mountain slopes, frequent; 9–10.

Danthonia macrantha Schrad. Dry mountain slopes and rocks, frequent; 9–10.

2. **D. Zeyheriana** Steud., var. **trichostachya** Stapf. Sandy places, locally frequent; 9–10. Between Slangkop and Red Hill; Klein Slangkop.

3. **D. lanata** Schrad. Similar situations, less frequent but more general; 9–10. Vlaggeberg; Hout Bay; Table Mountain; "Doornhoogde," *Ecklon;* var. **major** Nees, Patrys Vley, *Wolley-Dod*, 2956.

4. **D. lupulina** Roem. and Schult. "Flats near Doornhoogde," *Ecklon;* "Table Mountain," *Spilhaus.* Not found by us.

5. **D. cincta** Nees. Marshy flats, rare; 12–1. Muizenberg Vley; near Tokay; "Doornhoogde," *Ecklon.*

6. **D. stricta** Schrad. Dry hill slopes, occasional; 12–1. Lion's Head; Constantia Nek; "Table Mountain and Devil's Peak," *Ecklon.*

7. **D. curva** Nees. "Devil's Mountain," *Verreaux.* Not found by us.

Chætobromus Schraderi Stapf. Sandy flats, locally frequent; 9–10. Paarden Island, *Wolley-Dod*, 3078.

Phragmites communis Trin. In or by water, rare; 5–6. Muizenberg Vley and shore; Uitvlugt; Rapenburg Vley; Orange Kloof river.

†**Lagurus ovatus** Linn. Sandy waste places, rare; 11. Herschel Lane, Claremont; Plumstead station; Herzog near Retreat.

†**Polypogon monspeliensis** Desf. Moist places on flats, common; 9–2.

2. **P. tenuis** Brongn. Drier places, occasional; 11–1. Roadside towards Doornhoogde; Muizenberg Vley; Kamp's Bay; near Retreat.

†**Agrostis verticillata** Vill. Damp places, especially roadsides, frequent; 9–12.

2. **A. Bergiana** Trin. Wet places and streams on hills and mountains, frequent; 12–2.

3. **A. polypogonoides** Stapf. Moist places on flats, rare; 2. West end Muizenberg Vley, *Wolley-Dod*, 2349.

4. **A. lachnantha** Nees. Damp places, local; 11. Pond-bed in Newlands Cricket Ground, *Wolley-Dod*, 3559; "Liesbeck River," *Bergius;* "Ponds at Salt River," *Burchell.*

Aristida angustata Stapf. Dry banks, rare; 2. Roadside and railside between Newlands and Claremont, *Wolley-Dod*, 2387, 2388.

2. **A. barbicollis** Trin. and Rupr. "Cape Flats near Claremont," *Schlechter*, 492. Not found by us.

3. **A. vestita** Thunb. "Table Mountain," *Ecklon;* var. **Schraderiana** Trin. and Rupr., "Cape Town," *Harvey*. Not found by us.

4. **A. ciliata** Desf. "Near Cape Town," *Schlechter*, 37. Not found by us.

5. **A. capensis** Thunb. Dry hillsides, frequent; 11–2. The type and var. **Zeyheri** appear to be about equally frequent.

Stipa Dregeana Steud., var. **elongata** Stapf. Mountain kloofs, frequent; 12–2.

Tragus major Stapf. Dry flats and low hills, local; 1. Fort Wynyard; slopes over Sea Point, *Wolley-Dod*, 1088.

Sporobolus indicus R. Br. Roadsides and waste places, frequent; 8–12. Var. **laxus** Stapf, "Devil's Mountain," *Ecklon.*

2. **S. pungens** Kunth. Damp vley bottoms and shores, frequent; 10–3.

Diplachne fusca Beauv. Muddy vley shores, locally frequent; 10–1. Muizenberg Vley; Rapenburg Vley; Fish Hoek; "Doornhoogde," *Ecklon.*

Eragrostis glabrata Nees. Sandy shores or near the sea, local; 10. Paarden Island; "Wet places above Simon's Bay, frequent," *Milne.*

2. **E. curvula** Nees. Banks and hill slopes, frequent; 9–11.

3. **E. cyperoides** Beauv. Sandhills near sea, rare; 9–10. Paarden Island; "Green Point," *Ecklon.*

4. **E. elatior** Stapf. "Flats near Doornhoogde," *Zeyher.* Not found by us.

5. **E. sarmentosa** Nees. Sandy places, partial to damp, frequent, at least locally about Rondebosch, but also scattered; 12–1.

6 **E. brizoides** Nees. Flats and hill slopes, common; 5, 9–11.

7. **E. aspera** Nees. "Near Cape Town," *Spilhaus.* Not found by us.

Cynodon Dactylon Pers. Roadsides, fields, and waste places, very common; 9–5. The "Fine Quick" of the colonists, laid down for lawns, &c.

†**Eleusine indica** Gaertn. Sandy roadsides and ditches, rare; 2–3. One or two places near Claremont station; near Camp Ground; enclosure behind Groot Schuur, abundant and apparently planted.

Ehrharta longiflora Sm. Bushy places and roadsides, common; 9–11.

2. **E. bulbosa** Sm. Hill and mountain slopes, apparently rare; 11. Lion's Head near Sea Point; "Table Mountain; Constantia," *Ecklon.*

3. **E. capensis** Thunb. Hill slopes, rare; 12. Constantia Nek; "Cape Town," *Harvey.*

4. **E. longifolia** Schrad. Dry hill and mountain slopes, occasional; 11. "Table Mountain," *Ecklon;* "Simon's Bay," *Wright;* var. **robusta** Stapf, Orange Kloof; Tokay Plantation. Only the variety has been found by us.

5. **E. setacea** Nees. Mountain plateaux, locally frequent; 10–11. Lower Plateau over Skeleton Ravine; Waai Vley.

6. **E. Dodii** Stapf. Mountain rocks, very rare; 12. South slopes of Constantiaberg, *Wolley-Dod,* 1961. Only once gathered, and never refound.

7. **E. uniflora** Burch. "Cape Flats near Rondebosch, December," *Burchell.* Not found by us.

8. **E. erecta** Lam. Bushy shady places, common; 10–2.

9. **E. melicoides** Thunb. Hill slopes, apparently rare; 9. Lion's Head over Sea Point, *Wolley-Dod,* 1608. Though we have identified this plant from no other station, we think it may prove to be frequent.

10. **E. calycina** Sm. Flats and hill slopes, common; 8–10.

11. **E. subspicata** Stapf. Muddy places, very local; 11. Stream from Retreat to Muizenberg Vley, *Wolley-Dod,* 3519.

12. **E. Rehmannii** Stapf. Shady rocks and hill slopes, occasional; 10–2. Several places on east slopes Devil's Peak; "Table Mountain," *Ecklon;* var. **filiformis** Stapf, summit of Constantiaberg, *Wolley-Dod,* 3477.

13. **E. aphylla** Schrad. "Table Mountain," many collectors, but not found by us. "Simon's Bay," *Wright.*

14. **E. villosa** Schult. f. Sandy hills, frequent; 10–11.

†**Phalaris minor** Retz. Rubbish heaps and waste places, frequent; 9–11.

Melica racemosa Thunb. Hill slopes, occasional; 9–10. Tokay; Signal Hill; Smitswinkel Bay; Kamp's Bay.

†**Lamarckia aurea** Mœnch. Roadsides, locally common; 9. Above Simon's Town.

†**Dactylis glomerata** Linn. A casual; 9. Claremont; Simon's Town.

Lasiochloa ciliaris Kunth. Flats and hill slopes, occasional; 10–11. Wynberg Park; near Lion Battery, Signal Hill.

2. **L. longifolia** Kunth. Similar situations, frequent; 11. Var. **hispida** Stapf, and var. **pallens** Stapf, both occur.

Brizopyrum acutiflorum Nees, var. **capillaris** Nees. Grassy flats, very local; 10. Green Point Common; shore beyond Sea Point.

2. **B. capense** Trin. Flats to mountain slopes, frequent; 9–10. Var. **villosum** Stapf, near Lion Battery, Signal Hill, *Wolley-Dod*, 3110.

†**Briza maxima** Linn. Roadsides and open woods, very common; 9–11.

2. †**B. minor** Linn. Similar situations, common; 9–11.

†**Poa annua** Linn. Similar situations, reaching to summit of Table Mountain, very common; 6–11.

†**Scleropoa rigida** Griseb. Roadsides, rare; 11. By Wynberg Church; Constantia Road; Newlands Woods.

Festuca scabra Vahl. Flats to mountain tops, frequent; 9–12.

†**Vulpia Myuros** Gmel. Flats and mountains, rare; 10. Kenilworth; "Table Mountain," *Eckl.*

2. †**V. bromoides** S. F. Gray. Flats to mountain slopes, frequent; 8–11.

†**Bromus molliformis** Lloyd. Grassy places, frequent?; 10–11. Either this species or **B. mollis** Linn. is common. Our only gathering, *Wolley-Dod*, 1826, was named by Dr. Stapf as above.

2. †**B. patulus** Mert. and Koch. Roadsides and hill slopes, frequent; 9–11. Var. **vestitus** Stapf, is the prevailing form. Var. **pectinatus** Stapf, has also been found, but the type is not recorded.

3. †**B. maximus** Desf. Grassy banks, occasional; 10–11. Constantia Road, beyond Alphen; railside from Rondebosch to Wynberg; Hout Bay.

4. †**B. leptoclados** Nees. Shady places, rare; 8–1. By waterfall, Devil's Peak; bottom of kloof west of Lion's Head.

5. †**B. unioloides** Nees. Waste places, frequent; 9–12.

†**Brachypodium distachyum** Beauv. Roadsides and grassy hill slopes, frequent; 10–1.

2. †**B. flexum** Nees. Dry roadsides, rare; 12. "Near Cape Town," *Burchell*, 472. Var. **trachycladum** Stapf, roadside near Constantia Nek, *Wolley-Dod*, 2385.

†**Lolium temulentum** Linn. Roadsides and waste places, frequent; 9–12.

2. †**L. multiflorum** Lam. Cultivated ground and roadsides, frequent; 10–11.

3. †**L. rigidum** Gaud., var. **rottbœllioides** Boiss. Dry waste places and roadsides, common; 10–11.

Lepturus cylindricus Trin. Grassy and gravelly places, occasional; 11–12. Kirstenbosch Avenue; Green Point Common; Sea Point.

Agropyrum distichum Beauv. Sandy shores, very local; 11. Beyond Elsje Bay, *Wolley-Dod*, 2061.

†**Hordeum secalinum.** Wet places, frequent; 10–11.

2. †**H. murinum** Linn. Roadsides and waste places, common; 9–12.

FILICES.

Gleichenia polypodioides Sm. Clefts in rocks on mountains, occasional but general; 1.

Hymenophyllum obtusum Hook. and Arn. Wet shady rocks and tree-stumps, rare. "Table Mountain," *Buchanan, Marquard.* Not found by us.

2. **H. tunbridgense** Sm. Similar places, common; 12–2.

3. **H. rarum** R. Br. Similar places, common; 12–2.

Trichomanes pyxidiferum Linn. Kloofs, rare? Orange Kloof; "Constantiaberg," *Schlechter.*

Hemitelia capensis R. Br. Damp shady mountain kloofs, frequent; 7–9.

Adiantum Capillus-Veneris Linn. "Table Mountain," *Lady Barkly.* Not found by us.

2. **A. thalictroides** Willd. Bushy mountain slopes, frequent; 5–7.

Hypolepis anthriscifolia Presl. "Chapman's Bay," *MacGillivray;* "Waterfall, Devil's Peak," *Alexander.* Not found by us.

Cheilanthes pteroides Sw. Hill slopes, frequent; 8–9.

2. **C. capensis** Sw. Mountain slopes, frequent; 8–9.

3. **C. hirta** Sw. Dry mountain and hill slopes, common; 6–8.

4. **C. multifida** Sw. Bushy slopes, occasional; 8. Lion's Head; "Eastern ascent of Table Mountain," *MacGillivray.*

Pellæa auriculata Link. "Lion's Head; near Waterfall, Devil's Peak," *Wilms;* "Simon's Bay," *Milne;* "Table Mountain," several collectors. Not found by us.

2. **P. hastata** Link. "Devil's Peak," *Wilms.* Not found by us.

3. **P. calomelanos** Link. Mountain slopes; 6. Rocks on Lion's Head; "Table Mountain," *Pappe.*

Pteris flabellata Thunb. Mountain woods, 2. Devil's Peak; "Table Mountain," *Alexander;* "Chapman's Bay," *MacGillivray.*

2. **P. aquilina** Linn. Open or wooded slopes, common; 2.

3. **P. incisa** Thunb. Wooded slopes, occasional; 1–2. Orange Kloof; Devil's Peak; over Klassenbosch.

Lomaria attenuata Willd. Wet places on mountains, common; 2.

2. **L. punctulata** Kunze. In drier places, occasional; 2–3. Orange Kloof; above Tokay; near Bishop's Court.

3. **L. procera** Spreng. Wet places on mountains; 2–3. "Constantia," *Wilms.* We cannot distinguish our dried specimens between this species and the next. One or other is common and reaches the summit of Table Mountain.

4. **L. Boryana** Willd. "Above Kirstenbosch," *Blagrave;* "Summit of Table Mountain," *Milne.*

Blechnum remotum Presl. Mountains, occasional? Waterfall, Devil's Peak; "Table Mountain," *Alexander;* "Stinkwater Kloof," *Wilms.*

Asplenium monanthum Linn. In kloofs; 1–2. Waterfall, Devil's Peak; "Hout Bay," *Alexander.*

2. **A. erectum** Bory. In kloofs; 1–2. Waterfall, Devil's Peak; "Eastern ascent of Table Mountain," *MacGillivray.*

3. **A. Rawsoni** Baker. "Top of Muizenberg Mountain in crevices of rocks," *Rawson.* Not found by us.

4. **A. Adiantum-nigrum** Linn. "Riverside near bottom of Table Mountain," *Milne;* "Simon's Bay," *MacGillivray.*

5. **A. furcatum** Thunb. Mountain slopes, often in dry places, frequent; 10–12.

Aspidium aculeatum Sw. In kloofs, rare; 2–3. Waterfall, Devil's Peak.

2. **A. capense** Willd. Mountain slopes and rocks, often in dry places, occasional; 10–2. Waterfall, Devil's Peak; Lower Plateau; summit of Twelve Apostles; rocks on Constantiaberg.

Lastræa Thelypteris Presl. In vleys, common; 12–3.

2. **L. Filix-mas** Presl. "Table Mountain," *Guthrie.* Not found by us.

Polypodium lanceolatum Linn. Rocks and tree-stumps in shady places, frequent; 8.

Gymnogramme cordata Schlecht. "Waterfall, Devil's Peak; Table Mountain," *Wilms;* "Simon's Bay," *Wright.* Not found by us.

2. **G. leptophylla** Dur. "Waterfall, Devil's Peak," *Alexander.*

3. **G. Totta** Schlecht. Kloofs and slopes, frequent; 12–2.

Vittaria lineata Sw. Mountains, rare. Above Klassenbosch.

Acrostichum conforme Sw. Rocks in kloofs, occasional. Beyond Kirstenbosch; Table Mountain; "Devil's Peak," *Wilms.*

2. **A. viscosum** Sw. "Devil's Mountain and Table Mountain," *Bergius.* Not found by us.

Osmunda regalis Linn. "Table Mountain"; now believed to be eradicated, *teste Sim.*

Todea barbara Moore. Vleys and wet rocks, frequent; 7.

Schizæa pectinata Smith. Flats and slopes, common; 12.

Mohria Caffrorum Desv. Slopes at various elevations, frequent; 1–2.

Ophioglossum Bergianum Schlecht. "Kenilworth; near Wynberg; Hout Bay," *Schlechter;* "Lion's Rump," *Pappe.*

2. **O. vulgatum** Linn. Mountains, occasional. Table Mountain; Lion's Mountain.

LYCOPODIACEÆ.

Lycopodium gnidioides Linn. Dry rocks on mountains, rare; 7–8.

2. **L. carolinianum** Linn. "Constantiaberg, at 2,000 feet," *Schlechter.* Not found by us.

3. **L. pygmæum** Kaulf. "Shady places between bushes on Lion's Rump; eastern side of Table Mountain at Witteboom," *Ecklon;* "Rocks on Kenilworth racecourse, September," *Schlechter.* Not found by us.

CHARACEÆ.

Chara stachymorpha Gant. Muizenberg Vley.

2. **C. Kraussii** Braun. Fish Hoek.

3. **C. vulgaris** Linn. Hout Bay fisheries.

4. **C. fragilis** Desv., var. **Hedwigii** Kuetz. Vaarsche Vley.

5. **C.** sp. nov. Muizenberg Vley, *Wolley-Dod*, 3564.

Nitella Dregeana Kuetz, var. **grandis** H. and J. Groves. Rapenburg Vley above Bridge.

RECAPITULATION.

DICOTYLEDONEÆ	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
RANUNCULACEÆ			
Clematis	1		
Anemone	1		
Knowltonia	4		
Ranunculus	6	3	
MENISPERMACEÆ			
Cissampelos	1		
NYMPHÆACEÆ			
Nymphæa	1		
PAPAVERACEÆ			
Corydalis	2		
Fumaria	2	1	
CRUCIFERÆ			
†Nasturtium	1	1	
†Barbarea	1	1	
Cardamine	1		
†Alyssum	1	1	
Sisymbrium	2	1	
Heliophila	22		
Chamira	1		
†Brassica	2	2	1
†Diplotaxis	1	1	
†Capsella	1	1	
†Senebiera	2	2	
Brachycarpæa	1		
Lepidium	3		
†Neslia	1	1	
†Rapistrum	1	1	
†Raphanus	1	1	
Carponema	1		
†RESEDACEÆ			
†Reseda	2	2	
VIOLACEÆ			
Viola	2	1	
BIXACEÆ			
Scolopia	1		
Kiggelaria	1		
POLYGALACEÆ			
Polygala	10		
Muraltia	18		
Mundia	1		

	Total Species.	Non-Native Species (included in Total.)	Doubtfully recorded (not included in Total
FRANKENIACEÆ			
Frankenia	2		
CARYOPHYLLACEÆ			
Dianthus	1		
Silene	6	1	1
†Lychnis	1	1	
Cerastium	3	1	
†Stellaria	1	1	
†Sagina	1	1	
†Spergula	1	1	
†Spergularia	2	2	
†Polycarpon	1	1	
†PORTULACEÆ			
†Portulaca	1	1	
ELATINACEÆ			
Bergia	1		
MALVACEÆ			
†Lavatera	1	1	
†Malva	2	2	
Malvastrum	2		1
Hibiscus	3		
STERCULIACEÆ			
Hermannia	16		
TILIACEÆ			
Grewia	1		
LINACEÆ			
Linum	4		
ZYGOPHYLLACEÆ			
†Tribulus	1	1	
Zygophyllum	9		
GERANIACEÆ			
Monsonia	1		
Geranium	3	1	
†Erodium	2	2	1
Pelargonium	30		
Oxalis	32		
RUTACEÆ			
Macrostylis	1		
Diosma	3		1
Coleonema	1		
Adenandra	9		1
Barosma	2		
Agathosma	15		2

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
AQUIFOLIACEÆ			
Ilex	1		
CELASTRACEÆ			
Gymnosporia	8		
Putterlickia	1		
Pterocelastrus	2		
Cassine	2		
Maurocenia	2		
Lauridia	1		
RHAMNACEÆ			
Scutia	1		
Phylica	16		
Noltea	1		
AMPELIDACEÆ			
Vitis	1		
SAPINDACEÆ			
Melianthus	1		
ANACARDIACEÆ			
Rhus	11		2
LEGUMINOSÆ			
Cyclopia	3		
Podalyria	5		
Liparia	2		
Priestleya	6		
Amphithalea	4		
Walpersia	1		
Borbonia	5		
Rafnia	7		
Euchlora	1		
Lotononis	8		
Lebeckia	7		
Viborgia	1		
Aspalathus	50		
Melolobium	1		
Crotalaria	2	1	
Argyrolobium	4		
†Cytisus	1	1	
†Medicago	4	4	
†Melilotus	2	2	
Trifolium	9	7	
Psoralea	11		
Indigofera	16		
Tephrosia	2		
Sutherlandia	1		
Lessertia	6		
Hallia	5		
†Vicia	4	4	
Dolichos	2		
Fagelia	1		
Rhynchosia	3		
Virgilia	1		
†Cassia	1	1	
†Acacia	1	1	
ROSACEÆ			
Rubus	4		
Alchemilla	1		
†Poterium	1	1	

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
ROSACEÆ (*continued*)			
Cliffortia	23		
Grielum	1		
SAXIFRAGACEÆ			
Cunonia	1		
CRASSULACEÆ			
Dinacria	1		
Crassula	29		1
Grammanthes	1		
Rochea	4		
Cotyledon	5		
DROSERACEÆ			
Drosera	7		
BRUNIACEÆ			
Berzelia	2		
Brunia	2		
Staavia	4		
Audouinia	1		
HALORRHAGIDACEÆ			
Serpicula	1		
Gunnera	1		
LYTHRACEÆ			
†Lythrum	1	1	
Olinia	1		
ONAGRACEÆ			
†Epilobium	2	2	
†Œnothera	2	2	
Montinia	1		
CUCURBITACEÆ			
†Cucumis	2	2	
Melothria	1		
Kedrostis	1		
FICOIDEÆ			
Mesembrianthemum	62	1	1
Hymenogyne	1		
Tetragonia	6		
Aizoon	2		
Galenia	4		
Acrosanthes	1		
Pharnaceum	9		
Cœlanthium	1		
Polpoda	1		
Adenogramma	4		
Limeum	1		
UMBELLIFERÆ			
Hydrocotyle	13		
Hermas	4		
Arctopus	1		
†Sanicula	1	1	
Lichtensteinia	2		
†Apium	3	3	
Carum	2		
Sium	1		
Seseli	1		
†Fœniculum	1	1	
Œnanthe	1		
Capnophyllum	1		

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
UMBELLIFERÆ (*continued*)			
Anesorhiza	6		
Peucedanum	5		
†Daucus	1	1	
Caucalis	1		
ARALIACEÆ			
Cussonia	1		
CORNACEÆ			
Curtisia	1		
RUBIACEÆ			
Oldenlandia	1		
Plectronia	2		
Anthospermum	5		1
Nenax	2		
Carpacoce	2		
Galium	4	1	
DIPSACEÆ			
Cephalaria	1		
Scabiosa	2		
COMPOSITÆ			
Corymbium	3		
Pteronia	2		
Amellus	1		
Charieis	1		
Mairea	3		
Aster	1		
Felicia	10		1
†Erigeron	1	1	
Nidorella	1		
Conyza	4	1	
Chrysocoma	1		
Brachylæna	1		
Tarchonanthus	1		
Ifloga	4		
Gnaphalium	7	2	
Helipterum	4		
Helichrysum	29		1
Leontonyx	4		
Phænocoma	1		
Anaxeton	3		
Petalacte	1		
Perotriche	1		
Stoebe	8		
Disparago	4		
Elytropappus	3		
Bryomorphe	1		
Metalasia	8		
Relhania	3		
Leyssera	1		1
Athrixia	2		
Printzia	2		
Pulicaria	1		
Osmites	2		
Osmitopsis	1		
†Xanthium	2	2	
†Ambrosia	1	1	

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
COMPOSITÆ (*continued*)			
Bidens	1		
Eriocephalus	3		1
Athanasia	7		
Œdera	2		
†Chrysanthemum	2	2	
Matricaria	4		
Otochlamys	1		
Cotula	6		
Hippia	1		
Alciope	1		
Cineraria	1		
Senecio	41	1	
Euryops	2		
Gamolepis	1		
Gymnodiscus	1		
Othonna	13		
Dimorphotheca	3		
Tripteris	4		
Osteospermum	5		1
Ursinia	8		
Haplocarpha	1		
Arctotheca	1		
Cryptostemma	3		
Arctotis	6		
Venidium	1		
Gorteria	2		
Gazania	2		
Cullumia	4		
Berkheya	6		
†Silybum	1	1	
†Carbenia	1	1	
†Carthamus	1	1	
†Centaurea	2	2	
Gerbera	5		
Hieracium	1		
†Hypochœris	2	2	
Lactuca	1		
Sonchus	3	2	
†Urospermum	1	1	
CAMPANULACEÆ			
Laurentia	2		1
Lobelia	18		
Cyphia	10		
Lightfootia	7		
Wahlenbergia	7		
Microcodon	3		
Roella	6		
Prismatocarpus	5		
Treichelia	1		
ERICACEÆ			
Erica	92		
Philippia	1		
Blæria	2		
Grisebachia	1		
Simocheilus	7		
Sympieza	2		

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
ERICACEÆ (*continued*)			
Scyphogyne	2		
Salaxis	5		1
PLUMBAGINACEÆ			
Statice	4		
PRIMULACEÆ			
†Anagallis	1	1	
Samolus	2		
MYRSINACEÆ			
Myrsine	2		
EBENACEÆ			
Royena	2		
Euclea	1		
SAPOTACEÆ			
Sideroxylon	1		
OLEACEÆ			
Olea	2		
ASCLEPIADACEÆ			
Secamone	1		
Microloma	2		
Astephanus	1		
Schizoglossum	6		
Asclepias	4	1	
Cynanchum	3		
Eustegia	2		
Brachystelmaria	1		
Stapelia	1		
GENTIANACEÆ			
Sebæa	12		1
Belmontia	3		
Lagenias	1		
Chironia	5		
Orphium	1		
Villarsia	1		
Limnanthemum	1		
BORAGINACEÆ			
Heliotropium	1		
†Lithospermum	1	1	
Cynoglossum	1		
Lobostemon	9		
†Echium	1	1	
CONVOLVULACEÆ			
†Convolvulus	1	1	
Dichondra	1		
Falkia	1		
Cuscuta	1		
SOLANACEÆ			
Solanum	9	4	
†Physalis	1	1	
Withania	1		
Lycium	4		
†Datura	1	1	
†Nicotiana	1	1	
SCROPHULARIACEÆ			
†Verbascum	1	1	
Hemimeris	4		
Alonsoa	1		

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
SCROPHULARIACEÆ (*continued*)			
Diascia	2		
Nemesia	11		
†Antirrhinum	1	1	
†Cymbalaria	1	1	
Halleria	2		
Teedia	1		
Zaluzianskya	8		
Polycarena	2		
Phyllopodium	2		
Sutera	7		
Nemia	4		
Ilysanthes	1		
Limosella	2		
†Veronica	2	2	
Melasma	3		
Harveya	7		
Hyobanche	2		
Buchnera	1		
†Bellardia	1	1	
OROBANCHACEÆ			
Orobanche	1		
LENTIBULARIACEÆ			
Utricularia	2		
MYOPORACEÆ			
Oftia	1		
SELAGINACEÆ			
Hebenstreitia	5		
Dischisma	4		
Walafrida	1		
Selago	13		
Microdon	1		
Agathelpis	2		
VERBENACEÆ			
Campylostachys	1		
Stilbe	2		
†Lantana	1	1	
†Lippia	1	1	
Bouchea	1		
†Verbena	2	2	
LABIATÆ			
Mentha	3	2	
Salvia	4		
†Cedronella	1	1	
Ballota	1		
Stachys	3	1	
Leonotis	1		
PLANTAGINACEÆ			
Plantago	5	2	
†PARONYCHIACEÆ			
†Herniaria	1	1	
†Corrigiola	2	2	
†Scleranthus	1	1	
AMARANTACEÆ			
Amarantus	2	1	
Achyranthes	1		

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
CHENOPODIACEÆ			
†Chenopodium	5	5	
†Atriplex	1	1	
Exomis	1		
Chenolea	1		
Salicornia	2		
Suæda	1		
Salsola	1		
†PHYTOLACCACEÆ			
†Phytolacca	1	1	
POLYGONACEÆ			
Polygonum	7	3	
Rumex	7	4	
Emex	1		
CYTINACEÆ			
Cytinus	1		
Hydnora	1		
PIPERACEÆ			
Peperomia	1		
LAURACEÆ			
Ocotea	1		
Cassytha	2		
PROTEACEÆ			
Aulax	1		
Leucadendron	9		
Protea	10		
Leucospermum	3		
Serruria	15		
Mimetes	7		
Spatalla	1		
Brabejum	1		
THYMELÆACEÆ			
Arthrosolen	2		
Passerina	1		
Chymococca	1		
Cryptadenia	3		
Lachnæa	3		1
Struthiola	4		1
Gnidia	15		1
PENÆACEÆ			
Penæa	2		
Sarcocolla	4		
Brachysiphon	1		
LORANTHACEÆ			
Viscum	2		
SANTALACEÆ			
Thesium	18		
Thesidium	2		
Colpoon	1		
GRUBBIACEÆ			
Grubbia	2		
EUPHORBIACEÆ			
Euphorbia	13	2	
Cluytia	6		
Leidesia	2		
Adenocline	1		
EUPHORBIACEÆ (*continued*)			
Paradenocline	1		
†Mercurialis	1	1	
URTICACEÆ			
†Urtica	1	1	1
Australina	1		
Celtis	1		
†Cannabis	1	1	
MYRICACEÆ			
Myrica	5		
SALICACEÆ			
Salix	1		
GYMNOSPERMEÆ			
CONIFERÆ			
Callitris	1		
Podocarpus	1		
MONOCOTYLEDONEÆ			
ORCHIDACEÆ			
Liparis	1		
Acrolophia	5		
Eulophia	2		
Bartholina	2		
Holothrix	7		
Satyrium	21		
Pachites	1		
Disa	47		
Schizodium	6		
Pterygodium	15		
Ceratandra	4		
Disperis	6		
HÆMODORACEÆ			
Wachendorfia	2		
Dilatris	2		
Cyanella	1		
IRIDACEÆ			
Moræa	16		
Homeria	2		
Ferraria	1		
Hexaglottis	1		
Galaxia	2		
Romulea	10		
Bobartia	3		
Aristea	7		
Witsenia	1		
Hesperantha	5		
Geissorhiza	11		
Ixia	6		
Lapeyrousia	2		
Micranthus	2		
Watsonia	5		
Babiana	5		
Melasphærula	1		
Sparaxis	1		

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
IRIDACEÆ (*continued*)			
Tritonia	2		
Acidanthera	4		
Synnotia	1		
Gladiolus	24		1
Antholyza	7		
AMARYLLIDACEÆ			
Pauridia	1		
Curculigo	1		
Hypoxis	7		
Hessea	2		
Carpolyza	1		
Gethyllis	5		
Crinum	1		
Amaryllis	1		
Brunsvigia	1		
Ammocharis	1		
Nerine	3		
Cyrtanthus	1		
Hæmanthus	1		
Buphane	1		
LILIACEÆ			
Asparagus	9		
Kniphofia	1		
Aloe	1		
Bulbinella	2		
Bulbine	6		
Eriospermum	4		
Anthericum	15		
Chlorophytum	1		
Cæsia	2		
Agapanthus	1		
Tulbaghia	2		
Lachenalia	11		
Drimia	3		
Dipcadi	1		
Albuca	4		
Urginea	4		
Hyacinthus	1		
Ornithogalum	8		1
Androcymbium	2		
Wurmbea	1		
Bæometra	1		
Dipidax	2		
Ornithoglossum	1		
XYRIDACEÆ			
Xyris	1		
COMMELINACEÆ			
Commelina	1		
JUNCACEÆ			
Juncus	15		
Prionium	1		
TYPHACEÆ			
Typha	2		
ARACEÆ			
Richardia	1		

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
NAIADACEÆ			
Triglochin	3		
Aponogeton	2		
Potamogeton	1		
Ruppia	2		
Zannichellia	1		
RESTIONACEÆ			
Restio	29		
Dovea	9		1
Elegia	15		2
Lamprocaulos	1		
Leptocarpus	3		
Thamnochortus	16		
Hypolæna	5		
Hypodiscus	6		
Willdenovia	5		
CYPERACEÆ			
Pycreus	3		
Juncellus	1		
Cyperus	9		
Mariscus	3		
Eleocharis	2		
Bulbostylis	1		
Scirpus	21		1
Ficinia	36		
Fuirena	3		
Rhynchospora	1		
Carpha	1		
Ecklonea	2		
Schœnus	1		
Epischœnus	1		
Tetraria	17		
Macrochætium	1		
Cladium	1		
Chrysithrix	2		
Schœnoxiphium	2		
Carex	7		
GRAMINEÆ			
Imperata	1		
Rottbœllia	1		
Andropogon	3		
Anthistiria	1		
Paspalum	2	1	
Digitaria	1		
†Panicum	2	2	
Pennisetum	2		
Stenotaphrum	1		
Prionanthium	1		
Achneria	4		
Poagrostis	1		
†Aira	1	1	
Holcus	2	1	
Anthoxanthum	2		
Kœleria	2		
Avenastrum	4		
†Avena	3	3	
Pentaschistis	14		

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
GRAMINEÆ (*continued*)			
Pentameris	2		
Danthonia	7		
Chætobromus	1		
Phragmites	1		
†Lagurus	1	1	
Polypogon	2	1	
Agrostis	4	1	
Aristida	5		
Stipa	1		
Tragus	1		
Sporobolus	2		
Diplachne	1		
Eragrostis	7		
Cynodon	1		
†Eleusine	1	1	
Ehrharta	14		
†Phalaris	1	1	
Melica	1		
†Lamarckia	1	1	
†Dactylis	1	1	
Lasiochloa	2		
Brizopyrum	2		
†Briza	2	2	
†Poa	1	1	
†Scleropoa	1	1	
Festuca	1		
†Vulpia	2	2	
†Bromus	5	5	
†Brachypodium	2	2	
†Lolium	3	3	
Lepturus	1		
Agropyrum	1		
†Hordeum	2	2	

	Total Species.	Non-Native Species (included in Total).	Doubtfully recorded (not included in Total).
PTERIDOPHYTA			
FILICES			
Gleichenia	1		
Hymenophyllum	3		
Trichomanes	1		
Hemitelia	1		
Adiantum	2		
Hypolepis	1		
Cheilanthes	4		
Pellæa	3		
Pteris	3		
Lomaria	4		
Blechnum	1		
Asplenium	5		
Aspidium	2		
Lastræa	2		
Polypodium	1		
Gymnogramme	3		
Vittaria	1		
Acrostichum	2		
Osmunda	1		
Todæa	1		
Schizæa	1		
Mohria	1		
Ophioglossum	2		
LYCOPODIACEÆ			
Lycopodium	3		
THALLOPHYTA			
CHARACEÆ			
Chara	5		
Nitella	1		

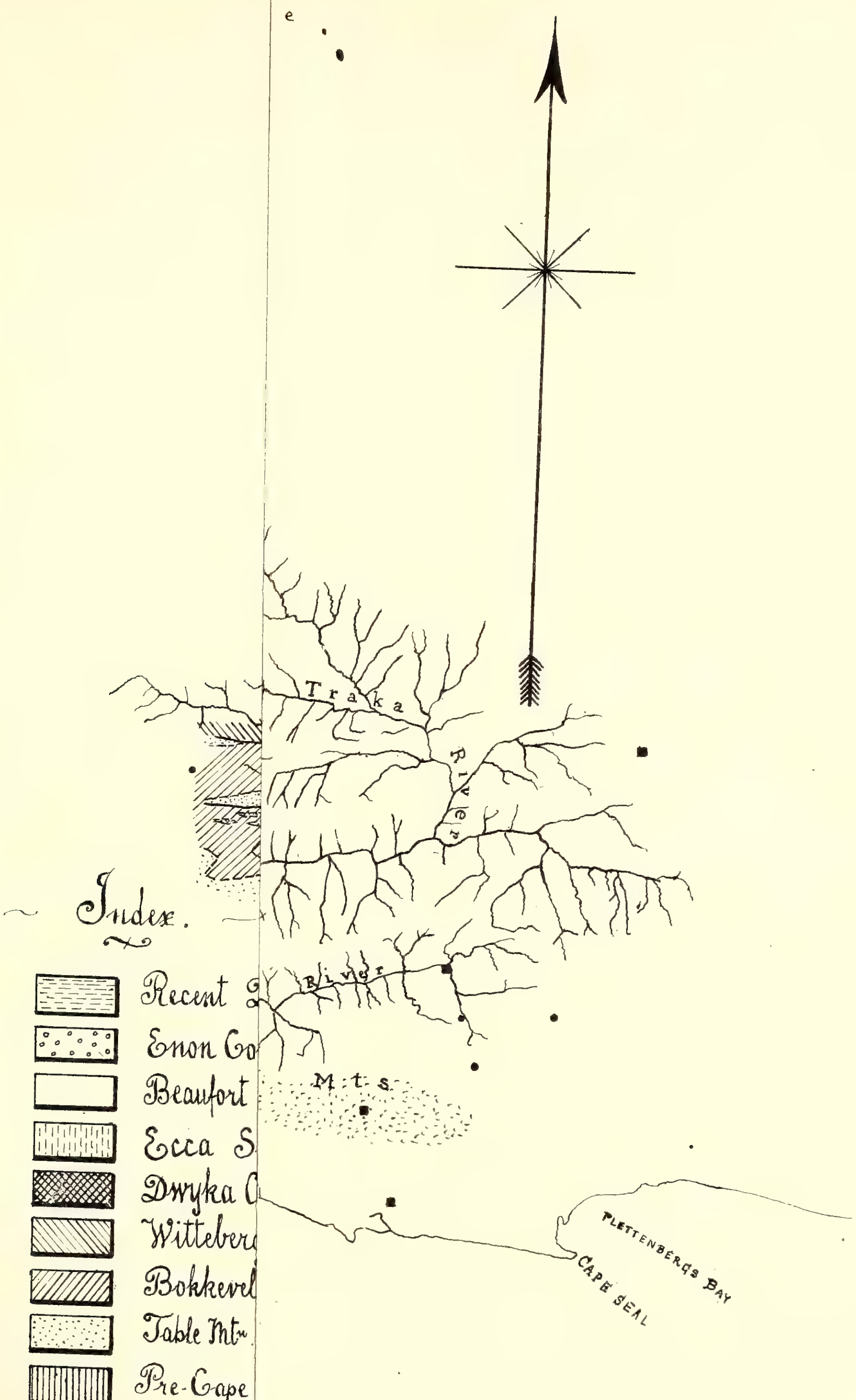
SUMMARY.

Total plants enumerated (excluding 31 of doubtful occurrence) :—

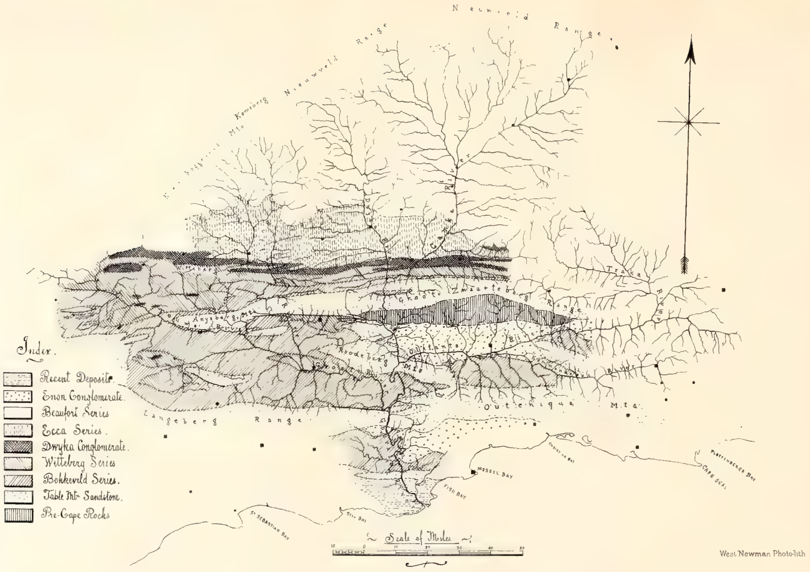
Phanerogamia—	
Dicotyledons	1,581
Gymnosperms	2
Monocotyledons	713
Cryptogamia	55
	2,351
Deduct foreign or doubtfully native species, marked †	179
Total native species of Cape Peninsula	2,172
Deduct Cryptogamia	55
Total Phanerogamia, native	2,117

Native Phanerogamia.	Orders.	Genera.	Species.
Dicotyledons	78	332	1,435
Gymnosperms	1	2	2
Monocotyledons	14	151	680
Totals	93	485	2,117

Plate III.



West, Newman Photo-lith.



West Newman Photo-lith

A.W. ROGERS; GOURITZ RIVER SYSTEM

THE GEOLOGICAL HISTORY OF THE GOURITZ RIVER SYSTEM.

By A. W. Rogers.

(Read March 4, 1903.)

(Plate III.)

The main watershed of the Colony lies between those rivers which flow north and west into the Atlantic, and those which flow south and east into the Indian Ocean. The watershed is remarkably simple and regular in form considering its length, in fact it approaches the theoretical form assumed by the watershed of a simple anticlinal uplift. Leaving the extreme south-west of the Colony out of account, owing to some special conditions which have complicated the problem there, we may trace the watershed from the mountains near Tulbagh eastwards to the neighbourhood of Matjes Fontein, then north-east along the Klein Roggeveld, Komsberg and Nieuweveld Ranges, round and between the head streams of the Gamka and Zak Rivers, thence across to the Sneeuw Bergen, Achter Rhenoster Bergen, Kikvosch Berg, down considerably to the south along the Bamboos Mountains, and thence along the Stormberg to the Drakensberg. The general course is somewhat east of north-east. The rivers with which we are at present concerned are those which flow south from the Nieuweveld, Komsberg, and Klein Roggeveld, and their tributaries, which enter the ocean by the Gouritz River.

The principal rivers of the drainage basin are the Buffel's, Dwyka, and Gamka Rivers north of the Zwartebergen; of these the two latter join north of the Gamka Poort and flow through the Zwartebergen together; between the Zwartebergen and Langebergen the Buffel's River is joined by the Touw's River, and the Gamka by the Oliphant's River; the two greater streams thus formed unite to make the Gouritz, which traverses the Langebergen and continues its course to the ocean without being joined by any considerable stream south of that range.

The Buffel's, Dwyka, and Gamka Rivers drain the Mordenaar's

Karroo and Gouph, districts which lie between 1,200 and 4,000 feet above the sea; they then traverse the Zwartebergen, a range of which the average height is about 5,000 feet above the sea, and after passing through a mountainous tract between the Zwartebergen and Langebergen they traverse the latter range.

It is clear that some explanation of this arrangement must be found, for the rivers might have been expected to avoid the Zwartebergen and run eastwards to the ocean along the country of moderate elevation that lies north of this mountain belt.

To enable a further discussion of the river system to be made, some important points in the geological history of the country between the watershed and the coast must be considered.

It is now known that the anticlines of the Zwartebergen, and in all probability all the other great anticlinal folds which lie east and west on the south of the Karroo, owe their origin to movements in the earth's crust which took place after the lower parts of the rocks of the Karroo System were deposited: this fact is proved by the occurrence of these rocks to the south of the Langebergen between Worcester and Robertson, where they are involved, together with the Cape System, in the folds produced by those movements, and by the presence of outliers of the lowest division of the Karroo System between the Zwartebergen and Langebergen.

It will be convenient to call the movements of the earth's crust which folded the rocks in the south of the Colony the Zwartberg movements; the folds produced by this great crumpling trend nearly east and west. It is important that they should be clearly separated in our minds from the movements which gave rise to the Cederberg anticline near the west coast. The Cederberg anticline trends some degrees west of north, and was in part produced somewhat earlier than the Zwartberg folds, for the Karroo System transgresses unconformably over the rocks affected by the Cederberg movements, but lies conformably upon the rocks affected by the Zwartberg movements.

It is certain that the Zwartberg movements were completed before the deposition of the Uitenhage Series, for the latter rests uncomformably upon the rocks disturbed by those movements; whether the Zwartberg folds were produced during or after the deposition of the upper parts of the Karroo rocks is an unsettled question, but it is not unlikely from the fact that the dolerite sheets and dykes so abundant in the Karroo do not occur in the districts where the rocks have been affected to an appreciable extent by the Zwartberg movements, that these movements took place during or shortly before the intrusion of the dolerite. This relationship between the dolerite and the folded sedimentary rocks, that is, the separation of the two in space, seems to me a very remarkable and important point. In the extreme north-west of the area occupied by the rocks which form the Zwartebergen and Langebergen, a part of the country which was affected only by the Cederberg movements, and to a very slight extent by them, the dolerite dykes extend outward from the great area occupied by the intrusive masses in the Karroo, into the older rocks*; and again in Pondoland, where the lowest member of the Cape System lies nearly horizontally, the dolerite has invaded it. These facts appear to me to confirm the supposition that the dolerite intrusions could not approach the rocks that were being folded, or which had just been folded. It is not improbable that the dolerite, which is so extensively spread through the rocks between Bushmanland and Natal, and which everywhere presents a striking uniformity in petrographical character, was intruded during one period, the limits of which are of course difficult to determine, but which lay between the time of the deposition of the Stormberg Series and that of the Cretaceous rocks of Pondoland, probably much nearer the former than the latter;† for the former were invaded by the dolerites and the latter contain boulders derived from the intrusive rock. If, therefore, the relationship between the Zwartberg folds and the dolerite intrusions is of the nature I have supposed, the date of the dolerite intrusions, approximately determined in Pondoland, gives us an idea as to the date of the formation of the great anticlines of the southern part of the Colony, viz., during the deposition of the Stormberg Series, or between the deposition of the upper part of the Beaufort Series and that of the upper part of the Stormberg. It is impossible at present to fix the date of the Zwartberg movements more closely, or rather the date of their maximum, for they must have lasted a long time geologically speaking.

The question of the former western limits of the Stormberg Beds is of great interest, but there is no direct evidence to decide it. At the present day the Stormberg Beds do not occur to the west or south-west of Steynsburg, but they must formerly have extended beyond

* A dyke of dolerite some fifteen miles long traverses the Dwyka Series on Beukes Fontein in the western or Ceres Karroo, where the Series has been tilted to the east by the same earth-movements that completed the Cederberg anticline. This dyke is some forty miles distant from the dolerite area of the Roggeveld and Nieuweveld.

† It seems likely that the intrusion of the dolerite was connected with the volcanic phenomena of the Drakensberg, which belong to the latest stage of the Stormberg Series. For a discussion of the volcanic and intrusive rocks of the Drakensberg, see E. H. L. Schwarz on "The Geology of Matatiele," Ann. Rep. Geol. Comm. for 1902.

their present outcrops. It is probable that the great accumulations of volcanic rocks, which lie above the ordinary sediments of the Stormberg Series in the Drakensberg and Basutoland, never extended much further west than Molteno, for the volcanic pipes or necks of the type of those of the Drakensberg have not been found west of that neighbourhood. These volcanic rocks have thickened the Stormberg Series in the east, and have also protected the underlying sediments, so that west of the Molteno district the Stormberg Beds have disappeared much more rapidly and completely than east of it. It is quite possible on this view that the Stormberg Beds once extended to the Roggeveld escarpment, and that when the uplift, which produced the main divide of the Colony, took place, the water which fell upon the newly uplifted land flowed in general north-west and south-east directions over a surface composed of the Stormberg Beds. It is certain that a great thickness of rock must have been removed from the Nieuweveld since the watershed was made. If we are right in our conclusion that the Zwartberg movements took place during the deposition of the Stormberg Series, it follows that the production of the main watershed of the land which resulted from the emergence of those deposits from the water in which they were laid down, was posterior to the production of the great southern anticlines.

After these anticlines rose from the water, they lost a vast amount of their substance by the ordinary atmospheric agencies. This process went on for long ages before a record was preserved of the events which took place during this great period of denudation in the south of the Colony. This record is contained in the deposits of the Uitenhage Series, the remnants of which are scattered widely between Algoa Bay, or even further east, and the town of Worcester. Near the towns of Worcester and Robertson the conglomerates of the Uitenhage Series rest directly upon the Malmesbury Beds and also upon the Ecca or possibly higher Beds of the Karroo System, which are faulted down against the pre-Cape rocks, proving that before the conglomerate was formed some 12,000 or 15,000 feet of rock had been removed by denudation on the upthrown side of the Worcester fault.*

The Uitenhage Beds which are of most importance to us in the present connection are the conglomerates, sandstones, and shales,

* E. H. L. Schwarz, Ann. Rep. of Geol. Comm. for 1896, p. 29. Further accounts of this fault east of Worcester will be found in the Reports for 1897, App. II. and III.; for 1898, App. III. and V. The estimate of 12,000 feet is obtained by adding up the thicknesses of the Cape System (10,000 feet) and the part of the Karroo System (2,000 feet at least) which have certainly been removed from the area immediately north of the Worcester fault.

which partly fill the depressions between the Zwartebergen and Langebergen, and similar depressions south of the latter range. These rocks extend in places to a level below that reached by the present river valleys. The Gamka River, for instance, south of Calitzdorp, runs across these rocks, and its tributary the Oliphant's River has the Uitenhage Series for its bed rock for a considerable distance. South of Herbertsdale sandstones belonging to the Uitenhage Series form the bed of the Gouritz River for some few miles. Near Mossel Bay the conglomerates at the base of the Series lie below sea-level; and at Swellendam their base was not reached by a bore hole put down to a depth of 800 feet below the present surface. The evidence afforded by the Uitenhage Series proves, that before these rocks were formed there were deep longitudinal valleys in the south of the Colony, and that the valleys north and south of the Langebergen were not directly connected as at present by a river traversing the latter, for there is no ancient transverse valley in the Langebergen, filled up with Uitenhage deposits. This absence of all traces of pre-Uitenhage transverse valleys in the Zwartebergen and Langebergen, together with the distinct evidence of longitudinal valleys, which were eroded relatively more deeply than the present valleys, affords strong evidence against the view that the Gamka and other rivers from the Karroo were antecedent to the mountain ranges; in other words, these rivers did not cut their valleys down through the slowly rising mountains.

The lowest points of the Zwartebergen and Langebergen now rise considerably higher than the highest level of the areas formed by the Uitenhage rocks, but these have suffered a great decrease in area and thickness during the lapse of time from their formation to the present day, during which it is very improbable that they were again depressed below sea-level. It seems likely that they once partially buried the Langebergen and Zwartebergen under the load of debris derived from these ranges, and, in the later stages of their deposition, from the country to the north which is now the Karroo. The result of this filling up of the pre-Uitenhage inequalities of surface was, that the rivers which were flowing southwards from the then recently formed watershed flowed south over the present position of the Zwartebergen, across the area of deposition as this gradually became dry land. Whether the rivers from the southern flank of the watershed formerly discharged into the estuaries and sea, in which the Uitenhage Series were being deposited, further east than the present Oudtshoorn district or in that district will be a difficult point to prove. It is probable, however, that in the later part of the Uitenhage period the rivers did enter the area between the Zwartebergen and Langebergen.

The striking regularity of the southern rivers in maintaining their channels across the diversified surface south of the Karroo is strong evidence in favour of the view that the general slope of the new land formed by the rising surface of Uitenhage rocks was, generally speaking, in direct continuity with the southern slope of the pre-existing watershed to the north. It is, in fact, probable that the rising of the southern part of the slope was but the accompaniment of the later history of the formation of that watershed and its southern drainage slope.

The published descriptions of the Uitenhage Series* plainly show that the earth movements which have affected the southern part of the Colony since their deposition were insignificant when compared with the Zwartberg movements, and at the same time that they produced a certain amount of difference in level in different parts of the area affected. The Oudtshoorn area has been less affected than the area south of the Langebergen. In Riversdale, for instance, the observed dips in the Uitenhage River beds rise to 20° or even more, and the direction of dip is generally toward the north or north-north-east, showing that there was a sinking of the Langebergen, or of the country on the southern flank of that range relatively to the country still further south, but this alteration of level has had no effect on the course of the Gouritz River, which traverses that part of the country.

After the Uitenhage sediments emerged from the water, the Karroo rivers ran southward from the watershed, across the partially buried mountain chains, and their beds in the lower half of their courses were formed by the Uitenhage rocks. These rocks are of a rather loose incoherent nature as compared with the Karroo rocks and those forming the buried mountain chains, and the rivers must have lowered their valleys comparatively quickly as long as the hard rocks of the unconformably buried ranges were not reached; but after these rocks had been laid bare in the valleys, the rate of the cutting down of the river channels must have decreased. The main river channels, at the time of the first exposure of the hard rocks below the Uitenhage Series, must have been well developed, so that the rivers could not find easier paths to the ocean than the courses given them on the emergence of the Uitenhage sediments. It thus came about that the rivers had to cut their valleys in the extremely hard quartzites of the Zwartebergen, Gamka Hills, Langebergen, and other previously buried ranges that lay in their way. We must thus look upon the river system south of the Karroo as a super-

* Ann. Rep. of Govt. Comm. for 1898, App. III., IV. and V.; 1899, App. II.; 1900, App. I.; and 1901, App. I.

imposed one as regards the folded country between the Karroo and the ocean; that is, it worked its way down from the surface (of Uitenhage sediments), upon which the main streams were consequent, to a highly diversified surface, the result of a former period of denudation, so that the rivers which thus maintained their courses came to have no direct relations to the structure of the country over which they ran after the removal of the unconformable Uitenhage rocks. The evidence which allows us to arrive at this conclusion is almost entirely derived from the remnants of the Uitenhage sediments, which once stretched much further in every direction than they do now. If we, in imagination, remove these remnants of Uitenhage rocks we do not make a profound alteration in the structure of the country between the Karroo and the ocean, we merely lay bare the underlying rocks of the Cape formation, and still older rocks; and one result would be a country like the Ladismith Karroo, and an extension of the George granites and slates to meet the Ruggens of Swellendam; but another result, and the one I wish to call attention to, would be that we should have no clue from the geology of the country to the history of the Karroo rivers.

The rising of the area south of the Karroo, after the deposition of the Uitenhage rocks, altered the relative heights of the watershed and of the southern area, so that at some points the latter is to-day higher than the former, but the elevation of the southern area took place so slowly that the main rivers were able to cut down their valleys as the land rose, and were never dammed back or diverted.

The Buffel's River, which traverses the Zwartebergen below Laingsburg, turns sharply to the east at the confluence of the Touw's River after traversing rather more than half the distance between the Zwartebergen and the Langebergen, and then flows through the latter range together with the Gamka River. The Buffel's River thus traverses the Langebergen some twenty-five miles further east than would be the case if it had taken a direct course to the sea instead of turning east to join the Gamka. On the theory we have adopted to explain the origin of the Karroo drainage, one would expect the Buffel's River to have flowed across the folded belt south of the Zwartebergen more or less parallel to the Gamka. It is a noteworthy fact that one of the lowest depressions on the crest of the Langebergen is situated just on the line which should, according to the hypothesis, have been taken by the Buffel's River. The depression is Garcia's Pass north of Riversdale. At the present day the Kaffir Kuil's River rises in the Langebergen, near Garcia's Pass, and occupies the position of the lower part of the former course of the

Buffel's River. The diversion of the Buffel's River was brought about by the more rapid erosion of the valley of the Gamka, which enabled the tributary of the latter from the west to cut back the divide between the Gamka and Buffel's Rivers to such an extent that the latter river deserted its old course and flowed into the Gamka. The level of the Garcia Pass is about 1,000 feet above the present level of the Buffel's River at the point where it changes its direction, and the diversion must have taken place a very long time ago. Examples of change in direction of rivers owing to the encroachment of a lateral stream, or in the language of the American geographers, the beheading of rivers, are to be found elsewhere in the Colony. One very clear case is that of the Drie Hoek's River in Clanwilliam which flows eastward from the Cederberg anticline, and which formerly ran across the escarpment of the Bokkeveld and Witteberg beds through Nieuwe Gift into the Kruis River, but a north branch of the Matjes River, working its way along the soft Bokkeveld shales, has captured the Drie Hoek's River, and the former eastward course of the latter is now indicated by a deep depression in the escarpment, a wind gap of the Americans. In this case the cause of the diversion is clear, the soft shales of the Bokkeveld Series yielded easily to the encroaching stream so that the Drie Hoek's River was forced to flow down that stream instead of maintaining its former valley across the harder beds of the upper part of the Bokkeveld Series. In the case of the Buffel's River the diversion is so old that we cannot know exactly what the determining factors were. The Langebergen evidently made it sufficiently difficult for the river to cut down its valley across the range, but whether the lateral affluent of the Gamka at the time of the diversion ran over the Uitenhage Series, or whether the river bottom had reached the underlying Bokkeveld Beds, is now impossible to find out.

From an inspection of the maps it is probable that the Traka has had a history somewhat similar to that of the Buffel's River, and has been captured by the Oliphant's River. Whether the Meiring's Poort River is another victim of the Oliphant's River is as yet uncertain; the Wagonpad's Nek in the Kamnassie Range, and a favourably situated depression in the Outiniqua's, point to that being the case, and the future examination of the country will decide the matter.

It appears not improbable that the Gouritz River system has developed by the encroachment of the Dwyka and Gamka Rivers and their affluents, which have captured the Buffel's, Meiring's Poort, and Traka Rivers, once streams with independent valleys from the Karroo to the ocean.

Throughout the country south of the Zwartebergen, and to a much smaller extent north of that range, there are scattered the remains of a former widespread plain covered with gravels and alluvial deposits that were formed when the general level of that portion of the country was probably some 800 feet to 1,000 feet lower than at present. These isolated patches of river-borne detritus are now often found to be cemented by iron compounds and silica into ferruginous and silicious rocks. Descriptions of these rocks have been published in the Reports of the Geological Commission, but a full consideration of them as a whole cannot be undertaken until much more is known of their relative heights above the present valley bottoms. We can only conclude that they record a past stage of the development of the river systems, during which the rivers had, in many parts of their courses, approached the limit of downward erosion, and as a consequence were levelling the country near them more rapidly than was possible while they were chiefly engaged in lowering their beds. The surfaces thus produced were gently undulating plains cut out of the softer rocks, the Uitenhage, Bokkeveld, and Witteberg Series, of the country between the mountains composed of the Table Mountain Series. The terraces cut in the latter are frequently seen south of the Langebergen, and are less well developed north of that range. Had this period of low level and great lateral erosion of the rivers continued to the present day, probably the most conspicuous difference in the resulting surface would have been a greater degradation of the mountain ranges by the extension of the terraces than has actually been the case. But after these terraces had been formed, the country was elevated relatively to the ocean, and the downward cutting powers of the rivers therefore restored, with the result that the rivers have cut deeply into the old peneplain, and the latter is only represented by the flat-topped hills capped with the surface quartzites and associated rocks, which are so conspicuous both to the south and north of the Langebergen.

The great bends of the Gouritz River below Herbertsdale, and between the Pogha Hills and Roode Berg, with the remains of the old peneplain still preserved as steep-sided hills some 600 feet to 800 feet high, enclosed by the bends, are an inheritance from this period of lateral erosion. While a river is actively cutting down its bed it does not take a circuitous route to its mouth; but rivers, whose fall is slight, meander considerably in the plains they traverse. The meanderings of the Gouritz, which are now so deeply sunk below the general surface of the country in their neighbourhood, were doubtless formed while the river was flowing sluggishly over the peneplains cut by itself and its tributaries; and their shape has been preserved during the period of rapid downward erosion of the river valley since the uplift began which upset the previous conditions. The Gouritz River has not yet reduced the gradient of its valley to such an extent that it can recommence the work of lateral erosion.

The general conclusions to which this enquiry into the history of one of the Karroo River Systems leads may be summarised:—

1. The emergence of land to the south of the present Karroo, due to the Zwartberg earth movements which took place some time between the period of deposition of the upper part of the Beaufort Series and the close of the Stormberg stage. A series of east and west valleys was originated on this land, and these valleys were extensively developed before the Uitenhage Series was formed.

2. The formation of the main watershed of the Colony by the uplift of the deposits of the latter part of the Karroo System; the uplift gave rise to the southerly drainage system of the Gouph and Mordenaar's Karroo.

3. The filling up of the east and west valleys by the deposits of the Uitenhage period (Lower Cretaceous?) which buried most of the old surface features south of the Karroo.

4. The emergence of the Uitenhage sediments owing to a continuation of the movement which brought about the formation of the main watershed, and the prolongation of the river valleys south of the watershed across the emerging Uitenhage rocks.

5. The formation of the Gouritz River system by the adjustment of the streams that brought about the confluence of the Dwyka Gamka and Buffel's Rivers, as well as other minor streams.

6. The production of the peneplains, whose traces are found widely spread between the Zwartebergen and the coast, during a period of decreased erosion of the rivers.

7. The renewal of the erosive powers of the rivers, which has caused the cutting up of the old peneplains.

The map of the Gouritz River system, which is appended in order to facilitate the reading of the paper, was kindly drawn up for me by Mr. A. L. du Toit, of the Geological Survey, and is based upon the Surveyor-General's map of 1895. The geological lines are taken from the field maps of Mr. E. H. L. Schwarz and myself. The black dots represent the positions of towns and villages, but their names were omitted, so that the map should not be overcrowded. The patches of high-level gravels and alluvium, capping the remnants of the peneplains mentioned in the paper, are not represented in this map.

AN UNRECOGNISED AGENT IN THE DEFORMATION OF ROCKS.

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(Plates IV.-VI.)

By the term Deformation as applied to rocks there is meant the shattering or crumpling which may be seen in the folded mountain ranges of all countries.

In this paper the two phenomena of fracture and flowage will not be separated, for the difference is one of degree only. Any of the forces that produce shattering or granulation will also produce distortion without fracture under certain circumstances.

The popular idea is that such deformation is due to some violent upheaval; for it seems natural on seeing any great manifestation of force to imagine that this has taken place with sudden and explosive energy. This idea held the field for a very long time in the infancy of Geology. But by the slow accumulation of facts and the patient observation of Nature, it became more and more certain that the great disturbances in the earth's crust took place with exceeding slowness.

It will be the object of this paper to show that this element of time has not been sufficiently considered in the theories propounded to explain the phenomena of rock-deformation. I will take certain pebbles that have been subjected to great pressure in the laboratory and in Nature, and will show that Nature working with small forces, but these acting for long periods, can deform the pebbles to a far greater extent than we can working with much larger forces but limited as to time. Although it will seem at first sight preposterous to explain the forces at work in producing mountains from the effects that can be produced on small pebbles, yet when it is remembered that the ultimate elements of rocks are grains much smaller than the pebbles used, it will be seen that we can only gain an insight into the *modus operandi* of mountain building by studying how these small grains or pebbles respond to stresses.

The first and most important agent in deforming rocks is pressure, either lateral, due to tangential stresses, or vertical, due to the dead weight of material.

The usual method of testing the strength of rocks is to subject a small block of the substance to immense pressure in a crushing machine, and noting the number of kilograms to the square centimetre required to break it. The following figures* will give some idea of the weight required to break a small cube under ordinary atmospheric conditions:—

Sandstone, from 120 to 897 kilograms.
Granite, from 1,234 to 2,036 ,,
Felsite, from 2,092 to 3,026 ,,

Knowing the specific weight of the various rocks, it is very easy to calculate the greatest height of a column whose foot can still bear the weight of the superincumbent mass without breaking. We find the following are the heights of these columns :—

Sandstone, from 620 to 4,400 metres.
Granite, from 4,300 to 7,600 ,,
Felsite, from 7,800 to 11,000 ,,

If a column of rock of the particular specific gravity and crushing strength, were to be made higher than these figures, the foot of it would give way. In Nature, however, the rocks are permeated with water, and it is a remarkable fact that the crushing strength is always less, sometimes considerably less, when the specimen tested is soaked in water ; for instance, in the particular rocks taken in the above table the differences are :—

Sandstone, 58 kilograms, or 6% less weight required.
Granite, from 7 to 54 kilograms, or ·06 to 2% less.
Felsite, from 141 to 934 kilograms, or 7 to 13% less.

I shall return to this point afterwards ; what I want to get at now is the height of a column of rock which, under natural circumstances in the earth's crust, would, by its own weight, crush the rock at the foot. The water in the interstices would buoy up the rock, and the effective weight of the column would be, not the weight of the material in air, but in water. Taking the new crushing values,

* These figures are taken from Hermann's "Steinbruchindustrie Sachsens," Berlin, 1899.

and dividing by the specific gravity minus 1, we get the following figures :—

Sandstone, from 1,280 to 8,100 metres, or from ·7 to 5 miles high.

Granite, from 6,700 to 12,000 metres, or from 4·1 to 7·5 miles high.

Felsite, from 11,700 to 15,700 metres, or from 7 to 9 miles high.

From this we see that most sedimentary rocks would be unable to support their own weight beyond five miles deep from the earth's surface, while this limit is somewhat deeper in the case of the more compact crystalline rocks. Hence, from the consideration of the crushing strength of rock alone, we get the fact that there is a zone from five to seven miles within the earth's surface in which the weight of the superincumbent material is greater than the cohesion of the constituent particles of the majority of rocks, or in other words, we get deformation of mass at those depths.

It is a matter of common observation that the actual zone of mass deformation is very much nearer the surface. The creep is mine-levels, where the rock not only bulges in from above, but rises up from below, is known from most deep workings, and in the case of deep bore-holes, a cylinder of rock of the section of the bore gradually rises from the bottom. It is a matter of surprise, however, that the rock in deep gorges does not tend to creep in and close the gulley. In the Zwarteberg range, the valleys of the Buffel's River, Gamka River and Meiring's Poort River are from three to five thousand feet above the level of the stream, which cuts right through the very centre of the range. The crushing strength of some sandstones is far below that requisite to support this weight, and no doubt the soft bands of rock in these Zwarteberg gorges have been squeezed out towards the bottom of the kloof, but just because they are soft rock, the weathering has the more easily attacked them, and hence any squeezing out of the softer layers would be quickly removed by denudation. For the hardest sandstones, however, the limit is far below that requisite to crush the rock, and as the Zwartebergen for the most part consists of hard quartzite, this would stand a crushing strain equal to 10,000 to 12,000 feet of its own material. This line of inquiry is interesting in another way, as it indicates there must be a limit to the height of mountains on this globe, and any theory that brings in a probable existence of mountains of very much greater height than the highest we now have must be a false theory. Dr. Croll, in his works on the glacial age, made a similar miscalculation when he postulated the existence of an ice-cap, ten, or even twenty miles thick, at the South Pole, whereas it is impossible for a column of ice more than 1,600 feet high to support its own weight; if more were piled on the top the bottom would melt.

Bernachi observed in icebergs that the maximum thickness, namely, 1,600 feet is not requisite to produce this melting, but that very much less will do. His observation is so interesting that I will quote his own words :—" On the 30th August, the temperature in the shade was—15° Fahrenheit, with a perfectly clear sky and a glaring sunshine beating on the north walls of the icebergs. From the south, upon which at that time of year the sun never shone, drops of water were oozing from top to bottom."* There was no possibility of bringing in external sources of heat to produce the melting, the source must have been internal, and here at once we have an illustration of the general principle, that there are causes which produce the crushing of materials other than that due to the intensity of the lode.

It may be objected that an illustration taken from ice has nothing to do with hard rocks, as the two are so different in nature, but it is manifest that if the rock were sufficiently heated, the cohesion of the particles would become similar to that of ice under the temperature at the surface of our globe. The main source of heat is supposed to be that left over from the cooling of earth, and it is a fact that the lower we go down the hotter the rocks become. The great amount of variation in the rates of increase, however, leads one to suspect that the internal heat of the globe is not the only source which produces this temperature. Thus, of the 57 observations given in Prof. Lebour's list, the lowest increase is, for every degree Fahrenheit :—

157·2 feet at Minas Geraës, Brazil,

and the highest :—

28·1 feet at Anzin, N. France,

or in other words, to get a temperature of 1000° F., in the one case one would have to go down 29 miles, and in the other case only five miles, or about the depth of sea-level below Mount Everest. In the experiments of Professors Rücker and Roberts-Austen† on the melting point of dolerite, it was found that the rock became soft at a temperature of 760° C. or 1,400° F., while complete fusion took place at 920° C. or 1,688° F. The melting point of quartz or silica is not

* " To the South Polar Regions," 1901, p. 218.

† Carried out at the suggestion of Rev. O. Fisher. See that author's " Physics of the Earth's Crust," Appendix, 1891, pp. 18–28.

known, but at 1,000° C. or 1,832° F. Dr. Callendar* found that rods of pure silica no longer returned to their original dimensions, showing that a partial change of state, or an incipient viscosity, had been produced at that temperature. Dolerite and quartz are probably the two extremes in the nature of rocks common to the solid crust of the earth, the varieties more basic than dolerite being of extreme rarity. It is evident, therefore, that by heat alone all rocks would be rendered plastic between 1,400° F. and 1,800° F., and this heat would be obtained between 8 and 45 miles down from the earth's surface.

The whole question of heat, in reference to the plasticity of rocks is an immense subject by itself, and is one which I do not intend to go into here. It has also been very ably treated by a number of investigators such as Mellard Read,† Fisher,‡ van Hise,§ Barus,|| and Doelter.¶ I only in passing wish to point out that the internal heat of the earth is a very real agent, which must be taken into account in dealing with the deformation of rocks. We have seen that the dead weight of the superincumbent material is of itself able to crush rocks, but in estimating the depths at which this takes place in Nature we find that the results obtained by crushing rocks at the surface must be very much lessened owing to the incipient plasticity induced by this internal heat. For the same reason I must leave out all reference to the potential and actual heat produced by the intense pressure, which led to Mallet's theory of the origin of volcanic energy.**

The next element to be taken into account in the deformation of rocks is the action of water. Sir Humphrey Davy†† was the first to propose the theory that water played a large part in the economy of the earth's interior, and derived the internal heat from the oxidation of metallic substances by means of water percolating down to depths where these exist in a metallic state. The difficulty to be overcome in this theory is to explain how the water gets down to such great depths against pressure; we see, for instance, that if there is any chance of a crack going down through the earth's crust, the intense pressure is sufficient to force up through it a mass of molten rock with explosive violence. We have also seen that

* See Shenstone, *Nature*, vol. lxiv., 1901, p. 65.

† "Origin of Mountain Ranges," 1886.

‡ "Physics of the Earth's Crust," 1889.

§ "Metamorphism and Rock-flowage," Bull. Geol. Soc. of America, 1898.

|| Bull. Geol. Survey, U.S.A., No. 103, 1893.

¶ "Neues Jahrbuch," 1901, ii., pp. 141–157; Tschermak's "Mitth.," xx., 1901, pp. 210–232, and pp. 307–330.

** Phil. Trans., Roy. Soc., vol. clxiii., 1873, pp. 147–227.

†† See Humboldt's "Cosmos," Bohn's Edition, p. 234.

crevices in the rock are bound to close at no very great depths owing to the immense pressure of the superincumbent mass. Prof. Suess* has been led from these difficulties to postulate that water never finds its way from the surface to the depths were high temperatures exist, and he maintains that the water in hot springs, like those of Brand Vlei near Worcester, and geysers, are the occluded vapour that is being given off by the cooling globe, so that every fresh volcanic eruption bringing up its immense quantities of water-vapour, and every hot spring, increases the quantity of water available at the surface of the globe. The Rev. O. Fisher† has explained how the water-vapour may have originally got into the molten rock. He supposes that when the earth was still a liquid body, the atmosphere consisted of the volatile elements, for the most part water, that are now found cooled on the earth's surface. Taking the present bulk of water and volatilizing it, it is found that the gaseous envelope thus formed would produce a pressure of 327 atmospheres at the surface of the liquid globe, a pressure quite sufficient to force a considerable amount of water-vapour into the liquid rock, on the principle of forcing carbonic acid into water with a sparklet. Even when the pressure is released in aerated water, a considerable amount of gas still remains held up in the liquid, and this is much more so in liquid rock.

I had occasion to notice this latter phenomenon in the lavas of the Drakensberg which have recently been mapped by the Geological Survey (pl. vi.). Here there are many thousands of feet of lavas piled up one upon another, and nearly all characterised by a great abundance of steam-holes. It is well known that lava, when ordinarily poured out on the surface, gives off water-vapour freely, but usually the lava solidifies into a more or less solid mass; it is only in particular cases, when the molten substance is cooled rapidly, that the water-vapour is retained in the rock, and one gets all varieties of cavernous lavas from pumice to the so-called amygdaloids. In the Drakensberg lavas, however, the top layer of any particular flow is usually fairly free of these blow-holes, showing that the water-vapour originally contained in it had been got rid of. The deeper layers, however, which cooled more slowly, are full of little hollows, and the bottom of most of the lava-flows are permeated with long tubular vesicles of the thickness of a lead pencil, and closely crowded together. This indicates that the water-vapour must have been occluded in the molten magna, and was only extruded on the rock reaching a certain temperature on cooling; as

* *Geographical Journal*, Vol. xx., 1902, p. 520.

† "Physics of the Earth's Crust," 1889, p. 148.

the top layers had already reached this temperature, and had therefore become impervious to water-vapour, this in the lower layers of the lava was forced to occupy spaces which it cleared by its own expansion.

Sir Lowthian Bell has described a similar occlusion of gas in ordinary furnace slag even at ordinary atmospheric pressure; on the slag cooling to a certain point, the gas is given out suddenly, exactly in the manner I have supposed the water-vapour in the Drakensberg lavas to be.* It is evident, therefore, that the rock sufficiently deep in the earth's crust to be in a state of potential fusion, must contain a very large amount of occluded water-vapour, but from the observations on the Drakensberg amygdaloids it is also very probable that this vapour is held in permanent occlusion and is not available for extrusion in hot springs. In spite of the high authority of Prof. Suess, I must conclude that such are fed by water from the surface. Further, I think the facts prove that all water that permeates deep-seated rocks not in the zone of potential fusion, is derived from the surface, or according to Posepny's nomenclature, is vadose, and not hypogene.

The difficulty to explain the creeping of water down to great depths against pressure is cleared up by Prof. Daubrée's† beautiful experiment on the capillarity of rocks. Prof. Daubrée placed a flag of sandstone on a vessel in such a way that the sandstone separated the lower from the upper half. The interior of the lower half communicated with a pressure gauge, and the upper was open to the air. On pouring a little water on the sandstone, and heating the vessel to 160° C., the pressure in the lower half was observed to increase. A stop-cock was now opened to the air, allowing the pressure in the lower half to become the same as that in the upper, and was then closed, this operation being repeated several times, the heating going on all the while. Every time the pressure of the lower half increased, showing that the water was drawn through the sandstone by means of the capillarity exerted by the minute interspaces and against the pressure exerted by the heated air in the lower half, which tended to force its way in the opposite direction. Substituting the flag of sandstone for the cooler portion of the earth's crust, and the moderate heat of the laboratory for the immense heat in the interior of the earth, we can easily see how the water in a similar way would be drawn down into these great depths; the differences in Prof. Daubrée's experiment and the actual state of affairs in Nature being one of degree and not of kind. If Prof. Daubrée's experiment is reversed, and water poured

* *Journal of the Iron and Steel Institute*, No. 11, 1881.

† "Geologie Experimentale," 1879, p. 258.

into the lower half of the vessel, the water becomes vapourised and exerts a pressure of several atmospheres in endeavouring to escape, yet it is apparently not able to find its way out through the sandstone. This is another reason for rejecting Prof. Suess' theory of the water in hot springs having come by transudation from the interior of the Earth.

Having now cleared the way for the statement that water permeates all rocks down to the zone of permanent potential fusion, it remains to examine how this water helps on the deformation of rocks. To get some idea of the nature of the solvent action of water under great temperatures and pressures we have to go to the experiments of Carl Barus* in America, though Hannay† to a certain extent cleared the ground.

Barus found that water under pressure at a temperature of 180° C. contained in capillary tubes of glass, decreased very markedly in volume, and this decrease went on at a fairly uniform rate the longer the conditions were maintained. On examining the tubes, he found that a considerable quantity of glass had been dissolved and redeposited in a crystalline condition. As the crystalline state is one of a closer packing of the molecules as compared with glass, the apparent decrease of volume in the water was thus explained. Below 180° C. this effect did not take place, but above it the solution and crystallization went on very much more rapidly, far more so than proportional to the increase of temperature. The control of experiments of this kind at enormous temperatures is extremely difficult; as the critical temperature of water is 773° F., above which it cannot exist as a liquid and the molecule already becomes unstable, it is probable that the power of dissolving silicates goes on at an increasing rate with increase of temperature, till it reaches a maximum at 773° F.; at this point, if not before it is reached, it is very probable that all known rock-substances are soluble in water.

The effects of solution on deformation are very remarkable. To begin with carbonates which are soluble in water containing carbonic acid. The effects in this case are to remove the carbonates bodily from points where there is pressure and to deposit it elsewhere. Some beautiful examples of this are given by Chapman from the oolitic limestones of Ilfracombe.‡ We see here the original rounded grains of the oolite pressed upon one another and flattened normal to the direction of pressure, not only so,

* Bull. Geol. Survey, U.S.A., No. 92, 1892, pp. 78–84.

† *Nature*, July 15, 1880.

‡ Geol. Mag. x., 1893, p. 100, pl. 5, especially Fig. 2.

but where two grains come together the material has been removed. Instances of the same kind on a larger scale are very common in the limestone conglomerates called the Nagelfluhe,* which occurs in Switzerland and in the foot-hills of the Jura. Prof. Daubrée† in trying to imitate the conditions of Nature, took two balls of limestone and placed them in a slightly acidulated solution, the upper one exerting at the point of contact a pressure of ten kilograms upon the lower. The result was just the reverse of what occurs in Nature, the carbonate of lime was dissolved from the surface of the spheres and deposited at the point of contact. He then varied the conditions. The two balls were placed one on top of the other as in the previous experiment, but a very small amount of liquid was allowed to drop on them from a cotton thread suspended above them and hanging over the side of a vessel containing the acidulated solution. Directly a drop fell on the spheres, it found its way to the point of contact, and was held there by capillary attraction. Under these circumstances, the limestone at the point of contact was dissolved and the centres of the two spheres slowly approached one another.

The effect of this on a bed of ordinary granular limestone when subjected to pressure is obvious. If a bar of any material is bent, the outer edge is in a state of tension, and the inner of pressure. If a bed of limestone, then, is subjected to a distortional force in the earth's crust, that part which is under pressure will have the constituent grains tending to dissolve, while that under tension will afford a resting-place for the matter dissolved, and the whole bed will in this way adjust itself till equilibrium is restored.

The effect of solution on more resistent substances like the natural silicates and quartz, is exactly similar to the carbonates, except that the operation must go on at greater depths than the carbonates. Van Hise has very thoroughly gone into the question, and has shown that in all probability the schistose rocks, in which the silicates and quartz are elongated parallel to the shearing, have assumed this character, not by a melting under enormous temperatures of the original material, and recrystallization of the minerals normal to the direction of pressure, but to a gradual solution of the minerals in the positions of pressure and a redisposition of the material in the positions of tension, the whole operation going on at comparatively moderate depths and temperatures.

The rate at which this solution goes on is probably very rapid. We have no actual experiments on rocks, but supposing that the

* Heim, "Mechanismus der Gebirgsbildung," Basel, 1878, atlas, pl. xiv., Fig. 12; see also Mellard Reade, *Geological Magazine*, 1895, p. 344.

† "Geologie Experimentale," p. 382.

rate is one-tenth that of glass, from Barus' experiments we find that water would dissolve and redeposit its own volume of minerals in five hours. If now the volume of water is one-tenth per cent. of the whole mass, the whole rock at or below the level at which a temperature of 180° C. exists, could be dissolved and redeposited in 5,000 hours, or considerably less than a year. As a matter of fact, however, most crystalline rocks on analysis give more than one-tenth per cent. of water, some schists and gneisses go up to 2% by weight or over 5% by volume, which means that they could be wholly recrystallized every 100 hours, or, say, every week.

Taking the extremes in the rate of increase of underground temperature as between 157·2 and 28·1 feet for every degree Fahrenheit, the temperature 180° C. or 356° F. would be obtained at a depth between 10·6 and 1·9 miles.

Whether our deductions from laboratory experiments are correct we cannot say, but the extreme distortion of many crystalline rocks is certainly very favourable to our conclusions. Instances of these distortions occur in the gneisses of Robertson and Prieska, and the old rocks of Johannesburg and Prieska, the Hospital Hill slates and the Griquatown Series especially; some cause has allowed these rocks to adapt themselves with the greatest ease to the most complicated stresses, and solution under high temperature is an adequate cause. Rocks that are being deformed by this means are solid throughout during the operation, yet they respond to small stresses like a plastic body without loss of their crystalline character; each grain of the rock, while retaining its own individuality, becomes wholly new formed by crystallization, somewhat after the manner of the fleshy parts of animals which are periodically entirely replaced by new material.

We have, then, three elements causing deformation in rocks, any one of the three being able to carry out the deformation by itself. They are:—

Pressure.
Heat.
Solution.

Each by itself can render deformation possible at the following depths:—

Pressure	5 to 7 miles.
Heat	8 to 45 miles.
Solution	1·9 to 10·6 miles.

The average diameter of the globe is 7,912 miles, so that a very small proportion is outside the zone in which deformation must go on. All below this zone is ready at the slightest strain to give way and flow in the direction of pressure, and this while the whole is entirely solid. From the rate of propagation of earthquake waves through the centre of the earth, it is found that the effective rigidity is nearly twice that of steel,* so that we must reject the idea that the centre of the earth is a molten mass and the crust is a thin skin formed on cooling. The present state of our knowledge indicates the reverse, namely, that the earth solidified from the centre outwards, and the apparent fluidity of the interior to be due to the weakness of the material to withstand the forces in operation at great depths.

I am not a sufficient mathematician to go into the question of how this agrees with the results of astronomical observations on the attraction of the moon on the earth, and the amount of distortion caused by the revolution of the earth; I only want to put the purely geological view of the case.

I do not wish also here to examine the effects of these three elements of distortion in combination. It is sufficiently obvious that any two combined must lessen the depth at which deformation can take place, but the amount effected will not have any bearing on my argument. One point, however, has already come out, namely, that time is an element which has to be taken into account. In the question of solution this was obvious, and in the case of earthquakes, although the centre of the earth is in a state of perfect plasticity, a sudden shock finds it more rigid than steel.

I will now endeavour to show that time may produce certain effects with agents so insignificant, that they would ordinarily be considered wholly insufficient to accomplish.

The secular bending of marble and alabaster is often compared with the flow of viscous materials, like sealing-wax and pitch, but the two cases are not analogous. Instances of this bending are known from many places. At the Alhambra † alabaster jambs of doorways have curved inwards, and in churchyards slabs of marble supported only on their ends have slowly bent downwards.‡

In the case of the marble we have a material composed of grains of calcite crystallised in rhombohedra and twinned parallel to a rhombohedron face. There is no question of heat or solution, for the same effects have been observed in old churches when the slabs have remained dry and at an equal temperature for one or two centuries.

* C. S. Knott, *Scottish Geographical Journal*, 1899; J. Milne, *Geographical Journal*, 1903, p. 7.

† S. Pickering, *Nature*, 1902, vol. 65, p. 81.

‡ Sir A. Geikie, Roy. Soc., Edinb.; T. J. J. See, *Nature*, vol. 65, 1902, p. 56.

In Baumhauer's experiment, if one takes a rhombohedron of calcite and presses a knife across one of the terminal edges, a slight sideward pressure being at the same time given to the blade towards the summit of the rhombohedron, the following effect is produced:—as the knife enters the crystal, successive layers, all parallel to the twinning-plane, glide along each other, and take up a position complementary to the original crystal, and form a twin by reflection.* This twinning-plane here is also a gliding-plane, but it is more than merely a gliding-plane in the ordinary sense. Along this plane, provided a particular pressure is applied in a particular direction, the crystal substance will move without breaking. The ultimate nature of a crystal is still very imperfectly known, but it seems that the molecules have a regular swing in a particular order, the rhythm of which is expressed outwardly by hard and fast crystal shapes. When the knife is pressed in a certain direction in the above experiment, it affects all the molecules in the portion twinned which are swinging in unison; hence all the molecules are affected equally by the disturbance, and their mutual arrangement is undisturbed before and after the experiment. In the slab of marble, the top layer is under pressure. In this layer there are thousands of grains, some of which lie in the right direction for the pressure to effect a movement along the plane of gliding, but as static pressure alone is not sufficient to cause any motion, the slab has to wait till some trembling of the earth occurs to start off the gliding. When the first set of crystal grains have accommodated themselves to the pressure, the distribution of stress over the surface of the layer is altered, and a new lot of grains come into the right position for the twin-gliding, and these also have to wait for an adequate shock before they adjust themsevles, and the process goes on slowly till the whole slab becomes markedly deformed in the course of years.

A great many crystals of rock-forming minerals have similar winning-planes, the felspars of dolerite, for instance, being very similar in this respect to calcite, but the experimental testing whether they will adjust themselves to pressure in the same way as calcite has not been done. Some crystals like quartz show no signs of similar lamellar twinning, nevertheless, even in quartz there is a variety known as "twisted" or warped, which Tschermak regards as due to a similar gliding along twin-planes. †

The ultimate molecular state of all crystals must be similar to that of calcite; the molecules must have symmetric movement, and there

* H. Miers, *Mineralogy*, 1902, p. 95.

† The experiments now being carried on by Prof. F. D. Adams at McGill College, Montreal, however, may throw light on this subject.

must be positions of pressure along which they will yield most easily. If then any granular rock composed of crystalline substances is subjected to slight stresses, at the same time is allowed to remain in this position for a sufficient period, the pressure will find out these directions of easy yield, and the rock will be thereby distorted.

Another view of the question is whether under sufficient pressure a rock will accommodate itself to stresses in the same way as when time is one of the elements in the process. Prof. Daubrée has recorded several experiments of this nature. For instance, he rolled a coin between the rollers of a machine for making sheet-iron, and produced a lengthening like that one often sees in fossils which have been subjected to pressure; he also placed a piece of chalk between two layers of lead and subjected them to immense pressure, the lead flowed, broke the chalk into bits and separated them.* The object of my experiments was to try and get such a high pressure that the solid bits subjected would be unable to fracture, at the same time to give the mass a differential movement sufficient to produce distortion. For the purpose some limestone pebbles, and a pencil of hard shale were imbedded in lead, the whole encased in a strong iron box. Through the courtesy of Mr. G. McGrath of the Salt River Works, the box was then put in a hydraulic ram, and subjected to a pressure of 70 tons, when the box began to give; eventually 75 tons was reached, when the box almost burst. The diameter of the box was 3·55 inches, giving an area of 11·15 square inches, so that the pressure per square inch was respectively 6·28 and 6·72 tons. Since the pressure in the interior of the box was the same in all directions, the rocks imbedded in the lead were subjected to this pressure. On opening the box and cutting out the stones it was found that the pressure was below that necessary to keep the parts of the rock in continuity and the experiment failed in its principal object. I hope at some future date to try the same experiment with a steel box sufficiently strong to get a pressure of 20 to 25 tons per square inch. It will be noticed (fig. 2, pl. iv.) that the pencil of slate is most distorted not in the zone of the greatest bulging of the lead, but considerably above this. The explanation of this is to be found in the way in which the box was filled. The lead was first poured in till the box was half full, and the specimens were placed in position, then another layer was added, and some pebbles placed in, and finally the whole was filled up. The first two pourings developed a small amount of dross on their surface as they cooled, and under pressure the layer of lead between these two surfaces remained separated from the rest, the consequence was that while the rest of

* "Geologie Experimentale," pp. 420–2.

the lead moved as a liquid, that between the two surfaces was forced to flow outwards only, and hence carried with it the portion of pencil embedded in it.

The pebbles of limestone seem to have been pressed to just about their crushing strength, for some are slightly cracked while others are intact. The pressure is 6·72 tons, or say 15,000 lbs. per square inch, a value which agrees with the average given for American limestones by Buckley.* The extraordinary thing about these pebbles is that the cracks are not at right angles to the direction of pressure, but to the sides of the containing box. This I think indicates that there must have been a balancing between the direction of crushing and the sides of the vessel holding the lead; at one time the sides would give way and the ram advanced; at others, the sides were sufficiently strong to prevent the ram moving. If now the operation had been stopped when the latter conditions were prevailing, the pressure on the contained pebbles would have been normal to the sides of the vessels, and the cleavage consequently parallel to them. The release of pressure also probably allowed a slight vertical movement in the lead, due to the elasticity of the sides, and in fact the needle of the gauge went up to 80 tons and then came back to 75 tons.

The experiment, however, proves that a pressure of 15,000 lbs. per square inch is insufficient to keep the parts of a bit of limestone in contact when there is differential movement in the mass. Whereas we have seen that when sufficient time is allowed the ordinary atmospheric pressure is sufficient to effect quite large deformations.

I will now take the case of the pebbles distorted by Nature where the element of time has had ample opportunity of coming into play. The first is one from the Enon Conglomerate. I gathered the specimen (fig. 1, pl. v.) from a large quantity of similar ores occurring in a high bank of red Enon Conglomerate, near Nuy Siding, on the Worcester-Swellendam line. Most of the pebbles were too large to carry away. The rock of which they are composed is a hard, sandy mudstone, derived from the Ecca Beds of the neighbourhood. It will be noticed that this has been crushed and deformed as if it had been simply a mass of plastic clay. There is no question of the pebbles having been soft at the time of squeezing; we have the rock from which they are derived within a short distance of the Enon Conglomerate, and in both the physical state of the sandstone is the same. There is no question also of water having played a part in the moulding of the rock, for the cracks quite open, and there are no infiltration products like in that figured by W. S. Gresley, from

* "Building and Ornamental Stones," Madison, 1898.

the Bunter of Cannock Chase.* Neither has heat had anything to do with softening the rock, and the greatest pressure that could have acted upon it is quite insufficient to have been the sole cause of the crushing. We do not know how thick the Worcester Enon deposits were; they apparently are, and always have been very much thinner than the rocks of the same age further east: to give the deposits a thickness of a quarter of a mile, or 1,300 feet, would be an outside maximum. Mellard Reade gives 15 cubic feet to the ton as the weight of Bunter Conglomerate,† which is a rock similar to the Enon; a quarter of a mile of this, then, would produce a pressure of ·61 tons or 1368·8 lbs. per square inch, while the crushing strength of a compact rock like the sandstone would be at least equal to that of the limestone, or more than ten times as much. In other words, to crush the sandstone one would have to have the conglomerate between two and three miles thick, which we can assuredly say was not the case.

The three cases of deformation having been found non-existent or insufficient, how came the stone to be crushed? To my mind the marble slab that bends under its own weight affords an adequate explanation. The stone is mostly made of quartz, and an argillaceous material consisting of minute scaly minerals, like kaolin and chlorite, with perhaps a small amount of reformed felspar. A certain number of these crystals will be in a position to give way when any pressure comes on the stone, especially the small flat crystals of kaolin; when these have slid as much as they are able, the internal arrangement of the rock will be slightly different, and a new set of grains will be in a position to give way when the next shock comes along, and this process, repeated indefinitely in the course of ages, would produce an accumulation of effects such as we see in the Enon pebble. Apart from the cup of indentation, which may, or may not, have been formed by solution, and which certainly has been produced in certain cases by solution in limestone (Heim) and quartzite (Gresley and M. Reade), the cracks that radiate from the indentation have been described before and have been figured in the case of the last two rocks. In the quartzite, the cracks are clearer cut, while in the limestone they are more irregular, and in my specimen of sandy mudstone, they have granular broken edges. In both limestone and quartzite the cracks are probably produced in the same manner as I have described for the mudstone, namely, by the constituent grains gradually giving way to stress.

Finally, in the cleaved Dwyka pebbles we have deformation under

* *Geological Magazine*, 1895, p. 239.

† *Geological Magazine*, 1895, p. 343.

even less pressure than that on the Enon Conglomerate, the agents, heat and solution, being equally absent. The split Dwyka pebbles occur in every locality where that conglomerate exists in the south, and where the rock was deposited under water, and the same phenomenon occurs in the north, where the rock is a boulder-clay formed on land. The conditions under which the pebbles have been cleaved is best studied, however, in the north of the Colony, where the shearing and cleavage of the matrix in which they are imbedded does not come in and confuse the results. The cleaved boulders in the Dwyka Conglomerate of Prieska occur in a moderate hard boulder-clay. The rocks that exhibit the cleavage are of all varieties, slate, quartzite, jasper, granite and amygdaloidal melaphyre. The cleavages are nearly always horizontal and are sometimes exceedingly numerous, cutting the rock into numberless thin laminæ, at other times only a few joints pass through the pebble. The cleavages cut through all minerals hard or soft equally, in a sharp cut, and are quite independent of the bedding of the sedimentary rocks (see fig. 2, pl. v.).

In some cases cleavage only is present, in others the laminæ are shifted in position. The cleavages do not pass into the matrix, which has all the appearance of being quite undisturbed. From what we have seen occurred with regard to the pencil of slate in the lead, it seems probable that this appearance of homogeneity in the Dwyka matrix is misleading. In reality there are probably faint divisions of the material corresponding to the cooled surfaces in the lead, and each one of these layers acted by itself and endeavoured to carry its included piece of boulder along whatever way the particular layer was spreading. If the flow was small, the rock was simply split; but if it was at all great, the friction between adjacent laminæ was overcome and they were shifted relatively to one another. If there had not been this parting, and the clay had really been homogeneous, it would have flowed round the boulders without disturbing the including fragment, in the same manner that the lead flowed round the pencil in the zone of greatest bulging.

We have seen, however, that in the case of the lead, that a pressure of 6·72 tons to the square inch was insufficient to cleave the pencil, it simply fractured it. The pressure on the Dwyka boulders was nothing like 6·72 tons. The ice on top could not have been 1,600 feet thick, for a greater weight could not be carried by the foot without melting; and 500 feet would be a liberal allowance for the thickness of glacial conglomerate at Prieska. All this would only produce a pressure of half a ton per square inch at the foot, quite insufficient to break the pebbles in the manner described. Here again I think the principle of the bending slab of marble comes to our help. Instead of a confused crack like that produced in the Enon pebbles, due to an irregularly distributed pressure, we have sharp lines, which can be explained by the grains in the line of fracture being gradually deformed in the direction of definite zones of flow in the clay matrix. By the accumulation of these effects the coherence of the particles was at length broken, and separation of the laminæ produced.

How great a part in general deformation on the globe this insidious slow-acting agent plays, is impossible to estimate at present, but I think from what we have seen above it must always be at work, and, side by side with denudation, tends to reduce all inequalities on the earth's surface to one dead level. If its action is not always to be detected in the rocks, it is one of the chief agents by which the destruction of erections made by human hands is accomplished.

EXPLANATION OF PLATES.

Plate IV., Fig. 1.

Case made of $\frac{1}{4}$-inch iron pipe, $3\frac{1}{2}$ inches in outer diameter. At each end there are iron rings which screw on, and into which the two end plates also screw. The end plates are made to screw down tight on the lead with which the case is to be filled, and two screw plugs in the centres of the plates can be forced in to take up any spare space. Molten lead was first poured in to heat the case, and tipped out directly it had set. The lead was then poured in to about half the height of the interior; a rod of hard shale and several limestone marbles were then placed in position, and more lead poured in. Then more marbles were put in and the case filled up. The lead was finally filed flat, and the case closed by screwing on the top.

	Dimensions before Crushing.	After Crushing.
Height........................	$3\frac{13}{16}$ inches	$3\frac{5}{16}$ inches
Outside diameter of pipe in centre	$3\frac{9}{16}$ inches	$4\frac{3}{16}$ inches

Plate IV., Fig. 2.

The lead taken out of the case after the crushing and sawn in two, showing the rod of shale and two marbles, the latter with no alteration of shape, but in reality with vertical cracks not shown in the photograph. The markings on the shale are original, and are probably due to rain-drips. It will be noticed that the rod is cracked and forced outwards a little above the centre, or zone of maximum flowage; the cracked portion lies between two surfaces formed on the lead as the successive pourings cooled. The foot of the rod is crushed to powder.

Plate V., Fig. 1.

Indented and crushed pebble of Ecca sandstone from the Enon conglomerate, Nuy siding, New Cape Central Railway.

Plate V., Fig. 2.

Boulder of amygdaloidal melaphyre in the Glacial (Dwyka) Conglomerate, near Prieska village, showing the splitting-up of the boulder into layers and shifting of one of them. Photograph taken by Mr. A. W. Rogers from the boulder *in situ.*

Plate VI.

Long branching blowholes in melaphyre from the lavas of the Drakensberg in the Division of Matatiele. The one on the right shows the actual bottom of the lava-flow with the first cooled surface, then the zone of small vesicles, then another solid zone, and finally the pipe amygdules. The white splotches on the left-hand specimen are aggregates of felspar laths.

Fig. 1

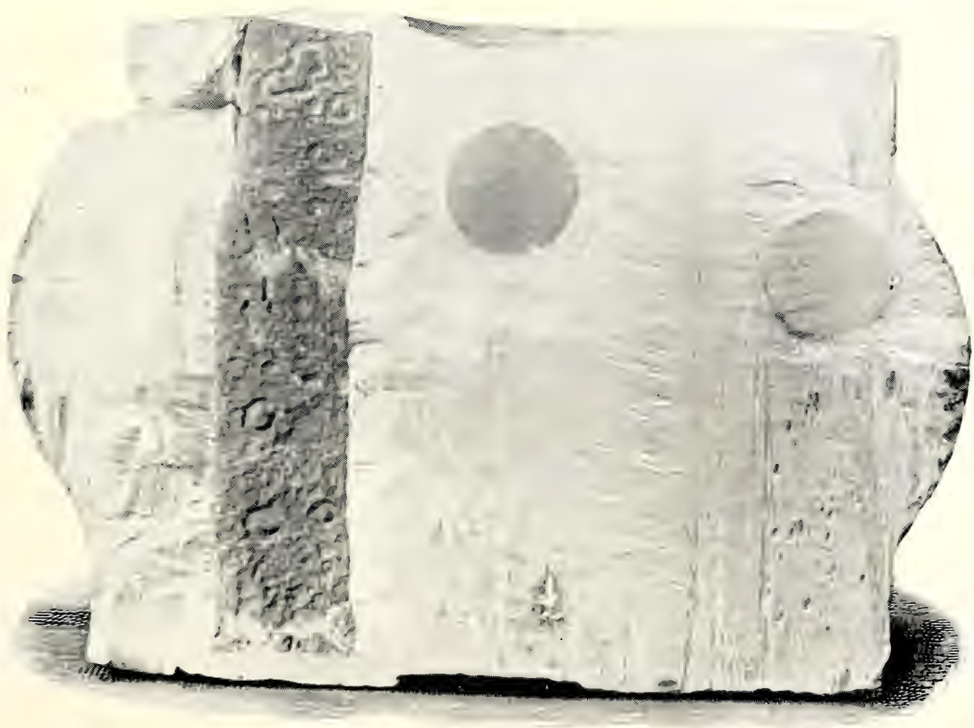


Fig. 2.

West, Newman phototyp.

Fig. 1.

Fig. 2.

West, Newman phototyp.

Plate VI.

West, Newman phototyp.

RESULTS OF EXPERIMENTS ON TABLE MOUNTAIN FOR ASCERTAINING THE AMOUNT OF MOISTURE DEPOSITED FROM THE SOUTH-EAST CLOUDS.

By R. Marloth, Ph.D., M.A.

(Plate VII.)

The climate of the south-western corner of South Africa is characterised by a rainy winter and a dry summer. While the total annual rainfall at the Royal Observatory is 27·95 inches,* three-fourths of this quantity, viz., 22·04 inches, fall during the six winter months, and 2·15 only, or 8 per cent., during the three summer months (December to February). Small as this latter quantity may be, it is often not reached, and it will even happen that two months pass without a drop of rain, or four months with less than a total of 1 inch.

Under these circumstances it is quite justifiable to call our summer practically rainless, although sometimes a single summer month may show as much as 3 inches of rain.

As I was induced to study this question principally on account of the influence which the rainfall and its distribution over the seasons have on the vegetation of our mountains, I may point out at once that the occurrence of an occasional wet summer in a country where this season is generally rainless would not affect the typical xerophilous nature of the vegetation, while, on the other hand, an exceptionally dry summer in a district which generally receives its rains during that season would weed out all plants which are without means of protection against such a calamity. These means of protection may be of various kinds, but they must enable the plants to tide over the period of drought and to preserve their life until better times, even if all delicate parts have to be sacrificed.

Bearing these facts in mind, it is easy to recognise from a glance

* The average for the ten years 1885 to 1894, taken from Mr. A. Buchan's report.

at its vegetation, that the south-western corner of the Cape has a dry and practically rainless summer, for the hills and lower slopes of the mountains from Cape Town to Clanwilliam, and from Caledon to Worcester and Ceres, are covered with dull-coloured, highly xerophilous shrubs and shrublets. Quite a different aspect, however, is presented by the higher mountains. Wherever one ascends them one finds that even in summer the vegetation of the higher parts is much denser than that of the slopes below. While on Signal Hill or the Paarlberg, at Caledon or at Tulbagh, a good deal of bare ground is visible between the shrubs, the higher mountains are covered with a thick layer of closely set vegetation. Every crack and crevice, every little depression, every ledge is occupied, and even precipitous walls are often clad with a luxuriant mass of shrublets, reeds and rushes.

Having visited many of the mountains of this area, and having spent many a day on their lofty heights, I felt more and more convinced that the vegetation of these higher regions could not exist without a regular supply of moisture, and that it consequently could not depend on the rainfall only for its water supply, but that the clouds, which cover these mountains during the south-east winds, must provide them with an additional and not inconsiderable quantity.

That there is no lack of such moisture in a south-east cloud is easily realised by any one who has ever spent a couple of hours in it. Grass and bushes may have been perfectly dry while the weather was fine, yet a few minutes after the formation of the table-cloth every leaf and every reed is covered with drops of water, and if the wanderer has to force his way through these reeds and rushes,* he will soon be as wet as if he had been out in a drizzling rain for a couple of hours.

For years it had been my wish to obtain some definite figures concerning the amount of water condensed from clouds in this way, but it appears that no such experiments have been conducted either here or anywhere else; at least, I could not find any records in handbooks on meteorology. It became, therefore, necessary for me to endeavour to obtain this information myself.

In November, 1901, I took two 5-inch rain gauges to the top of Table Mountain, and placed them about midway between the east

* The designation reeds and rushes is not correct in a botanical sense. The plants resemble them only in their appearance, but they belong to another order, viz., *Restionaceæ*.

and west ends of the upper plateau. One I left open in the usual way, the other one I surmounted with a framework representing a bunch of reeds. The arrangement consisted of two rings of 5 inches diameter, which were connected by four rods of stout wire, the whole frame being 1 foot high. Pieces of wire netting were fixed inside the rings, and reeds were drawn through the meshes and fastened with thin wire. The frame was then inserted into the other rain gauge, fitting into its opening by means of a narrow socket. Four wires attached at opposite sides and fastened to stones near by protected the frame against the fury of the wind. I had consequently one ordinary gauge and one with an imitation bunch of reeds 1 foot high.

The first reading of my gauges was made eleven days afterwards, on the day when I had the pleasure of revealing the charms of our mountain to a distinguished party of explorers, viz., to Professor von Drygalski and several members of the German Antarctic Expedition. The gauge with the reeds had overflown, while the other one was also nearly full, there having been a heavy rain a few days before. Although the difference was not large, it was evident that the reeds had caught some water. With the aid of some members of the Mountain Club the readings were made at intervals of seven or ten or fourteen days. We found, however, very soon that the bottles which I used were too small; at least that one with the reeds was full every time we came there. I substituted a bottle of double the size, but also that one was generally quite full, compelling me to take up another one which was capable of holding still more. By that time, however, the summer of 1902 was nearly over, and although we continued the readings for some time during the winter, I do not intend to include this part of my observations in this paper, because I found that the reeds caught an enormous amount of rain, which is so largely in excess of that shown by the open gauge, that it may well form the subject of another investigation.

At the beginning of last summer I set to work again, but, owing to some delays, the gauges were put in order only on December 21, 1902. The first reading of the season was made on January 1, 1903, when it was found that the open gauge contained nothing, while the other one showed 15·22 inches of moisture, and that for a period of ten days. The next reading took place on the 11th of January. The open gauge was again dry, the other one showing 14·64 inches. In twenty-one days the reeds had condensed moisture corresponding to 29·86 inches of rain, while the open gauge showed nothing.

The following table gives the results of the readings from December 21, 1902, to February 15, 1903:—

Period.	Open Gauge.	Gauge with Reeds.	Difference.	Gauge at Maclear's Beacon.
1902–3.				From Dec. 17, 1902, to Feb. 16, 1903.
Dec. 21 to Jan. 1	...	15·22	15·22	
1903.				
Jan. 1–11	...	14·64	14·64	
Jan. 11–18	1·04	16·66 (full)	15·62	
Jan. 18 to Feb. 1	3·51	16·66 ,,	13·15	
Feb. 1–15	0·42	16·66 ,,	16·24	
Total	4·97	79·84	74·87	6·99

For the sake of comparison I have added the total rainfall observed at Maclear's Beacon, and kindly communicated to me by Mr. Thomas Stewart.

The observations came to an untimely end on the 15th of February, because a week afterwards the gauges were found to be destroyed. Although this incident prevented me from continuing the observations to the end of the summer, it does not affect the main question or the main result.

This result is, that from December 21, 1902, to February 15, 1903, that is, in fifty-six days, the gauge with the reeds had condensed a quantity of moisture equivalent to 74·87 inches of rain, and that quantity was recorded although the last three times the gauge had overflown. It is not too much to assume that, as the season of the south-east clouds extends over double that time, there would consequently be a condensation of moisture, exclusive of all rain, of at least 150 inches during the summer alone.

If one considers that the average annual rainfall at Cape Town (Town House) is 23·84 inches, at the Royal Observatory 27·95, and at Newlands (Bishop's Court) 55·54, which is almost the highest record for any low-level station in the Cape Colony, the extraordinary nature of these results is obvious, and it is not surprising that the vegetation of our mountains is so different from that of the hills.

I do not wish to be understood to say that this amount of moisture condensed by the reeds is in other respects equivalent to a similar quantity of rain. It is well known that the first rainfall at the end of the summer hardly affects the springs, the reason being that practically all that water is absorbed by the soil and the vegetation. The roots and underground stems of the plants penetrate the earth in all directions, and form a spongy, matted mass, varying in thickness from a few inches to several feet. This sponge absorbs a large amount of moisture, and only when it is fully saturated will it allow any excess to drain away into the fissures of the rocks below. Simultaneously the plants refill their tissues every time the roots become moist, hence it is obvious that a large quantity of the moisture thus condensed is retained by the plants and the soil. There may be an inch of condensation or more and yet nothing might be able to flow away, for where the condensation is at its highest the vegetation will be the thickest and tallest. As soon as the condensation ceases evaporation begins. It is well known that even the south-east wind blows sometimes without forming a cloud on the mountain. During clear weather the store of water in the huge sponge on the mountain becomes rapidly exhausted until another good south-easter comes to fill it again. When, however, the south-east clouds cover the mountain for several days in succession, a considerable quantity of water must find its way into the rocks, and finally into the springs, hence I am of the opinion that the varying yield of the springs in summer, especially during the latter part of it, is largely influenced by the longer or shorter duration and the frequency or rarity of the south-east clouds.

It was interesting to me to find the other day that a similar effect had been surmised by others. In Dr. Brown's book on the "Water Supply of South Africa" occurs the following passage: "These springs (springs above Cape Town) were produced, in all probability, in a great measure by the percolation through the masses of Table Mountain of moisture deposited on the summit by the cloud produced on the mountain by the south-easters in the summer season," and a few pages further on the author quotes a statement by Mr. P. Fletcher: "I believe, from what I have observed, that there is much more moisture deposited in the mountain in summer than is generally supposed."

In support of this view I may also mention the experience of Mr. William Hunt at Stellenbosch, who, as the owner of the mills, has a permanent right to a certain share of the stream coming from the Jonkershoek valley. Naturally he has watched the quantity of water in the stream, especially during the dry season, and he states it as his experience that invariably after a severe south-easter the quantity of water in the stream increases considerably.

This side of the question, however—that means to say, the influence which the south-east clouds have on the yield of springs and streams—requires further investigation. It will hardly be possible to investigate all the mountain ranges on which they occur, for they often cover all the higher parts from Table Mountain to the Zwartebergen and the northern end of the Cedarbergen, but a beginning might be made with Table Mountain.

If the days on which the mountain is covered with clouds were recorded, if daily gaugings of some of the streams on and around the mountain were taken, and if then after a number of years these records were compared with each other and the rainfall, it would be quite possible to demonstrate the amount of this influence.

My object in undertaking these experiments was a different one. I stated at the beginning of my paper that I wanted to ascertain more exactly the climatic conditions under which the plants on the mountains existed. That side of the question has been answered. Their summer is not dry. Their climate is that of a swamp—a permanent swamp in winter, a periodical swamp in summer, which dries up during a long spell of fine weather, but becomes soaking wet during the days of the south-east cloud. These results explain why such luxuriant and thickly set vegetation prevails on the upper parts of these mountains, why shrubs 6 to 8 feet high crown the summit of Devil's Peak, why thickets of beautiful heaths 4 to 5 feet high grow on the top of the Jonkershoek peaks, why there is a little forest of yellow wood, Kiggelaria, Olinia, and other trees on the top of Klapmuts Hill, why the cedar grows only at a certain level of the Cedarbergen, why Proteas and heaths abound on the Zwartebergen, and why there are little lakes, even late in summer, on the top of Table Mountain as well as close to the summit of Dutoit's Peak.

It was my object to understand these facts and to be able to explain them to others. This I think I have done. The purely meteorological side of the question I leave to others for further investigation.

R. Marloth photo. West, Newman proc.

MARLOTH: Gauges of the Table Mountain for ascertaining the amount of Moisture deposited from the South East Clouds.

DESCRIPTION OF A REMARKABLE TERMITOPHILOUS ISOPOD.

By W. F. Purcell, Ph.D.,

First Assistant in the South African Museum.

The three specimens of the curious Crustacean described in this paper were discovered by Dr. Hans Brauns in the galleries of a Termite, which he identified as *Hodotermes viator*.

Dr. Brauns pointed out to me the resemblance between this Crustacean and a South African Staphylinid beetle, *Trilobitideus mirabilis* Raffr. (Revue d'Entomologie, *v.* 18, pp. 1–3, pl. 1, figs. 1–7, 1899), which was discovered by Mr. Raffray and Dr. Brauns in the nests of the ant *Dorylus helvolus* L. This resemblance is truly remarkable, especially as regards the form and sculpturing of the head and the 2 anterior thoracic segments.

Gen. PHYLLONISCUS n. g.

Body very broad, lightly convex in the middle portion but strongly expanded and deplanate laterally. Head semicircular, foliaceous, strongly expanded horizontally towards the front and sides, its width being three-fourths that of the first thoracic segment, its anterior margin entire and evenly convex between the sharp lateral angles. Eyes absent. Inner branches of first maxillæ with 2 very unequal pencilli near apex on inner side, the distal one being very much shorter than the proximal one. Antennæ, when at rest and folded, completely covered and hidden by the broad head (as in fig. 2), the flagellum very short, 4-jointed. Legs short and, excepting the anal pair, completely covered by the tergites. Anal legs with the basal segment broad, flattened, parallel-sided, transversely truncated at the apex, the outer half of which is sinuated for the reception of the exopodite; exopodite produced for half its length beyond the apex of the penultimate abdominal segment, terete, stylet-shaped, the endopodite lamelliform, quadrate, narrowed at the base but expanding slightly towards the truncated apex, which bears a minute bristle-like stylet at the inner angle. Telson short, reaching to apex of basal segment of anal legs, the posterior margin convex at the sides, but produced backwards in the middle portion, the apex emarginate.

Phylloniscus braunsi n. sp.

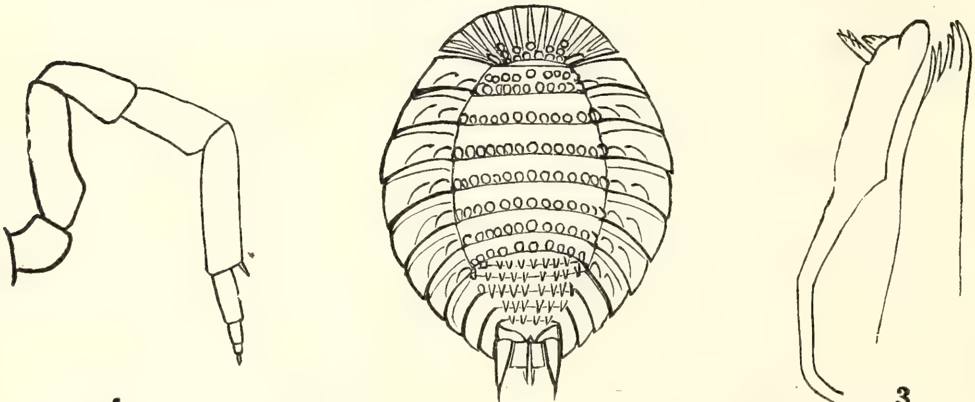
Types.—3 ex. (No. 9863) from the subterranean galleries of *Hadotermes viator* at Willowmore, Cape Colony (*Dr. H. Brauns*).

Colour white, the lateral parts and the head semi-transparent.

Form very broadly ovate, widest at the fourth thoracic segment.

Head with the posterior margin slightly sinuous in the middle part and almost straight or slightly sinuous in the slightly oblique lateral parts; basal part of upper surface with 3 transverse arcuate rows of low tubercles, the expanded part of head with 13–15 rounded radiating ribs (counting 1 along the posterior margin on each side).

Thorax.—Convex mesial portions of segments I–III straight behind, of IV almost straight, of V–VI slightly and broadly sinuated behind, provided in segment I with 2 transverse rows of low rounded



1. 2. 3.

Phylloniscus braunsi n. sp. Fig. 1, left antenna from below (× 90 times). Fig. 2, dorsal view of the Isopod (× 6 times). Fig. 3, outer and inner branch of one of the maxillæ of the first pair (outer branch on right of figure) (× 90 times).

tubercles (9 in the anterior and 10 in the posterior row, the median tubercle being absent or rudimentary in the latter), and in II–VII with a single posterior row of 11–15 tubercles, those in the posterior segments conical and directed backwards; the epimera of all these segments subsimilar, the anterior margins being slightly convex and the posterior margins sinuated, the upper surface provided with a large basal tubercle, a small one and an oblique ridge near posterior margin.

Abdominal segments each with a transverse row of conical tubercles above, the median tubercle from the second segment on being absent; segments I and II very short, III and IV with the epimera continuous with and similar to those of the thorax, except that the tubercles are absent.

Antennæ with the second segment lobate at base externally, subequal to the fifth in length, the third or fourth segments subequal but together longer than the fifth; flagellum about as long as the fourth segment of the scape and much shorter than the fifth, its basal segment forming half, its second segment a quarter, of the whole length, the segments becoming successively narrower, the apical segment very minute.

Length in millimetres (to apex of telson) 5·8; width of fourth segment 5; of head $3\frac{1}{4}$.

Since the above went to press I found four other specimens of *P. braunsi* at Matjesfontein, Cape Colony, under a stone in the galleries of a dark-coloured *Hodotermes* (evidently *H. mossambicus*).

A NOTE ON THE QUANTITIES GIVEN IN DR. MARLOTH'S PAPER "ON THE MOISTURE DEPOSITED FROM THE SOUTH-EAST CLOUDS."

By Charles M. Stewart, B.Sc.

(Read July, 1903.)

The interesting experiments carried on by Dr. Marloth between December 21, 1902, and February 15, 1903, constituted an attempt to measure the amount of moisture deposited during the prevalence of the so-called summer "South-Easters," winds which are usually accompanied by a cloudy mass on the top of Table Mountain, forming the well-known "Table-cloth"; in other words, an endeavour was made by the author of the above-mentioned paper to ascertain the quantity of moisture deposited on a vertical surface by what may be assumed to be a saturated, horizontally-moving current, as against the amount deposited on a horizontal surface, represented by an ordinary rain-gauge.

The quantities given in the account published in the *Cape Times* of 27th of May last are so enormous as to have excited considerable astonishment and wonder; it therefore seems advisable to inquire into the method adopted so as to ascertain to what extent the figures are reliable, and thus enable it to be decided whether or not the problem has been satisfactorily solved.

Dr. Marloth's description of the apparatus employed by him is given in the following paragraph :—

"In November, 1902, I took two five-inch rain-gauges to the top of Table Mountain, and placed them about midway between the east and west ends of the upper plateau. One I left open in the usual way, the other I surmounted with a framework representing a bundle of reeds. The arrangement consisted of two rings of 5 inches diameter, which were connected by four rods of stout wire, the whole framework being 1 foot high. Pieces of wire netting were fixed inside the rings, and reeds were drawn through the meshes and fastened with thin wire. The frame was then inserted into the other rain-gauge, fitting into its opening by means of a narrow socket. Four wires attached at opposite sides, and fastened to stones near by, protected the frame against the fury of the wind. I had consequently one ordinary gauge and one with an imitation bundle of reeds 1 foot high."

Further on we are informed that the observations came to an untimely end on the 15th of February, the gauges being destroyed the week after.

In order to understand what follows it is necessary to make the following remarks on rainfall-measurement in general.

The object of rainfall-measurement is to ascertain as accurately as possible the depth in inches of the water which would accumulate on a level surface if the rain were to remain where it fell.

To enable this to be done, the rain is collected in a specially-constructed vessel, called a rain-gauge, of known area, and the amount is measured off by means of a graduated measure which shows true inches and fractions of an inch, corresponding to the receiving-area of the gauge. One of the chief points to be attended to by rainfall observers is that the area is not altered in any way, otherwise the graduated measure will indicate erroneous quantities, and the results will be worthless. Rain gauges are generally circular in shape, and as a circle encloses the greatest area of all closed curves of the same perimeter, the smallest indentation or squeezing in of the rim of the funnel must make the rainfall indicated too little in amount. Conversely, if by any means whatever the receiving-area is artificially increased, the measure will indicate quantities which are too large.

Now in the case of the rain-gauge with the framework containing the reeds, used by Dr. Marloth, we have not only the actual horizontal area of the five-inch rain-gauge collecting the moisture, but the whole of that part of the superstructure above the lower ring is capable of catching moisture, and being so constructed as to drain into the gauge, thus adds its quota to that which would be caught under ordinary circumstances by the plain open rain-gauge. It will therefore be seen that the catchment area has been increased in the case of Dr. Marloth's second rain-gauge by an amount depending on the area of that part of the superstructure already indicated.

Through the courtesy of Dr. Marloth I have been able to closely examine the apparatus used, which was but roughly constructed, and defies accurate measurement. However, the following figures, which were obtained by using a pair of compasses as callipers, and measuring off on a diagonal scale, will give a rough approximation to the true area :—

Upper ring, inside surface	=	15·371	sq. in.
Upper ring, outer surface	=	18·394	,,
Wire netting (51·84 in. × 0·05 in.)	=	8·143	,,
Four wire rods (each 9·2 in. × 0·16 in.)	=	18·498	,,
Eighteen reeds (each 10·5 in. × 0·09 in.)	=	53·438	,,
Rain-gauge (decreased in diameter to 4·82 in.)	=	18·247	,,
Approximate catchment area	=	132·091	,,

This result is well under the actual area, as certain surfaces, such as the bent-over ends of the reeds, part of the lower wire netting which has been so pulled up as to project above the gauge and thus act as an addition to the receiving surface, as well as other small items, have been omitted.

In fact this superstructure practically acts as a sponge or filter, having an area approximately equal to 114 square inches, which with the receiving surface of the gauge itself brings it up to about 132 square inches.

Now as the water (79·84 inches) collected by this gauge represents the depth as measured off by means of a measure graduated to show inches of rainfall collected by a rain-gauge 5 inches in diameter (*i.e.*, having an area of 19·635 square inches), it follows that—

$$79{\cdot}84 \text{ in.} \times 19{\cdot}635 \text{ sq. in.} = 1567{\cdot}6584 \text{ cubic in.} =$$

the total amount collected.

Therefore this quantity divided by the approximate area found as above would give a result closely approaching the true depth of rainfall—

$$\therefore 1567{\cdot}6584 \text{ cubic in.} \div 132{\cdot}091 \text{ sq. in.} = 11{\cdot}87 \text{ in.}$$

If we assume that the 4·97 inches collected by the plain rain-gauge was equal to the rainfall collected by this second gauge. subtracting we get

$$11{\cdot}87 \text{ in.} - 4{\cdot}97 \text{ in.} = 6{\cdot}90 \text{ in.}$$

as the amount deposited from the "South-East Cloud." This amount divided by 57, the number of days during which the experiments were carried on (December 21, 1902 to February 15, 1903), gives an average deposit of 0·12 inch *per diem*, on the assumption that the cloud-covering on the mountain was continuous throughout this period.

Even on the very improbable supposition that the rain collected by the open gauge fell absolutely vertically, so that the horizontal area of the rain-gauge alone formed the catchment area, while the remainder of the water caught was deposited only on the vertical reeds, &c., by a horizontal current, it will be found that the deposit from the "Table-cloth" is simply almost doubled, amounting to 12·97 inches during the period, and representing a daily average of 0·23 inch.

In fact, in whatever way we may care to regard the deposition of moisture to have taken place, it will be found that Dr. Marloth's figures are enormously in excess of the true amount.

All experiments in this connection ought to admit of but one interpretation if any reliance has to be placed on the results obtained, and a comparison made between the amounts collected by the two gauges. The following considerations will show how faulty the experiments discussed are in this respect:—

The reeds have been assumed to be right circular cylinders of 0·09 inch diameter, but it may be regarded as an open question if the moisture soaking in through the cut ends would not cause the reeds to swell in spite of their siliceous skeleton, and thus still further increase the area exposed to the horizontally-moving current.

Attention ought also to be drawn to the possible effect of the reeds in decreasing the velocity of the wind by breaking it up into small whirls, and so producing practically a calm over the gauge, thus admitting of a vertical deposit of moisture. The action is similar to that of a Nipher's shield for rain-gauges at any considerable elevation above the ground, which breaks up the eddies tending to carry the rainfall over the gauge, and so renders the amount caught at any elevation practically the same as that falling on the ground.

The amount deposited from the mist ought to vary with the density of the mist and the velocity of the wind.

One advantage that the vertical catchment area possesses over that of the horizontal gauge is that the water rapidly runs downwards into the receiver, and so is protected from possible evaporation during any break in the prevalence of the mist.

In estimating the effect of such deposits from mists on water supply, it ought to be borne in mind that in the apparatus described the reeds have been placed to the best advantage, being on an average 1 inch to 1½ inch apart, and so arranged that they do not overlap, as would be the case with a close natural growth of these plants; consequently the deposition of moisture under natural circumstances would most likely be confined almost entirely to the few outer layers of a patch of these reeds, thus materially diminishing the average amount of moisture deposited. In all probability the effect of a fog or mist on reservoirs is mainly beneficial as a check on evaporation.

Again, as both iron and vegetation are good radiators of heat, it follows that under a calm, clear sky a certain amount of dew would be deposited during the night, thus complicating matters still further, unless special observations were made and daily readings taken.

The nett result of the experiments seems to be that it has been proved that a deposit of water takes place on growing plants during the prevalence of the "South-Easters," probably sufficient for their nourishment during the dry season, although it is possible that the plants would thrive equally well in a humid atmosphere, from which, however, no actual deposition of moisture took place, as on the lower slopes of low hills during the prevalence of a sea breeze. As far as actual quantitative results are concerned, the problem is as far from being solved as before these experiments were undertaken.

OBSERVATIONS ON THE FLIGHT OF BIRDS AND THE MECHANICS OF FLIGHT.

By E. W. Young, M.I.C.E.

(Read February, 1903.)

It is only quite lately that the possibility of mechanical flight has been seriously entertained. Within my own memory even scientific men were quite at a loss in attempting to explain the flight of birds. No experiments had been made of the effect of wind upon inclined planes, while the deductions from theory were grossly erroneous. Some experiments made by myself with rough apparatus thirty years ago convinced me of the incorrectness of theory, and at my suggestion the Aeronautical Society of Great Britain, of which I was a member, constructed an apparatus in 1873-74 for ascertaining the effect of wind upon inclined planes, as an indispensable preliminary to the construction of machines for mechanical flight. Since those days many careful and elaborate experiments have been made by Maxim, Professor Langley, and others, and the solution of the problem of mechanical flight seems to be close at hand.

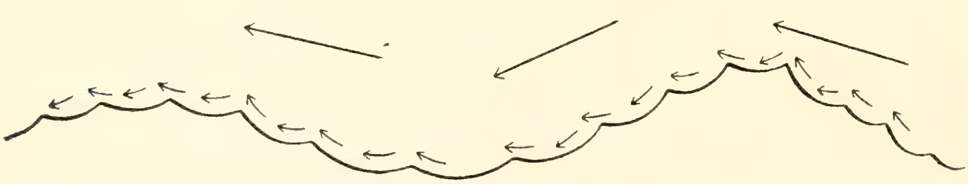
There is still some mystery connected with the flight of birds which calls for explanation; chiefly the extreme ease with which some birds fly, or rather soar. In endeavouring to account for this, let me begin by an elementary description of the action of a bird's wing during flight.

One of the best positions for studying the flight of birds is the deck of a steamer. If we watch a gull following the vessel with quietly beating wings, we notice that the body of the bird scarcely perceptibly drops during the upstroke of the wings, showing that the bird is supported, not only by the downward stroke, but during the upward stroke of the wings; that is to say, the wind strikes the underside of the wing even during the upward stroke. This is effected by the peculiar construction of the bird's wing, in which the muscles are springs tending to pull the after edge of the wing downward to meet the rush of the wind. During the downward stroke the wing bone is at the lower level, and propulsive effect is obtained by the bird thus—

During the upward stroke the wing bone is at the higher level, thus—

the bird being supported by the wind striking the inclined plane of the wing. This seems simple enough, but how are we to explain the flight of the albatross and other sea birds which seldom beat the air with their wings? When and where is the work done which keeps them in motion?

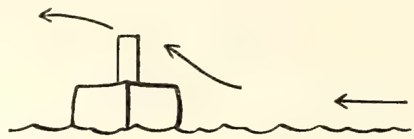
Long observation of the flight of the albatross and other sea birds has convinced me that they are sustained by upward currents of air due to the wind striking the inclined surfaces of the waves. The wind blowing over the sea, and the land, too, to some extent, is a current undulating in a vertical plane chiefly. The wing of the bird is so constructed that the air always impinges on the underside; so that, while supported by the upward current, the bird escapes the reverse action due to the downward current. Again, the upward current, when the wind is strong, is much more violent than the downward, while the velocity of the bird's motion and the elasticity of the wing muscles enable it to derive support from the air even in a current with a downward inclination.



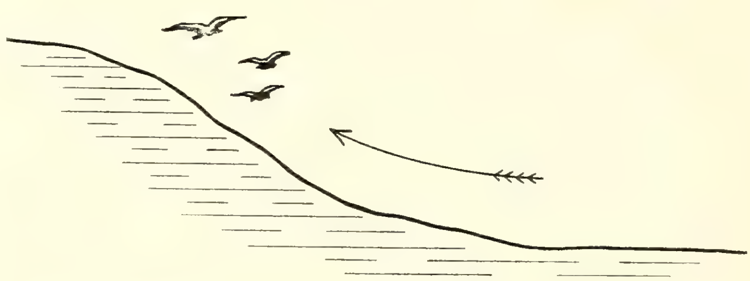
This diagram represents two large waves with a surface of wavelets. The arrows show the direction of the wind glancing upward from the backs of the waves, the larger representing the major currents and the smaller the minor, and the upward currents largely exceeding the downward in force. Two facts seem to me noticeable; one, that the stronger the wind the easier and more rapid the bird's flight; the other, that the bird continually glides downwards as close to the waves as possible, often seeming to stroke the *back* of the wave with the tip of the wing. I have seen large gulls of the albatross kind advance rapidly in the teeth of the wind, close to the surface of the water, without a single stroke of the wing for a hundred yards or more. The bird was, in fact, gliding down an inclined plane. From the momentum thus acquired the bird can lift itself to a considerable height above the waves, from which it descends by an easy slope close to the surface again. The bird merely steers itself in the breeze, which does all the work. So little effort being required from the bird, we can understand how it can keep on the wing for so long. This also seems to explain why it is that albatrosses and similar soaring gulls are so seldom seen to alight upon the water to feed. If severe work were done fuel, in the shape of food, would be constantly needed. Consider now the flight of the gannet. This bird is not a soaring bird ; it flaps its wings strongly and raises itself to a considerable height above the waves where it can obtain very little support from upward currents, and remains there until it plunges into the sea for its prey. It then, with great effort, raises itself to the necessary height, and generally, as I have noticed, within five minutes makes another plunge. It is, in fact, feeding, for it must require a good deal of food to enable it to make such violent exertion. As it cannot rest in the air like the albatross, it is frequently to be seen seated on the water.

About the flight of flying-fish there is controversy as to whether the animal beats the air or soars. To ordinary eyesight—at any rate to mine—there appears to be no vibratory motion. Some observers, however, are confident that the wings do vibrate, and argue that failure to observe it is due to the rapidity of the motion. But rapidity of motion results in invisibility, as is the case with the wings of insects and humming birds. It is again urged in favour of the vibratory theory that it is incredible that an animal could jump for one or two hundred yards. This jump, however, is easily explained by the theory of upward currents. Directly the fish springs from the water he commences to soar as an albatross does, and is carried forward by the upward currents, of which he obtains full benefit, being close to the surface of the water during most of his flight. If he touch the top of a wave he sculls with his tail and obtains fresh impetus ; and perhaps he might take very much longer flights than he does if he were more independent of salt water.

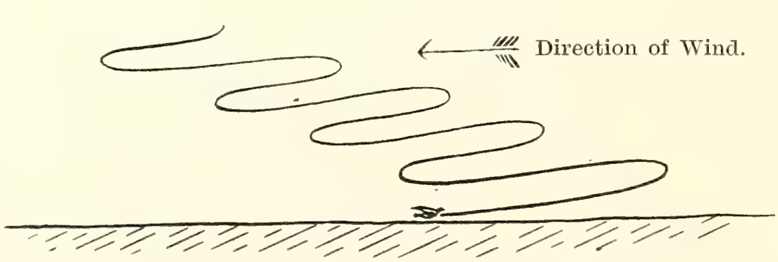
Ordinary gulls, which seldom soar, will do so when conditions are favourable, as when following a vessel they happen to find themselves in the upward current produced by the glancing of the wind from the vessel's side. I have seen gulls resting, without apparent effort, over the vessel going at high speed. The diagram shows how the wind is deflected upwards by the ship's side.



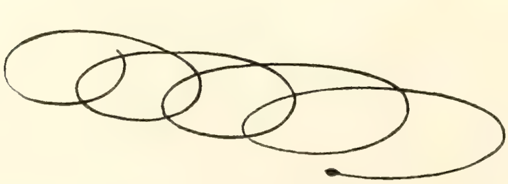
Land birds take advantage of upward currents also. I observed a hawk rise to a height of some three thousand feet, ascending in a spiral without a single flap of its wings. On another occasion I saw a hawk beating a paddock suddenly commence to ascend in spirals. While watching the marvellous performance the dust rose in a whirlwind from an adjacent road, rendering visible the tourbillon of which the bird was taking advantage to get upward. I have seen a



number of vultures poised, stationary as a boy's kite, over the slope of a hill, evidently utilising the upward slant of the wind produced by the hill. Vultures utilise their own inertia to mount.



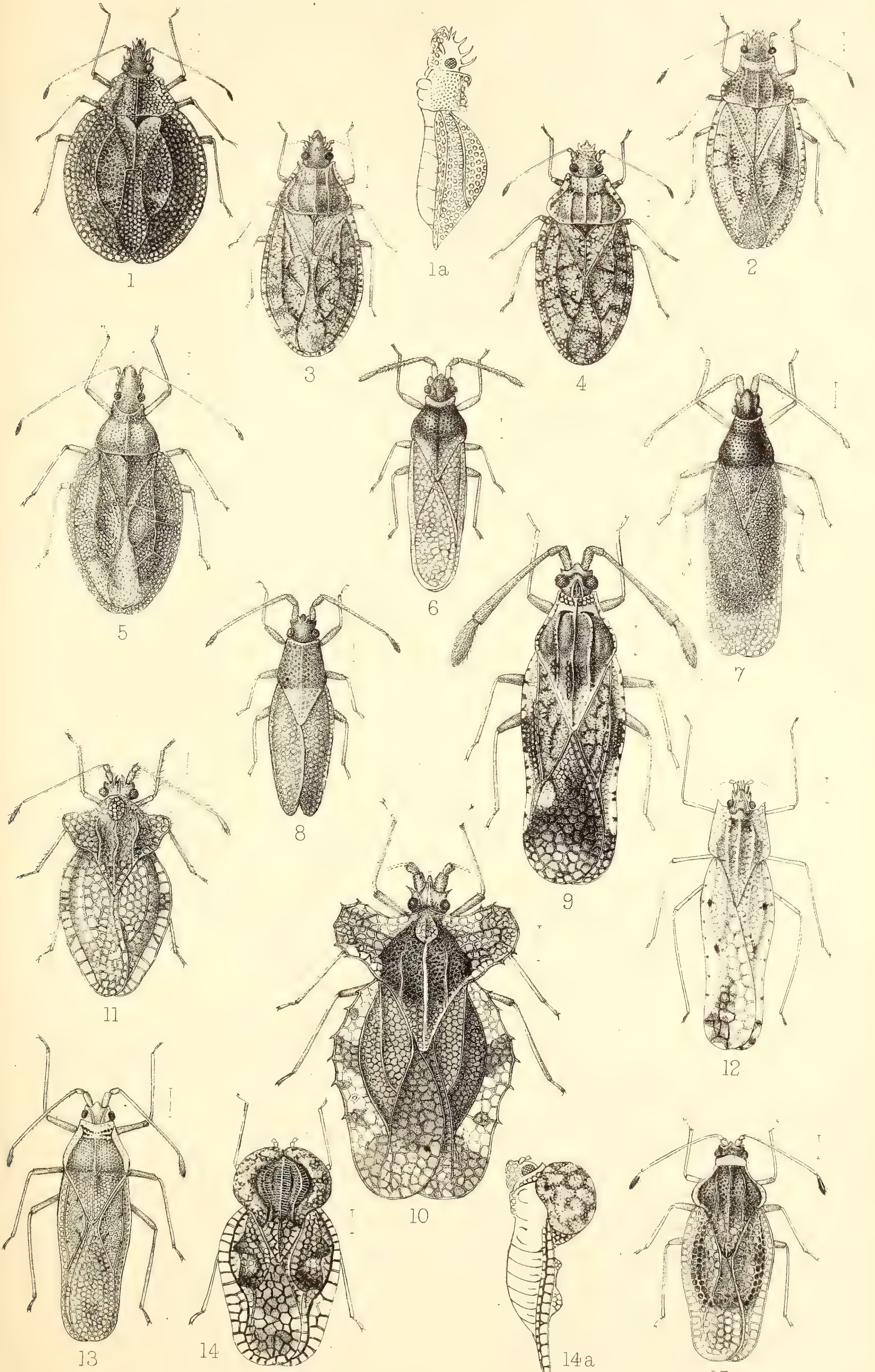
SIDE ELEVATION OF BIRD'S TRACK IN AIR.



PLAN OF BIRD'S TRACK.

I have observed these birds when disturbed run flapping violently up wind until lifted from the ground, and continuing to beat the air until they got an elevation of from twenty to thirty feet, when they began to wheel, beating their wings scarcely at all. The bird ascends by an inclined spiral. The work is done by the wind, which lifts the bird, partly by the slight upward currents, but chiefly by the inertia of the bird, which drifts with the wind, the horizontal distance drifted being the mechanical equivalent of the same distance advanced in still air. The diagram shows the bird's course in air in side elevation and plan.

The small expenditure of power required to carry the albatross for hours over the sea seems to prove that mechanical flight is practicable, at any rate over the surface of the sea. The important point is to imitate the elasticity of the bird's wing. This seems to have been overlooked hitherto. Many machines have been made with supporting planes, but, so far as I know, they were all too rigid. With thoroughly elastic planes the greater part of the work would be done by the wind, and the motive power would chiefly be necessary for steering purposes.



Horace Knight ad nat. lith.

West, Newman imp

SOUTH AFRICAN TINGIDIDÆ.

ON SOUTH AFRICAN *TINGIDIDÆ* AND OTHER HETEROPTEROUS RHYNCHOTA.

(Plate VIII.)

By W. L. Distant.

Since publishing my first paper on these insects * I have received considerable more material, and am thus able to increase our knowledge of the Ethiopian Tingids. The present communication refers exclusively to South African genera and species, and I hope soon to largely supplement this enumeration. Some generic division has been made, and greater generic division is doubtless still necessary for some of the earlier described species. The described non-Palæarctic species of Africa, excluding also those of Madagascar and the other African islands, I previously enumerated as 26 species distributed in 12 genera, the present paper brings up the list to 40 species contained in 21 genera.

TINGIDIDÆ.

Division CANTACADERARIA.

ULMUS, gen. nov.

Posteriorly broadly ovate; head about as long as pronotum, with two moderately long porrect spines at apex, and with six long erect discal spines arranged in pairs, eyes almost touching anterior margin of pronotum; antennæ slender, apical joint short and thickened; pronotum with the anterior and posterior margins truncate, the

* Ann. South Afr. Mus. ii. p. 237 (1902). I may here revert to the title of that paper "African *Tingididæ*" as of course referring only to the Ethiopian region, in a similar interpretation to Stål's "Hemiptera Africana," Shelley's "Birds of Africa," &c.

lateral areas moderately ampliated, finely and thickly areolate, the margins sinuate, the posterior lateral angles rounded and obtusely prominent, the disk depressed with a central carination not reaching anterior margin ; scutellum small, distinctly exposed; elytra discally gibbous, discoidal areas little more than half the length of elytra, elongately ovate, a transverse line between them a little before their middle defining the basal area which is strongly longitudinally centrally carinate, sutural area narrowly ovate with a faint central longitudinal carinate line, subcostal area obliquely depressed, costal area narrow, thickly areolate but with the areolets a little larger than those more closely arranged in the other areas; legs of moderate length, femora a little incrassated, obscurely angularly toothed at apices.

Ulmus testudineatus, sp. n. (Pl. VIII., fig. 1 and 1a).

Black, shining; lateral pronotal areas, and the costal area of the elytra with the centres of the areolets greyish-white; elytra with two transversely oblique spots at base, and a transverse spot crossing outer margin of discoidal area and inner margin of subcostal area, greyish-white; tibiæ ferruginous; antennæ ferruginous, the apical joint black.

Long. $2\frac{3}{4}$ mm.

Hab. Transvaal; Pretoria District (Coll. Dist.).

Sinalda, gen. nov.

Allied to *Phatnoma* by the raised transverse lines to the discoidal and subcostal areas of the elytra, but differing by the non-dilated lateral areas of the pronotum, which are more or less convex, not spinously ampliated; the elytra are also relatively narrower.

I had intended, at least for the present, to consider the genus now proposed as a section of *Phatnoma*, from which it differs practically by the above characters alone. That method is now rendered inadvisable by the remarks of my vigilant critic Dr. Bergroth, who has stated definitely that three of my species thus treated must be placed in the genus (Oriental according to present knowledge) *Gonycentrum* (*Teleia*, Fieb.). That, however, is an error which the figures should have prevented, for *Gonycentrum* is without the transverse raised lines to the elytra, and thus the foundation of a new genus becomes necessary to prevent the confusion caused by my friend's proposed correction?

I transpose three species from *Phatnoma* to Sinalda. The other species, *P. humerale*, Dist., is a typical *Phatnoma*.

Sinalda æthiops.

Phatnoma æthiops, Dist., Ann. S. Afr. Mus. ii. p. 239, pl. xv., fig. 14 (1902).

Gonycentrum æthiops, Bergr., Ann. Soc. Ent. Belg. viii. p. 297 (1903).

Sinalda testacea.

Phatnoma testacea, Dist., Ann. S. Afr. Mus. ii. p. 238, pl. xv., fig. 13 (1902).

Gonycentrum testaceum, Bergr., Ann. Soc. Ent. Belg. viii. p. 297 (1903).

Sinalda obesa.

Phatnoma obesa, Dist., Ann. S. Afr. Mus. ii. p. 239, pl. xv., fig. 16 (1902).

Gonycentrum obesum, Bergr., Ann. Soc. Ent. Belg. viii. p. 297 (1903).

Sinalda elegans, sp. n. (Tab. VIII., fig. 2).

Head, pronotum, body beneath, and legs, brownish-ochraceous; broad anterior and narrow posterior margins to pronotum, elytra, head beneath, and prosternum greyish-white; sutural area and transverse lines to posterior half of subcostal area to elytra, and a broad oblique lateral fascia to prosternum, ochraceous; antennæ pale ochraceous, the apical joint piceous; pronotum tricarinate, the central carination continuous, the other two not extending from base beyond the anterior pale area; lateral margins not angulate, the posterior angles subprominent and broadly rounded; scutellum small, just visible; elytral sutures well defined, subcostal area with distinct transverse raised lines, costal area composed of areolets.

Long. 2½ mm.

Hab. Cape Town (C. G. H., March).

Sinalda reticulata, sp. n. (Tab. VIII., fig. 3).

Brownish-ochraceous; head, anterior lobe of pronotum, body beneath, and femora, fuscous brown; head very thickly granulate, spines robust; antennæ mutilated in specimen described; pronotum with three discal longitudinal carinations, the central one straight, the other two a little curved; elytra with the transverse carinate lines to the discoidal area oblique, numerous, forming three areolets, the upper one of which is centrally divided; transverse line to subcostal area obscure; all the carinate lines and a series of small spots on lateral margin fuscous.

Long. 3 mm.

Hab. Cape Colony; Priska (Purcell, S. Afr. Mus. and Coll. Dist.).

Allied to *S. æthiops*, Dist., but differing by the more carinate elytra.

Sinalda nebulosa, sp. n. (Tab. VIII., fig. 4).

Head fuscous, antennæ brownish-ochraceous with the apex fuscous; pronotum brownish-ochraceous, the margins paler, the discal carinæ fuscous; scutellum piceous; elytra dirty stramineous with fuscous mottlings, arranged in spots on the costal area, the raised transverse lines fuscous; body beneath piceous; femora piceous, their apices and the tibiæ luteous, apices of tibiæ and the tarsi fuscous; head above with robust spines, of which the most prominent are one at apex, porrect, one on each side in front of antennæ, also porrect, one on each side behind antennæ and one discal, obliquely erect; pronotum very obscurely punctate, with the lateral areas a little convexly ampliated towards the posterior angles, the lateral margin a little upwardly sublaminate, the three central carinations very pronounced, a distinct constriction a little before anterior margin; elytra with the discoidal a little wider than the subcostal area; discoidal area with a straight transverse raised line before middle, and two oblique raised lines at apex, subcostal area with three more obscure raised lines.

Long. $2\frac{1}{2}$ mm.

Hab. Cape Colony; Grahamstown (Albany and British Mus.).

Astolphos, gen. nov.

Head long, about as long as pronotum, somewhat longly produced in front of antenniferous tubercles, but not spined at apex, a small spine on each lateral margin in front of eyes, antennæ with the first and second joints minute, together shorter than apical joint; eyes prominent, subsessile; pronotum tricarinate, the central carination continuous, the other two indistinct, and not extending beyond anterior area of pronotum, anterior margin profoundly concavely sinuate, the anterior angles porrectly subangulate, distinctly transversely constricted about one-third behind anterior margin, whence the lateral margins are almost straightly oblique to lateral angles which are subprominent and subangulate; posterior margin truncate; scutellum exposed; elytra broad, the areas well defined, in shape and structure much as in *Phatnoma;* rostrum apparently reaching the posterior coxæ, but imperfectly seen in a carded specimen.

Allied to *Phatnoma*, but differing by the large and non-anteriorly spined head, &c.

Astolphos capitatus, sp. n. (Tab. VIII., fig. 5).

Almost uniformly pale castaneous with the exception of pale areolets on costal and apical areas of elytra; head smooth; anterior area of pronotum transversely granulate, remaining area somewhat coarsely punctate; elytra with the claval, discoidal, and subcostal areas somewhat coarsely granulate, the costal area areolate, discoidal wider than subcostal area, both with a few transverse raised lines which are mostly oblique; anterior margin of prosternum narrowly stramineous; antennæ ochraceous, apical joint piceous.

Long. 3 mm.

Hab. Cape Town (C. G. H., March).

Division **SERENTHIARIA.**

Serenthia peringueyi, sp. n. (Tab. VIII., fig. 6).

Head and antennæ black; first joint of antennæ, and the legs, ochraceous; pronotum pale brownish, its anterior margin and posteriorly produced area stramineous, anterior transverse area behind pale anterior margin, and central carination, piceous; elytra very pale dull ochraceous; lateral margins a little darker, extreme lateral edge stramineous; body beneath piceous, head beneath and sternum somewhat greyishly pubescent, anterior and posterior margins of prosternum, ochraceous; antennæ robust; posterior disk of pronotum coarsely punctate; elytra areolate.

Long. 2 mm.

Hab. Cape Town (C. G. H., April 14th); Darling (C. G. H., Nov. 7th); S. Afr. Mus. and Coll. Dist.).

LULLIUS, gen. nov.

Head scarcely produced in front of antenniferous tubercles; antennæ short, two basal joints much thickened, subequal in length, together considerably longer than fourth joint, first joint slightly stouter than second joint, third joint a little stouter at base than apex; pronotum with the anterior margin a little concavely sinuate, lateral margins nearly straight, posterior margin longly, angulately produced, disk tumid, sometimes carinate; elytra moderately deflected on each side, broader, sometimes narrower at apex than at base, costal and apical areas areolate; femora longer than tibiæ; rostrum about reaching posterior coxæ.

Allied to *Serenthia,* but with the femora longer than the tibiæ; lateral marginal areas of the hemelytra strongly depressed, &c.

LULLIUS MAJOR, sp. n. (Tab. VIII., fig. 7).

Head, pronotum, excluding produced posterior area, and body beneath black; antennæ, anterior margin of pronotum, and legs ochraceous; posterior pronotal area and elytra pale brownish, the areolets at costal and apical areas greyish; pronotum, and elytra excluding the areolate areas, granulate; elytra rather strongly depressed on each side.

Long. $3\frac{1}{2}$ mm.

Hab. Cape Colony.

LULLIUS? MINOR, sp. n. (Tab. VIII., fig. 8).

Closely allied to the preceding species, but much smaller; antennæ and legs darker, elytra much narrower, narrower at apex than at base, and wanting the apical areolate area; pronotum with a distinct carination, &c.

Long. 2 mm.

Hab. Cape Colony.

EURYCERA GLABRICORNIS (Tab. VIII., fig. 9).

Copium glabricorne, Montand., Revue d'Entom. xi. p. 267 (1892).

Greyish-brown; pronotum testaceous-brown; head, antennæ, and sternum, black; legs testaceous; antennæ robust, second joint shorter than the first, third joint longest, its apex thickened, fourth joint stout, cylindrical; pronotum finely granulate, with three central greyish carinæ, the central one straight and continuous, the two lateral ones anteriorly a little curved and not reaching apex, lateral and anterior margins greyishly carinate, the discal carinations obscurely margined with black, the central carination distinctly black before apex; elytra granulate, obscurely speckled with black, most distinctly so along the lateral margins and on the apical area; body beneath fuscous; elytra considerably extending beyond the abdominal apex.

Long. $4\frac{1}{2}$ mm.

Var. Apical area of the pronotum nearly wholly black.

Hab. Cape Town (Lightfoot, S. Afr. Mus. and Coll. Dist.); Natal; Durban (Bell—Marley, Brit. Mus.); Transvaal; Zoutpansberg, Shilouvane (Junod, Brit. Mus.), Rikatla, near Delagoa Bay (Junod).

I here figure Montandon's type, kindly lent me by its describer. This appears to be a more melanic form than the ordinary appearance of the species as described above.

Division TINGIDARIA.

Phyllontochila junodi, sp. n. (Tab. VIII., fig. 10).

Umber-brown; head immersed to eyes, which are black and almost touch the anterior margin of the pronotal hood; antennæ with the first and second joints umber-brown, remainder mutilated in specimen described; pronotum with the interior of many of the areolets creamy-white, especially on the produced lateral and posterior areas, its disk piceous; elytra with the discoidal and subcostal areas almost uniform umber-brown, the costal and sutural areas creamy-white with the margins of the areolets brown, the first with large medial apical brown spots and some small lateral spots of the same colour; body beneath and legs piceous; head armed with a long semi-erect spine in front of each eye; pronotal hood with an erect discal anterior spine, pronotal lateral areas strongly ampliated on each side, slightly directed upward, their apices angularly truncate, their margins shortly spined, pronotal disk tricarinate; elytra with the discoidal a little wider than the subcostal area, areolets small, dense, with their margins thick and coarse, costal and sutural areas with the areolets larger and with finer margins, lateral margins of the first very distinctly spined.

Long. $4\frac{1}{2}$ mm.

Hab. Transvaal; Zoutpansberg District, Shilouvane (Junod, Brit. Mus.).

SANAZARIUS, gen. nov.

Broadly subovate; head immersed to eyes, which almost touch the anterior margin of the pronotum, its disk armed with two long converging spines each placed just behind base of antennæ; antennæ somewhat short, first and second joints short, strongly incrassated, second shorter than first and subglobose, third joint long, slender, fourth short, thick, pyriform; pronotum with a raised elongate hood, with somewhat large areolets, disk tricarinate, its lateral angles somewhat angularly produced; elytra with the discoidal area slightly wider than the subcostal area which is a little oblique, costal area narrowest, with transverse veins, sutural area narrow.

Sanazarius cuneatus, sp. n. (Tab. VIII., fig. 11).

Head and pronotum piceous-brown; elytra with the discoidal and sutural areas pale brownish-ochraceous, the interior areas of the areolets somewhat greyish, subcostal area piceous, costal area greyish with transverse fuscous lines; body beneath piceous, legs fuscous brown; head and pronotum thickly greyishly pilose; pronotum with its disk tricarinate, the lateral angles subacutely produced; elytra with the areolets of the discoidal area somewhat large, their margins distinctly raised, areolets to the sutural area very small; apices of the tarsi piceous.

Long. 2½ mm.

Hab. Cape Colony; Grahamstown (Albany and Brit. Mus.).

HÆDUS, gen. nov.

Head with two anterior porrect spines, and a porrect spine on each side between eyes and base of antennæ (the last mutilated in typical specimen), and with two long suberect spines at base; rostrum imperfectly seen (carded specimen); eyes about touching anterior margin of pronotum; pronotum with the lateral areas ampliated, largely areolate, margins nearly obliquely straight, anterior angles angulately produced, anterior margin concave, with a short central prolongation or hood, the disk convex, three central longitudinal carinations sharply raised; elytra widened from base, but narrowed towards apex, areolets of the sutural area moderately large, discoidal area rather less than half the length of elytra, distinctly moderately foveate; legs slender.

Allied to *Leptostyla*, Stål.

Hædus clypeatus, sp. n. (Tab. VIII., fig. 12).

Head and pronotum pale brownish-ochraceous; eyes and two spots on anterior area of pronotum, black; pronotum with the longitudinal carinations stramineous, the lateral areas semihyaline with the margins of the areolets stramineous; elytra semihyaline, margins of the areolets stramineous, fuscous on sutural area, a spot near centre of discoidal area and another spot at its apex, and some confluent markings near apex of sutural area, piceous; legs pale ochraceous; body beneath apparently more or less piceous (as far as can be distinguished from a carded specimen).

Long. 4½ mm.

Hab. Cape Colony; Wynberg (Lightfoot—S. Afr. Mus. and Coll. Dist.).

Teleonemia australis, sp. n. (Tab. VIII., fig. 13).

Dull stramineous; antennæ brownish-ochraceous, apical half of fourth joint black; head above centrally brownish-ochraceous, the apex, and a lateral carina on inner side of each eye, very pale stramineous; eyes piceous; pronotum with the anterior area, lateral and posterior margins, and carinæ, very pale stramineous, some transverse linear black markings at posterior margin of anterior area; margins of elytra and of discoidal area very pale stramineous; sutural area speckled with brown; abdomen beneath castaneous thickly greyishly pilose; legs and rostrum ochraceous: apex of rostrum, extreme apices of tibiæ, and apices of the tarsi, black; pronotum finely granulate, tricarinate, central carination continuous, two lateral carinations only existing on posterior prolongation; the lateral margins and anterior area very distinct; elytra with discoidal area, excluding margins, finely rugosely areolate, sutural area a little more prominently areolate.

Long. 4 mm.

Hab. Cape Town (C. G. H.).

"Very common at Cape Town during the latter part of the summer, working mainly on the under side of the leaves of *Olea europea*, which soon turn yellow and have the peculiar granular appearance often caused by Hemiptera" (C. W. Mally).

Monanthia mitrata, sp. n. (Tab. VIII., fig. 14 and 14a).

Pale piceous, mottled with obscure ochraceous; discoidal area of the elytra obscure ochraceous, with two conical piceous rugosities, one at middle, the other at apex; subcostal and costal areas hyaline, with the margins of the areolets piceous; pronotum with the lateral areas globosely dilated, broadly upwardly reflexed and shell-like, central disk rugose, central carination continuous and profound; body beneath dark piceous; legs brownish-ochraceous; antennæ mutilated; basal areas of the raised pronotal margins hyaline, areolate, margins of areolets, piceous.

Long. 3 mm.

Hab. Grahamstown.

"Very abundant at Grahamstown, where it is so destructive to sagn that it is scarcely possible to grow it" (C. W. Mally).

Genus COMPSEUTA.

Monanthia, subgen. *Compseuta*, Stål, En. Hem. iii. p. 133, 1873.

Type. *C. ornatella*, Stål.

Compseuta ornatella.

Tropidocheila ornatella, Stål, Öfv. Vet.-Ak. Förh. 1855, p. 37, 1.

Monanthia (*Physatochila*) *ornatella*, Stål, Hem. Afr. iii. p. 28, 3 (1865).

Monanthia (*Compseuta*) *ornatella*, Stål, En. Hem. iii. p. 133 (1873).

Monanthia ornatella, Dist., Ann. S. Afr. Mus. ii. p. 242, pl. xv., fig. 9 (1902).

Caffraria (Stockholm Mus.). Rikatla, near Delagoa Bay (Junod, Coll. Montandon).

Since I figured this species, I have further studied the other species that have been included in the genus *Monanthia*, and cannot see why the great structural differences should not be recognised as generic characters.

Compseuta montandoni, sp. n. (Tab. VIII., fig. 15).

Head black; antennæ luteous, the apical joint black; pronotum with the anterior lobe castaneous, the posterior prolongation luteous, areolate, with the centres of the areolets piceous, the central carinæ and lateral margins luteous, the anterior collar greyish; elytra luteous, central areas of the areolets to discoidal area and base of sutural area more or less piceous; legs luteous; body beneath (imperfectly seen on carded specimen) with at least the lateral areas black; anterior collar to pronotum coarsely granulate; anterior area of pronotum tumid, punctate, the carinæ narrow but well raised, the lateral margins a little ampliated and reflexed; apices of the tibiæ piceous.

Long. 3 mm.

Hab. Rikatla, near Delagoa Bay (Junod, Coll. Montandon).

Allied to *C. ornatella*, Stål, but differing by the more elongate and apically subacute posterior prolongation of the pronotum; pronotal disk castaneous, not black.

The following species were forwarded to me for identification by Mr. Lounsbury, the Government Entomologist of the Department of Agriculture, Cape Town; and I have to thank Mr. C. W. Mally, the assistant entomologist, for the excellent manner in which they reached my hands. Some of the Tingididæ previously described were also in the collection, and I have added the notes on habits, &c., which accompanied the specimens.

Family LYGÆIDÆ.

Blissus diplopterus, sp. n.

Head, antennæ, pronotum, scutellum, abdomen above, body beneath, rostrum, and femora, black; lateral margins of abdomen above and beneath, apices of femora, the tibiæ, and the tarsi reddish-ochraceous; corium stramineous, its apical angle black; membrane pale silvery, the veins obscurely fuscous; antennæ with the second and fourth joints longest and subequal in length; head, pronotum, and scutellum very coarsely punctate; central lobe to head, two discal spaces to anterior pronotal lobe, and a central carina to scutellum, impunctate; clavus with a series of punctures near each lateral margin, the same on inner and apical margins of corium, the apical angular area of corium very coarsely punctate.

Long. $3\frac{1}{2}$ mm.

Hab. Cape Colony; Hex River.

Found in a deserted wasp's nest on a prune-tree at the Cape Orchard Co., Hex River (C. W. Mally).

PAMERA LOUNSBURYI, sp. n.

Head, pronotum, scutellum, and body beneath, black; antennæ and legs ochraceous; apical joint of antennæ, anterior femora, excluding bases and apices, and a subapical annulation to intermediate and posterior femora black; corium dull luteous, fuscously punctate, the lateral margins and an oblique discal fascia widened at inner angle, impunctate; membrane pale fuliginous, subhyaline; antennæ with the second joint slightly longer than third, fourth joint incrassated, about as long as second; rostrum reaching the anterior coxæ, first joint black, apical joint piceous, remainder ochraceous; pronotum constricted near middle, anterior lobe tumid, much narrower than posterior lobe; anterior femora strongly spined beneath.

Long. 4 mm.

Hab. Cape Colony; Paarl.

CLIGENES ÆTHIOPS, sp. n.

Head, antennæ, pronotum, and scutellum black; basal margin of pronotum obscurely castaneous; corium dull, obscure stramineous, apical margin and angle black, a somewhat large piceous spot near inner angle, and a small piceous spot at about centre of lateral margin; clavus with two longitudinal series of fuscous punctures; outer disk of corium (excluding lateral margins) fuscously punctate; membrane dark greyish, its apical margin pale hyaline; body beneath and legs piceous, the last sometimes more or less castaneous; antennæ with the second joint a little longest, its base attenuated, first, third, and fourth joints subequal in length; pronotum transversely impressed near middle, the impression posteriorly margined with a broad series of punctures, anterior lobe moderately tumid; scutellum long, triangular, slightly tumid, its lateral margins distinctly reflexed; corium profoundly sinuate near inner angle of apical margin, the membrane being thus broadly truncate at base.

Long. 3 mm.

Hab. Cape Colony; Hex River.

"Under leaves and rubbish that had collected among the tufts of grass under some willows growing along the banks of the Hex River" (C. W. Mally).

The first African species described of this genus already recorded from the Nearctic, Neotropical, and Oriental regions.

HYDROMETRIDÆ.

Angilla germari, sp. n.

Head, pronotum, antennæ, rostrum, coxæ, and legs ochraceous; eyes, a spot between them, two spots on anterior area of pronotum, body beneath, apex of rostrum, apex of second and the whole of the remaining joints of antennæ, black or fuscous; hemelytra brownish-ochraceous, with an oblique basal streak and a few small apical spots greyish-white; antennæ pilose, the first, third, and fourth joints subequal in length, the second a little shortest, tarsi about equal in length, their apices piceous.

Long $4\frac{1}{2}$ mm.

Hab. Cape Colony; Caledon (S. Afr. Mus. and Coll. Dist.).

PROCEEDINGS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

ANNUAL ADDRESS TO THE MEMBERS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY,

ON JULY 31, 1901.

BY THE PRESIDENT, L. PÉRINGUEY, F.E.S., F.Z.S., ETC.

SOME PHASES OF INSECT LIFE IN SOUTH AFRICA.

II.—*Phonation in Insects.*

In my previous address I took as my subject the *Protective Colouration* in South African insects. In the present one I shall deal with the *Phonation*, or sound * produced by some of the South African insects.

From Colour to Music, of a kind, the transition is not so abrupt as it might at first seem, were it proved that the artistic emotions of an insect could be measured by our standard, or possibly the standard of some other vertebrate animals.

But although we may not be able to pronounce a final opinion as to the resulting value of sounds in insects, sound-producing apparatuses are present in many, and especially among the Orthopterous ones (grasshoppers, &c., &c.), which offer the best instances of a highly protective resemblance to inanimate surroundings.

* I do not allude here to the sound produced by the mere vibration of the wings of bees or flies on the wing.

Better developed in the male, and sometimes restricted to him, these musical organs are often present in the female, although seldom as highly developed as in the male. Contrary, however, to the usual belief, many a female is apt to produce shrill, piercing notes which sometimes, but seldom, so far as is now known, equal that of the male in power and volume of sound.

But just as the protective resemblance is of two sorts, the phonation of insects is also of two kinds, viz.:—

I. For challenge or wooing purposes.

II. For defensive purpose.

Phonation for wooing purpose.

It is in the Orthopterous order of insects that the stridulating, or music-producing organ, as well as the auditory organs, are most developed.

We shall take them in systematic order.

Mantinæ.—Among our South African species I have not been able to ascertain the stridulation reported to have been observed among the *Mantinæ*, but *Empusa*, when seized, does occasionally produce a noise by rubbing its wings together. The membranaceous coverings rubbed against the asperities of the dorsal part of the abdomen produce this sound which, however, in this raptorial species could be used only as a means to frighten an enemy.

Gryllinæ-Locustinæ.—The *Gryllinæ* and *Locustinæ* are especially adapted to produce music of a high class; that is if the volume and the continuation of the sound be the only consideration.

Most of you are acquainted with that of the House Cricket, perhaps the best virtuoso among its kindred. If we want to ascertain how the musical sound is produced, we find that in the male the basal part of the upper wing bears on one side a file on the inner surface, and the other wing has a sharp, marginal edge; by raising the upper wings and rubbing them rapidly, the animal, through the friction of one wing against the file, or serrulate part of the other, produces a rasping noise. The insect is able in some cases to modify or to increase the sharpness of this noise by raising the anterior part of the body (*pronotum*), or by altering the angle of the upper wings, which are raised when vibrating.

To describe these stridulating organs would prove too technical a task. In the two Sub-Families, *Gryllinæ* and *Locustinæ*, they are based on the same plan. But the noise produced is not always in the proportion of the length of the wings, or body, or of the anal surface which is to act as a resounding board. In the case of

Eugaster and *Hetrodes*, known here under the name of "Corn-crakes," in which the upper wings are almost rudimentary and hidden under the pronotum, the noise produced is certainly sharper or more sharply rasping than in any other South African species of *Locustinæ* which I have been able to observe. These rudimentary tegmina, for the lower wing is quite obliterated, are very strong and quite hidden under the elongated pronotum. By the raising or lowering of the prothorax, the latter acting as a resounding board, I have made the live animal produce notes pitched in a different key.

If, under favourable circumstances, you carefully observe the male of *Gryllus capensis* at work, you will find that the modulation of the ear-splitting noise is due also to the raising or lowering of the upper wings, the surface of the chitinous abdomen acting also as a resounding board.

Stridulating or sound-producing organs imply of necessity specialised ears both in the male and in the female: in the male to enable him to redouble his efforts against the singing power of his rival or rivals, or perhaps to enable him to acknowledge his defeat; in the female to enable her to appreciate perhaps the superiority in that line of one of her numerous suitors, perhaps also for her to repeat *sotto voce* the challenge or love-song of the suitor. These organs of audition are situated on the front legs in the *Locustinæ*, and are in the shape of an oblong or ovate exposed tympanum, or of a slit at the bottom of which is a tympanic membrane. It sometimes happens even, that in some species in which the wings are totally obliterated, and are therefore incapable of producing sound in the orthodox manner (*Stenopelmatinæ*), these organs of audition are occasionally retained.

I have already alluded, in treating of the protective colouration in insects, to some of the wonderfully well-protected leaf-like *Locustids*. In their case it is easy to conceive that this phonation should have developed in the way it has, owing to the possible inability on their part to discover their mates on account of their protective resemblance to their surroundings. In the *Gryllinæ* which are not so well protected, and are more of troglodyctic disposition, and mostly nocturnal, the great adaptation to sound-producing is probably due to their being dwellers in caves. You can at any time obtain here in summer nights a singing contest by inducing a Cricket kept in captivity to commence its chirping.

Acridiinæ.—In the *Acridiinæ*, of which the peregrine locust is a type, the organs for the production of sound are of a greatly modified type. Instead of the basal part of the wings, it is the hind thigh (femur) which serves that purpose. These thighs, which are always, or nearly always, greatly developed, for most, if not all the *Acridiinæ* are, or were once upon a time, saltatorial insects, play the chief *rôle* here, and the rasping, rattle-like noise is produced by the friction of the inner face of the femur against the outer face of the upper wing, or against the asperities of the abdomen when the wings are absent.

The auditory organs are in the shape of a tympanic cavity closed by a membrane, and situate near, over, or alongside the articulation of the said hind thigh. These ears exist in both sexes.

I do not know of any more pleasant, lazy occupation than to watch in a piece of stubble some *Œdiponinæ* doing their courting. If you have once been told of it, you cannot fail afterwards to notice that a male which has already loudly proclaimed to the world that he intends to win a mate, does occasionally move his thighs in precisely the same manner as when producing sound; yet no sound is audible to us; the female likewise will agitate her femora rhythmically, but no sound is audible to us. Does it, however, follow that the sound is not audible to them? The resounding board is too close to the instrument for them not to perceive the sound, of which they are the best judges. I have often witnessed a mating so suddenly accomplished as to imply, seemingly, a complete or partial understanding, between the two parties—an understanding possibly communicated in a subdued tone.

In addition to these striking examples of sound-producing *Œdipods*, we have in South Africa, and restricted so far to South Africa, the most aberrant type of a musical grasshopper yet discovered. This is the "*Blasop*," ten species of which are now known to me.

In some of these extraordinary insects (*Pneumorinæ*), four species have most conspicuous silver-white patches. In one of them, *Cystocœlia scutellaris*, the female is resplendent with longitudinal silvery bands edged with pink or magenta, and is one of the very rare cases in insect life where the female is more gorgeously coloured than the male, the latter having only a few, and smaller patches on the thorax and upper wings. The female is only partly apterous, and cannot fly, but the male is fully winged. The femora in both sexes, instead of being large and broad, are slender, but the abdomen has acquired in the male the form of a huge transparent vesicle the better to act as a sounding board. On the side of the second basal abdominal segment there is a short sub-arcuate series of triangular serrate teeth against which is rubbed a short but elongated serrulate file situated in the inner part of the thigh. The noise, produced at night, is short, but deep and loud, and it has earned to the insect the Caffre name of "*Groounya.*" I have heard it at Seymour, in the Cape Colony; it is most impressive.

Other Orders of Insects.—The *Pneumorinæ*, however, are not the only insects in which the abdomen has become hugely inflated for sound-producing purpose, and among a quite different order, the *Cicadæ*, we have an analogous case in *Tettigonia vespiformis.*

You have doubtless all heard in the Cape Peninsula the shrill noise produced by the *Cicadæ*, called here "Singeetjees." Bad as it is, there is no comparison with what obtains on the West Coast of Madagascar, where I was once compelled to abandon a Kabari held with the natives owing to the piercing, deafening noise proceeding from the adjoining tamarisk-trees, where a number of *Cicadæ* were holding their concert.

In *Cicadæ* the male only is musical, the female being voiceless. This was known to remote antiquity, and poetic wags, at least one of them, have made use of this tit-bit of natural history knowledge for comparison, which, like most comparisons, is of course odious. The sound-producing apparatus in the *Cicadæ* is very different from that of the other insects. The structure is partly thoracic and partly abdominal, and the sound is produced by three ventral membranes, one of which, the timbal, vibrates at the same time as the others, the whole body acting as a resounding board in order to possibly modify or increase the sound. This sound, however, in the case of our two common species here, seems to be always pitched in the same key. Another species, *Tympanystria trichiosoma*, Walk., not uncommon round Cape Town, is almost mute on trees, but punctuates the curve of its flight by a short, click-like note.

In the LEPIDOPTERA the males of some species also produce a clicking noise when on the wing.

Stridulating or noise-producing organs are probably more common in COLEOPTERA and other orders of insects than it is supposed. Bedel has found one on the legs of a *Carabid* also represented in South Africa. But some insects produce sound without special noise-producing organs.

The death-watch, *Anobium striatum*, which has found a home here, produces its well-known ticking noise by striking its head against the wood; this is connected with sexual purposes.

With sexual purposes must also be connected the singular habit of the male of the numerous species of the Tenebrionid genus *Psammodes*, of striking the ground with the abdomen, and producing thus at dusk, or at night, a very audible noise which has earned to it the local name of "Tock Tockie," one of the rarely appropriate vernacular names applied at this end of the African Continent.

Among several kinds of white ants (*Termitinæ*), the caste called Soldiers produces a rattling sound. According to Haviland, one of the species (*Termes carbonarius*) has reached the highest stage of development in this direction, for the soldiers can hammer in rhythmic unison. "At first a few begin irregularly, then they get into time, and the others take it up. Every soldier in the exposed portion of the nest, after the nest has been opened, stands up and hammers with his head; the blow is given thrice in very quick succession, and then there is an interval of two seconds."

This peculiarity cannot, however, be connected with sexual purposes owing to the sex of the operators.

Phonation for defensive purposes.

In addition to this love-chirping, my observations have led me to the conclusion that the development of the music-producing apparatus is not merely connected with wooing purposes, but is, more particularly in many, if not in all the acridiiform *Œdipodi*, a means of defence by intimidation when threatened with capture. I have already mentioned, when treating of colouration, that some of the South African Œdipods of the genera *Caloptenus*, *Cosmorhysa*, *Acrotylus*, &c. (which harmonise so wonderfully with the soil on which they squat), display in their short, very jerky flight the brilliant colouring of their under wings, but what I have not yet told you is, that at the same time they give out, while on the wing, a very shrill, rattling noise, which, with perhaps the exception of the ubiquitous *Ædalus marmoratus* and *A. nigro-fasciatus*, they seldom make use of, at least in such a key, for courting purposes.

It is also worthy of note that in the South African *Locustinæ*, *Hetrodes* and *Eugaster*, in which the stridulating organs are very short, but similarly developed in both sexes, the highly resounding, but always short, rasping noise produced is mostly heard when capture is threatening, or when the animal is alarmed.

During a collecting trip to Namaqualand, I found that in the neighbourhood of O'okiep any dwarfish bush left alive after a long prolonged drought was tenanted by two species, *Hetrodes pupa* and *Eugaster vittatus*, whose presence was revealed to me merely by the piercing rasping noise not twice repeated, which the projection of my shadow seldom failed to elicitate.

In our Toad-Locusts (*Eremobiinæ*, *Pamphagienæ*) a similar adaptation occurs, and in spite of some expressed erroneous deductions, I can assert that very seldom, and then only at dusk, did the examples of *Methone Anderssoni*, which I kept under observation, produce in captivity a vibrating noise of comparatively short duration. The animal is usually resting on the ground with its huge thighs folded against the body, which is not supported by the legs. When alarmed, however, this huge body is suddenly raised upwards, resting for a short time on the tarsi as if on stilts, while a shrill rasping note is simultaneously produced by the abdomen being rubbed against the supporting femora during its upward projection.

The female of the large Stick-insect, *Palophus haworthi*, produces when alarmed, a very loud, alarming noise by somewhat different means from those of *Methone*. Her wings, which are folded over the abdomen, are too short to support the body in flight, but when alarmed, these fan-like, folded wings are suddenly opened with a tearing sound, and the body is jerked upwards as in *Methone*.*

The females of *Pneumorinæ*, belonging to the genera *Pneumora* and *Bula*, are wingless, yet they have rudiments of wings hidden under the pronotum, which they use for producing a very loud rasping sound,† when threatened with seizure. The feeble creature looks almost defiant when, danger threatening, she raises her pronotum to produce the would-be terrifying noise, followed, however, by an attempt at getting rapidly away. She does not hop, but walks, the result probably of the wonderful adaptation of her colouring to her surroundings.

Both sexes of the Carabidous beetle *Microlestia tabida* and *M. oxygona*, the former fairly common on the slopes of Table Mountain, stridulate with great force when alarmed or captured; the noise is produced by the rapid friction of the abdominal segments against the wing-covers—the wings proper have disappeared. Most, if not all the *Lamiinæ* of the Family *Cerambycidæ*, produce a somewhat similar noise by moving the prothorax on the supporting part of the mesothorax. Another beetle, *Crioceris*, does likewise. *Trox* stridulates also when captured. The Hymenopterous female *Mutilla* does the same.

Many more instances could I give you, but I think I have told you enough to-night to show that *Phonation* in insects is not merely connected with sexual purposes, but is also resorted to as protection against possible foes. Of course we have no direct proof that a natural enemy would be scared away from its prey by its intimidating noise, but my own observations lead me to conclude that the acquirement and the use made of these noise-producing organs, either for courting or for defensive purposes, and probably for both

* This noise and the attitude of the insect was sufficient to put to flight a tame cat before which a female *Haplolophus* displayed her frightening tactics.

† Quite different from that of the male, and very much louder and shriller.

in many cases, is also one of the phases in the life-history of some insects which, so far as we now know, seems to complete that chain of protection commencing with colouration, and having for its object the preservation of the species in its endeavour to perpetuate its race.

Annual General Meeting.

July 31, 1901.

Mr. L. Péringuey, President, in the Chair.

The Secretary read the General Report of the Society for the year ending June 30, 1901, and the Treasurer the financial statement for the same period.

General Report of the Society for the Year ended June 30, 1901.

During the past year, eight ordinary meetings of the Society were held. At these, in addition to short notes on various subjects, and exhibits of specimens of zoological, botanical, or ethnographical interest, the following papers were read:—

"Some Phases of Insect Life in South Africa," Presidential Address, by L. Péringuey.

"On the Appearance and Disappearance of a Mud Island at Walfish Bay," by F. W. Waldron.

"Notes on Stone Implements of Palæolithic Type found at Stellenbosch and the Vicinity," by L. Péringuey.

"On the Structure of the Palate in *Dicynodon* and its Allies," by R. Broom.

"On *Ictidosuchus primævus* nov. spec.," by R. Broom.

"On the Periodical Changes in the Rainfall at the Royal Observatory, Cape of Good Hope, since 1841," by J. T. Morrison.

"On the Leg and Toe Bones of *Ptychosiagum*," by R. Broom.

"On the History of the Local Names of Cape Fishes," by J. D. F. Gilchrist.

"Evidence of Glacial Action during the Deposition of the Table Mountain Sandstone," by A. W. Rogers.

"The Rainfall of the Cape Peninsula," by T. Stewart.

"Some Pressure and Temperature Results for the Great Plateau of South Africa," by J. R. SUTTON.

"Observations on the Marine Currents and on the Temperature and Salinity of the Sea around the Cape Peninsula," by J. D. F. GILCHRIST.

"The Magnetic Elements of the Cape of Good Hope from 1605 to 1901," by J. C. BEATTIE.

The Council has with deep regret to record the death of Mr. F. Y. St. Leger, who joined the Society in 1878.

During the year twenty-six new members were elected, and five resigned, so that the total number of ordinary members at June 30, 1901, was 168. Two honorary members were elected by the Council, namely, Professor H. G. SEELEY, of London, and Professor E. COHEN, of Greifswald, each distinguished as having devoted himself to South African scientific problems.

The following table shows the increase in the membership during the past five years :—

	Ordinary Members.	Honorary Members.
1897	100	2
1898	121	2
1899	132	2
1900	148	2
1901	168	4

Of the *Transactions*, Part 2 of Vol. XI., containing three papers and twelve plates, was published in September, 1900, and Part 3 of the same volume, with five papers and ten plates, in June, 1901. These two parts of Vol. XI. contain some of the papers read at the ordinary meetings of the Society during the year. In addition it was decided to publish Vol. XII. and to devote the entire volume to the continuation of Mr. Péringuey's Catalogue of South African Coleoptera. Pages 1–563, with nine plates, were accordingly published in April, 1901. This portion of the volume contains the Family *Lucanidæ*, and the Sub-Families *Coprinæ*, *Aphodiinæ*, *Troginæ*, *Chironinæ*, *Geotrupinæ*, *Hybosorinæ*, *Orphninæ*, and *Dynastinæ*, of the Family *Scarabæidæ*. It will be followed at an early date by the concluding pages of the volume, and in addition the fourth and concluding part of Vol. XI. will soon be sent to the printer.

The Library of the Society was increased by the addition of 150 volumes or pamphlets. The Societies from which Transactions or other publications are now regularly received are as follows :—

AFRICA.

Colony of the Cape of Good Hope.

Cape Observatory, Annals.

H.M. Astronomer at the Cape, Reports of.

Geological Commission, Annual Report.

Marine Biologist, Annual Report.

Marine Investigations in South Africa.

Meteorological Commission, Annual Report.

South African Museum, Annual Report; Annals.

Natal.

Mining Industry; Reports.

Transvaal.

Geological Society of South Africa, Transactions.

AMERICA.

Canada.

Geological and Natural History Survey of Canada, Annual Report.

Canadian Record of Science.

Canadian Institute, Transactions, Proceedings.

Hamilton Scientific Association, Journal and Proceedings.

Nova Scotian Institute of Science, Proceedings and Transactions.

Ottawa Literary and Scientific Society, Transactions.

United States.

American Anthropologist.

Baltimore, Johns Hopkins University, Annual Report, Hospital Bulletin, University Circulars.

Buffalo Society of Natural Sciences, Bulletin.

California Academy of Sciences, Occasional Papers.

Chicago Field Columbián Museum, Publications.

Cincinnati Society of Natural History, Journal.

Davenport Academy of Natural Sciences, Proceedings.

Indiana Academy of Science, Proceedings.

Indianapolis Department of Geology and Natural Resources, Annual Report.

Kansas University Quarterly.

Lancaster Pa., American Mathematical Society, Transactions.

Minnesota Academy of Natural Sciences, Bulletin.

New York Academy of Sciences, Annals.

Philadelphia, American Philosophical Society, Proceedings.

Philadelphia Museums, Scientific Bulletin.

Smithsonian Institute, Annual Report.
Texas Academy of Sciences, Transactions.
United States National Museum, Bulletin, Proceedings.
Wisconsin Academy of Sciences, Transactions.
Wisconsin Geological and Natural History Survey, Bulletin.

MEXICO.

Instituto Geologico de Mexico, Boletin.
Observatorio Meteorologico Central de Mexico, Boletin Mensual.
Sociedad cientifica "Antonio Alzate," Memorias y Revista.

ARGENTINA.

Academia Nacional de Ciencias in Cordoba, Boletin.
Instituto Geografico Argentino, Boletin.
Museo Nacional de Buenos Aires, Communicaciones.
Museo de la Plata, Revista.

CHILI.

Société Scientifique du Chili, Actes.

URUGUAY.

Museo Nacional de Monte Video, Anales.

ASIA.

Asiatic Society of Bengal, Journal; Proceedings.
Colombo Museum, Report.

AUSTRALASIA.

SOUTH AUSTRALIA.

Adelaide Observatory, Meteorological Observations.
Royal Geographical Society of Australia, South Australian Branch, Proceedings.
Royal Society of South Australia, Memoirs; Transactions.

QUEENSLAND.

Queensland Museum, Annals; Report.
Royal Society of Queensland, Proceedings.

VICTORIA.

Royal Society of Victoria, Proceedings; Transactions.

NEW SOUTH WALES.

Australasian Association for the Advancement of Science, Report.
Australasian Museum, Memoirs; Records; Reports.
Department of Mines and Agriculture, Annual Reports.
Geological Survey of New South Wales, Records; Mineral Resources.
Linnean Society of New South Wales, Proceedings.

Royal Society of New South Wales, Abstracts of Proceedings ; Journal and Proceedings.

University, Calendar.

New Zealand.

Wanganui Public Museum, Annual Report.

EUROPE.

Austria.

K.K. central Anstalt für Meteorologie und Erdmagnetismus, Jahrbuch.

K.K. Naturhistorisches Hofmuseum, Annalen.

Kais. Akademie der Wissenschaften, Sitzungsberichte.

Belgium.

L'Académie royale des Sciences, &c., Annuaire ; Bulletins.

France.

Marseilles Faculté des Sciences, Annales.

L'Institut Colonial de Marseilles, Annales.

Paris, La Feuille des Jeunes Naturalistes.

Nantes La Société des Sciences Naturelles de l'Ouest de la France, Bulletin.

Germany.

Berlin, Kön. Preuss. Akademie der Wissenschaften, Sitzungsberichte.

Cassel, Verein für Naturkunde, Bericht.

Dresden, Verein für Erdkunde, Jahresbericht.

Halle, Kais. Leop.-Carol. Deutsche Akademie der Naturforscher, Abhandlungen, Leopoldina, Nova Acta.

Hamburg, Naturhistorisches Museum, Mitteilungen.

,, Wissenschaftlichen Anstalten, Jahrbuch der Leipzig, Verein für Erdkunde, Mitteilungen.

Great Britain and Ireland.

Cambridge Philosophical Society, Proceedings.

Cambridge University Library, Report.

London, Anthropological Institute of Great Britain and Ireland, Journal.

,, Royal Astronomical Society, Memoirs, Monthly Notices.

,, British Association, Report.

,, Royal Geographical Society, Journal, Year-book and Record.

,, Geological Society, Quarterly Journal.

,, Zoological Society, Proceedings, Transactions.

Manchester Literary and Philosophical Society, Memoirs and Proceedings.
,, Geographical Society, Journal.
Edinburgh, Royal Society, Proceedings.
,, Royal Physical Society, Proceedings.
,, Scottish Geographical Magazine.
,, Scottish Microscopical Society, Proceedings.
Glasgow, Philosophical Society, Proceedings.

HOLLAND.
Royal Academy of Sciences, Proceedings.

ITALY.
Museo di Zoologia et Anatomia Comparata della R. Univers. di Torino, Bollettino.

PORTUGAL.
Sociedade de Geographia de Lisboa, Boletin.

RUSSIA.
La Société Impériale des Naturalistes de Moscou, Bulletin.
L'Académie Impériale des Sciences de St. Pétersbourg, Memoires, Bulletin.

SWEDEN.
Stockholm, Kongl. Vitterhets Historie och Antiqvitets, Akademien, Manadsblad.
,, Kongl. Svenska Vetenskaps Akademien, Handlingar; Bihang.
,, Antiquarisk Tidskrift för Sverige.
Upsala, Geological Institute of the University, Bulletin.

SWITZERLAND.
Lausanne, Société vaudoise des Sciences naturelles, Bulletin.
Zürich, Naturforschende Gesellschaft, Vierteljahrsschrift, Neujahrsblatt.

The Council has undertaken the duties of a Regional Bureau in connection with the International Catalogue of Scientific Literature, the first volume of which is expected to be published at the beginning of 1902.

From the Treasurer's Statement appended to this Report it will be seen that the financial position of the Society is satisfactory. The balance of £383 6s. existing at June 30th does not, however, show the actual assets. On the credit side there is a sum of £6 for extra copies of author's papers, £50 due for *Transactions* delivered, while the presumably recoverable arrear subscriptions amount to £82. On the debit side there remains a balance of £77 8s. 6d. due for

Volume XII. of the *Transactions*, and (say) £5 for small items outstanding, that is to say, the net sum owing to the Society on June 30th was £55 11s. 6d., in addition to the sums in hand shown in the Treasurer's Statement.

The ordinary members of the Society are divided into 91 town members paying £2, and 77 country members paying £1 per annum. The members in arrear whose subscriptions can be considered good comprise :—

	£	s.	d.
4 Town Members for 1900	8	0	0
12 Country ,, ,, ...	12	0	0
19 Town ,, 1901	38	0	0
24 Country ,, ,, ...	24	0	0
	£82	0	0

In addition to these, one country member has not paid his subscription for five years, one town member for the same period, another for four years, and a third for three years.

On behalf of the Council,

L. Péringuey, *President.*

Geo. S. Corstorphine, *Secretary.*

Cape Town, *July* 24, 1901.

Sir David Gill expressed the Society's thanks to the officers, and moved the adoption of the Report and the Treasurer's Statement. On Mr. T. Stewart seconding, the motion was unanimously adopted.

The meeting then proceeded to the election of President. The scrutineers, Dr. Crawford and Mr. E. H. V. Melvill, declared that Sir David Gill had been unanimously elected President. The election of five members of Council was proceeded with. It was resolved that the member elected with the smallest number of votes should hold office for one year to fill the vacancy caused by Sir David Gill's election as President, and that the other four elected should hold office for the usual period of two years.

As the result of the ballot the scrutineers declared Messrs. Beattie, Corstorphine, Péringuey, and Sclater elected for two years and Dr. Muir for one.

THE HON. TREASURER IN ACCOUNT WITH THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

July 1, 1900, *to June* 30, 1901.

Receipts.	£	s.	d.	£	s.	d.
To Balance in Bank				480	10	11
,, ,, in Cash				0	9	6
,, Subscriptions :—						
Arrears for 1899	7	10	0			
15 Subscriptions—Town 1900 ..	30	0	0			
15 ,, Country 1900 ..	15	0	0			
65 ,, Town 1901 ..	130	0	0			
42 ,, Country 1901 ..	42	0	0			
,, New Members' Subscriptions	19	2	0			
				243	12	0
,, Sale of Publications				72	8	6
,, Receipts from Authors for extra copies of Papers ..				6	0	0
,, Miscellaneous small receipts				1	10	3
				£804	11	2

Expenditure.	£	s.	d.	£	s.	d.
By Publications :—						
Messrs. West Newman for Printing—						
Vol. XI. part 1	68	7	0			
Vol. XI. part 2	100	13	0			
Vol. XII. part 1, on account ..	150	0	0			
Printing Plates for Vol. XII. part 1	7	17	0			
Drawing and Photography ..	4	3	0			
				331	0	0
,, Stationery and Printing Circulars				31	1	0
,, Freight Charges				10	17	3
,, Library Catalogue				3	0	0
,, Attendance at Meetings and Clerical Assistance ..				7	12	0
,, Petty Cash, chiefly postage				36	5	3
,, Bank Charges				1	9	8
				421	5	2
,, Balance in Standard Bank on Fixed Deposit at $3\frac{1}{2}$ per cent.				300	0	0
,, Floating Balance in Bank				80	12	9
,, Petty Cash Balance				2	13	3
				£804	11	2

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

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

(Signed) G. M. Clark, W. F. Purcell, } *Auditors.*

The retiring PRESIDENT read his annual address on "Phonation in Insects."

A cordial vote of thanks was accorded Mr. PÉRINGUEY for his address.

The meeting then formed itself into an Ordinary Monthly Meeting.

Sir DAVID GILL, on taking the President's chair, expressed his thanks for the honour the Society had paid him, and stated that he would endeavour in every way to forward the interests of the Society, and continue the work which Mr. Péringuey had so efficiently performed during his tenure of office.

The following gentlemen were nominated for election at the next meeting: Professor C. E. LEWIS, South African College, by Drs. J. C. BEATTIE and G. S. CORSTORPHINE. JOHN AVERILL ALSTON, Esq., M.R.C.S., L.R.C.P., by Drs. E. BARNARD FULLER and G. S. CORSTORPHINE.

The following gentlemen were elected ordinary members: His Excellency Sir WALTER HELY-HUTCHINSON, G.C.M.G.; Messrs. D. BAXTER, M.A.; LOUIS E. BENJAMIN, B.A., LL.B., Cape Town; ALAN GRANT DALTON; R. COLSON, Pretoria; K. ERIKSEN, Cape Town; the Hon. T. L. GRAHAM; Professor W. S. LOGEMAN; and Mr. T. REUNERT.

Notice of motion of the following additional rule was given by Messrs. SCLATER and CORSTORPHINE:—

"That the Council be empowered to remove from the roll the names of such members as are two or more years in arrear with their subscription."

Mr. SCLATER showed two drawings and read an account of the new African mammal, the *Ookapi*.

The President, Sir DAVID GILL, supported the following recommendation of the Council:—

"That the Society take steps to have a commemorative tablet to the Abbé de la Caille erected on the house now built on the site of the Abbé's residence here in 1751." After some discussion it was unanimously agreed that a sum of £25 should be devoted to the erection of a suitable tablet.

Ordinary Monthly Meeting,

September 4, 1901.

Sir David Gill, K.C.B., F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The President expressed the indebtedness of the members to Dr. Muir for the support and assistance which he had afforded the Society by the use of the Education Department Hall during the past six years. Though that hall was no longer available for evening meetings, Dr. Muir had placed the one in which the meeting was being held at the disposal of the Society, and the President moved that the Society present and record its thanks to Dr. Muir for the valuable aid he has given, and was continuing to give, to its work.

The proposal was unanimously carried.

The President stated that the Council of the Society had appointed a Committee to arrange for the reception of the British and German Antarctic Expeditions which were due in Cape Town at an early date. The Right Hon. Sir Gordon Sprigg had, at an interview that afternoon, expressed the Government's willingness to assist the Society in entertaining the guests. The Prime Minister's Secretary, Mr. Sydney Cowper, would communicate the Government's agreements. Mr. Cowper had also intimated that the Committee of the Civil Service Club had generously granted the use of the large dining-hall for the proposed dinner.

The President announced that the memorial to the Abbé de la Caille was being attended to, and progress would be reported at an early meeting.

The following gentlemen were nominated for election as ordinary members: Mr. J. G. Hallack, Cape Town, by Rev. G. H. R. Fisk and Dr. G. D. Corstorphine; Dr. Gerard Carré, Wynberg, by Messrs. B. R. MacMillan and Dr. G. S. Corstorphine.

Professor C. E. Lewis, M.A., and Mr. John Averill Alston, L.R.C.P., M.R.C.S., were elected ordinary members.

After some discussion the following new rule, of which due notice had been given, was unanimously passed:—

"That the Council be empowered to remove from the roll the names of such members as are two or more years in arrear with their subscription."

The Secretary read a letter on "Veld Dust Columns and Whirlwinds," which had been forwarded to the President by Mr. J. M. Orpen, Salisbury.

Mr. Orpen wrote that his brother, the late Mr. F. H. Orpen, had first told him that all the small dust columns which one sees over the veld moved in the same direction as the cyclones in the Southern Hemisphere, and his own observations confirmed this. Mr. Orpen wanted to know if other members of the Society could also confirm the observation.

Mr. E. Hutchins stated that he had noticed that the larger dust storms moved clockwise over the Karoo, but he had seen small ones turning in either direction.

Mr. C. Stewart said that as the cause of the dust pillars was purely local he saw no reason why they should turn in one direction rather than the other.

Mr. Garwood Alston thought the large and small ones must move in the same direction.

The President said that obviously there was room for further data bearing on Mr. Orpen's question being collected, and trusted that some of the members would devote their attention to the matter.

Dr. W. F. Purcell gave some extracts from a paper on the South African "Baviaan" and "Trap-door" spiders in the collection of the South African Museum, and exhibited specimens of some of the more interesting forms.

The spiders may be recognised by their possessing four instead of two lungs on the under side of the abdomen, and also by the fact that their poison fangs are parallel and directed backwards, whereas in other spiders the fangs are opposable. To the naturalist this group is specially interesting, as it is generally held that the two-lunged spiders were derived from four-lunged forms. In South Africa the group is represented principally by two families. One of these, the *Theraphosidæ*, or "Baviaan" spiders, include our largest spiders. Their feet are provided with a dense pad of short hairs, which enable the animal to walk up perpendicular surfaces. Five genera, two of which are new, and a number of species are now known from South Africa. The principal genus is *Harpactira*, *H. atra* being the well-known form from the Cape Peninsula. This spider makes a hole in the ground, near the middle of which it suspends its eggs on a thin web, and then sits at the bottom of the hole. This arrangement serves to keep the eggs dry when water gets into the hole. The Cape Town species is also recorded from Gordon's Bay and from Malmesbury, but has not been found elsewhere. Dr. Purcell exhibited other species, including *H. tigrina* from Port Elizabeth and the Native Territories.

Another group is the trap-door spiders proper, easily recognised by the structure of their bodies, which are very thick, while the legs are very short. These spiders have powerful spines in a row on their mandibles for burrowing, those which make their trap-door nest in holes on trees being destitute of such spines. There are about thirty species of this group now known in South Africa, about half that number being new to Science. Some make their nests in holes in the ground, perfectly cylindrical at bottom, but having the upper part somewhat wider and closed with a heavy lid.

The PRESIDENT, in thanking Dr. Purcell for his interesting paper, congratulated him on the success which had attended his investigations into the habits and structure of such an interesting group of animals.

Mr. CHARLES STEWART read a paper on "The Hot Winds of Namaqualand, with some reference to the Berg Winds of the South Coast."

The characteristic features of the winds of Port Nolloth, on the west coast of Cape Colony (lat. 29° 14′ S., long. 16° 51′ E., and 26 feet above sea-level), and at O'okiep, about 50 miles inland to the S.E., on an elevated plateau (3,036 feet above sea-level in lat. 29° 36′ S., and long. 17° 52′ E.) were investigated by constructing "Wind-Roses" from observations taken simultaneously at both places at 9 a.m. during January–September, 1900, in order to verify the accuracy of an account furnished by the observers at these stations. The results went to show that at Port Nolloth there are two winds, viz., N.W.'ly and E.'ly, the average temperatures of which are higher than the mean temperature at 9 a.m., while at O'okiep the warm winds blow from N.E. and S.E.

Special attention was directed to the E.'ly winds (*i.e.*, those between E.N.E. and E.S.E.) at Port Nolloth, which are hot and dry, and usually accompanied by cloudless, or almost cloudless, skies; these are confined to the winter months, April–September, and their approach is heralded by a reddish glare in the evening sky. They are succeeded by cool, cloudy weather, which may or may not be accompanied by rain.

The N.E.'ly and E.'ly winds at O'okiep blow throughout the year, but their temperature, as in the case of the prevailing S. winds at Port Nolloth, corresponds with the season, being cold in winter and warm in summer; they are occasionally accompanied by one or other of the higher (Cirrus) clouds coming from N. or N.W. The S.E.'ly winds seem to be of rare occurrence and confined to the summer months. These summer E. and N.E. winds at O'okiep do not reach Port Nolloth.

An examination of the 44 cases in which the wind was E.'ly at Port Nolloth showed that the simultaneous wind at O'okiep was N.E. 14 times, E. 12 times, N.W. 5 times, N. 3 times, S. 3 times, and S.W. twice, while it was calm there on 5 occasions. These winter N.E.'ly or E.'ly winds at O'okiep are cold when blowing over the plateau as far as Klipfontein, situated on its western edge, at an elevation of 3,004 feet (railway measurement). They are experienced as hot winds at Anenous, 6 miles further west (*i.e.*, 48 miles from Port Nolloth), at the base of the plateau, at an elevation of 1,770 feet, where they blow at times with almost hurricane force, occasionally filling a railway cutting with drift sand, and blocking traffic. This wind may increase in temperature the further west it blows, culminating at Port Nolloth, or it may die out as a hot wind before reaching there. These E. winds may continue for a few hours, but mostly last two or three days at Port Nolloth, while the N.E.'ly and E.'ly winds at O'okiep may prevail for weeks.

Mean barometric pressure during these winds is found to be relatively high at both places; the observers stated that at O'okiep the barometer usually rises with this wind, and commences to fall before the wind blows out; while at Port Nolloth the reverse usually occurs, that is, the barometer falls with E. wind and rises before the wind blows out. A comparison of the barometric readings during these E. winds with those of the preceding days shows that this does occasionally occur, but also shows that there may be (*a*) a simultaneous rise or fall at both places; (*b*) rise at Port Nolloth, fall at O'okiep; (*c*) a steady barometer at O'okiep, with fall at Port Nolloth. The mean temperature at 9 a.m. for the nine months was 55·8° at Port Nolloth and 63·7° at O'okiep. This state of the relative temperatures was reversed in June–August, especially in July, when Port Nolloth had a mean temperature of 4·1° F. above that of O'okiep. This reversal is due to the hot E. winds which may start to blow during day or night, and actually raised the temperature to 83·2° at 9 a.m. on one occasion. Another reading gave dry bulb, 78·2°; wet bulb, 59·3°; dew point, 52·3°; relative humidity, 40 per cent. On the same day the observations at O'okiep were: dry bulb, 48·0°; dew point, 37·7°; humidity, 67 per cent.

When the E. wind at Port Nolloth has a force of only 1 on the Beaufort scale of 0·12 the temperature there is, with few exceptions, lower than at O'okiep, but when it is 2 or more, the temperature at Port Nolloth is the higher.

These E. winds at Port Nolloth are usually succeeded by N.'ly or

S.'ly winds with cloudy, cool weather (a fall of 40° F. in one hour has been noted) and occasional rain, but at O'okiep the wind continued N.E.'ly or E.'ly fifteen times out of twenty-four, the other directions being N.W. four times, N. twice, S.W. once, and calm twice.

A remarkable result of these hot winds is what may be termed an occasional inversion of the seasons, the hottest month with highest temperatures (103°–105° F.) sometimes occurring in the winter months of April–September. These irregularities disappear when the mean of eleven years is taken; the average monthly temperature then shows a normal curve, reaching a maximum of 60·3° in February, gradually decreasing to a minimum of 53·8° in August, then rising regularly to the end of the year.

Another peculiarity noted by the observers is that the temperature falls slightly between 1 and 5 p.m. This is evidently due to an attempt of the sea-breeze to assert its influence.

At Clanwilliam similar hot, strong, dry, E. winds are experienced for two or three days at a time in clear weather, usually from end of December to middle of April; these also go round to N., and when they have reached N.E., clouds of the Cirro-Cumulus type appear on the northern horizon, but pass off without rain falling. In 1900 and 1901 these winds have occurred from April to June, much to the detriment of crops, grass, and agriculture generally. The weather preceding their occurrence is oppressive, but cool and pleasant after they have blown over. The appearance of these winds is unfailingly indicated by an abnormal rise of the barometer, the more sudden the rise the sooner and more violent the wind will be. Such winds seem to be general along the West Coast.

The "Berg-wind" is the name given to a wind having essentially the same characteristics, coming along the south coast of the Cape Colony, at least between Swellendam and Storms River, at the base of the mountain ranges. At the latter place it blows almost invariably from a N. by W. direction, and occurs at intervals chiefly during the period May–August, but sometimes also in April and September. It lasts usually for 24 hours, but two of from 36 to 48 hours may be expected during the season; there are usually four to six in these months. They are very dry, and if long continued render veld or forest highly inflammable. A N.E. Berg-wind has been experienced at Storms River, and one in the month of January. A bright orange glow in the sky, lasting some ten minutes after sunset and before sunrise, is locally taken as a sure sign that a Berg-wind is coming. A Berg-wind stops dead, and is followed by a gentle breeze from W, increasing steadily in force, and bringing rain or cold, cloudy weather. The barometer falls during a Berg-wind and rises after.

The description given by the various observers leaves no doubt that the E. wind of Port Nolloth and the Berg-winds of the south coast belong to the same category as the Föhn of Switzerland, the Chinook of Canada and the United States, and the North-Westers of New Zealand, from all of which, however, they differ in the absence of a cloud mass on the mountains, owing to the air coming from the dry interior of top of Africa.

The Port Nolloth E. winds may be accounted for by the formation of a cyclone in the South Atlantic, having its centre to the N.W. of Port Nolloth, and travelling in a S.E.'ly direction, while the interior of Africa is probably occupied by an anti-cyclone. The centre of these cyclones evidently passes to the north, and sometimes to the south of O'okiep, similarly to those of Clanwilliam. In the case of Storms River, the centre of the cyclone probably lies S.W. of this station and travels westwards.

The explanation of the conversion of a cold wind into a hot wind was given by Dr. Hann, of Vienna, in his investigation of the Föhn. The air which is drawn away from the base of the mountain towards the centre of the cyclone is replaced by the air from the plateau, which, being pressed upon in its descent by other air rolling down on top of it, is compressed to a slightly greater density, and heated approximately at the rate of 1·6° Fahr., for every 300 feet of descent (called the " normal adiabatic rate ").

The Cape Town South-Easter more closely resembles the Föhn in having occasionally cloudy mass forming the well-known " Table Cloth " of Table Mountain.

It is proposed that the general term " Berg-winds " would sufficiently indicate the nature of such winds in Cape Colony, where, from its physical configuration, such winds should be of common occurrence.

The rise in the barometer before these winds at O'okiep and Clanwilliam points to the probable existence of a peri-cyclonic ring of high pressure, separating the cyclonic circulation to westwards, from the probable anti-cyclonic circulation of the interior.

Mr. D. Hutchins stated that he had had a large experience of Berg-winds, and could say that often the ordinary wind of the Karoo became a Berg-wind under the mountains. There was no doubt in his mind that Mr. Stewart was right in his explanation.

The PRESIDENT concurred in the explanation of the origin of the conversion of the cold into a hot wind given by the author, and proposed a vote of thanks to Mr. Stewart for his interesting paper, which was unanimously agreed to.

ORDINARY MONTHLY MEETING.

October 2, 1901.

Sir DAVID GILL, President, in the Chair.

The minutes of the last meeting were confirmed.

The SECRETARY read a letter from Lord Milner's Private Secretary expressing His Excellency's thanks for the congratulations of the Society.

Mr. J. G. HALLACK, Cape Town, and Dr. GERARD CARRÉ were elected ordinary members of the Society.

Mr. HERBERT BAKER reported that he and Mr. Péringuey had looked at the house on which the memorial to L'Abbé de la Caille was to be erected, and that he had made a sketch of the proposed tablet which, he recommended, should be cast in bronze.

Mr. BAKER, with the sanction of the President and members present, introduced the question as to the steps the Society should take concerning the Town Council's proposal not to build the Town House portico which had recently been pulled down. Mr. Baker said: "I trust you will agree with me that the protection of our few ancient buildings is a duty which should be undertaken by this Society, and I may remind you that it has already accepted the principle by discussing other archæological subjects, such as the Portuguese crosses and the Post-office stones. Of old buildings in the peninsula which are not private property we have only four—the Castle, Constantia, Tokai, and the Town House—and as the Castle has already been very much altered, we may say that the Town House was (I cannot say is) the only complete building in Cape Town, and the protection of it therefore seems to be all the more important. The chief arguments on the other side are as follows: (1) That the building is not of any great antiquity; (2) that it is built only of plaster; (3) that it is not very beautiful. As to its age, it is true that it was only built in the Governorship of van

Tulbagh, between 1750 and 1760. (It is interesting, by the way, that the old Court-house at Tulbagh has a somewhat similar porch, a sketch of which I am able to show you.) But age is a matter of comparison, and 150 years is old in proportion to the age of the Colony. Holland might as well cease to reverence its old buildings, which are little more than three centuries old, because those of England go back to the twelfth century, which again would appear quite modern in comparison with those of Italy. The old Colonial architecture of the Southern States which is now so much reverenced by the Americans is very little, if at all, older than the earlier buildings of Cape Colony. As to the plaster, it is well to remember that, with all our modern knowledge and science, we have introduced nothing better to build with in Cape Town, and also that the Romans, and in some cases the Greeks, plastered their buildings. The architectural merits of the Town House may perhaps be a matter of taste; it certainly lacks height and a fine roof, but we could wish that some of the modern buildings in Cape Town possessed more of the elements of good architecture which this does. I think the prejudice against it, with some people, arises from its bad and dingy colouring, and partly from its present business associations. (Laughter.) All this, however, will or can be changed. I speak with the more confidence as to its possible improvement in appearance as, having spent some time of my life in the restoration of old buildings in England, I know how often one has been completely surprised at the result of restoration upon a building of what seemed a most unprepossessing nature. I should be the last to let reverence for the remains of the past stand in the way of any real public progress or improvement, but it is difficult to see how this really exists in the case under discussion, and I trust that this Society will see its way to make a vigorous protest." Proceeding, Mr. Baker suggested that the building should be preserved with the object of having it converted into a museum, and concluded by formally moving that the Society draw up a petition for presentation to the City Council asking that the old portico be restored.

The President said he had the very greatest sympathy with what had fallen from Mr. Baker. They had very few ancient memorials in this part of the world, and he thought they would be very foolish and very wrong if they allowed these old landmarks to be destroyed. He would be very glad to see the Town House retained as a museum. There were many old things still left in the Colony which could be acquired and stored in such a museum. He felt sure that it could thus be made extremely interesting to visitors to Cape Town. The question was whether they, as a Society, should intervene by petition. He thought they were perfectly entitled to do so. Such action would be quite within the scope of the Society.

Mr. D. Tennant, jun., said he had great pleasure in seconding Mr. Baker's motion. It was difficult to understand the position taken up by the Town Council. First of all, they said the portico was an obstruction. That argument hardly held water, as there was the whole of Greenmarket Square before the Town House, and therefore plenty of elbow-room. Moreover, it had been there for a great number of years, and had never before been found to be an obstruction. What seemed really to be the case was that they had deliberately let the portico fall into this state of disrepair simply to provide an excuse for getting rid of it. Then it was urged that the portico was a danger to the public. If that was really so, he could only say that the Town House authorities had done a very wrong thing in allowing crowds to gather under it at the time of the Royal visit, or so lately as on the occasion of the arrival of Lord Milner. He considered that old landmarks should not be thus ruthlessly destroyed, and that the ratepayers as a whole should be prevailed upon to protest against such destruction. A great deal of sentiment was associated with the building. There were so few old buildings linking the present with the past. The Town House had been the scene of many memorable events. No other building in the city had so many historic associations, and he considered that the City Council had been guilty of a very high-handed proceeding in taking destructive measures without consulting the people of Cape Town. He hoped sincerely that the old portico would be restored.

It was agreed *nem. con.* that the Society forward a formal resolution to the Corporation urging the rebuilding of the portico.

The President summarised Dr. A. W. Roberts's paper, "The Variation of the Star C.P.D. $-41^{\circ}\cdot4511$."

Mr. D. E. Hutchins read a note on the introduction of a decimal coinage, weights and measures for South Africa.

After some discussion, it was resolved that a Committee consisting of the President, Dr. Beattie, Dr. Crawford, Professor Thomson, Mr. E. T. Littlewood, and Mr. Hutchins be appointed, with power to add to its numbers, to prepare a report on the advisability of introducing or legalising a decimal coinage and the metric system of weights and measures into South Africa.

The President briefly summarised Mr. H. G. Fourcade's paper, "On a Stereoscopic Method of Photographic Surveying," and intimated that time would be afforded for a demonstration and discussion of the method at the next meeting.

Ordinary Monthly Meeting.

October 30, 1901.

Sir David Gill, President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were nominated for election as ordinary members at the next meeting: Dr. Anderson, Medical Officer of Health, Cape Town, by Mr. R. O. Wynne-Roberts and Dr. G. S. Corstorphine; Rev. B. Guyer, Claremont, by Mr. Sydney Cowper and Sir David Gill; Mr. Ohlsson, by Messrs. John Proctor and G. S. Corstorphine; Mr. C. S. Meacham, F.C.S., Newlands, by Messrs. H. Bolus and G. S. Corstorphine; Mr. J. Saxon Mills, M.A., Cape Town, by Messrs. Herbert Baker and G. S. Corstorphine; Mr. J. Robertson, Wynberg, by Messrs. E. T. Littlewood and G. S. Corstorphine; Mr. H. P. Shepherd, Stellenbosch, by Messrs. L. Péringuey and G. S. Corstorphine.

Dr. Lawrence Crawford communicated a "Note on the Summation of the Natural Numbers," by Mr. J. R. Sutton, of Kimberley.

Mr. H. G. Fourcade gave a further explanation and demonstration of his stereoscopic method of photographic surveying, which had been communicated by the President at the close of the last meeting.

After some discussion on the merits of the plan, it was proposed by Dr. Crawford, and seconded by Dr. Flint, that the matter of assisting Mr. Fourcade in obtaining financial aid to enable him to have the instrument made which is necessary for his method, should be referred to the Council of the Society. This was unanimously agreed to.

Ordinary Monthly Meeting.

November 27, 1901.

Sir David Gill, President, in the Chair.

The Minutes of the last meeting were read and confirmed.

The following nominations for election as ordinary members were made: James P. Muirhead, Esq., by Sir David Gill and Mr. G. M. Clark; E. F. Kilpin, Esq., C.M.G., by Mr. D. E. Hutchins and Dr. G. S. Corstorphine; Rev. J. O'Neil, by Messrs. L. Péringuey and W. L. Sclater; B. W. Ritso, Esq., by Dr. G. S. Corstorphine and Mr. W. L. Sclater.

The following gentlemen were elected ordinary members of the Society: Dr. A. Jasper Anderson, Rev. B. Guyer, Messrs. C. S. Meacham, J. Saxon Mills, O. A. Ohlsson, J. Robertson, and H. B. Shepherd.

The President stated that the reference to Council with regard to Mr. H. G. Fourcade's instrument for a stereophotographic method of surveying had been favourably received, and the Council had decided to approach the Government regarding financial aid towards the manufacture of the instrument.

The President intimated that the dinner in honour of the German Antarctic Expedition on board the *Gauss*, would be held on Tuesday, December 2nd, the hour and place to be intimated later to subscribers.

The following communications were read:—

"Transactions of Malignant Jaundice of the Dog by a Species of Tick," by Mr. C. P. Lounsbury.

"The Transkei Gap," by Messrs. A. W. Rogers and E. H. L. Schwarz.

"The Results of some Experiments on the Rate of Evaporation," by Mr. J. R. Sutton.

Ordinary Monthly Meeting.

February 26, 1902.

The Secretary having intimated the receipt of a telegram from the President stating that he was suffering from influenza, and the Vice-President being absent, the meeting elected the Rev. Dr. Flint to the Chair.

The minutes of the last meeting were read and confirmed.

The following nominations for election at next meeting were announced: D. C. Andrew, Esq., Cape Town, by Messrs. G. S. Corstorphine and W. L. Sclater; Miss L. M. Bernard, Wynberg, by Messrs. E. T. Littlewood and J. Robertson; Polhemus

Lyon, Esq., by Rev. Dr. Flint and Dr. G. S. Corstorphine; F. P. Mennell, Esq., Bulawayo, by Messrs. E. H. L. Schwarz and G. S. Corstorphine; H. Clement Notcutt, Esq., Kimberley, by Messrs. G. S. Corstorphine and J. G. Lawn; Kurt Dinter, Esq., Windhoek, by Messrs. J. C. Watermeyer and G. S. Corstorphine; Hon. G. D. Smith, Cape Town, by Drs. G. S. Corstorphine and J. D. F. Gilchrist.

The following gentlemen were elected ordinary members of the Society: E. F. Kilpin, Esq., C.M.G.; James M. P. Muirhead, Esq.; Rev. J. A. O'Neil; B. W. Ritso, Esq.

The Secretary read letters, forwarded by the President, from the Imperial German Consul-General, and Professor Erich van Drygalski, thanking the Society for its hospitality to the latter and his staff on board the *Gauss*.

The Secretary intimated that the Council of the Society had hired a room in the building in which the meeting was being held for safe keeping of the library. Dr. J. C. Beattie had given his services as librarian, and it was hoped that in a short time the room would be ready for the use of members. It was suggested by the Chairman that the question of ensuring the Library should be referred to the Council.

The Secretary intimated that during the year the Society would celebrate its semi-jubilee. The question as to what special form the celebration should assume was left to the Council.

The Secretary read the following notice of motion by Mr. T. Stewart for consideration at the next meeting: "That a Committee be appointed to correct and revise the Rules of the Society."

The report of the Committee on the metric system and decimal coinage was presented as follows:—

Report of the Committee on Decimal Coinage and the Metric System.

At the ordinary meeting of the Society held on October 2, 1901, the President (Sir David Gill), Dr. J. C. Beattie, Dr. Lawrence Crawford, Mr. D. E. Hutchins, Mr. E. T. Littlewood, Dr. T. Muir, Professor Thomson, and the Secretary of the Society were appointed as a Committee, with power to add to their number "to prepare a report on the advisability of introducing a decimal coinage and the metric system of weights and measures into South Africa, or of legalising these throughout the region."

The following gentlemen were subsequently appointed to the Committee: Mr. G. M. CLARK and Mr. H. G. FOURCADE.

The Committee met on December 27, 1901, the following members being present: Sir DAVID GILL, in the Chair, Messrs. H. G. FOURCADE, D. E. HUTCHINS, E. T. LITTLEWOOD, Dr. T. MUIR, Professor THOMSON, and the SECRETARY of the Society.

It was unanimously agreed to lay the following report before the Society at the next ordinary meeting.

The Committee recommends:—

"1. The desirability of making the metric system of weights and measures legal throughout the several South African Colonies, as it is at present in England.

2. The compulsory introduction, at some definite date, of the metric system by the Home Government, with a view to its early adoption throughout the Empire.

3. That a decimal system of coinage be adopted, the sovereign being taken as the fundamental unit.

4. That the attention of the several governments and administrations, and other bodies in South Africa interested in the question be directed to the above recommendations."

Considerable discussion ensued, and after various suggestions had been offered and amendments made the meeting agreed upon the following:—

"1. The desirability of making the metric system of weights and measures legal throughout the several South African Colonies, as it is at present in England.

2. The compulsory introduction at some definite date of the metric system into the several South African Colonies.

3. The adoption throughout the Empire of a decimal system of coinage, the sovereign being taken as the fundamental unit."

It was resolved that the above resolutions be sent to the Hon. the Prime Minister, and that the Society should ask the Colonial Government to draw the attention of the Home Government and the other Governments of the Empire to the necessity for the introduction of the metric system and of a decimal coinage throughout the Empire, and that the suggestion be made to the Hon. the Prime Minister that this subject might be worthy of consideration at the forthcoming conference of Colonial Ministers in London.

It was further resolved that the above resolution should be communicated to other scientific societies.

The following report of the Committee appointed to consider the erection of a memorial tablet to the Abbé de la Caille was unanimously adopted :—

Report of the Committee appointed to arrange for the erection of a memorial to the Abbé de la Caille.

"The Committee consists of the President (Sir David Gill), Messrs. Herbert Baker, and L. Péringuey.

The design, prepared by Mr. Herbert Baker, and already submitted to and approved by the Society, will cost, executed in bronze, the sum of £40. The Committee recommends that this expenditure be authorised—the original grant being £25."

The paper on "Irrigation of the Orange River," by Mr. F. B. Parkinson, was postponed to the next meeting.

The Chairman proposed that as this was the first meeting held in the Board Room of the South African Association, the thanks of the Society to the Secretary and Directors of the Association should be recorded in the minutes. This was heartily agreed to.

Ordinary Monthly Meeting.

March 26, 1902.

In the absence of the President and Vice-President, Mr. Thomas Stewart was elected Chairman.

The Chairman stated that it was with deep regret that the members of the Society had just learned of the death of the Hon. Mr. Rhodes at six o'clock that evening, and he would be expressing their feelings if he at once adjourned the meeting till further notice. The announcement was received by all members rising, and the meeting forthwith adjourned.

Postponed Ordinary Meeting.

April 9, 1902.

Mr. L. Péringuey, Vice-President, in the Chair.

The minutes of the meeting of February 26th were read and confirmed.

The following nominations for election at the next meeting were announced: Mr. A. C. van der Hoop, Consul-General for Holland, by Messrs. W. L. Sclater and G. S. Corstorphine; Dr. Maberly, Salt River, by Drs. R. Marloth and G. S. Corstorphine; Mr. H. E. V. Pickstone, Groot Drakenstein, by Messrs. A. Struben and G. M. Clark.

The following were elected ordinary members of the Society: Miss L. M. Barnard, Wynberg; Messrs. D. C. Andrew, Cape Town; Polhemus Lyon, Wynberg; F. B. Mennell, Bulawayo; H. Clement Notcutt, Kimberley; Kurt Dinter, Windhoek; Hon. G. D. Smith, Cape Town.

Mr. T. Stewart moved "That a committee be appointed to revise and correct the rules and bye-laws of the Society." The motion having been passed *nem. con.*, the President, Messrs. G. M. Clark, Sydney Cowper, the Secretary, and Mr. Stewart were appointed as the Committee.

The Rev. Dr. William Flint read a paper on "The Legal and Economic Basis of some Colonial Teaching Universities, with a local application."

A discussion, in which Messrs. Beattie, Clark, Cowper, Gilchrist, Hammersley-Heenan, Littlewood, Marloth, Muirhead, Stewart, and Struben joined, took place as to the most effective way in which Dr. Flint's paper could be discussed. It was ultimately resolved by 22 votes to 3, that the paper be printed at once and brought up for discussion at a future meeting.

Mr. Westhofen exhibited a mass of root cut out of a water-pipe at Muizenberg.

The reading of Mr. Parkinson's paper was postponed till next meeting.

Ordinary Monthly Meeting.

April 30, 1902.

Sir David Gill, President, in the Chair.

The minutes of the last two meetings were read and confirmed.

The following nominations for election at the next meeting were read: Mr. S. H. Hayward, Cape Town, by Messrs. H. G. Fourcade and G. S. Corstorphine; Mr. Rudyard Kipling, by Miss M.

Wilman and G. S. Corstorphine; Mr. A. J. Lewis, Cape Town, by Drs. L. Crawford and G. S. Corstorphine.

The following gentlemen were elected ordinary members of the Society: Mr. A. C. van der Hoop, Dr. Maberly, Mr. H. E. V. Pickstone.

The Secretary intimated that the paper read by the Rev. Dr. Flint at the last meeting had been printed and would be sent to members so that it might be discussed at the next meeting.

The President stated that as a result of his interview with the Right Hon. the Premier to ask for some financial aid to enable the particular photo-theodolite described by Mr. H. G. Fourcade to the Society at the meeting held on October 2, 1901, to be constructed, he had now received information that a grant of £200 would be placed at Mr. Fourcade's disposal.

At the request of the President, the Secretary read a paper on "Irrigation on the Orange River," by Mr. F. B. Parkinson.

Mr. Kilpin mentioned how in connection with the question of irrigation a scheme for utilisation of the Hartz River had been drafted and brought into Parliament by the late Mr. Rhodes. Mr. Kilpin handed in a copy of the votes. Proceedings of the House of Assembly containing the motion by Mr. Rhodes—"That the House go into Committee for an address to the Officer Administering the Government for leave to consider the following: That this House, in consideration of the advantage that would result to the country from the construction of irrigation works in the Hartz River valley, recommend for the purpose of constructing such works:

(1) That a Board be constituted representative of the districts of Griqualand West.

(2) That the Government be authorised to guarantee on the credit of the Colony a loan to be raised by the Board for an amount not exceeding £200,000.

(3) That the capital and interest of this loan be secured upon the landed property and mines in Griqualand West.

(4) That the Board have power to levy a local rate on all landed and mining property in Griqualand West for the purpose of paying interest on and for a sinking fund for the said loan.

(5) That no landed or mining property shall be pledged, nor shall any local rate be levied upon it until consent shall have been obtained from

- (*a*) Municipalities in regard to land in Municipalities.
- (*b*) Village Management Boards in regard to land in villages having such Boards.

(*c*) Divisional Councils in regard to land outside Municipalities and to places under Village Management Boards: Provided that in no case shall any landed or mining property be pledged or any local rate levied until the De Beers Mining Company shall have first consented to the application of these provisions to De Beers Mines.

(6) That the Crown Land referred to in the resolution of the House of Assembly, dated the 14th of May, 1886, between the Hartz and Vaal River, be granted to the said Board in consideration of the execution of this irrigation scheme.

After discussion, with leave of the House, the motion was withdrawn."

Mr. WIENER stated that he had always thought that the Hartz River scheme would prove advantageous, and regretted extremely that nothing had been done to carry it out. Mr. Wiener knew of farms in Calvinia where the rivers flood and irrigate the land naturally, resulting in wheat returns of 100 to 150-fold.

Mr. FITT gave an account of the Hartz River scheme, and referred to the Blue Book containing all the details. Mr. Fitt hoped that the Government would realise the advantage of extended harvesting of the surface waters.

Mr. STRUBEN referred to the difficulties of small irrigation schemes on the upper part of the Orange River, comprehensive schemes being there essential. Mr. Struben hoped that Mr. Parkinson would furnish the Society with the initial cost, cost of pumping, and the capacity of the plant described in his paper.

Dr. MARLOTH read a paper on "Some recent observations on *Roridula*." Mr. C. MALLY exhibited and named some of the insects which Dr. Marloth had found on the plants which he had observed.

ORDINARY MONTHLY MEETING.

Wednesday, May 28th.

Sir DAVID GILL, K.C.B., F.R.S., President, in the Chair.

The minutes of the preceding meeting having been read and confirmed, the following nominations were made: The Hon. R. I. FINNESMORE, Puisne Judge, Natal, by Messrs. T. MASON and W. ANDERSON; Rev. W. OWEN JENKINS, Diocesan College, by Drs. CRAWFORD and CORSTORPHINE.

A ballot having been taken, the following gentlemen were elected members of the Society: Mr. SAVILL H. HAYWARD, Cape Town; Mr. RUDYARD KIPLING, Mr. A. J. LEWIS, Cape Town.

Mr. HUTCHINS then gave notice that he had some important communications to make to the Society at the next meeting on the metric system and decimal coinage; he further informed the Society that he had received certain pamphlets bearing on the subject.

Mr. WIENER then read his paper on "Notes on some Recent Deep boring."

The discussion was opened by the PRESIDENT, who pointed out the danger of using Latin formulæ derived from observations comparatively near the surface to determine the temperature at great depths beneath the earth's crust. It is much more certain that the interior is solid than that the formulæ are correct. More observations are certainly necessary. The President called upon Mr. RITSO to speak. He wished for further information as to the mechanical means used.

The discussion closed with a hearty vote of thanks to Mr. Wiener.

A mathematical communication by Mr. J. R. SUTTON on "Some Results Derived from the Constant Values in the Periodic Formulæ" was taken as read.

The discussion by the Rev. Dr. Flint's paper on "The Legal and Economic Basis of some Colonial Teaching Universities with a local application" was opened by Professor CRAWFORD. He referred to the different types of universities in Great Britain and the Colonies. Discussing the matter of local application of the principles governing the different kinds of universities, Professor Crawford said that he thought that the idea of making an Oxford or a Cambridge in South Africa, though perhaps it might be an accomplishment of the distant future, was not one which could be practically discussed just now. The speaker thought that the only scheme open at present was the establishment of a university like one of the Australian universities, where practically the university and the college were one, though there were subsidiary affiliated colleges, or the establishment of a university like Victoria University, Manchester, with incorporated colleges. If, as suggested by Dr. Flint, the best plan was found to be the making of a university of one of the present colleges, with the other colleges affiliated, the speaker thought that they must go to the best endowed and best equipped of the present colleges. If the other scheme were adopted, the governing body should be almost entirely composed of representatives elected by the incorporated colleges. At the same time before any college could become incorporated it would have to show that it was properly equipped.

Professor FREMANTLE considered that the idea of an Oxford or Cambridge, if attainable at any future time, should not have the door closed upon it now.

Professor RITCHIE also spoke, pointing out the situation in South Africa with its small population.

Dr. FULLER then gave notice that he would move a resolution at the next meeting.

As this was the last meeting which Dr. Corstorphine would attend as Secretary, the PRESIDENT expressed the great regret of all the members of the Society at the loss of one who had done so much to further its aims, and at the same time wished him all success in his new sphere.

ORDINARY MONTHLY MEETING.

July 2, 1902.

L. PÉRINGUEY, Vice-President, in the Chair.

The minutes of the preceding meeting having been read and confirmed, the following nominations were made: Dr. FISMER, Cape Town, by Messrs. PÉRINGUEY and PURCELL; Dr. A. E. THOMSON, Cape Town, by Messrs. T. STEWART and CLARK.

A ballot was taken, and the following were elected members of the Society: Hon. R. I. FINNESMORE, Puisne Judge, Natal; Rev. W. OWEN JENKINS, Diocesan College, Rondebosch.

Dr. CORSTORPHINE was appointed as Delegate from the Society to the incoming Meeting of the British Association for the Advancement of Science.

The discussion on Rev. W. Flint's paper was resumed by Dr. FULLER, who moved the resolution:—

"That the Society is of opinion that at the present time the needs of university education in Cape Colony are very imperfectly met; and that in order satisfactorily to promote university interests, an inquiry should be held on the whole question of university education in Cape Colony. The Society suggests that the inquiry should in particular be directed to the consideration of the following points: (1) The possibility of the equipment of one or more educational institutions in a manner that shall make it, or them, able to satisfactorily meet the demands of university teaching in Cape Colony; (2) the possibility of devoting more money to university teaching in Cape Colony; (3) the possibility of obtaining better results from the money at present devoted to university teaching in Cape Colony."

Professor C. E. LEWIS expressed the view that the Society should not embark on the field of general advisers, and regretted the line taken in previous discussion. He was one interested in education, but thought the matter should have been brought before other assemblies. Any inquiry that should be held ought to cover the whole field, and the Society should not lay down the lines to be followed.

Sir JOHN BUCHANAN, Vice-Chancellor of the University, was thankful to the Society for discussing this vital matter of education. Higher education had made considerable progress during the last thirty years. He pointed out that it had been already proposed in the Cape of Good Hope University Council to approach the High Commissioner with the view of discussing the whole matter of higher education in South Africa, and that a commission will probably be appointed. He considered that whilst the Society might not fix the details of a scheme, they ought not to hesitate to discuss matters.

Dr. BEATTIE, whilst in sympathy with Professor Lewis, thought his objections fell to the ground, and seconded Dr. Fuller.

Mr. STEWART asked to whom the suggestion was to be made, whilst Dr. MARLOTH was of opinion that it was not part of the business of the Society to throw out a programme of inquiry.

Eventually Dr. FULLER withdrew the particular suggestions. Dr. CRAWFORD proposed to substitute "South Africa" for "Cape Colony." Mr. T. STEWART, in seconding Professor Lewis, expressed himself as in entire agreement with the need of improving university education, but was doubtful whether 10 per cent. of the members of the Philosophical Society ought to be the lever to obtain that object.

After some further discussion Dr. FULLER gave notice that he would move at the next meeting that the resolution of the Society should be sent to the Colonial Secretary, and Mr. T. STEWART gave notice that the matter be referred to the Council. The proposal put to the meeting was—"That the Society is of opinion that at the present time the needs of university education in South Africa are very imperfectly met, and that in order to satisfactorily promote university interests an inquiry should be held on the whole question of university education in South Africa." This was carried, and the meeting adjourned.

ANNUAL ADDRESS TO THE MEMBERS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY

On September the 17th, 1902.

By the President, Sir DAVID GILL, K.C.B., F.R.S., LL.D., etc.

The report of the Secretary, now in your hands, describes the work of the Society during the past year, but it leaves the President to make allusion to the fact that this annual meeting represents our semi-jubilee.

In the year 1900 we had the pleasure of congratulating our member, Dr. Muir, on his election to the Royal Society of London. To-day I feel sure you will no less cordially congratulate another member, Mr. S. S. Hough, who has quite recently earned the same distinction.

The Society was declared constituted on the 22nd of June, 1877, with an original roll of thirty-nine members, which by the 30th of the same month had risen to seventy-eight. The rules of the Society were adopted on July 16th; the ballot for the election of the President and Council followed on July 23rd, and the first ordinary monthly meeting was held on September 26th of the same year.

It will not be forgotten that the first President of the Society was Sir Bartle Frere; those who remember these early days can alone estimate the impulse which his tenure of office gave to the Society. This impulse was not alone due to the high position of the President, it lay rather in his constant interest in and sympathy with the aims and objects of the Society, and in his encouragement of all who were doing, or desired to do, honest scientific work. Besides this he delivered two addresses from the Presidential chair which are characteristic of the broad views, the foresight, the wide knowledge and high administrative capacity of the man. These addresses contain matter which we can with great profit study now,—suggestions, some of which we have in whole or part adopted, others that the Society or the Country would do well to take to heart and adopt in the future.

The first of these addresses was on the subject of the Native Races of South Africa—and here he draws attention to the need for preserving all that we now can of the languages, history, folk-lore, poetry, and characteristics—intellectual as well as physical—of the native African races. It is not now my object to follow this address—interesting, important, and eloquent as it is—but there is one suggestion which it contains that the Council of the Society might well consider. It is this, I quote Sir Bartle's words :—

"Your Society could not open (in ethnology) with a better preface than by publishing a Summary of Dr. Bleek's literary labours and republishing all his reports to the Government Department of Native Affairs between 1873 and time of his death."

Sir Bartle's second address is full of helpful and far-seeing suggestion ; as instances of such foresight I may perhaps mention his indication of the importance of "inquiries regarding the Tetse-fly, its habits, and a possible cure for its bite," an inquiry which in the hands of Colonel Bruce, of the Army Medical Department, has within the past few years led to such important results, and earned for the inquirer a well-won Fellowship of the Royal Society. It is but right to add that the man who gave the opportunity to Colonel Bruce was His Excellency Sir Walter Hely Hutchinson, then Governor of Natal, who intended to be present at this meeting, but is prevented by the results of a severe chill.

A Bathometric Survey is urged by Sir Bartle Frere, and the Geological Commission is now thinking about it. The need for accurate survey of the Country is strongly urged by our first President, and action, as we shall see later, has followed his suggestion.

There is a great temptation to continue my address in this strain, to dwell on the important suggestions and interesting reminiscences contained in other Presidential addresses, and on the valuable original scientific work, especially in South African botany and entomology, contained in the Transactions of the Society.

But I have been led away from this subject by another consideration, viz., that to-night we not only celebrate the first semi-jubilee of the South African Philosophical Society, but the third jubilee of an event of no small scientific importance, viz., the laying of the foundation of exact Sidereal Astronomy in the Southern Hemisphere.

The first extensive and accurate catalogue of the stars of the Southern Hemisphere rests on the observations of the Abbé de la Caille, which were made at the Cape of Good Hope in 1752—that is to say, 150 years ago. This circumstance has led me to regard the present as a fitting opportunity for reviewing the history and progress of Astronomy and Geodesy at the Cape as a most suitable subject for the present address.

On October 5, 1892, I had the honour to deliver a lecture in connection with the Kimberley Exhibition of that year, and may perhaps be allowed to quote the words used on that occasion in reference to Lacaille and his work:—

"Lacaille's expedition was one of the most memorable, successful, and useful scientific expeditions ever undertaken, and Lacaille himself one of the most earnest and active astronomers that ever lived. Although he died at the age of forty-nine, Lalande said of him with perfect justice and truth that, during a comparatively short life, he had made more observations and more calculations than all the astronomers of his time put together. It required a man of such extraordinary energy and enthusiasm to perform the feat of determining with considerable precision for the time, the places of ten thousand stars in a single year. He laid the foundations of the Sidereal Astronomy of the Southern Hemisphere; he did that great work in a single year at Strand Street, in Cape Town; he won the love and friendship of all who knew him; he rendered many scientific services to the Dutch Government of the day, including a survey of Houts Bay; and, if ever in this Colony we reach that point of civilisation in which the works of our scientific worthies will be commemorated by statues erected to their memory, that of the Abbé de la Caille has unquestionable claim to be the first of the series."

Well, ladies and gentlemen, I am happy to say that this suggestion has borne some fruit.

Mr. L. Péringuey during his Presidency brought forth the subject of erecting a Memorial to Lacaille before the Council of the Society.

At the ordinary meeting on July 31, 1901, the following resolution was, on the recommendation of the Council, brought before the Society and unanimously adopted:—

"That the Society take steps to have a commemorative tablet of the Abbé de la Caille erected on the house now built on the site of the Abbé's residence in Cape Town in 1752."

The tablet was designed, as a labour of love, by Messrs. Herbert Baker and Masey, architects, of Cape Town, and it is now before you to-day, preparatory to being placed on a site the nearest practicable to the spot where Lacaille lived and worked.

It bears, as astronomical symbols, the stars of the Southern Cross and Lacaille's quadrant; the geometrical figures represent the plan of Lacaille's measurement of an arc of meridian at the Cape, another of his labours to which further reference will presently be made.

The reasons why Lacaille selected the Cape of Good Hope as the scene of his labours are not far to seek. A glance at the map of the world and some slight knowledge of the history of civilisation will show that in 1752 the Cape of Good Hope was perhaps the only spot situated in a considerable Southern Latitude which an unprotected astronomer could visit in safety, and where the necessary aid of trained artizans to erect his Observatory could be obtained. At the Cape these advantages had existed for a century, and besides being the most southerly point conveniently available, it is situated nearly in the same meridian as Central Europe, so that almost simultaneous meridian observations of the Moon and Planets could be made in both hemispheres for the purpose of determining their parallax, or the same phenomena of Jupiter's satellites could be noted in both hemispheres for the purpose of determining the longitude of the Cape.

In these days the longitude of the Cape was very imperfectly known. Nowadays there are few points on the habitable parts of the globe whose longitude is not known within three or four miles, and all important points within a fraction of a mile; but in those days there was an uncertainty, as to the longitude of the Cape, of many miles. To secure a fresh and well-determined departure from a point which would be sighted or touched by most vessels bound to or from the East Indies was a matter of practical importance so well understood that it furnished the most powerful argument for smoothing Lacaille's path, and was accepted by Governor Tulbagh as a sound reason for giving Lacaille a hearty welcome, building an Observatory for him, and affording him every aid.

The Cape may thus be regarded as the birthplace of exact astronomy in the Southern Hemisphere.

From the days of Lacaille practically nothing was done in the way of Southern Astronomy for seventy years, until the year 1821, when Sir Thomas Makdougall Brisbane, having been appointed Governor of the Colony of New South Wales, and being himself an ardent amateur of the science, resolved to establish an Observatory at his own expense. With this view he made a collection of astronomical books and instruments, and engaged two assistants—Mr. Charles Rumker and Mr. James Dunlop—to act as his astronomers.

On his arrival in the Colony in November, 1821, a situation for the Observatory was fixed upon at Paramatta, near his official residence, about fifteen miles distant from Sydney. Evidently no time was lost, for the Observatory was completed, the instruments mounted, and observations begun by May, 1822. Sir Thomas Brisbane had acquired a taste for astronomy by making sextant observations at sea. He had no previous experience in the use of the larger instruments of precision, and those which he selected for his Observatory proved unsuitable, partly from defects in their construction or erection, partly from inefficient methods of use. The result is that the catalogue of 7,385 stars computed and prepared by Mr. Wm. Richardson from about forty thousand observations made at Paramatta in the years 1822–26 is of comparatively little value.

The Royal Observatory at the Cape was established by an Order in Council on the 20th of October, 1820. The first holder of the office of His Majesty's Astronomer was the Rev. Fearon Fallows, who arrived at the Cape in May, 1821, and, after some inquiry, selected the site of the present Observatory, and made preliminary observations with portable instruments which he had brought with him for the purpose.

In his days the site was practically a bare rocky hill covered with thistles, infested with snakes (its name was Slang Kop or Snake Hill), the jackals howled dismally around it at night, and a guard of soldiers had to be established to protect the property from theft. To give some idea of the Observatory surroundings—a member of the Maclear family told me that in Fallows's days a hippopotamus found its way from the Berg River into the treacherous marsh which then existed, about half a mile from the Observatory, near to the site of the present railway bridge at Maitland. The poor animal sank in the mud so deep as to be unable to get out, and was killed by the neighbouring farmers. The story goes that their bullets could not penetrate the animal's hide, so they cut holes in the hide and fired through them.

It was not until December, 1824, that building operations were commenced, nor until the end of 1828 that the instruments were mounted and ready for work.

Meanwhile Fallows, to occupy himself, opened a school and taught the children of neighbouring farmers. His fee was a load of earth for each lesson, and to this we owe nearly the whole of the soil and the amenities of the site.

During 1829 and 1830 observing was prosecuted with vigour. In the latter year Fallows's excellent assistant, Captain Ronald, fell sick, and Fallows was left alone to do what should have been the work of four men—a task in which he was most ably assisted by his wife, whose aptitude and intelligence were such that with very little instruction she was soon competent to make observations with the Mural Circle whilst Fallows himself observed with the transit instrument.

The cares and anxieties which he endured enfeebled his constitution. Fallows had left England full of high aspiration, full of strength and energy which it was his ambition to devote to the great scientific task before him. The plans for the Observatory which he had approved before leaving England were delayed four years before he received them at the Cape. The Whigs, in a fit of economy, suddenly cut £10,000 off the estimates for completing the Observatory, and the building was left without the necessary out-houses and servant's accommodation, without roads or easy means of communication, without sources of food-supply—a mere block of masonry on a barren hill. His two original assistants failed him, one suddenly leaving him, and the other had to be dismissed for misconduct. By a gross oversight on the part of the maker, the great Mural Circle was sent out in an imperfect condition. The worry and perplexity which this caused him by apparently anomalous results (which fortunately affect his observations only in detail but not sensibly in the mean result) are stated on high authority to have been the means of shortening his life.

In the summer of 1830 he experienced a severe attack of scarlet fever from which his enfeebled constitution never rallied. In March, 1831, he reluctantly went to Simon's Bay for rest, and there died on the 25th of July, 1831, in the 43rd year of his age.

His widow conveyed the manuscripts of his observations to England, and they were finally reduced and published by Sir George Airy. The catalogue contains the right ascensions of 425 stars observed with the transit instrument, but of these the declinations of only 88 were observed with the mural circle.

Fallows's successor was Mr. Thomas Henderson, a man who by his inborn genius raised himself by degrees from the position of a lawyer's apprentice in Dundee to that of one of the most accomplished scientific men of his time. He reached the Cape in April, 1832, and, together with his assistant, Lieutenant Meadows, worked unremittingly for thirteen months, and then resigned the post. Henderson was not physically a strong man, and it was impossible for the strongest adequately to fulfil the duties of his office without more assistance; the circumstances pressed too strongly against him, and he was too honourable a man to accept the emoluments of an office without the most punctilious discharge of its duties. In his letter of resignation, addressed to the Secretary of the Admiralty, he mentioned that not only the state of his health rendered him unable much longer to support the requisite exertions, but that the Observatory itself, considered as a place of residence, laboured under so many disadvantages and required a mode of life so different to what he had been accustomed, that he found it impracticable to remain longer. His letter proceeds as follows:

"Perhaps I may be pardoned for taking the liberty of recommending to their Lordships' consideration the state of the Observatory, which I am afraid would, in the opinion of every British subject who takes an interest in science and regards the honour of his country, be deemed not satisfactory."

He adds a detailed memorandum pointing out the works necessary in his opinion to render the Observatory a fit place of habitation, and concludes as follows:

"After all this, it is much to be feared that it is beyond the power of Government to make the Observatory an agreeable place of residence. Its situation upon the verge of an extensive sandy desert, exposed to the utmost violence of the gales which frequently blow, without the least protection from trees or other objects to shelter from the wind or sun, some miles distant from markets, shops, or the habitations of persons with whom those belonging to the Observatory can associate, the want of good water and the state of the bulk of the population from whom servants must be taken and other aid applied for, will always prove considerable drawbacks from the comforts of persons sent from England to do the duties of the Observatory, and great obstructions to the undisturbed cultivation of the science."

Resignation was a very serious step for Henderson to take, for he had no private means beyond a pension of £100 a year, to which he had become entitled on the abolition of an office which he held as Advocate Clerk to Lord Eldin when the latter retired from the Supreme Court of Edinburgh.

Henderson was rather the refined observer than the pioneer; he was a man who, granted the means and appliances, knew how to turn them to the best effect and to attain to the highest precision of which his instruments were capable. But he was not the man to fight an uphill battle with neglect at home, and to compel Fate, in the shape of official indifference or incapacity, to do his bidding and raise the status and equipment of the Observatory to the ideal level which he claimed for it. That required a dogged persistence and force of character of another kind.

But Henderson, by his own methods, attained results of high importance in many directions.

His self-sacrifice helped to remove many of the difficulties of his successors, and he overcame the want of official assistance at the Cape by taking the observations to Edinburgh with him and reducing them there. In 1834 he was appointed Astronomer Royal for Scotland, but he continued to devote all the time that could be spared from his other duties to the reduction of his Cape observations. They were all ultimately published, and proved how successfully and faithfully Henderson had worked. He gave to the world a catalogue of the principal southern stars of an equal accuracy with the work of the best observatories in the Northern Hemisphere, and which will in all time be regarded as the true basis of the most refined Sidereal Astronomy of the Southern Hemisphere. His observations gave by far the most accurate determination of the moon's parallax then available; they determined the longitude of the Cape with a precision which refined modern methods, with the aid of the electric telegraph, have barely changed. Above all, Henderson was the first man to produce reliable evidence of the measurable parallax of any fixed star.

Henderson's successor was Mr. (afterwards Sir) Thomas Maclear. At the time of his appointment to the Cape he was practising his profession of doctor of medicine at Biggleswade, but was well known as one of the most competent and energetic amateur astronomers of his day.

Maclear reached the Cape on January 5, 1834, and took up his residence at the still desolate looking Observatory.

Ten days afterwards Sir John Herschel also arrived at the Cape and installed himself, his family and his instruments at Feldhausen, Newlands, within three miles of the Royal Observatory, and the next four years were spent in happy mutual intercourse between the astronomers, each assisting with heart and soul the labours of the other.

Sir John Herschel came to the Cape to catalogue the nebulæ of the Southern Hemisphere on the same plan as that on which his father had catalogued the nebulæ of the Northern Hemisphere. His expedition was a purely private one, carried out with his own instruments at his own expense, alike an act of devotion to Science and a noble tribute to the memory of his father. Sir John Herschel was thus never His Majesty's Astronomer at the Cape, but it was to Maclear and the Royal Observatory that Herschel appealed when he desired the exact determination of the place of a star, and he never appealed in vain.

On the other hand, one can imagine what, to a temperament like Maclear's, was the stimulus given by such society and such an example. It was the brightest and most delightful period of Maclear's life ; it set a stamp on the future character of his work and the policy of his directorate, and, if possible, increased his ardour as a diligent observer. To his latest days (and only his very latest days was I privileged to know) he spoke of Sir John Herschel and his times and of all the work—yes, and of all the fun—they had together, with a racy enthusiasm but seldom met with in one beyond the years of middle life, and still more seldom in a man bereft of sight and on his last sick bed.

Herschel worked at Feldhausen from 1834 to 1838, and during these busy years collected a mass of observations which on his return to England he proceeded to reduce ; finally, in 1847, he published a splendid volume entitled, "Results of Astronomical Observations made during the years 1834–5–6–7–8 at the Cape of Good Hope, being a completion of a telescopic survey of the whole surface of the visible heavens—commenced in 1825."

Its most important feature is a complete catalogue of 1707 nebulæ and star clusters observed by him in course of his telescopic sweeps, a large proportion of them being observed a number of times.

Next in importance probably is his list of 2102 double stars detected, and their places, position angles and distances estimated in course of the same sweeps, and a large number of micrometrical measures of some of these stars made with the seven-foot telescope. The work further contains a survey of the Nebeculæ or Magellen clouds ; an invaluable series of estimates of the relative magnitudes of the principal fixed stars—by a method of sequences ; an attempt to determine the distribution of stars in space and the constitution of the galaxy, by the process of gauging,—that is by counting the number of stars seen in the field of his telescope in different parts of the sky ; a series of observations of Halley's comet ; many observations of the satellites of Saturn and solar spots, and delineations of the forms of the most striking nebulæ and star clusters.

During his stay at the Cape, Herschel also, at the request of the Cape Government, devoted much time to the problem of education in the young Colony, and, as the result of his experience, prepared the scheme of education which was adopted and has been followed almost to the present time.

To return now to Maclear and his work. Maclear brought to bear upon the difficulties which Fallows and Henderson encountered all the energy and practical talents which distinguished him. By exchange and sale and purchase of land the Observatory property was consolidated. By the preparation of well-considered plans, and untiring persistence in urging their execution, he ultimately succeeded in getting suitable outhouses and other pressing works carried out; better communication with the main road to Cape Town was established, and a windmill was erected for the supply of water from the then unpolluted Liesbeek River, trees were planted, earth was carted, and as time went on the barren hillsides were covered with verdure, fruit trees grew in the most favoured spots, and a wide belt of pine and wattle broke the force of the south-easters. Maclear grew each day more and more attached to the place which he had made habitable, and he became more and more at heart a colonist. His bright nature knew no difficulties, he was daunted by no official neglect, but returned again and again to press on the execution of any scheme which he deemed essential to the welfare of the Observatory. His frank and cordial manners were peculiarly suited to win him favour wherever he went, and contributed in an extraordinary degree to forward some of his great works.

I have dwelt thus at length on these circumstances of the first years of Maclear's life at the Cape, because a fair estimate of his work cannot be arrived at without their due consideration. In the face of Henderson's reports it required no small courage to throw up a lucrative profession and betake himself and his family to a distant colony where the conditions of life appeared so uninviting. It was no small part of his work to ameliorate those conditions and to secure to his successors at least the ground work of refined and comfortable surroundings.

These administrative duties in no way interfered with the scientific labours of Maclear's office, for to these no man ever gave himself up with more untiring energy. From the date of his arrival the transit instrument and the mural circle were kept in constant use. Under the clear skies of the Cape it was inevitable that with a man of such a temperament observations would far exceed the computing powers of a small staff. The personal establishment of the Observatory was much too limited to enable the astronomer to reduce and publish the great mass of observations which he accumulated; to do this would have required several assistants and an adequate staff of computers, and these Maclear had not. The wonder was not that the observations were not reduced, but that so large a mass of work was actually done. In this respect Maclear was not fairly treated, but he did his best under the circumstances, and no man could do more—few, indeed, would have done as much. He was also carrying out, at the same time, a long series of observations on the bright star Alpha Centauri, to test or confirm Henderson's result for the parallax of that star.

It is an instance of the sanguine and energetic temperament of the man that he could, in addition to these absorbing occupations, turn his attention—not as a separate work, but as a work superadded to the labours of the Observatory—to the measurement of an arc of meridian. In 1838 the first part of this great work, "The Verification of Lacaille's Arc of Meridian," was commenced. The measurement of this arc and its extension were commenced in 1840, and the field work was finished in 1847. It is impossible to convey within the limits of this address an adequate idea of the indomitable energy and perseverance with which this operation was carried out, of the difficulties surmounted, and of the extent and value of the work accomplished with limited means. That all this was fully recognised at the time is sufficiently testified by the fact that for this work he received the gold medal of the Royal Society of London, and the Lalande medal of the Institute of France.

In 1847 a 46-inch achromatic telescope by Dollond was mounted equatorially, and in 1849 an equatorial by Merz, of 7 inches aperture and $8\frac{1}{2}$ feet focal length, was added to the instrumental equipment of the Observatory. These instruments were vigorously employed in the observation of double stars, comets, and nebulæ, and of occultations of stars by the moon. The original records show that the observations were sustained nearly all night long, and contain frequent notes to the effect that the watch had been brought to a close by the rising sun. All comets visible in the Southern Hemisphere were diligently observed by Maclear, and the results of the observations promptly published through the Royal Astronomical Society. Simultaneously with these observations, the meridian instruments were worked with redoubled energy, and during the years 1849–53 the whole of the stars in the British Association Catalogue having south declination were observed generally three times in each co-ordinate. The energy with which this series of observations was carried on is shown by the fact that in 1852 between 9,000 and 10,000 observations of right ascension were made with the transit instrument; on some nights over 100 stars were observed. These observations, in form of the "Cape Catalogue for 1850," have been published by the present astronomer. In 1855 the new transit circle (a facsimile of that at Greenwich) arrived, and was duly mounted with the assistance only of local masons and labourers, and observations were commenced with it at the end of the same year.

In 1859 Maclear paid a visit of a few months to England, and keenly enjoyed the seeing of old friends and making the personal acquaintance of many men who previously were only known to him by repute or correspondence. He returned to the Cape in 1860, and in June of the same year received the honour of knighthood—a well-merited recognition of his labours in science.

After 1860 Maclear's attention was chiefly directed to the reduction of his previous observations. He reduced the valuable series made in 1835–40, which has since been revised and published by his successor, Mr. E. J. Stone, as the "Cape Catalogue for 1840." Sir Thomas also partly reduced the observations made with the new transit circle in the years 1856–60, a work also completed and published by Mr. Stone, under the title "Cape Catalogue for 1860." In addition to all this, he made a long series of observations of the moon and stars, for the purpose of determining the longitude of the Observatory and the parallax of the moon.

Besides these varied astronomical labours, Maclear gave much attention to meteorological, magnetic, and tidal observations. He was successful in exciting an interest throughout the Colony in meteorological observation, and was always ready to lend a helping hand to any student of science. He threw himself with heart and soul into all measures by which he could promote the well-being of the Colony. He was a trustee of the South African Museum and a member of the Examining Board. He originated the Meteorological Commission, and continued during his life a member of it. For many years he assisted in the establishment of lighthouses, and was the originator of and took part in a Commission on Standards of Weights and Measures. He felt the keenest interest in sanitary matters, and in cases of emergency has lent his medical assistance. Maclear was the intimate friend of Livingstone. Their acquaintance commenced in 1850, when Livingstone came to him for assistance as to the best means of ascertaining his position when on his travels. Livingstone's quickness and aptitude for the work won Maclear's heart; the men were kindred spirits, and their friendship lasted to the end. The reduction of Livingstone's observations was performed at the Observatory, and formed a serious item in the work undertaken, but the labour was the labour of love.

The year 1861 was shadowed by a sad bereavement—the death of Maclear's beloved wife. Maclear occupied himself still more closely with his official duties and the various Colonial matters in which he took a part until, in 1870, he retired from the Observatory and took up his residence at Mowbray, about a mile from the scene of his former labours. Latterly his sight failed him, and in 1876 he became totally blind. In his declining health he was tenderly nursed by his devoted family; he kept up his interest in science and politics with unabated vigour, his daughters reading to him for hours together. He was particularly interested in all matters connected with the exploration of Africa, and the last occasion on which he left his house was to attend a meeting held in Cape Town when Stanley visited the Colony. No name was better known or better loved in the Colony than that of Sir Thomas Maclear. On the occasion of his last public appearance which I have just mentioned, he was received with even greater applause than that which greeted Stanley himself.

The latter years of Maclear's directorate were embittered by what must be considered unfair demands for immediate publication of results. It cannot be denied that prompt and methodical publication of astronomical results greatly enhances their value, and it is the unquestionable duty of the director of every observatory to comply with these conditions as far as lies in his power. But Maclear had not the necessary staff—proper provision for the enormous computing and clerical labour involved was never made. Fallows's observations had to be reduced and published after his death. Henderson devoted much of the time of the subsequent years of his life to discussing and publishing the results of his thirteen months' observations at the Cape, and Maclear was doubtless under the impression that in some way provision would be made for the reduction of his observations also. No such provision was made. Acting under specific instructions, which involved long absences from the Observatory during many successive years on the survey, not only Maclear himself, but one observatory assistant also was required for the field work of the survey. Thus the unreduced observations necessarily remained untouched, and meanwhile, under the stimulus of his direction and example, and in compliance with his instructions, others were yearly added. Then followed urgent demands for the reduction of the observations of the survey, a work of great labour that occupied much of the time of his staff. Think, too, of the influence of the example of Sir John Herschel. He toiled nearly all night in observing, and took to England the results of his labours for discussion and reduction. Maclear had absorbed in this school the influence of the motto of the Herschel family, "Quidquid nitet notandum." Could such a man, under such an influence, give up the glorious opportunities offered by the clear skies at the Cape, and the instruments at his command? A thousand times no. He did the utmost that man could do to reduce and publish what must be published for the immediate needs of science; he toiled in observing and reduction as few directors of observatories ever have, and waited in vain for the provision of an adequate computing force. Had he stopped observing to devote his powers exclusively to reduction, would he have been wise? I think not. His observations remained capable of reduction, and they have been reduced, and form a monument to his faithful stewardship.

Sir T. Maclear gently breathed his last on July 14, 1879, and his remains were interred in the Observatory grounds beside those of his wife, not far from the spot where Fallows is buried. The House of Assembly at Cape Town agreed to the following resolution on July 17, 1879: "That this House desires to express its deep sense of the signal services rendered by the late Sir Thomas Maclear, Knt., F.R.S., F.R.A.S., to the general cause of astronomical and geographical science while in charge of the Royal Observatory, Cape Town, and also to the material interests of the Colony in the practical application of his researches; and, furthermore, its high appreciation of his devotion for so long a period of years to the cause of South African exploration and civilisation, and that this resolution be recorded in the journals of the House." Never was a like recognition of service better earned. One only regrets that it was not made on his retirement, when it certainly would have been not less grateful to him who had so worthily earned it than it was to his sorrowing family.

Sir T. Maclear's successor, Mr. E. J. Stone, was for many years Chief Assistant at the Royal Observatory, Greenwich, under Sir George Airy. An accomplished mathematician, and well known to astronomers as the author of many admirable and important papers, he was of all English astronomers of his time the man required at the Cape. Apart from the plans which he had formed for his work there, it was known that there existed great stores of observations partially reduced and entirely unpublished which had been accumulated by Maclear, but which were thus unavailable for the purposes of science. There certainly was no man in England so well fitted to complete their reduction and prepare them for press. With a long training in the rigid and methodical methods of Sir George Airy, with great powers of his own in the organisation and superintendence of large masses of computation, with a clearly defined plan in his mind as to the work he meant to do, and a fixed determination that nothing should interfere to turn him from that purpose, with the entire sympathy and powerful support of his former chief, with official instructions consonant with his own wishes, he applied himself during the whole of his stay at the Cape to two great objects: (1) The preparation of Maclear's meridian observations for press; (2) the re-observation of the stars which had been observed by Lacaille more than a century before, and the formation of a catalogue of southern stars complete to the seventh magnitude.

Unlike Maclear, Stone himself took but little part in observing, but, having strong sympathy at home, he organised an excellent staff and carried out both these great works in a very complete manner. Stone's Catalogue of 10,000 Southern Stars was printed after his return to England, the Cape Catalogues of 1840 and 1860, based on Maclear's observations, having been passed through the press during his stay at the Cape. The whole forms a splendid memorial to Stone's methodical energy, to the high sense of duty which actuated him, a proof of his sound judgment as to the needs of science at the time, and of his concentrated earnestness of purpose in their pursuit.

Thus far I have confined myself almost to biographical detail, but detail which is necessary for due appreciation of the aims and motives of the Cape astronomers and for presenting to you, and to all who are interested in the progress of the intellectual life of South Africa, a brief history of what has been done in one great branch of science, and the circumstances under which the work was done.

In 1879 I had the honour to succeed Mr. Stone on his appointment to the post of Radcliffe Observer at Oxford. Let me endeavour at this point to put you in my own place, and to consider what it was my duty to do with reference to future work.

Stone and his contemporary, Dr. Gould, at Cordoba, in the Argentine Republic, had accomplished great things for the sidereal astronomy of the Southern Hemisphere, and it has been said with truth that for the epoch 1875 from their labours alone we have, on the whole, a more satisfactory knowledge of the positions of the stars in the Southern Hemisphere than we have of the same class of stars in the Northern Hemisphere from the combined labours of all the observatories of Europe and America.

First, then, it was necessary to return to daily observations of the sun and of certain of the planets, of stars near the northern and southern horizon for testing the amount of refraction, and to make frequent observations of the principal stars which are employed as the fundamental points of astronomy. These are objects not of much popular interest, but they are the real objects for which national observatories are chiefly established, which permit the refinement and perfection and true progress of the science, and form the material on which the fair superstructure of Astronomy of precision is based.

In pursuance of this type of work we have now published the following Star Catalogues as the result of Meridian observations made since 1879 :—

The Cape Catalogue of 1,713 Stars for the Equinox 1885 from observations 1879 to 1885.

The Cape Catalogue of 3,007 Stars for the Equinox 1890 from observations 1885 to 1895 ; and there is now in the press

The Cape Catalogue of 8,560 Stars for the Equinox 1900 from observations 1896 to 1899.

The object of the latter Catalogue is to provide points of reference on the photographic plates which cover in duplicate the zone of the heavens between Declinations $-40°$ and $-52°$, that is to say the zone which forms the Cape share of the international Carte du Ciel.

The stars of this Catalogue have been so selected as to secure the condition that there shall be at least ten of these standard stars well distributed over each of the 1,512 photographic plates which cover the zone. As each star has been observed at least three times, there is ample material for making a rigid determination of the constants of each plate. These constants are required for converting the co-ordinates of star-images as measured on the plates into the true places of the stars in the sky. But I find from the discussion of the proper motions of these stars a very interesting fact. The proper motions of stars were hitherto supposed to be of an entirely accidental character—that is to say, in any considerable area of the sky the mean proper motions of the stars, apart from those produced by motion of the sun through space, would be zero. The discussion in question shows that this is not so, but *apparently* that the brighter (or nearer) stars are revolving as a whole with respect to the fainter (or more distant) stars. This opens up a great cosmical question which will demand much future study, and which is now attracting the attention of astronomers.

Besides the regular and systematic publication of our own results it was no less obligatory to undertake the reduction and preparation for press of those observations of Maclear which had not been published by Stone.

The whole of this has now been overtaken ; the results are published in two catalogues, viz. :—

The Cape Catalogue of 4,810 Stars for the Equinox 1850 from observations 1849 to 1852 ; and

The Cape Catalogue of 1,905 Stars for the Equinox 1865 from observations 1861 to 1870.

All these catalogues to which I have referred are technically known as Catalogues of precision, and the stars which they contain are, as a rule, well-known stars. They are thus no mere list of stars of which the places are given merely with precision sufficient for their identification, but they are the mean results of observations of high accuracy repeated on several different nights, and, in the case of important stars, on many different nights, in order to provide those reference points in the heavens which are required for the purposes of astronomy of precision.

But it has become now necessary to go farther and to devise and erect an instrument capable of excluding some of those sources of error which may still affect our observations. Thus, if we intercompare the results of nearly simultaneous observations at Cordoba, Melbourne, and the Cape, we find small systematic differences which are too persistent in character to be the result of accidental errors of observation. When observations of a particular star made on a number of different nights, with the same instrument at the same Observatory, agree pretty closely *inter se* we can derive from the agreement of the results the probable accidental error of observation and the probable accidental error of the mean result. Similarly we can derive the probable error of the position of the same star from observations made at another Observatory. Now if these two results disagree beyond the limits which their probable errors would lead us to expect, then there is reason to suspect some systematic cause for their difference. This may have its origin in the instrument itself, in the condition of its surroundings, or in some peculiarity of the observer. We can trace out these sources of error in various ways; we find with the same instrument personal peculiarities between different observers which are affected by the brightness of the star or the direction of its motion. There exist means for tracing out, determining, and eliminating these. Or there may be errors due to the installation of the instrument; for example, the Cape transit circle is placed in a room which is part of the Observatory main building, with thick walls and so on, so that it is impossible to equalise the temperature inside the room with that of the external air. This produces small errors due to abnormal refraction. Then there may be instrumental errors—due to mechanical defects, such as errors of graduation of the divided circle and errors in the form of the pivots. No workmanship of human hands is perfect; the only course is to provide the most perfect means for the determination of the errors. There may be also other instrumental errors due to flexure (vertical or lateral) of the tube of the telescope or of the axis on which the tube is mounted. There must be means for eliminating these errors, and this can be best done by providing means for reversing the telescope, pivot for pivot, and eye end for objective end, on the same tube, so that in the mean not only these errors, but the errors of flexure of the graduated circles are eliminated in the mean of observations made in the four possible positions of the instrument.

All these things, and others besides, which it would take too long to enter upon, have been considered in the new instrument now in course of erection. Instead of being mounted in a house with heavy stone walls, the Observatory is a steel structure with vertical walls and a semi-cylindrical roof, the axis of the latter coinciding with the axis of the instrument. The walls and roof are of triple steel, the spaces between the separate $\frac{1}{16}$-inch thick walls forming ventilating shafts, so that if the sun should heat up the outer sheet a current of air is set up between the walls, and the heated air escapes by ventilating chimneys at the outer ends of the Observatory.

The two halves of the building are rolled six feet apart by an electro-motor before the instrument is used, so that the instrument stands practically in the open air, and thus all local abnormal effects of refraction are avoided.

We hope with this instrument to avoid most, if not all, those systematic errors which are the real bane to progress in exact astronomy.

But there is another class of Star Catalogue which is most necessary and important, not only to serve for the nomenclature of the stars, but for the study of stellar distribution in space, viz., a complete Catalogue of all stars to a given order of magnitude, with their approximate positions and magnitudes.

Argelander and his successor Schönfeld had catalogued in this way *all* the stars to the 9th magnitude from the North Pole to Declination 20° South. It was most desirable to complete that work in the Southern Hemisphere.

The Society is aware how the photographing of the great comet of 1882, with Mr. Allis' camera attached to an equatorial and the number of star-images photographed on the same plates, led me to realise that photography was the way to make this catalogue. The work was duly set on foot and the photographs taken by Mr. C. Ray Woods; the plates were measured by Prof. Kapteyn, of Gröningen (for our staff was insufficient to overtake this latter additional labour), and we have now a Catalogue of *all* the stars down to $9\frac{1}{4}$ magnitude and most of those to the 10th magnitude between Declination 19° S. to the South Pole. It is published in three large volumes of the

Annals of the Cape Observatory, and contains the approximate places and magnitudes of 454,875 stars, under the title of the Cape Photographic Durchmusterung.

But the experiments which led up to the Cape Durchmusterung had a still more important result. They were the means of setting on foot the experiments of the brothers Henry in Paris on the construction of astronomical photographic object glasses,—experiments which met with such success as to lead me, on June 4, 1886, to propose an International Astro-photographic Congress, with a view of considering how this now perfected method of observation could be most efficiently applied to the complete cartography of the sky. The proposal was favourably received by Astronomers generally, and Admiral Mouchez, then Director of the Paris Observatory, threw himself with so much ardour into the promotion and encouragement of the scheme, that in 1887 a general congress of fifty-seven Astronomers from all parts of the world met at Paris under his presidency to consider what international action should be taken to promote its full development. It is greatly owing to his earnestness, his tact and large-hearted sympathy that the meeting ended with complete success, and with an unanimous resolution to pursue a definite and united programme for cataloguing all the stars to the 11th order of magnitude and for making chart plates of the whole sky, including stars of the 14th magnitude. Further meetings of the Permanent Committee appointed for the execution of the work were held in 1889, 1891, 1893, 1896, and 1900. The next will probably be held in 1904. The sky was divided into zones amongst eighteen different observatories, most of which have made good progress with their share of the work. Three South American observatories, which for various reasons had made no progress, were, in 1900, replaced by those at Cordoba, Monte Video, and Perth (Western Australia). The Cape work makes satisfactory progress, and many discoveries crop up by the wayside as we proceed.

Amongst the most interesting of these are the variable stars.

South Africa has been the chief seat of study of variable stars in the Southern Hemisphere, and Dr. Roberts of Lovedale its most accomplished student. He began observing variable stars in 1891 with no other equipment than an old theodolite and an opera glass. From 1891 to 1894 he made a rough survey of the southern sky south of decl. $-30°$ which resulted in the discovery of twenty variable stars, four of which are of the Algol type. This large increase in the known number of southern variable stars led Roberts to devote himself more and more to the study of the light curves of known variables.

From 1900, with a new equatorial telescope presented to him by Sir John Usher, and specially designed for this class of work, he commenced an elaborate series of observations on what are known as the Algol variables. These constitute a peculiarly interesting class of objects. For many days together the star shines with uniform light, suddenly at a particular moment the light of the star begins to wane, diminishing until a certain minimum is reached and again increasing in brightness till the normal magnitude is restored. These periodic fluctuations recur with great regularity. The obvious conclusion is that two stars revolve about each other nearly in a plane directed towards the sun, and consequently one star in the course of its revolution obliterates the other. When the stars are not in the same line with the sun we see as a single star their combined light, when in a line we see the light of only one *plus* such part of the light of the second as is not obscured by the first. There are thus two kinds of minima, one when star No. 1 is in front of No. 2, and *vice versâ.*

From the light curves expressing the amount of light at each instant during the waning and waxing of the light Roberts finds it possible to determine the density and figure of the disc of the components, and the elements of the binary system.

Roberts found the accuracy attainable with his new instrument was such as to warrant investigations of this nature, and these led to conclusions bearing directly on the cosmical problem of Stellar evolution. He found, for example, that the mean density of eight southern Algol variables is $\frac{1}{9}$ that of the sun. Further, in the case of those double stars of which the components revolve in contact, he found that the resulting oblateness in the figure of the component stars agrees in a striking manner with that found by George Darwin from purely theoretical considerations.

Besides this he has undertaken an independent determination of the magnitudes of all the stars brighter than 9·2 magnitude which are situated south of declination $-30°$, and also the regular observation of about 120 variable stars. Roberts has made in all about 250,000 independent estimations of stellar magnitude, and all this as work entirely outside heavy duties in connection with the Lovedale Institute, of which he has, in Dr. Stewart's absence, been the responsible director. I know few instances of more successful devotion of small means and limited opportunity to the attainment of great scientific ends than the work of Dr. Roberts.

In the same field a large amount of work and discovery has been done by Mr. R. T. A. Innes, Secretary at the Royal Observatory. He undertook the revision of the Cape Durchmusterung as a labour of love outside the routine of his office. Kapteyn had naturally found many anomalies between the results of the Cape photographic plates and those of previous Star Catalogues, of which he prepared special lists, containing stars existing in other catalogues not found on the Cape plates.

Every one of these many hundred cases has been examined, and in hardly a single instance has an error been found in the Cape Durchmusterung—the discrepancies generally arise from misprints or errors of reduction in the other catalogues, or the stars have proved to be variable or so red as not to be photographically bright enough to produce an impression. A complete account of this revision, together with numerous observations of variable stars, is now in press.

The more pressing duties of the Cape Observatory had prevented the devotion of much of its time to the observations of double stars. Maclear, it is true, had made a long series of observations of α Centauri and of a few of the most interesting of the other double stars then known; Ellery at Melbourne had also made a number of measures, but during the past twenty-five years the only Observatory which had systematically devoted a considerable part of its time to this object was that of Sydney, where, under Mr. Russell's direction, many valuable series of observations were made.

Mr. Innes, previous to his arrival at the Cape, had devoted himself to this branch of astronomy, and, with comparatively feeble means, had discovered about forty previously unknown double stars and published their estimated distances and position angles. In the course of his revision of the Durchmusterung, and by making use of opportunities of exceptional definition, he has now added about three hundred to the list of known southern double stars, all of a class that would appear single in our photographic plates. He has also applied the 18-inch refractor of the new McClean telescope to that work, and with Mr. Lunt has made many measures of the position angles and distances of southern double stars. In addition to this he has prepared a reference catalogue of southern double stars with a bibliography of the subject, which is published in the Annals of the Cape Observatory, vol. ii. part 2.

I have referred briefly to Henderson's discovery of the parallax of Alpha Centauri; let me endeavour now to place its importance before you in its true light. If we observe the position of a fixed star on dates six months apart we are virtually observing it from two points of space 186 millions of miles apart, because in the course of that time the earth occupies two opposite points in its orbit round the sun, and the earth's distance from the sun is approximately

93 millions of miles. Viewed from such different standpoints, one would naturally imagine that the apparent position of a star would be changed, or if the stars were at different distances from the earth their relative positions would be changed. But previous to Henderson's time no astronomer had been able to produce satisfactory evidence of anything of the kind. The conclusion would be that the stars are infinitely distant, or rather so distant that the orbit of our earth round the sun when viewed from the nearest star, with an instrument as powerful as the best telescopes we possess, is but a speck in invisible minuteness. Here was a bar to any sound conclusion as to the dimensions of the universe—a problem that had defied the utmost skill of man to solve. How far beyond the power of measurement were these distances? Were they just beyond that verge or infinitely beyond it? Would any clue be given us as to the dimensions of the immensities of systems beyond our own? The conception of infinite distance is an impossibility—the mind loses itself in fruitless attempts to realise what infinite distance means, and yet here were those mysterious stars apparently proving to the baffled philosopher and astronomer that their distances were infinite.

I wish that I could stop to explain in detail the method of Henderson's observations and the grounds of his conclusions—the subject of distances of fixed stars might well occupy an address for itself. I can only state now that in the years 1835–40 the two great masters of practical astronomy, Bessel in Germany and Struve in Russia, devoted themselves to the problem, and finally produced evidence, each in case of different stars, of a really measurable parallax. But whilst those great masters had been exhausting the resources of their skill in observation, and that of the astronomical workshops of Europe in supplying them with the most refined instruments for this purpose, a quiet, earnest man had been at work at the Cape, and, *without knowing it at the time*, had really made the first observations which gave decisive evidence of the measureable distance of a fixed star. Henderson deduced his remarkable result after his return to England, but previous to the results of Struve and Bessel. Probably Bessel's result was the most convincing, and it was to Bessel that in 1842 was awarded the gold medal of the Royal Astronomical Society. Sir John Herschel, in presenting the medal, said: "Should a different eye and a different circle continue to give the same result, we must of course acquiesce in the conclusion; and the distinct and entire merit of the *first* discovery of the parallax of *a* fixed star will rest indisputably with Mr. Henderson. At present, however, we should not be justified in anticipating a decision, which time alone can stamp with the seal of absolute authority."

I think that a less over-cautious judgment might have agreed to accept the evidence which Henderson produced. Be that as it may, a different eye and a different circle, the eye of Sir Thomas Maclear and his new transit circle, *did* confirm Henderson's conclusion.

Bearing in mind the traditions of the Observatory, the importance for the sake of science which these investigations presented, and the advantages which modern instruments and improved methods might afford, I acquired possession of a heliometer which I had used in Lord Crawford's (then Lord Lindsay) expedition to Mauritius. This instrument had been kindly lent by its noble owner for my expedition to Ascension, so that I was well aware of its good qualities. A young American astronomer, Dr. Elkin, who was my guest for two years at the Cape, joined me in making a series of researches on the distances of certain southern stars.

We determined together the distances of nine interesting stars. I shall briefly state here only that naturally one of our chief objects was to confirm, or otherwise, Henderson and Maclear's results for the parallax of α Centauri. It was confirmed; α Centauri proved not to be quite so near us as they had made out, but very nearly so. The result was that from four independent series of observations, two of them by Elkin and two by myself, the parallax of α Centauri was proved to be three-quarters of a second of arc. It is therefore beyond all doubt that Henderson's discovery was a real one, though the result was somewhat too great. Herschel's verdict must therefore be confirmed, and the palm for first breaking down the barriers that separated us from any knowledge of the distances of the fixed stars be accorded to the memory of the Cape Astronomer, Henderson. So far as all existing researches go, α Centauri is the nearest of the fixed stars. Regarding the faint comparison stars as practically infinitely distant, let us try to realise how near or far distant α Centauri really is. If we wish to deal with distance so immense, we must adopt a more convenient unit of measure. The most convenient unit for our purpose is the number of years that light would take to reach us. Light takes almost exactly 500 seconds of time to come from the sun; this is a figure easy to remember, and is probably exact to a single unit. The sun is in round numbers 93 millions of miles distant. The parallax of α Centauri is three-quarters of a second of arc; therefore its distance is 275,000 times the distance of the earth from the sun, and therefore light, which travels to the earth from the sun in 500 seconds (*i.e.*, in 8⅓ minutes), would take 4·36—say 4⅓—years to come from *α* Centauri.

To return now to other researches with my small heliometer. Altogether in the first campaign we determined the parallaxes of nine of the most interesting southern stars, and the first results of the kind obtained in the Southern Hemisphere.

With these results I was able to approach the Lords Commissioners of the Admiralty and state that this work had been done with a heliometer, my own property; that in consequence of its small optical power its applications were limited, that in a new instrument not only the optical power but the mechanical efficiency could be much increased and the work rendered more rapid and more accurate. Their Lordships were pleased in 1884 to sanction the construction of a new heliometer of 7 inches aperture. It was ordered from Messrs. Repsold in the same year, and completed in 1887.

I may here state that my anticipations were fully realised. It was proved (Annals of the Cape Observatory, vol. vii., part 2) that one observation with the new heliometer was of the same weight as three observations with the old one, and that a set of observations with the new instrument, in consequence of improvements in the mechanical design of the new instrument, could be made in half the time that a similar set could be made with the old one. The efficiency of the new instrument was therefore six times that of the old one.

With the new heliometer a fresh series of investigations for stellar parallax was undertaken. In several instances, by way of test, the parallax of the same star was investigated, and in every case the results with the new instrument agree substantially with those derived with the older one.

The following table gives the whole of the results arrived at, and contains all that astronomy up to the present time can tell of the distances of the fixed stars in the Southern Hemisphere.

Results for Parallax of Bright Stars.

(Arranged in Order of Star's Magnitude.)

The References marked §3, §4, &c. refer to Sections of Part 2, Cape Annals, Vol. viii.; those marked p. 97, &c., refer to the page of the Memoirs R. A. S., Vol. xlviii.

Name of Star.	Magnitude.	Observer.	Reference to Publication.	Parallax and its Probable Error.	Adopted Parallax and Probable Error.
				″ ″	″ ″
α Canis Majoris ...	—1·76	Gill	p. 97	0·370 ± 0·009	0·370 ± 0·005
		Gill	§ 3	0·370 ± 0·010	
		Elkin	p. 115	0·378 ± 0·022	
α Argus	—0·96	Gill	§ 4	0·000 ± 0·010	0·000 ± 0·010
		Elkin	p. 183	0·003 ± 0·035	
β Orionis	0·35	Gill	§ 1	0·000 ± 0·010	0·000 ± 0·010
		Finlay	§ 12	0·001 ± 0·027	
α_2 Centauri	0·40	Gill I.	p. 33	0·747 ± 0·013	0·752 ± 0·010
		Gill II.	p. 51	0·760 ± 0·013* / 0·021†	
		Elkin I.	p. 69	0·783 ± 0·028	
		Elkin II.	p. 81	0·676 ± 0·027	
α Eridani	0·51	Gill	§ 7	0·043 ± 0·015	0·043 ± 0·015
β Centauri	0.83	Gill	p. 161	0·000 ± 0·019	0·030 ± 0·015
		Gill	§ 2	0·046 ± 0·017	
α Crucis	1·02	Gill	§ 8	0·050 ± 0·019	0·050 ± 0·019
α Virginis	1·21	Gill	§ 9	0·019 ± 0·010	0·000 ± 0·020
α Piscis Australis......	1·27	Gill	§ 6	0·130 ± 0·014	0·130 ± 0·014
α Scorpii............	1·34	Finlay	§ 13	0·021 ± 0·012	0·021 ± 0·012
β Crucis	1·49	Gill &Finlay	§ 11	0·000 ± 0·008	0·000 ± 0·008
α Gruis	1·92	Gill	§ 5	0·015 ± 0·007	0·015 ± 0·007

* Excluding possible systematic errors.

† Including possible systematic errors.

Results for Parallax of Stars having Large Proper Motions.

(*Arranged in Order of the Amount of Proper Motion.*)

Name of Star.	Magnitude.	Observer.	Reference to Publication.	Parallax and its Probable Error.	Adopted Parallax and Probable Error.
				″ ″	″ ″
Z. C. V^h. 243	8·5	de Sitter	§ 16*	0·319 ± 0·027	0·312 ± 0·016
		de Sitter	§ 16†	0·338 ± 0·020	
Lacaille 9352 ...	7·1	Gill	p. 153	0·283 ± 0·016	0·283 ± 0·016
ε Indi	4·8	Gill	p. 129	0·286 ± 0·011	0·273 ± 0·040
		Elkin	p. 138	0·170 ± 0·032	
o_2 Eridani	4·5	Gill	p. 160	0·166 ± 0·018	0·166 ± 0·018
ε Erandi 4·3	4·3	Elkin	p. 179	0·149 ± 0·017	0·149 ± 0·017
β Hydri	2·9	Gill	§ 10	0·134 ± 0·007	0·134 ± 0·007
ζ Tucanæ	4·3	Elkin	p. 172	0·138 ± 0·027	0·138 ± 0·027
P. XIV^h 212	A 6·3	de Sitter	§ 15	A0·162 ± 0·011	0·167 ± 0·001
	B 7·9			B0·173 ± 0·012	
τ Ceti	3·6	de Sitter	§ 14	0·310 ± 0·012	0·310 ± 0·012
Lacaille 2957 ...	6·0	de Sitter	§ 17	0·064 ± 0·024	0·064 ± 0·024

Time does not permit me to enter into detail as to the conclusions to be drawn from these observations, but reference may be made to the original work (Annals of the Cape Observatory, vol. viii., part 2, pp. 140B to 144B).

The following general conclusions may, however, be quoted:—

1. The absolute amount of light radiated by a single star varies in he 22 stars observed from about 10,000 times to less than $\frac{1}{300}$ part of that given off by our sun, so that indeed " one star differeth from another star in glory."

2. The absolute velocities at right angles to the line of sight vary for the 22 stars from $2\frac{1}{2}$ to 70 miles per second,—velocities which are of the same order of magnitude as the velocities in the line of sight determined by spectroscopic methods.

3. The average parallax of a star of the first magnitude is $\frac{1}{10}$ of a second of arc.

4. The sun, if placed at the average distance of the first magnitude stars, would appear to us as a star of the fifth magnitude.

* Parallax determined by observation of distances from a pair of stars situated nearly in the major axis of the parallactic ellipse.

† Parallax determined by observations of position angle of a pair of stars situated nearly in the minor axis of the parallactic ellipse.

The new heliometer has also been applied in extensive operations for determining the great fundamental unit of astronomy—the Solar Parallax.

In the presidential address which I had the honour to deliver on the 30th of July, 1880, I dealt with the various methods available for this determination, and that which was indicated as in my opinion the best was the observation of minor planets by means of the heliometer. In the year 1888 there was a very favourable opposition of the minor planet Iris, and in 1889 very favourable oppositions of Victoria and Sappho; and the heliometer observers at Yale College (New Haven, U.S.), Göttingen, Leipzig, Bamburg and Oxford promised co-operation.

Plans of observation were prepared and circulated, with the result that all the above-named heliometer observatories co-operated. Dr. Auwers, of Berlin, came to the Cape in 1889 and assisted in the observation of Victoria, and 22 meridian observatories shared in the determination of the places of the comparison stars. The year 1890 was devoted to the heliometer triangulation of the comparison stars.

Dr. Auwers discussed the 9620 meridian observations of the comparison stars, and the 760 meridian observations of the planets Dr. Elkin discussed the heliometer observations of Iris for parallax, those of Victoria and Sappho for the same object were discussed and the whole combined by myself.

The very exact places of the comparison stars obtained by a combination of the meridian and heliometer observations, enabled me also to derive a very valuable determination of the mass of the moon from the observations of Victoria. The details of the whole are contained in Vols. vi. and vii. of the Annals of the Cape Observatory, and the results are:—

Value of the solar parallax from observations of—		Probable error.
Victoria	$8''\cdot8013 \pm$	$0''\cdot0061$
Sappho	$\cdot7981 \pm$	$\cdot0114$
Iris	$\cdot8120 \pm$	$\cdot0090$

The finally adopted results were:—

Value of the solar parallax $8''\cdot802$, probable error $\pm\ 0''\cdot005$
Ratio of the mass of the moon to that of the earth $1 : 81\cdot702 \pm 0\cdot094$

and these results have been adopted for use in the national ephemeris by the international committee which met at Paris in 1896.

A series of observations was made with the heliometer in August to December, 1891, in order to determine the mass of Jupiter and correct the elements of the motions of his satellites. Ever since telescopes were invented the phenomena of these satellites have been regularly observed, especially the eclipses, and as the latter phenomena are capable of fairly accurate observation they serve as a means of determining terrestrial longitudes; and, indeed, have well served that purpose in recent Arctic expeditions. Laplace (in his *Mechanique Celeste*) has developed the theory of the mutual perturbations of the satellites; Bouvard, Delambre, and Damoiseau have successively laboured to produce tables which should accurately represent the observed phenomena, but from various causes Damoiseau's tables, which in 1836, when they were published, very fairly represented the observations, now show considerable discrepancies.

The real obstacle to the construction of satisfactory tables was the want of the best data. The only accurate observations available were those of eclipses—they admirably determine the Jovicentric longitude but leave the latitude determinable only by the duration of the eclipse—and this duration is of course involved with many other unknowns as well as uncertainties—personal, instrumental, and so forth. What really was wanted was some independent determination of the Jovicentric latitude of each satellite in many different parts of its orbit.

All observers of Jupiter's satellites employing methods other than eclipses had measured the positions of the satellites relative to the planet. In the new observations I observed the relative positions of the satellites to each other, because it is obvious that the relative co-ordinates of two sharply-defined small discs can be more accurately measured than can the relative co-ordinates of the estimated centre of a large disc like that of Jupiter and a small disc like that of a satellite. The disadvantage of the method which I had adopted was, of course, that the whole of the elements of all the satellites had to be simultaneously regarded as unknown quantities, instead of discussing those of each satellite independently. But de Sitter's reduction of the observations, involving as it did the formation of over 500 equations of condition and their simultaneous solution for 27 unknown quantities, showed that the result well repaid the labour—as the probable error of the single observation came out only $\pm 0''\cdot083$.

The resulting mass of Jupiter agreed exactly with that which Newcomb had derived in an entirely different way, viz., by the perturbations of Jupiter on the motions of comets and minor planets; important corrections of the elements of the satellites, especially of the inclinations and nodes, were also determined. Similar observations were made by Mr. Bryan Cookson with the Cape heliometer in 1901, and are being continued in the current year. The results of these observations, together with series which it is proposed to take during the next two or three years, will provide all the data now wanting for the formation of tables whose real errors for many years to come will probably be far less than the accidental errors of observation.

With regard to astronomical work of other kinds, mention may be made of observation of the transit of Venus in 1882, of long series of extra-meridian observations of occultations of stars by the moon, and of all comets visible from the Cape during the past 23 years, and now the regular observation with the heliometer of all oppositions of major planets.

In 1881 and 1882 the longitude of Aden, previously determined in connection with Lord Crawford's transit of Venus expedition to Mauritius in 1874, was connected with the Cape, the operation also including determination of the longitudes of Durban, Delagoa Bay, Quillimaine, Mozambique and Zanzibar.

In 1889 operations were organised for determining the longitudes of stations on the west coast of Africa. Commander Pullen, who was to be the travelling observer, spent three weeks at the Observatory in practising observing with the vertical circle, and afterwards in determining his personal equation. In the course of the operations he made the necessary time-determinations and exchange of signals at Port Nolloth, Mossamedes, Benguela, St. Paul de Loanda, Saõ Thomé and Bonny. At the last of these stations he was seized with malarial fever on October 27th, but so far recovered as to make observations and exchange longitude signals with the Cape on the 29th. A relapse followed, but on the morning of November 2nd he telegraphed to the Cape that he was much better and expected to resume work in a few days; the same evening he became insensible, and died at his post early the following morning. His papers were subsequently forwarded to the Cape, and the observations on reduction proved to be of exceptional accuracy and value, giving results for the longitudes of all the above-mentioned stations of remarkable accuracy.

With regard to the great field of work opened out by the presentation to the Observatory by Mr. Frank McClean of a large telescope and observatory fitted for astrophysical work, I have recently spoken at length on the occasion of the unveiling the inscription stone by H.E. the Governor. I may therefore assume that we may take that portion of the address as read; but I hope that in order to make this history complete the Council will permit my words on that occasion to be added as an appendix to the present address.

The system of signals for the regulation of time throughout the Colony has been regularly maintained. Previous to February 8, 1892, this signal was given at one o'clock local mean time, but on and after that date the one o'clock Observatory mean time signal was discontinued, and a single signal at Greenwich mean noon was substituted.

At the same time arrangements were made for changing the civil time of the Colony. Previous to the date in question Observatory mean time was used for telegraph purposes throughout the Colony, and the disconnected railway systems used the local time of their principal terminal station.

Each principal town had clocks fitted with two hands, one showing local, the other railway time. On the junction of the Eastern and Western railway systems of the Colony some change in the time arrrangements became necessary, and it was decided that the meridian of $22\frac{1}{2}°$ E. of Greenwich should be adopted for all time purposes throughout the Colony. Circulars were prepared giving a popular explanation of the proposed change, the magistrates, field-cornets and other town or village authorities were separately instructed that—

"At midnight on Sunday, February 7th, the public clocks at .... should be set $\left\{\begin{matrix}\text{forwards}\\\text{backwards}\end{matrix}\right\}$ ...."

The change of time was thus made simultaneously throughout the Colony without the slightest hitch or inconvenience—indeed, a week after it took place it seemed to have been generally forgotten that any change had been made. This uniform time of the Cape Colony has since been adopted in the Transvaal and Orange River Colony.

It is a matter of regret to me that when the change was made the meridian of 30° (two hours) E. of Greenwich was not adopted, as I strongly urged that it should be, in accordance with the International programme. That programme, however, has been adhered to, as far as possible, by giving the signal at Greenwich mean noon, which corresponds with half-past one o'clock of the presently adopted meridian, and would correspond with two o'clock if the meridian of 0° E. were adopted.

It is now proposed, I believe, to adopt the international arrangement—the time signal can then be given at one or two o'clock as may be desired.*

* Since the 1st of March, 1903, the meridian of 30° E. of Greenwich has been adopted.

One of the duties that appeared to be laid upon me by the traditions of the Observatory and the labours of my predecessors was that of the geodetic survey of the Colony. Lacaille in 1752 had measured an arc of meridian at the Cape, and his results appeared to prove that the form of the earth was different in the southern from the northern hemisphere. It was a matter of very great scientific importance to decide whether this discrepancy arose from any errors in Lacaille's work, or was due to non-symmetry in the form of the earth.

Fallows, during the period of his enforced idleness, or rather, when he had only insignificant instruments at his disposal, pressed the desirability of employing his time in this work, but the request was unwisely refused. It was to settle this question that Maclear undertook his revision and extension of Lacaille's arc. He found a small error in the astronomical length of Lacaille's arc, due to local attraction at the Southern Station, and two unavoidable errors in the triangulation produced by the comparatively crude instruments and methods of the day. He extended the arc nearly to the northern limits of the Colony, and southwards to Cape Point, and it was the great triumph of Maclear's life's work to prove that the form of the earth, so far as it was possible to derive such a result from a comparatively small arc of meridian, was symmetrical in the southern hemisphere with that of its known form in the northern hemisphere.

Besides settling this scientific question, Maclear's work was of immense value to the Colony in rigorously determining the position of important points which served as the groundwork of the future survey of the Colony. Prominent points visible from the sea were in some instances marked twelve miles in error on the best maps previous to the surveys of Maclear and Bailey. It became, then, one of my first objects to urge upon the Colonial Government of the day the extension of the geodetic survey of South Africa. I submitted a plan, and recommended the employment of officers and men of the Royal Engineers for the work. The proposal was strongly supported by Sir Bartle Frere, by Sir George Colley, and Sir Charles Mitchell, and finally an agreement was arranged between the Government of Natal and the Cape Colony to carry out the work jointly on the plan which I had proposed.

Time does not permit me to go into the details of this work—I find it necessary to reserve this for a separate occasion. Suffice it for the present to say that between the years 1883 and 1894 the complete principal triangulation of the Cape Colony and Natal was carried out by Colonel Morris, and I had the satisfaction of completing the results for press which were published and presented to Parliament in 1896.

Since then I have superintended the re-reduction of Bailey's Survey to the system of the geodetic survey, and have recently had the satisfaction of issuing it in an accurate and homogeneous form as a second volume of the Geodetic Survey of South Africa.

The late Mr. Rhodes provided for the Geodetic Survey of Rhodesia, and under my direction a chain of triangles has been carried from Bulawayo to Iron Mine and thence nearly along the 30th meridian to the Zambesi. I am now organising the campaign for extending the work from the Zambesi to Tanganyika.

During a recent visit to Johannesburg I had the satisfaction of submitting to Lord Milner a plan for the Geodetic and Ordnance Survey of the Transvaal and Orange River Colony. The plan has been approved, and I am happy to state that the man who so successfully carried out the Geodetic Survey of the Cape Colony and Natal—Colonel Morris, R.E., C.B., C.M.G.—has accepted the superintendence of the work. In his hands I feel sure of its success.

These operations practically will ensure the completion of a chain of triangulation along the 30th meridian from the South of Natal to Tanganyika. It is the dream of my life to see that work carried to the Mediterranean.

Valuable geodetic work has been done by Mr. Bosman in British Bechuanaland, and his chain of triangulation there has been connected at both its extremities by chains of triangulation with the system of geodetic triangles in the Colony.

I rejoice to believe that under Captain Jurisch and Mr. Bosman the Secondary triangulation of the Cape Colony is about to be taken up, and thus a sound system laid down for the cartography of the country.

In the year 1896 I was sent on a mission to Berlin by the Colonial Office to arrange with the German Government for the demarcation of the 20th meridian—the diplomatic boundary between British Bechuanaland and German South West Africa. Plans were submitted by Baron von Danckelmann (the geographical expert attached to the German Foreign Office) and myself. These plans were approved, and both governments placed the scientific direction of the work in my hands. The operation has been in progress since 1898, Major Laffan, R.E., and a German representative are in charge of the field work, which is now nearly completed. The computations are made at the Observatory.

And now, ladies and gentlemen, I pray you to forgive me for the long time that I have trespassed on your patience. If I have done so it is through my desire to do homage to the lives and work of the great men who have laboured before me. The difficulties, the hardships and disappointments they have experienced have not been encountered in vain. The work that despite all obstacles they accomplished stands now, and ever will stand, a memorial of their ability and devotion, and a precious bequest to science. They have paved the way to lighten these difficulties for their successors, whose lives now lie in pleasant places. Official coldness or neglect I have never known; on the contrary, my proposals have, at the hands of the Lords Commissioners of the Admiralty, always met with complete consideration and efficient support during the twenty-three years I have had the honour to serve them. The Observatory itself now forms one of the most beautiful of the many lovely homes on the Cape Peninsula, and when health fails for the efficient discharge of my duty there, I will take my departure from it with loving memory of the many happy days spent under its roof, of the faithful and cordial support of my subordinates, and of the good and true friends who have visited me within its walls.

APPENDIX.

SPEECH DELIVERED ON THE OCCASION OF UNVEILING, BY HIS EXCELLENCY THE HON. SIR W. HELY-HUTCHINSON, THE INSCRIPTION STONE OF THE TELESCOPE AND OBSERVATORY, PRESENTED BY MR. FRANK McCLEAN TO THE ROYAL OBSERVATORY, CAPE OF GOOD HOPE, SEPTEMBER 19, 1901.

May it please Your Excellency,—The ceremony which I am about to ask Your Excellency to perform is one regarding which some explanation seems to be necessary. We all understand the significance of the laying of a foundation stone or the formal opening of a new building, but it is evident that the function of to-day represents neither the one nor the other. Your Excellency will therefore perhaps permit me to enter into a short account of the origin and history of this great telescope and of the observatory under the dome of which we are now assembled. If in so doing I appear at first somewhat discursive, I trust to be forgiven on account of the interest of the subject and of the occasion. Until about forty years ago the science of astronomy concerned itself chiefly with the positions of celestial objects. It occupied itself with the observation of their apparent places in the sky, tracing the origin of their motions, and finally computing and predicting these motions for all past and future time. It has measured not only the dimensions and determined the elements of our planetary system, but it has also made no small progress towards a knowledge of the dimensions of the Sidereal System and of the amount and direction of our sun's motion through space. It has catalogued the stars to a high order of magnitude, and determined many facts as to their distribution in space. There is no subject to which higher genius has applied itself than that of unravelling the celestial motions and the laws which govern them. Thus the old astronomy, from the difficulties of her task, the beauty and precision of her methods, and the proved accuracy of her predictions, has earned for herself the acknowledged position of queen of the sciences. But her task is by no means ended, for the so-called old astronomy still provides, and for ever will provide, a boundless field for research and for exercise of the highest efforts of the human intellect.

Sixty years ago no one believed it possible that astronomy could embrace the study of the constitution as well as the motions of celestial objects. It is true that the speculations of Laplace seemed so well based, and to fit so well with known facts and scientific possibilities, as to afford the belief that the sun and planets had been evolved from common primordial matter. But Laplace's views could only be regarded in the light of a hypothesis; they were not capable of that proof which is necessary to raise speculation, however plausible, to the level of scientific truth. Comte, in his "Cours de Philosophie Positive," expressed the opinion of his time thus: "We may speculate with some hope of success on the formation of the Solar System of which we form a part, for it presents to us numerous perfectly well-known phenomena, susceptible perhaps of giving proof of its true immediate origin. But what, on the other hand, could possibly form a rational basis for our conjectures on the formation of other suns? How confirm or disprove by the evidence of phenomena any cosmogonical hypothesis when no phenomena of such a kind are known, nor, doubtless, are even knowable?" In other words, the philosophic dictum of sixty years ago was that the chemical constitution of other systems than our own is a subject which, from the nature of things, must be regarded as unknowable. But the discovery of the lines in the Solar Spectrum by Fraunhofer, the interpretation of the meaning of these lines by Kirchhoff and Bunsen, and the application of the spectroscope to other celestial objects has upset that philosophic conception of the unknowable, and given to us the new astronomy.

This new astronomy deals not so much with the position as with the constitution of celestial objects. Its aim is not so much to answer the question where is such a star, but what is it, what can we find out about its chemical constitution, and the chemical history of its development? But with all this distinctive difference between the new and the old astronomy, it is impossible to divorce the one from the other. There is perhaps no finer illustration of the co-relation of the physical sciences than is to be found in the outcome of this new development of astronomy. The old astronomy required the combined efforts of the optician, the mechanician, the engineer, the observer, and the mathematician for its pursuit, the new astronomy adds those of the physicist and the chemist, and we are every day finding out not only how each and all of these branches of science contribute to the advancement of astronomy in general, but also how their common application to astronomy has contributed to the advancement of those separate sciences. I may perhaps be permitted to dwell briefly on this most interesting subject. The fact that light travels with a measurable velocity was first demonstrated by Roemer in 1675, because he found that the eclipses of Jupiter's Satellites apparently occurred too soon when the earth is near Jupiter and apparently too late when far from Jupiter—a phenomenon that could only be accounted for on the assumption that light travels with a measurable velocity. Here, then, is a notable contribution by the old astronomy to the science of physics. Newton, as every one knows, showed how sunlight, after passing through a slit and a prism, was split up into its component colours. Fraunhofer in 1815 proved that this spectrum, or coloured ribbon, viewed with more perfect appliances than Newton employed, is crossed by fine dark lines; in other words, that certain very definite kinds of refrangibility, or colours of light, are wanting in the solar spectrum. Fraunhofer actually measured the position in the spectrum of 600 of these lines, but their significance remained a mystery until 1859, when the explanation was found by Kirchhoff and Bunsen. They showed that substances in a state of vapour absorb rays of the same refrangibility as they themselves, when sufficiently heated, emit—and that the dark lines in the solar spectrum are produced by the absorption of vapours of metals, &c., which exist in the solar atmosphere, many of these metals, &c., being the same as those with which we are familiar, such as iron, calcium, sodium, magnesium, hydrogen, &c. With this discovery the new astronomy sprang into life. Sir William Huggins, the present President of the Royal Society, was the first to apply, in a really crucial and scientific manner, this new engine of research to other systems than our own. With infinite labour and ingenuity he designed and had constructed a spectroscope applicable to analysis of the light of celestial objects. It was requisite that this spectroscope should be mounted on a telescope, so that the comparatively faint light of a star might be collected by the object glass, and be projected at its focus on a slit of one or two thousandth parts of an inch in width, and be retained steadily on that slit, in spite of the diurnal motion of the earth. Farther, it was necessary to provide means by which the infinitely small point of light formed by the star's image should be widened, so that there should be seen in the field of view, not a mere coloured line, but a coloured ribbon of appreciable width. Finally, means had to be contrived for introducing into the slit (just as if it had come from the star), the light given off by terrestrial substances in a state of incandescence, so that the dark lines in the spectrum of the star might be compared with the bright lines of the spectra of terrestrial substances. The labour of overcoming all these difficulties was great, but great also was the reward. To use Huggins' own words: "The time was, indeed, one of strained expectation and of scientific exaltation for the astronomer, almost without parallel; for nearly every observation revealed a new fact and almost every night's work was red-lettered by some discovery." Time does not allow me to proceed in the order of history nor to classify the work done by Huggins and his successors. The spectra of vast numbers of the stars were shown to be identical with those of the sun, the spectra of others were less complex, of others more so, but all contained evidence of the existence of chemical substances which are contained in our globe. As powerful telescopes had shown many objects, previously supposed to be only nebulous, to consist of separate stars, the belief naturally began to be held that all nebulæ were in reality distant systems of stars which would be seen as such if only adequate optical means and sufficiently clear and steady atmospheric conditions were available. But Huggins' spectroscope showed that many nebulæ were not stars at all, that many well-condensed nebulæ, as well as vast patches of nebulous light in the sky, gave only bright lines in the spectroscope—lines which proved that such nebulæ were not stars at all, but inchoate masses of luminous gas. Evidence upon evidence has accumulated to show that such nebulæ consist of the matter out of which stars (*i.e.*, suns) have been, and are being, evolved. The different types of star spectra form such a complete and gradual sequence (from simple spectra resembling those of nebulæ, onwards through types of gradually increasing complexity) as to suggest that we have before us, written in the cryptograms of these spectra, the complete story of the evolution of suns from the inchoate nebulæ onwards to the most active sun (like our own) and then downward to the almost heatless and invisible ball. The period during which human life—nay, even life of any kind—has existed on our globe is probably too short to afford observational proof of such a cycle of change in any particular star, but the fact of such evolution, with the evidence before us, can hardly be doubted. I most fully believe that when we have farther studied the modifications of terrestrial spectra, under sufficiently varied conditions of temperature, pressure, and environment, our certainty of the fact will be greatly increased. But in this study we must also have regard to the spectra of the stars themselves. The stars are the crucibles of the Creator. There we see matter under conditions of temperature and pressure and environment, the variety of which we can hardly hope to emulate in our laboratories, and on a scale of magnitude beside which the scale of our greatest experiment is less than that of the drop to the ocean. I believe we must look to the new astronomy for aid in the solution of many great chemical problems.

The astronomer of the new school has to thank the physicist and the chemist for the foundation of his science, but the time is coming —we almost see it now—when the astronomer will repay the debt by wide-reaching contributions to the very fundamenta of chemical science. Thirty years ago there was first observed, in the spectrum of the sun's chromosphere, a very remarkable bright yellow line, near the position of the well-known D lines of Sodium. So distinctive was this line, and so certainly not due to any known terrestrial substance, that it was called the Helium line. In 1894 Lord Rayleigh, who was engaged in determining the densities of the principal gases, found what was then to him an inexplicable difference between the weight of a volume of nitrogen prepared from atmospheric air and the weight of the same volume of nitrogen prepared from ammonia or by other chemical means. Repeated experiment showed that the weight of the constant volume of atmospheric nitrogen was about $\frac{1}{200}$ greater than that of the chemically prepared gas. After exhausting all means of testing the purity of the chemically prepared nitrogen, Lord Rayleigh and Professor Ramsay, in January, 1895, finally traced the cause of their perplexity to a hitherto unknown gas present in our atmosphere which they named Argon. Here was a great chemical discovery due to the co-operation of the physicist and the chemist. On the publication of this paper Mr. Meirs of the British Museum directed Ramsay's attention to a paper by Hildebrand, in which the author had found that the mineral uranite contained nitrogen; and Ramsay naturally was desirous of examining every source of nitrogen. Accordingly he boiled clevite—a uranite of lead containing rare earths—with weak sulphuric acid, and after collecting the evolved gas he found that its spectrum gave not only the now known Argon lines but also new lines, one of which, to Ramsay's intense surprise and delight, absolutely coincided with the Helium line, which had been known for twenty-six years in the spectrum of the solar chromosphere. Of course, as soon as Helium was prepared, its spectrum was thoroughly studied, and then Lockyer and McClean were quick to show that many of the lines, which occurred in the spectra of a large class of stars, were due to this same Helium. Here was another chemical discovery in which the astronomer and the chemist were mutually helpful—a discovery also that is yet destined to throw much light on the evolution of stars.

One more illustration, and I am done. The study of the phenomena of light has compelled the conviction that light is the result of vibrations or waves in ether, as sound is the result of vibrations in air, and that just as slow and rapid vibrations of air produce respectively low- and high-pitched notes, so do slow and rapid vibrations of ether produce red and yellow or blue and violet light respectively. If now one imagines oneself standing beside a railway track and that an engine comes along sounding its whistle, it is clear that as the engine approaches the bystander more waves of sound of the whistle would reach the ear in a second of time than if the engine were at rest. As a consequence of this if the engine is travelling at a rate in any way comparable with the velocity of sound a sharper note will be heard than if the engine were at rest—on the other hand, if the engine is running away from the bystander the pitch of the whistle will for a like reason be lowered. The matter is easily put to the test by any one who chances to be beside a railway track when an engine blowing its whistle is approaching at high speed; the instant that the engine passes a sudden lowering of the whistle-note will be perceived. If one had a tuning-fork, emitting the exact note given by the railway whistle when at rest, it would be possible, with the aid of another suitable whistle that could be tuned to the note of the moving whistle, to determine the velocity of approach or recession of the train from the difference of the number of vibrations per second between the two forks. Just in the same way, if we knew the exact wave-length of a particular line in the spectrum of a star, and if we observe the wave-length of the same ray as it reaches the earth, we have a means of determining the velocity of approach or recession of the star, provided that the velocity of the star's motion has a measurable relation to the velocity of light. Doppler pointed out this possibility in 1841, but it was not until Huggins had begun stellar spectroscopy that, about 1865, he turned his attention to this possibility of the new astronomy, and in 1866 made the first attempts to determine motions in the line of sight. Such a task was, of course, impossible until the lines of the star spectra had been identified with those of known terrestrial substances, just as it would have been impossible for an observer to determine the velocity of a railway train at any moment by means of the note of the whistle that reached his ear, unless the observer also had a tuning-fork emitting the same note as the whistle of the engine when at rest. But Huggins had already identified many star lines with those of terrestrial spectra, and, so far, was in a position to attempt the task. He showed in 1866 that such work was possible, but it required the application of photography (first used for this purpose by Vogel) and exhaustive study of the theory of the spectroscope, and the greatest refinement in its construction and its use, to give the new engine of research the requisite reliability. These preliminary difficulties are now overcome, and daily results of the greatest importance are being added to our storehouse of knowledge.

It would occupy too long were I to enter on the numerous problems to which this branch of the new astronomy is applicable, but it will be evident how great an advantage to astronomy must be this new power to determine not, as formerly, only angular velocity at right angles to the line of sight, but the actual linear velocity of motion in the line of sight itself. These examples, which I fear I have quoted at too great length, enable me to explain in a few words the full significance of the ceremony which we have assembled to-day to witness.

Until the year 1894, there existed neither at the Cape nor in any observatory in the Southern Hemisphere, any adequate equipment for pursuit of the new astronomy, nor was there apparently much hope of the need being supplied. For forty years the new astronomy had been vigorously prosecuted in the Northern Hemisphere, the first great harvest of results obtainable with moderate means had been reaped, and great establishments were founded for research in the new fields of work. It thus became obvious that if anything was to be done to equalise the possibilities of research in these new fields in both hemispheres, no small outlay would be required. On my appointment as H.M. Astronomer in 1879, Mr. Newall, who then possessed the largest telescope in England, offered the loan of it for a period of years to prosecute research in the new astronomy at the Cape, but it was considered by the authorities at home that the cost of its transport and the erection of a suitable building and dome could not be entertained unless the telescope might remain permanently the property of the Observatory. Mr. Newall had good reason for limiting his offer to loan; for his son, then a young man, gave promise of scientific tastes, and he is now using that instrument at Cambridge, and obtaining with it the most refined spectroscopic results that have yet been secured in England. The busy years rolled on, and I had almost resigned myself to the idea that, during the period of my directorate at least, the Royal Observatory at the Cape must limit itself to the pursuit of the old astronomy, for which purpose it was well equipped. But in 1894 arrived a letter from Mr. Frank McClean, offering to present, for the use in the Southern Hemisphere, and preferably to the Cape, a telescope and observatory the specification for which corresponds with the instrument now before us and the building in which we are now assembled. Mr. McClean further stated that the optical part of the instrument had been for some time under construction by Sir Howard Grubb, of Dublin, and the whole would probably be completed before the end of 1896. The new instrument was also to be fitted with object glass, prism, spectroscopes, &c., so that, upon the completion of all, the Cape Observatory might enter on the pursuit of the new astronomy with every advantage possible in the way of equipment. Here was indeed a revival of hopes almost dead, of ambitions almost abandoned. The value of the gift was, if possible, enhanced by the fact that Mr. McClean is himself a distinguished worker in Astrophysics. One had seen his splendid photographs of terrestrial spectra, one knew something, but not all, of the great work on which he was then engaged, viz., of obtaining intercomparable spectra of all the stars to the 3½ order of magnitude, and one felt that his gift was due solely to a clear and well-founded perception of the needs of science and of an earnest and helpful desire to fulfil them. The Lords Commissioners of the Admiralty accepted, with warm appreciation of Mr. McClean's generosity, the offer of this splendid instrument and expressed the view that its possession would greatly increase the utility of the Cape Observatory, and might be expected to result in considerable advancement to science. The year 1896 saw the Observatory building ready for reception of the telescope and the dome erected. In the following year Mr. McClean visited the Cape, attached his object-glass prisms to our photographic telescope, and was thus enabled to complete that remaining portion of his spectroscopic survey of the whole heavens which could not be completed from his own observatory in Kent. His work at the Cape was also memorable by his discovery of the existence of oxygen in the spectra of a certain class of stars, and for this discovery and his spectroscopic labours generally he was awarded the gold medal of the Royal Astronomical Society of London in 1899. With the fullest expectation that the instrument would be erected during 1897, Mr. McClean had ordered the inscription stone which Your Excellency is about to uncover to be cut. It was not until April, 1898, that forty-four cases containing the telescope arrived from Dublin, nor until November of the same year that all was complete and ready for testing. Then another disappointment was in store. The large object glass was, after exhaustive trials, found to be defective in some particulars, and, at the request of Sir Howard Grubb, it was sent to Dublin in October, 1899, for correction, and was not returned to the Cape until early in the current year. The insertion of the inscription stone had been delayed until the telescope might be regarded as complete, and it is only within the past two or three months that the final tests have assured us that this may now be regarded as the case. It remained only to wait for a fitting time and occasion to perform the ceremony of uncovering the stone—a gracious office which you, Sir, have kindly undertaken to perform to-day. It will be found when you have done so that the stone bears the inscription, "The Victoria Telescope," and the date 1897, the year when the donor intended that the telescope should be completed and this ceremony performed. It is named the Victoria Telescope in honour of the great and good Queen whose jubilee it was intended to celebrate, and to whose beloved memory only it must now stand. I venture to hope it will long stand to honour that memory and to fulfil, by useful work, the noble intentions of its large-minded donor.

Ordinary Monthly Meeting.

July 30, 1902.

Sir David Gill, President, in the Chair.

The Minutes of the last meeting having been read and confirmed, the following nominations were made : Messrs. Palmer, Campbell, Young, and Herbert. Dr. A. E. Thompson and Dr. Fismer were elected members of the Society.

A motion by Dr. E. B. Fuller fell through owing to the absence of the proposer.

Mr. E. H. L. Schwarz read a paper on the Volcanoes of Griqualand East.

In the district of Matatiele the Geological Survey has recently discovered nineteen or twenty old volcanic necks which are undoubtedly the vents out of which the amygdaloidal lavas that cover the Drakensberg were erupted. The necks are either entirely filled up with solidified lava, or with ashes that were thrown out and fell back into the vent, or with both lava and agglomerate. An actual lava-flow was discovered in connection with a vent on the crest of the mountains, which, by the removal of the overlying lava-flows, shows the original surface formed on cooling.

The main interest of the discovery is that the volcanoes form a line running north-east, and parallel to the main watershed of South Africa. This is traversed once only by the Orange River. A map of the rivers of South Africa shows that the watershed runs uninterruptedly past the region where the volcanoes are present, so that at one time, apparently, the rivers came off it, at one side flowing south-east and on the other north-west. The volcanoes were thrown across this system of rivers, and the waters that originally flowed into the Indian Ocean were turned back and forced across the watershed.

The volcanoes therefore were active after the Karroo had become dry land, and the Karroo sediments themselves must have been laid down in a sinking basin, whose axis ran north-east.

The Stormberg sandstones on which the Drakensberg lavas rest must have been derived from a granitic region, which does not exist in the north, except at too great a distance for the sediments of such coarse nature to have been derived from it. There must therefore have been an old Permian land to the south of our present shore-line which has since sunk beneath the sea.

Exhibits were made of Photographs of Fog Crystals by Mr. C. Stewart; of Black Rain collected at Kimberley by Mr. J. Lewis; and of Volcanic Dust from Barbadoes by Mr. Lewis and Mr. E. H. L. Schwarz.

Ordinary Monthly Meeting.

August 27, 1902.

Mr. T. Stewart in the Chair.

The Minutes of the last meeting were read and confirmed.

Messrs. T. Palmer, S. G. Campbell, H. A. Herbert, and E. W. Young were elected ordinary members of the Society.

The following nominations were made: Professor Andrew Young by Messrs. Crawford and Beattie; C. J. Moorsom, Esq., by Sir David Gill and L. Péringuey.

Mr. D. E. Hutchins read a "Note of the late Storm and the Warning from Argentina."

Storms travelling from continent to continent may be traced by passing ships if there are sufficient for the purpose, as is the case on the Atlantic between America and Europe. Failing this, a connection may be established by noting the recurrence of storms of a marked type. The first storm so noted was in the case of the very extraordinary storm and summer rains prevailing in January, 1901. This was traced to New Zealand.

An attempt is now being made to trace the possible connection between storms leaving the Argentine and arriving at the Cape. On the 1st inst. the Agricultural Department was advised by cable that a storm with a barometrical reading as low as 29·6 had occurred in the Argentine. This storm may reasonably be expected to connect with the severe storms at the Cape on the 12th and 13th insts., when three ships were wrecked in Table Bay, and railway communication was interrupted for several days. On this assumption the time of passage would be 18 days, which, though 5½ days longer than the average, is 2 or 3 days within the maximum period within which such a storm might be expected to reach here. The success of this warning renders the subject one which should be pursued further in view of the importance of storm warnings, particularly to the shipping and farming community.

Mr. A. W. ROGERS, F.G.S., gave an exhibition of lantern slides illustrating some of the recent work of the Geological Survey.

The slides were prepared from photographs selected from the collection made during the past three years by the field geologists of the survey. Five views illustrated the types of country occupied by the ancient (Pre-Table Mountain sandstone) rocks of Prieska and Van Rhyn's Dorp. The occurrences of the Table Mountain sandstone in the divisions of Clanwilliam and Van Rhyn's Dorp and in Pondoland, were depicted in several slides, which showed the similarity of the country formed by that rock in these far distant parts of Cape Colony. The views taken in Clanwilliam and Van Rhyn's Dorp also demonstrated the fact that the Table Mountain sandstone thins out northwards from the Cedarbergen, and that the thickness of rock separating the denuded surface of the Pre-Table Mountain sandstone rocks from the Dwyka Conglomerate constantly diminishes in the same direction, a state of things due to the denudation of the Witteberg, Bokkeveld, and Table Mountain sandstone groups before the deposition of the Dwyka Conglomerate. The succession of rocks from the Table Mountain sandstone to the Witteberg in the country east of the Cedarbergen was shown in several slides. The characteristic features of the Dwyka Conglomerate, and the glaciated surface of the underlying rocks in the neighbourhood of Prieska, were shown in many slides, and for the sake of comparison a view of the Conglomerate as it occurs near Karroo Poort was thrown upon the screen. The rest of the slides illustrated the rocks above the Ecca Beds. An interesting comparison between the dry Karroo type of country, composed of sedimentary rocks of Karroo age and intrusive dolomite, and the well-watered district in Pondoland formed by the same rocks, was made by throwing upon the screen several views taken in the two districts. The two last views were illustrations of the Cretaceous rocks of eastern Pondoland, and the consolidated sand-dunes of Bredasdorp.

Professor J. C. BEATTIE read some "Observations of Atmospheric Electricity at Cape Town," by W. H. LOGEMAN, Esq., B.A.

Annual General Meeting.

September 17, 1902.

Sir David Gill, K.C.B., F.R.S., President, in the Chair.

The Secretary read the General Report for the year ended June 30, 1902.

The Treasurer made a statement showing a credit balance of £482 19s. 10d.

Sir David Gill was re-elected President, and Messrs. L. Crawford, J. D. F. Gilchrist, R. Marloth, and T. Muir elected Members of the Council for two years.

The President read as his address, " Some Notes on work done in South Africa in the department of Astronomy and Geodesy."

General Report and Statements for the Year ended June 30, 1902.

COUNCIL.

Sir David Gill, K.C.B., F.R.S., *President.*
L. Péringuey, F.Z.S., *Vice-President.*
J. C. Beattie, D.Sc., F.R.S.E.
G. M. Clark, A.M.I.C.E., *Hon. Secretary.*
J. D. F. Gilchrist, M.A., Ph.D.
R. Marloth, M.A., Ph.D.
T. Muir, C.M.G., LL.D., F.R.S.
T. Stewart, F.G.S., M.I.C.E.
W. L. Sclater, M.A., F.Z.S., *Hon. Treasurer.*

During the past year ten ordinary meetings of the Society were held. At these meetings the following papers were read:—

"The Phonation of Insects," by L. Péringuey, *Presidential Address.*

" Veld Dust Columns and Whirlwinds," by J. M. Orpen.

"Baviaan and Trap-door Spiders," by W. F. Purcell.

" The Hot Winds of Namaqualand." by C. Stewart.

"The Variation of the Star C.P.D.—41° 45′ 11″," by A. W. Roberts.

" On a Stereoscopic Method of Photographic Surveying," by H. G. Fourcade.

"On the Summation of the Powers of the Natural Numbers," by J. R. Sutton.

"Transmission of Malignant Jaundice of the Dog by a Species of Tick," by C. P. Lounsbury.

"The Transkei Gap," by A. W. Rogers and E. H. L. Schwarz.

"Some Experiments on the Rate of Evaporation," by J. R. Sutton.

"Irrigation on the Orange River," by F. B. Parkinson.

"The Legal and Economic Bases of some Colonial Teaching Universities, with a Local Application," by Rev. Wm. Flint.

"Some recent Observations on Roridula," by R. Marloth.

"Notes on some recent Deep Boring," by L. Wiener.

"Some Results derived from the Constant Values of the Periodic Formulæ," by J. R. Sutton.

The Society has taken steps in reference to the erection of a Commemorative Tablet to the Abbé de la Caille, to be placed on the house now occupying the site of the Abbé's residence in Cape Town in 1751.

The Society has discussed the matter of the Town House Portico, and sent a resolution to the Town Council expressing their wish that the Portico should be rebuilt as nearly as possible after the original plan, as it was felt that such mementoes of old Cape Town as existed should as far as possible be preserved.

A Committee was appointed to discuss the Metric System and Decimal Coinage, and it was approved by the Society that the following resolutions should be sent to the Government and to other scientific societies :—

1. The desirability of making the Metric System of Weights and Measures legal throughout the several South African Colonies, as it is at present in England.

2. The compulsory introduction at some definite date of the Metric System into the several South African Colonies.

3. The adoption throughout the Empire of a decimal system of coinage, the sovereign being taken as the fundamental unit.

There was a long discussion upon the Rev. Wm. Flint's paper, and it was eventually passed—"That the Society is of opinion that at the present time the needs of University education in South Africa are very imperfectly met, and that in order to satisfactorily promote University interests an inquiry should be held on the whole question of University education in South Africa."

It has been felt for some time that the existing Rules of the Society are not in accordance with its present requirements. A small Committee of five members has been appointed to consider the revision of the Rules.

The paper by Mr. H. G. Fourcade on a Stereoscopic Method of Photographic Surveying was considered to promise so much success that the Government were approached by the Council for a grant to enable the author to complete his instruments. This application was favourably received by the Government, and a grant of £200 obtained.

In addition to the ordinary meetings, a series of five general lectures of a popular type were given. These were :—

The Migration of Birds, with special reference to South Africa, by W. L. Sclater.

Earth Magnetism in South Africa, by J. C. Beattie.

Some Phases of Marine Life, by J. D. F. Gilchrist.

The Development of Water-power, with some reference to South Africa, by J. T. Morrison.

The Spectroscope and its application in Astronomy, by Sir David Gill.

During the year the English and German Antarctic exploring ships, the *Discovery* and the *Gauss*, called at Cape Town on their way to the South Pole. The Society entertained the officers and scientific staff of both vessels at dinner.

For a long period the meetings of the Society were held, through the kindness of Dr. Muir, in the hall of the Education Department. The meetings, through the kind permission of the directors, are now held in the building of the South African Association. In the same building a room has been hired for the library of the Society.

The duties of Secretary and Librarian have been separated, and Dr. Beattie has undertaken the duties of Librarian. His report on the Library is appended.

The Society regrets that it has lost the valuable services of Dr. G. S. Corstorphine as Secretary, owing to his departure from Cape Town. At the meeting held on May 28th it was resolved that the thanks of the Society should be accorded to Dr. Corstorphine for the excellent work that he had carried out in the Society's interests.

The Society regret that they have lost by death Sir Richard Southey, one of the original members of the Society, Mr. J. E. B. Rose, and Dr. G. E. C. Anderson.

During the year 43 new members have been elected, whilst deaths and resignations have reduced the membership by 8. The net increase has been 35.

The following table gives the numbers since 1897 :—

Year.	Ordinary Members.	Honorary Members.
1897	100	2
1898	121	2
1899	132	2
1900	148	2
1901	168	4
1902	203	4

The increase of membership is the greatest yet recorded in the history of the Society. It is to be hoped that the interest taken in the scientific affairs of South Africa will continue to increase.

The concluding part of Volume XI. of the *Transactions* has been issued on June 12, 1902.

The Treasurer's statement is appended. From this it will be seen that the credit balance of the Society amounts to £482 19s. 10d.

Signed on behalf of the Council,

David Gill, *President.*

G. M. Clark, *Hon. Secretary.*

LIBRARIAN'S REPORT.

The Society has for the first time rented a room, in which its books are now kept. The Librarian has prepared a list of societies who do not exchange publications with this Society. He has also prepared a list of the chief gaps in the various transactions and proceedings in the possession of the Society.

J. C. Beattie.

ADDITIONS TO THE LIBRARY.

Adelaide.

Transactions of the Royal Society of South Australia, vol. xxv., pts. 1, 2.

Proceedings of the Royal Geographical Society of Australasia South Australian branch, Sessions 1898–9 to 1900–1901.

Baltimore.

Johns Hopkins University Circulars, Nos. 144–9, 154, 155, 156, 157.

Johns Hopkins University Studies, Nos. 6, 7, 8.
Bulletin of the Johns Hopkins Hospital, vol. xii., Nos. 109–23, 125–7, 128–9; vol. xiii., Nos. 130–2, 133.

BASEL.
Verhandlungen der Naturforscher der Gesellschaft zu Basel, band xiii., heft 2.
Namenregister, 1875–1900.

BERLIN.
Sitzungsberichte der K. Ak. der Wissensch., 1902, pt. xxxix.–liii.

BOSTON, U.S.A.
Publications of the University of Pennsylvania. New Series, No. 6.
Contributions from the Botanical Laboratory, vol. ii., No. 2.

BRUSSELS.
Académie Royale de Belgique.
Bulletin de la Classe des Sciences for 1899, 1900, 1901, 1902, pts. 1, 2, 3.
Annuaire for 1900, 1901, 1902.

BUENOS AIRES.
Boletin de la Academia Nacional de Ciencias en Cordoba.
Communicaciones del Museo Nacional de Buenos Aires, tomo i., No. 10. 8vo.

CALCUTTA.
Asiatic Society of Bengal.
Journal, pt. i., No. 1; pt. ii., No. 1 of 1901; pt. iii., No. 1 of 1900.
Proceedings, 3–8, 1901.

CAMBRIDGE, ENGLAND.
Proceedings of the Cambridge Philosophical Society, vol. xi., Nos. 4, 5.

CAPE TOWN.
Geological Commission.
Annual Reports for 1896, 1897, 1898, 1899.
Bibliography of South African Geology, pt. i. and ii.
Report of the Government Biologist for 1900.
Catalogue of Fishes by the Marine Biologist.

CHICAGO.

Field Columbian Museum.

Annual Report Series, vol i., No. 6.

Geological Series, vol. i., No. 8.

Zoological Series, vol. 2, vol. 3, Nos. 3, 4, 5.

CHRISTIANIA.

Forhandlinger Videnskabs Selskabet, Nos. 1, 2, 3, 4.

CINCINNATI.

Journal of the Cincinnati Society of Natural History, vol. xix., Nos. 7, 8; vol. xx., No. 1.

COLORADO.

Colorado College Studies, vol. ix.

DRESDEN.

XVII. Jahresbericht des Vereins für Erdkunde zu Dresden.

EDINBURGH.

Scottish Geographical Magazine, vol. xvii., Nos. 9, 10, 11, 12; vol. xviii., Nos. 2, 3, 4, 5.

GLASGOW.

Proceedings of the Philosophical Society, vol. xxxii.

HALIFAX.

Proceedings and Transactions of the Nova Scotian Institute of Science, vol. x., pt. 2.

HAMBURG.

Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten, xvii., Jahrgung; xviii., Jahrgung.

Berheft, Nos. 1, 2, 3, 4 for xvii. Berheft. No. 2 for xviii.

INDIANOPOLIS.

Proceedings of the Indiana Academy of Science for 1900.

KASSEL.

Abhand. und Berichte xlv. des Vereins für Naturkunde zu Kassell, 1899–1900; xlvi., 1900–1901.

LA PLATA.

Publicaciones Univers. de La Plata.

Fac. Sci. Math., No. 1.

Lausanne.

Bulletin de la Société Vaudoise des Sciences Naturelles, vol. xxxvii., Nos. 141, 142.

Lawrence, Kansas.

Bulletin of the University of Kansas, vol. ix., Nos. 3, 4 ; vol. x., Nos. 1, 2.

London.

List of Geological Society, London, November 6, 1901.

Geological Literature added to Geological Society's Library in 1900.

Quarterly Journal of the Geological Society, vol. lvii., pt. 4 ; lviii., pt. 1.

Monthly Notices of the Royal Astronomical Society, Appendices to vol. li. ; vol. li., Nos. 3, 4 ; vol. lxii., Nos. 1, 2, 3, 4.

Report of the British Association for the Advancement of Science, 1900, 1901.

Transactions of the Zoological Society, vol. 16, pt. 2, 3.

Proceedings of the Zoological Society, vol. 1, pt. 2 ; vol. 2, pt. 1.

Quarterly Journal of the Royal Meteorological Society, vol. xxvii., No. 120 ; vol. xxviii., Nos. 121, 122.

The Geographical Journal, vol. xvii., No. 4 ; vol. xviii., Nos. 4, 5, 6 ; vol. xix., Nos. 1, 2, 3, 4, 5.

Annals of the South African Museum, vol. ii., pt. vi., vii., viii., ix.

Journal of the Anthropological Institute of Great Britain and Ireland, vol. xxxi.

Madison.

Transactions of the Wisconsin Academy, vol. xii., pt. 2 ; vol. xiii., pt. 1.

Manchester.

Journal of the Manchester Geographical Society, vol. xvi., Nos. 1, 2, 3, 4, 5, 6, 10, 11, 12 ; vol. xiii., Supplement.

Memoirs and Proceedings of the Manchester Philosophical Society, vol. xlv., pt. 4 ; vol. xlvi., pt. 1, 2, 3, 4.

Melbourne.

Report of the 8th Meeting of the Australian Society for the Advancement of Science. 8vo. 1899.

Chamber of Mines, Victoria, 3rd Annual Report.

,, ,, Monthly Returns, July, August.

Proceedings of the Royal Society of Victoria, vol. xiv., New Series, pt. ii.

Mexico.

Boletin Mensual del Observ. Meteor. Central de Mexico, July–Dec., 1900; Jan., Feb., March, May, June, July, 1901.

Memorias y revista dela Soc. Cient. Antonio Alzate, vol. xv., Nos. 1–6, 7–12; xvi., 1; xiii., 1, 2.

Boletin del Instituto Geologico de Mexico, N 15. segunda parte.

Milwaukee.

Bulletin of the Wisconsin Natural History Society, vol. 2, No. 1.

Minneapolis.

Bulletin of the Minnesota Academy of Natural Sciences, vol. iii., No. 3.

Missonla, Montana.

Bulletin of the University of Montana.

Bulletin No. 3. Biological Series, No. 1.

Montevideo.

Anales del Mus. Nac. de Montevideo, tome iii., ent. xxi., xxii.; tome iv., ent. xix., xxii.

Montreal.

Canadian Record of Science, vol. iii., No. 6; vol. viii., No. 7.

Moscow.

Bulletin de la Société Imperiale des Naturalistes de Moscou, 1900, Nos. 3, 4; 1901, Nos. 1, 2; 1902, Nos. 1, 2.

Oberlin, Ohio.

The Wilson Bulletin, vol. ix., No. 1.

Ottawa.

Geological Survey of Canada.

Index to Reports.

Annual Report with Maps, vol. xi.

Paris.

La Feuille des Jeunes Naturalistes Revue Mensuelle, Nos. 372, 373, 374, 375, 376, 377, 378.

Catalogue de la Bibliothèque, Fasc. xxxi., 1, 2.

Philadelphia.

Proceedings of the American Philosophical Society, vol. xxxix., No. 164; vol. xl., Nos. 165, 166.

Memorial Volume I.

Proceedings of the Academy of Natural Sciences, vol. liii., pt. 1, 2.

PIETERMARITZBURG.

First Report of the Geological Survey of Natal and Zululand.

SAN FRANCISCO.

Proceedings of the Californian Academy of Science.

Zoology, vol. ii., Nos. 1–6.

Botany, vol. i., No. 10; vol. ii., Nos. 1, 2.

Geology, vol. i., Nos. 7, 8, 9.

Math. Phys., vol. i., Nos. 5, 6, 7.

SANTIAGO.

Actes de la Soc. Sci. du Chili, tome xi., 1, 2, 3 livr.

STOCKHOLM.

K. Svenska Vetenkaps Akadem.

Handlingar, bd. 33, 34.

Bihang, bd. 26, Nos. 1, 2, 3, 4.

ST. PETERSBURG.

Bulletin de l'Académie Imperiale des Sciences, 5th Series, tome xii., 2–5; tome xiii., 1–3.

Mémoires de l'Académie Imperiale des Sciences, tome x., Nos. 4, 5, 7.

SYDNEY.

Journal and Proceedings of the Royal Society of New South Wales for 1900, vol. xxxiv.

Records of the Australian Museum, vol. iv., Nos. 2, 4, 5.

Proceedings of the Linnean Society of New South Wales, vol. xxv., pt. 4; vol. xxvi., pt. 1, 2, 3.

University Calendar for 1901.

Current Papers, by H. C. Russell.

Annual Report of the Department of Mines for the Year 1900.

Geological Survey. Mineral Resources, No. 10.

TORINO.

Bolletino del Museo di Zoologia e Anatomia comparata della R. Univ. di Torino, Nos. 382–403.

TORONTO.

Transactions of the Canadian Institute, No. 13, vol. vii., pt. 1.

URBANA.

Bulletin of the Illinois State Laboratory of Natural History, vol. vi., pt. 1.

VIENNA.

Annalen des K. K. Natur. Hof Museum, band xv., No. 2.

Sitzungsberichte der K. akad. der Wissensch. Mathematisch. Natur. Wissen Classe, bd. cix., heft vii., viii.–x.

Jahrbücher der K. K. Central Anstalt für Meteorologie und Erdmagnetismus.

Jahrgang, 1899, bd. xxxvi.

Jahrgang, 1900, bd. xxxvii.

WASHINGTON CITY.

Annual Reports of the Smithsonian Institution, 1897, 1898, 1899, 1900.

Annual Report of the U.S. National Museum, 1898, 1899.

THE HON. TREASURER IN ACCOUNT WITH THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY, JULY 1, 1901, TO JUNE 30, 1902.

RECEIPTS.

	£	s.	d.	£	s.	d.
To Balance in Bank, on fixed deposit at 3½ per cent.	300	0	0			
,, Floating Balance in Bank	80	12	9			
,, Petty Cash Balance	2	13	3			
				383	6	0
,, Subscriptions—						
Arrears for 1899, 1900	12	0	0			
14 Subscriptions, Country, 1901	14	0	0			
15 ,, Town 1901	30	0	0			
47 ,, Country, 1902	47	0	0			
72 ,, Town, 1902	144	0	0			
New Members' Subscriptions, for broken periods	27	15	0			
				274	15	0
,, Sale of Publications				89	19	2
,, ,, Lecture Tickets				8	16	6
,, Receipts from Authors for extra copies of Papers				6	0	0
,, Special Subscriptions of Members and the Government to the *Gauss* and *Discovery* Dinners				140	1	6
,, Interest on Money at fixed deposit				10	10	0
,, Miscellaneous small receipts				2	0	6
				£915	8	8

EXPENDITURE.

	£	s.	d.	£	s.	d.
By Publications—						
Messrs. West Newman & Co., for printing—						
Vol. XI., pt. 3	£54	2	0			
Vol. XII., pt. 1, balance	77	8	6			
,, M. Dujardin for preparing plates for Vol. XII., pt. 2, and Vol. XIII., pt. 1	37	13	6			
				169	4	0
,, Stationery and Printing Circulars				29	17	6
,, Purchase of Furniture for Library, &c.				25	4	6
,, One Quarter's Rent for Library				9	4	0
,, Expenses incurred for Lectures				7	13	6
,, Freight Charges				4	2	2
,, Clerical assistance and attendance at meetings				12	17	6
,, Fee for compilating International Catalogue of Scientific Literature				10	0	0
,, Petty expenses, chiefly postage				21	10	3
,; Cost of Dinners to *Gauss* and *Discovery*				141	2	6
,, Bank Charges				1	12	11
				£432	8	10
By Balance in Bank on fixed deposit at 3½ per cent.	£300	0	0			
,, Floating Balance at Bank as per Bank Book	156	7	2			
,, Cash in hand not paid into Bank till after June 30	25	9	8			
,, Petty Cash Balance	1	3	0			
				482	19	10
				£915	8	8

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

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

(Signed) W. F. PURCELL, M. WILMAN, } *Auditors.*

LIST OF MEMBERS,

For year ending July 31, 1902.

HONORARY MEMBERS.

1897 Fisk, *Rev.* G. H. R., *C.M.Z.S.*, Church House, Cape Town.
1897 Trimen, R., *F.R.S.*, Entomological Society, London.
1900 Cohen, *Prof.* E., University, Greifswald.
1900 Seeley, *Prof.* H. G., *F.R.S.*, King's College, London.

ORDINARY MEMBERS.

1897 Alston, E. G.
1901 Alston, J. A., *M.R.C.S.*, Union Street, Cape Town.
1895 Alston, G., 1, Lilian Villas, Wandel Street, Cape Town.
1890 Amphlett, G. T., Standard Bank, Cape Town.
1901 Anderson, A. J., *M.A.*, *M.B.*, Medical Officer, Cape Town.
1886 Anderson, T. J., *M.L.A.*, Kenilworth.
1900 Anderson, Wm., Geological Survey Office, Maritzburg, Natal.
1902 Andrew, D. C., Union Castle Co., Cape Town.
1877 Arderne, H. M., The Hill, Claremont, C. C.
1895 Baker, H., Castle Company's Chambers, Cape Town.
1897 Barker, C. N., Rownham, Malvern, Natal.
1902 Barnard (Miss), L. M., Wynberg, C. C.
1901 Baxter, W., *M.A.*, South African College School, Cape Town.
1899 Beard, Herbert R., *B.A.*, Woodside, Wynberg, C. C.
1897 Beattie, J. C., *D.Sc.*, *F.R.S.E.*, South African College, Cape Town.
1882 Beck, J. H. M., *M.D.*, Rondebosch, C. C.
1901 Benjamin, L. E., *B.A.*, *LL.B.*, Cape Town.
1899 Berry, *Hon. Sir* Wm. Bisset, *M.D.*, Houses of Parliament, Cape Town.
1877 Bolus, H., *F.L.S.*, Kenilworth, C. C.
1897 Brauns, H., *M.D.*, *Ph.D.*, Willowmore, C. C.
1900 Broom, R., *M.D.*, *B.Sc.*, Pearston, C. C.
1877 Buchanan, *Hon. Sir* John, Claremont, C. C.
1901 Carré, G., Wynberg.
1898 Churchill, F. O. F., Wyebank, Natal.
1899 Clark, G. M., *M.A.*, *A.M.I.C.E.*, General Post Office, Cape Town.
1900 Clifton, G. H., *M.D.*, Green Point, C. C.
1901 Colson, R., Pretoria.
1901 Cookson, B., *M.A.*, Royal Observatory, C. C.
1896 Cooper, A. W., Richmond, Natal.

1895 Corstorphine, G. S., *B.Sc.*, *Ph.D.*, Johannesburg.
1896 Cowper, Sydney, *C.M.G.*, Claremont, C. C.
1901 Cox, *Dr.* J. H., Colonial Office, Cape Town.
1901 Craig, William, *A.M.I.C.E.*, Cape Town.
1899 Crawford, Lawrence, *M.A.*, *D.Sc.*, South African College, Cape Town.
1895 Cregoe, J. P., P.O. Box 1,420, Johannesburg.
1895 Crowhurst, J. W., *F.R.C.V.S.*, Arderne's Bldgs., Cape Town.
1898 Dale, Langham, Colonial Office, Cape Town.
1902 Dinter, Kurt, Windhoek, German S.W. Africa.
1890 Dodds, W. J., *M.D.*, Valkenberg, Mowbray, C. C.
1899 Don, David, The Maze, Berea, Durban, Natal.
1898 Drege, J. L., Port Elizabeth, C. C.
1901 Dwyer, F. L., C.G.R., Cape Town.
1877 Ebden, *Hon.* A., Rondebosch, C. C.
1897 Edington, A., *M.B.*, Graham's Town, C. C.
1901 Eriksen, K., Long Street, Cape Town.
1895 Evans, M. S., *F.Z.S.*, Durban, Natal.
1890 Fairbridge, W. G., 133, Longmarket Street, Cape Town.
1899 Feltham, H. L. L., P.O. Box 46, Johannesburg.
1900 Findlay, F. N. R., Pretoria.
1902 Finnemore, *Hon.* Mr. Justice R. I., *F.R.S.A.*, Supreme Court, Maritzburg.
1902 Fismer, F., *M.D.*, Wandel Street, Cape Town.
1901 Fitt, J. E., *A.M.I.C.E.*, Public Works Dept., Cape Town.
1892 Fletcher, W., P.O. Box 670, Cape Town.
1901 Flint, *Rev.* Wm., *D.D.*, Rosebank, C. C.
1901 Fourcade, H. G., Forest Dept., Cape Town.
1899 Francis, J. A., Durban, Natal.
1898 Fry, Harold A., P.O. Box 46, Johannesburg.
1899 Fuller, C., *F.E.S.*, Agricultural Dept., Maritzburg.
1895 Fuller, E. Barnard, *M.B.*, Church Square, Cape Town.
1877 Fuller, T. E., Agent-General, Victoria Street, London.
1896 Gilchrist, J. D. F., *M.A.*, *BSc.*, *Ph.D.*, South African Museum, Cape Town
1879 Gill, *Sir* David, *K.C.B.*, *LL.D.*, *F.R.S.*, Royal Observatory, Cape Town.
1897 Graham, F. G. C., Graham's Town, C. C.
1901 Graham, *Hon.* T. L., Sonnenstrahl, Wynberg, C. C.
1901 Grant-Dalton, A., *M.I.C.E.*, Cape Govt. Railways, Cape Town.
1899 Gray, Charles J., Department of Mines, Maritzburg.
1897 Gunning, J. W. B., *Ph.D.*, The Museum, Pretoria.
1901 Guyer, *Rev.* B., *M.A.*, Claremont, C. C.
1901 Hallack, J. G., Mowbray, C. C.
1898 Hamilton, T. H., Engineer's Dept., C.G.R., Cape Town.
1891 Hammersley-Heenan, R. H., *M.I.C.E.*, Table Bay Harbour Board, Cape Town.
1902 Hayward, S. H., Cape Town.
1901 Hely-Hutchinson, *H.E.*, The *Hon. Sir* W. F., *G.C.M.G.*, Government House, Cape Town.
1901 Hirst, W., Cape Central Railways, Mansion House Chambers, Cape Town.
1898 Holland, C. T., P.O. Box 200, Bulawayo.
1900 Honey, J. W., Customs House, Pretoria.
1902 van der Hoop, A. C., Consul-General for the Netherlands, Cape Town.
1901 Horn, W. J., South African College, Cape Town.
1899 Hough, S. S., *M.A.*, *F.R.S.*, Royal Observatory, C. C.
1889 Howard, R. N., *M.R.C.S.*, O'okiep, C. C.
1897 Hugo, D. de Vos, *M.B.*, Worcester, C. C.
1896 Hugo, *Hon.* J. D., Worcester C. C.

1891 Hutcheon, D., *M.R.C.V.S.*, Dept. of Agriculture, Cape Town.
1897 Hutchins, D. E., *F.R.M.S.*, Kenilworth, C. C.
1895 Impey, S. P., *M.D.*, Queen Victoria Street, Cape Town.
1900 James, R., *M.D.*, Loop Street, Cape Town.
1883 Janisch, N., Colonial Office, Cape Town.
1902 Jenkins, *Rev.* W. Owen, *M.A.*, Diocesan College, Rondebosch, C. C.
1898 Juritz, C. F., *M.A.*, Government Laboratory, Cape Town.
1892 Kannemeyer, D. R., *M.B.*, Burghersdorp, C. C.
1902 Kilpin, E. F., *C.M.G.*, Houses of Parliament, Cape Town.
1902 Kipling, Rudyard, Rottingdean, Brighton, England.
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.*, Concordia, C. C.
1900 Lawn, *Prof.* J. G., Kimberley, C. C.
1899 Ledoux, C. A., *F.E.S.*, *F.Z.S.*, Bacteriological Institute, Graham's Town, C. C.
1901 Leslie, T. N., Vereeninging, Transvaal.
1902 Lewis, A. J., Government Laboratory, Cape Town.
1902 Lewis, C. E., *M.A.*, South African College, Cape Town.
1877 Lightfoot, The *Ven. Archdeacon*, Cape Town.
1888 Lindley, J. B., *C.M.G.*, *M.A.*, *LL.B.*, Claremont, C. C.
1892 Lithman, K. V., Dock Road, Cape Town.
1896 Littlewood, E. T., *M.A.*, *B.Sc.*, High School, Wynberg, C. C.
1901 Logeman, W. S., South African College, Cape Town.
1895 Lounsbury, C. P., *B.Sc.*, Department of Agriculture, Cape Town.
1901 Lyle, J., *M.A.*, South African College School, Cape Town.
1902 Lyon, P., Wynberg, C. C.
1902 Maberley, *Dr.* J., Woodstock.
1899 McEwen, T. S., *A.M.I.C.E.*, General Manager Cape Govt. Railways, Cape Town.
1900 Macmillan, B. R., Department of Agriculture, Cape Town.
1897 Macpherson, J. W. C., *M.B.*, Stellenbosch, C. C.
1900 Mally, C. W., *B.Sc.*, Department of Agriculture, Cape Town.
1894 Mally, L., 8, Shortmarket Street, Cape Town.
1898 Mansergh, C. L. W., Public Works Department, Cape Town.
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.
1900 Masey, F. E., Castle Company's Chambers, Cape Town.
1899 Mason, W. G., *B.Sc.*, *F.H.A.S.*, Elsenburg, Mulder's Vley, C. C.
1899 Masson, J. L., Surveyor-General's Office, Maritzburg.
1896 Mayer, C., Stellenbosch, C. C.
1901 Meacham, C. S., Mariedahl, Newlands, C. C.
1897 Meiring, I. P. v. H., Worcester, C. C.
1901 Melvill, E. H. V., Johannesburg.
1902 Mennell, F. P., Bulawayo.
1899 Millar, A. D., 298, Smith Street, Durban, Natal.
1900 Milner, H. E. *Viscount*, *G.C.B.*, *G.C.M.G.*, Johannesburg.
1899 Moffat, J. B., Mafeking, C. C.
1898 Molengraff, G. A. F., *Ph.D.*, Pretoria.
1896 Morrison, J. T., *M.A.*, *B.Sc.*, *F.R.S.E.*, Victoria College, Stellenbosch, C. C.
1892 Muir, T., *C.M.G.*, *LL.D.*, *F.R.S.*, Department of Education, Cape Town.
1902 Muirhead, J. M. P., *F.S.S.*, Selwyn Chambers, St. George's Street, Cape Town.
1901 Noorden, P. M. van, Willowmore, C. C.
1902 Notcutt, H. C., *B.A.*, Kimberley, C. C.
1899 Oakley, H. M., The Colonnade, Greenmarket Square, Cape Town.

1901 Ohlsson, O. A., 10, Adderley Street, Cape Town.
1902 O'Neil, *Rev.* J. A., *S.J.*, Dunbrody, Uitenhage, C. C.
1900 Orpen, J. M., Bulawayo.
1899 Osborn, W., Durban, Natal.
1899 Pakeman, *Capt.* A. E., East London, C. C.
1901 Payne, E., Cape Town.
1885 Péringuey, L., *F.E.S.*, *F.Z.S.*, South African Museum, Cape Town.
1901 Perry, T. W., Public Works Department, Cape Town.
1902 Pickstone, H. E. V., Groot Drakenstein, Paarl.
1899 Piers, C. E., *M.D.*, Rheede Street, Cape Town.
1901 Proctor, J., College House, Cape Town.
1895 Purcell, W. F., *Ph.D.*, *M.A.*, South African Museum, Cape Town.
1899 Queckett, J. F., *F.Z.S.*, The Museum, Durban, Natal.
1899 Quentrall, Thomas, Kimberley, C. C.
1894 Raffray, A., Consul-General for France, Cape Town.
1901 Reunert, T., *M.I.C.E.*, Johannesburg.
1895 van der Riet, B., *Ph.D.*, *M.A.*, Victoria College, Stellenbosch, C. C.
1900 Ritchie, W., *M.A.*, South African College, Cape Town.
1902 Ritso, B. W., *F.G.S.*, Public Works Department, Cape Town.
1898 Rix-Trott, H., Port Elizabeth.
1892 Roberts, A. W., *D.Sc.*, *F.R.A.S.*, Lovedale.
1901 Roberts, R. O. W., Town House, Cape Town.
1901 Robertson, J., Boys' High School, Wynberg.
1900 Robertson, W., *M.D.*, Dept. of Agriculture, Cape Town.
1896 Rogers, A. W., *M.A.*, *F.G.S.*, South African Museum, Cape Town.
1899 Rohden, M. F., Oudtshoorn.
1897 Ross, A., *F.Z.S.*, Johannesburg.
1900 Russell, W. A., *M.A.*, Education Department, Bloemfontein.
1890 Ryan, P., Rosebank, C. C.
1895 Saunders, H. P., Arderne's Bldgs., Cape Town.
1890 Schönland, S., *Ph.D.*, *M.A.*, Albany Museum, Graham's Town, C. C.
1896 Schreiner, *Hon.* W. P., *K.C.*, Lyndale, Newlands, C. C.
1878 Schunke-Hollway, H.C., *F.R.G.S.*, Simondium, Paarl, C. C.
1895 Schwarz, E. H. L., *A.R.C.S.*, South African Museum, Cape Town.
1896 Sclater, W. L., *M.A.*, *F.Z.S.*, South African Museum, Cape Town.
1901 Shepperd, H. P., Stellenbosch, C. C.
1877 Silberbauer, C. F., 4, Liesbeek Villas, Rondebosch.
1896 de Smidt, H., *B.A.*, The Treasury, Cape Town.
1877 Smith, *Hon.* C. Abercrombie, *M.A.*, Wynberg, C. C.
1901 Smith, *Rev.* E. W., Aliwal North, C. C.
1902 Smith, *Hon.* G. D., Cape Town.
1900 Stanford, W. E. M., *C.M.G.*, Native Affairs Office, Cape Town.
1897 Stewart, C., *B.Sc.*, Meteorological Dept., Cape Town.
1833 Stewart, T., *F.G.S.*, *M.I.C.E.*, St. George's Chambers, Cape Town.
1895 Stoney, W. W., *M.D.*, Kimberley, C. C.
1899 Struben, A., Westoe, Mowbray, C. C.
1897 Sutton, J. R., *B.A.*, Kimberley, C. C.
1901 Tatham, *Major* C. J. W., *R.A.M.C.*, Wynberg, C. C.
1898 Tennant, David, 102, Wale Street, Cape Town.
1902 Thomson, *Dr.* A. E., *M.D.*, Burg Street, Cape Town.
1895 Thomson, W., *M.A.*, *B.Sc.*, *F.R.S.E.*, University Chambers, Cape Town.
1882 Tooke, W. Hammond, Department of Agriculture, Cape Town.
1896 Tredgold, C. H., *B.A.*, *LL.B.*, P.O. Box 306, Bulawayo.

1896 Turner, G., *M.D.*, Government Buildings, Pretoria.
1896 Veale, H. B., *M.B.*, Pretoria.
1897 Versfeld, J. J., *L.R.C.S.*, Stellenbosch, C. C.
1877 de Villiers, The *Right Hon. Sir* J. H., *K.C.M.G.*, *P.C.*, Wynberg, C. C.
1900 Waldron, F. W., *A.M.I.C.E.*, Public Works Dept., Cape Town.
1900 Walsh, A., Port Elizabeth, C. C.
1900 Watermeyer, G., Supreme Court, Cape Town.
1898 Watermeyer, J. C., *B.A.*, Windhoek, German S.W. Africa.
1893 Westhofen, W., *M.I.C.E.*, Public Works Dept., Cape Town.
1878 Wiener, L., Newlands, C. C.
1898 Wilman, (Miss) M., Kenilworth, C. C.
1900 Wilson, H. F., *M.A.*, Groenhof, Bloemfontein.
1897 Wood, J. Medley, Berea, Durban.

Ordinary Monthly Meeting.

October 29, 1902.

L. Peringuey, Vice-President, in the Chair.

The Minutes of the last meeting were read and confirmed.

The following nominations were made: Messrs. L. G. Maclear Ladds, F. R. Malleson, A. Milligan, and F. Brooks.

Professor Andrew Young and C. J. Moorsom, Esq., were elected members of the Society.

Dr. J. D. F. Gilchrist exhibited some new deep-sea fishes—*Selachophidium guentheri*, *Apogon quecketti*, *Neoberyx spinosus*, *Paraliparis australis*—and made some remarks on the same.

Mr. C. Stewart summarised Mr. J. R. Sutton's paper on "Elementary Synopsis of the Diurnal Meteorological Conditions at Kimberley."

Mr. Barry McMillan read "Some Notes on a Fishing Ground off Cape Point."

This bank falls within the area bounded by the parallels of latitude 34° 23′ 45″ and 34° 25′ 15″ south, and longitude 18° 34′ 15″ and 18° 35′ 30″ east. It is about five miles south, 27° east (magnetic) from Cape Point Lighthouse. Its greatest length, from N.W. to S.E., is about $2\frac{1}{4}$ miles; its greatest width, from north to south, about $1\frac{1}{4}$ miles. The soundings on the bank varied from 23 fathoms to 13 fathoms.

A portion of rock (exhibited) detached by the dredge also brought up algæ, sponges, corals, alcyonarians, ascidians, echinoderms, ophiurids, and other starfish, polyzoa, hydrozoa, and several species of crabs, indicating the presence of fish food in abundance. A ton weight of fish was caught in less than three hours with six hand-lines. The catch comprised Seventy-four (*Dentex rupestris*), Roman (*Chrysophrys cristiceps*), Red Steenbras (*Pagrus laticeps*), Hangberger (*Cantharus Blochii*), Albacore (*Seriola Lalandii*), Silverfish (*Dentex argyrozona*) Fransch Madam (*Pagrus Holubi*), and Blue Fish (*Stromateus microchirus*). The fish were large and in excellent condition.

Ordinary Monthly Meeting.

November 26, 1902.

Sir David Gill, K.C.B., President, in the Chair.

The Minutes of the last meeting were read and confirmed.

The following nominations were made: Dr. Eric Nobbs of Cape Town and Mr. Fred. Eyles of Bulawayo.

Messrs. T. G. Maclear Ladds, F. R. Malleson, A. Milligan, F. Brooks, were elected members of the Society.

After discussion it was agreed to celebrate the half jubilee of the Society and the unveiling of the La Caille's tablet by a banquet, and Messrs. W. A. Sclater and L. Péringuey were instructed to make the necessary arrangements for the same.

Mr. C. W. Mally gave brief notes on the life history of a *Lygæid* Bug which has been found to attack cereals in the Hex River and Malmesbury Districts. Also a short outline of spraying experiments with a view to destroying a species of *Bryobia* fungus which causes serious damage to prune trees at Hex River.

Ordinary Monthly Meeting.

February 4, 1903.

Dr. R. Marloth in the Chair.

The Minutes of the last meeting were read and confirmed.

The following nomination was made: Dr. W. L. Griffiths.

Dr. E. Nobbs, Mr. Fred Eyles, and Mr. R. W. Menmuir were elected members of the Society.

Mr. E. W. Young read a paper on "Observations on the Flight of Birds and the Mechanics of Flight."

Mr. E. H. L. Schwarz read a paper "On the Deformation of Rocks, illustrated experimentally by Crushed Pebbles." The first part of this paper consists of an examination of the various agents by which deformation of rocks is affected, and the circumstances under which they act. The main agents are heat, pressure, and solution, which, either singly or in combination, are capable of twisting and crumpling rocks like the hard quartzite of the Zwartebergen. Instances of deformation, however, are quoted in which these agents have not acted on the rocks, and the explanation suggested is that the crushing is due to the giving way of the crystalline constituents of the rocks along twin planes. This, which is certainly the case in some instances of the bending of marble, where the calcite crystals are very easily twined, is probably also the cause with sandstones with mud between the grains, the Kaolin crystals being the weak element, and even it may happen in sandstones and quartzites, quartz being now known to have a gliding plane. It is to this cause that the instability of stone building is due. An experiment was carried out with pebbles embedded in lead and crushed in an iron cylinder. The main result was the demonstration that for pebbles in a conglomerate to be deformed, there must be separation of the matrix layers. All the results, however, that were hoped for were not obtained, owing to the pressure administered—namely, seventy-five tons—being insufficient.

Ordinary Monthly Meeting.

March 4, 1903.

Sir David Gill, K.C.B., President, in the Chair.

The Minutes of the last meeting were read and confirmed.

The following nominations were made: Messrs. J. Dodt, Bloemfontein; P. Havers, Stellenbosch; and A. Du Toit, of Cape Town.

Dr. W. L. Griffiths was elected an ordinary member.

Mr. A. W. Rogers read a paper on "The Geographical History of the Gouritz River System."

The Gouritz River is supplied by the Buffels, Dwyka, Gamka, and Traka Rivers from the Great Karroo, and these are joined by minor streams between the Zwartebergen and Langebergen.

The Karroo rivers had their origin on the southern slope of the watershed of the Colony, which was formed subsequently to the great southern anticlines. The region between and even beyond these anticlines was deeply eroded by the pre-Uitenhage rivers, which had east and west courses. The Uitenhage sediments filled up the pre-Uitenhage valleys, and partially embedded the Zwartebergen and Langebergen, and when they emerged from the water they rose as a continuation of the main southern drainage slope; the result was that the Karroo rivers continued their courses across the newly emerged sediments, and by the gradual removal of these the rivers worked their way down to the underlying buried surface of folded rocks. The Gouritz River system is thus a superimposed one as regards the country south of the Great Karroo, and by the diversion of the Buffels, Meirings Poort, and Traka Rivers into the Gamka, came to have its present form.

Ordinary Monthly Meeting.

April 30, 1903.

Held in the Hall of the Young Men's Christian Association.

Sir David Gill, K.C.B., President, in the Chair.

The President welcomed the members of the South African Association for the Advancement of Science.

The Minutes of the last meeting were read and confirmed.

The following nominations were made: Messrs. B. Dyer, J. P. Johnson, C. H. Slott, Professor A. Dendy, and Mr. G. F. Travers-Jackson.

Messrs. T. Dodt, P. Havers, and A. Du Toit were elected ordinary members.

The Secretary announced the distribution shortly of the Second Part of Vol. XII. and of Part I. of Vol. XIV. Three more Parts were in the press.

The Secretary exhibited a Meteorite that had been seen falling in the Transkei.

Dr. Marloth read his paper on "Results of Experiments on Table Mountain for ascertaining the amount of Moisture deposited from the South-East Clouds." A long discussion ensued, and a vote of thanks to Dr. Marloth was passed.

At the conclusion of the meeting a Conversazione was held.

Ordinary Monthly Meeting.

May 27, 1903.

L. Péringuey, Vice-President, in the Chair.

The Minutes of the last meeting were read and confirmed.

The following nominations were made: Dr. Marius Wilson, Dr. E. Lansberg, and Dr. G. A. Casalis of Cape Town.

Messrs. B. Dyer, J. P. Johnson, C. H. Stott, Professor Dendy, and Mr. G. F. Travers Jackson, were elected ordinary members.

Dr. Purcell exhibited some specimens of a new Termitophilous Land Crustacean belonging to the *Oniscidæ*, which were discovered by Dr. H. Brauns in the galleries of the White Ant, *Hodotermes viator*, at Willowmore, Cape Colony. This Crustacean shows a remarkable resemblance, first noticed by Dr. Brauns himself, to a wingless staphylinid beetle, *Trilobotideus*, which lives in the nest of a South African ant (*Dorylus helvolus*). The head and thoracic segments of both are shaped and sculptured in almost exactly the same manner.

Dr. Marloth exhibited a relief map of the Cape Peninsula, and gave a *résumé* of his paper read at the last meeting, in order to lead to a discussion of the points he advanced.

After discussion Dr. Maberley gave notice that he would move at the next meeting that "the Society takes up the matter of carrying on Dr. Marloth's investigations on the amount of moisture deposited on Table Mountain by the South-East Clouds."

Ordinary Monthly Meeting.

July 1, 1903.

Sir David Gill, K.C.B., President, in the Chair.

The Minutes of the last meeting were read and confirmed.

The following nominations were made: Dr. G. B. Douglas Macdonald, Uniondale; Professor H. H. W. Pearson, Cape Town; Mr. W. R. Caley, Fort Beaufort.

Dr. Marius Wilson, Dr. E. Lansberg, Dr. G. A. Casalis, were elected ordinary members of the Society.

Mr. A. W. Rogers exhibited some specimens of rocks from the volcanic necks of Sutherland, collected by the Geological Survey near the village of Sutherland, and from Saltpetre Kop. He pointed out that the necks were of the Kimberley type, but that the materials filling them were very various in character, and that in one case an igneous rock in close connection with the pipes resembled, in so far as the naked eye could judge, the melite-basalt of Spiegel River, which occurs in a pipe-like manner. If this resemblance on further examination held good, some new light might be thrown on the question of the age of the pipes of the Kimberley type.

Dr. Gilchrist exhibited a number of deep-sea fish recently procured by the Government steamer *Pieter Faure*, and of several new species of flat fish from the South African coast. The former included two new species of *Melanocetus*, *Bathysaurus ferox*, and several species of *Scopelus*. Among the latter were a new species of sole recently found at Kalk Bay, *Solea fulvo-marginata*, and other new flat fish procured during the investigation of the *Pieter Faure* on the Natal Coast.

After a discussion, in which Messrs. Thos. Stewart and C. Stewart took part, Dr. Maberley moved that his motion "that the Society takes up the matter of carrying on Dr. Marloth's investigations on the amount of moisture deposited on Table Mountain by the South-East Clouds" be referred to the Council.

LIST OF MEMBERS,

For year ending July 31, 1903.

HONORARY MEMBERS.

1897 Fisk, *Rev.* G. H. R., *C.M.Z.S.*, Church House, Cape Town.

1897 Trimen, R., *F.R.S.*, Entomological Society, London.

1900 Cohen, *Prof.* E., University, Greifswald.

1900 Seeley, *Prof.* H. G., *F.R.S.*, King's College, London.

ORDINARY MEMBERS.

1897 Alston, E. G.

1901 Alston, J. A., *M.R.C.S.*, Union Street, Cape Town.

1895 Alston, G., 1, Lilian Villas, Wandel Street, Cape Town.

1890 Amphlett, G. T., Standard Bank, Cape Town.

1901 Anderson, A. J., *M.A.*, *M.B.*, Medical Officer of Health, Cape Town.

1886 Anderson, T. J., *M.L.A.*, Kenilworth.

1900 Anderson, Wm., Geological Survey Office, Maritzburg, Natal.

1902 Andrew, D. C., Union Castle Co., Cape Town.

1877 Arderne, H. M., The Hill, Claremont, C. C.

1895 Baker, H., Johannesburg.

1897 Barker, C. N., Rownham, Malvern, Natal.

1902 Barnard (Miss), L. M., Wynberg, C. C.

1901 Baxter, W., *M.A.*, South African College School, Cape Town.

1899 Beard, Herbert R., *B.A.*, Woodside, Wynberg, C. C.

1897 Beattie, J. C., *D.Sc.*, *F.R.S.E.*, South African College, Cape Town.

1882 Beck, J. H. M., *M.D.*, Tulbagh.

1901 Benjamin, L. E., *B.A.*, *LL.B.*, Cape Town.

1899 Berry, *Hon. Sir* Wm. Bisset, *M.D.*, Houses of Parliament, Cape Town.

1877 Bolus, H., *D.Sc.*, *F.L.S.*, Kenilworth, C. C.

1897 Brauns, H., *M.D.*, *Ph.D.*, Willowmore, C. C.

1903 Brooks, F., Bulawayo.

1900 Broom, R., *M.D.*, *B.Sc.*, Pearston, C. C.

1877 Buchanan, *Hon. Sir* John, Claremont, C. C.

1902 Casalis, G. A., *M.D.*, Claremont, C. C.

1901 Carré, G., *M.B.*, Wynberg.

1898 Churchill, F. O. F., Wyebank, Natal.

1899 Clark, G. M., *M.A.*, *A.M.I.C.E.*, P.O. Box 1,113, Johannesburg.

1900 Clifton, G. H., *M.D.*, Green Point, C. C.

1901 Colson, R., Lydenburg, Transvaal.

1901 Cookson, B., *M.A.*, Royal Observatory, C. C.

1896 Cooper, A. W., Richmond, Natal.

1895 Corstorphine, G. S., *B.Sc.*, *Ph.D.*, P.O. Box 1,167, Johannesburg.

1896 Cowper, Sydney, *C.M.G.*, Claremont, C. C.

1901 Cox, *Dr.* J. H., Colonial Office, Cape Town.

1901 Craig, William, *A.M.I.C.E.*, Public Works Department, Cape Town.

1899 Crawford, Lawrence, *M.A.*, *D.Sc.*, South African College, Cape Town.

1895 Cregoe, J. P., P.O. Box 1,420, Johannesburg.

1898 Dale, Langham, Colonial Office, Cape Town.

1903 Dendy, A., *D.Sc.*, South African College, Cape Town.

1902 Dinter, Kurt, Windhoek, German S.W. Africa.

1890 Dodds, W. J., *M.D.*, Valkenberg, Mowbray, C. C.

1902 Dodt, J., Museum, Bloemfontein, O. R. C.
1899 Don, David, The Maze, Berea, Durban, Natal.
1898 Drege, J. L., Port Elizabeth, C. C.
1901 Dwyer, F. L., C.G.R., Cape Town.
1903 Dyer, B., Library, Kimberley, C. C.
1877 Ebden, *Hon.* A., Rondebosch, C. C.
1897 Edington, A., *M.B.*, Graham's Town, C. C.
1895 Evans, M. S., *F.Z.S.*, Durban, Natal.
1903 Eyles, F., Bulawayo, Rhodesia.
1890 Fairbridge, W. G., 133, Longmarket Street, Cape Town.
1899 Feltham, H. L. L., P.O. Box 46, Johannesburg.
1900 Findlay, F. N. R., Pretoria.
1902 Finnemore, *Hon.* Mr. Justice R. I., *F.R.S.A.*, Supreme Court, Maritzburg.
1902 Fismer, F., *M.D.*, Wandel Street, Cape Town.
1901 Fitt, J. E., *A.M.I.C.E.*, Public Works Dept., Cape Town.
1892 Fletcher, W., P.O. Box 670, Cape Town.
1901 Flint, *Rev.* Wm., *D.D.*, Rosebank, C. C.
1901 Fourcade, H. G., Forest Dept., Cape Town.
1898 Fry, Harold A., P.O. Box 46, Johannesburg.
1899 Fuller, C., *F.E.S.*, Agricultural Dept., Maritzburg.
1895 Fuller, E. Barnard, *M.B.*, Church Square, Cape Town.
1877 Fuller, T. E., Agent-General, Victoria Street, London.
1896 Gilchrist, J. D. F., *M.A.*, *B.Sc.*, *Ph.D.*, South African Museum, Cape Town.
1879 Gill, *Sir* David, *K.C.B.*, *LL.D.*, *F.R.S.*, Royal Observatory, Cape Town.
1897 Graham, F. G. C., Graham's Town, C. C.
1901 Graham, *Hon.* T. L., Sonnenstrahl, Wynberg, C. C.
1901 Grant-Dalton, A., *M.I.C.E.*, Cape Govt. Railways, Cape Town.
1899 Gray, Charles J., Department of Mines, Maritzburg.
1903 Griffiths, W. L., *M.D.*, Mansion House Chambers, Cape Town.
1897 Gunning, J. W. B., *Ph.D.*, The Museum, Pretoria.
1901 Hallack, J. G., Mowbray, C. C.
1898 Hamilton, T. H., Engineer's Dept., C.G.R., Cape Town.
1891 Hammersley-Heenan, R. H., *M.I.C.E.*, Table Bay Harbour Board, Cape Town.
1903 Havers, P., Stellenbosch, C. C.
1902 Hayward, S. H., Hofmeyr Chambers, Cape Town.
1901 Hely-Hutchinson, *H.E.*, The *Hon. Sir* W. F., *G.C.M.G.*, Government House, Cape Town.
1902 Herbert, H. A., African Banking Corporation, Cape Town.
1901 Hirst, W., Cape Central Railways, Mansion House Chambers, Cape Town.
1900 Honey, J. W., Customs House, Pretoria.
1902 Hoop, van der, A. C., Consul-General for the Netherlands, Cape Town.
1901 Horn, W. J., South African College, Cape Town.
1899 Hough, S. S., *M.A.*, *F.R.S.*, Royal Observatory, C. C.
1889 Howard, R. N., *M.R.C.S.*, O'okiep, C. C.
1897 Hugo, D. de Vos, *M.B.*, Worcester, C. C.
1896 Hugo, *Hon.* J. D., Worcester, C.C.
1891 Hutcheon, D., *M.R.C.V.S.*, Dept. of Agriculture, Cape Town.
1897 Hutchins, D. E., *F.R.M.S.*, Kenilworth, C. C.
1883 Janisch, N., Colonial Office, Cape Town.
1903 Johnson, J. P., Cleveland, Johannesburg.
1898 Juritz, C. F., *M.A.*, Government Laboratory, Cape Town.
1902 Kilpin, E. F., *C.M.G.*, Houses of Parliament, Cape Town.
1902 Kipling, Rudyard, Rottingdean, Brighton, England.
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.*, Concordia, C. C.
1903 Ladds, J. G. McLear, Cape Govt. Railways, Cape Town.
1903 Lansberg, E., *M.B.*, Cape Town.
1900 Lawn, *Prof.* J. G., Johannesburg.
1892 Ledoux, C. A., *F.E.S.*, *F.Z.S.*, Bacteriological Institute, Graham's Town, C. C.
1901 Leslie, T. N., Vereeninging, Transvaal.
1902 Lewis, A. J., Government Laboratory, Cape Town.
1902 Lewis, C. E., *M.A.*, South African College, Cape Town.
1877 Lightfoot, The *Ven. Archdeacon*, Cape Town.
1888 Lindley, J. B., *C.M.G.*, *M.A.*, *LL.B.*, Claremont, C. C.
1892 Lithman, K. V., Dock Road, Cape Town.
1896 Littlewood, E. T., *M.A.*, *B.Sc.*, High School, Wynberg, C. C.
1901 Logeman, W. S., South African College, Cape Town.
1895 Lounsbury, C. P., *B.Sc.*, Department of Agriculture, Cape Town.
1901 Lyle, J., *M.A.*, South African College School, Cape Town.
1902 Lyon, P., Wynberg, C. C.
1902 Maberly, *Dr.* J., Woodstock.
1899 McEwen, T. S., *A.M.I.C.E.*, General Manager Cape Govt. Railways, Cape Town.
1900 Macmillan, B. R., Department of Agriculture, Cape Town.
1897 Macpherson, J. W. C., *M.B.*, Stellenbosch, C. C.
1902 Mallison, P. R., Hex River, C. C.
1900 Mally, C. W., *B.Sc.*, Department of Agriculture, Cape Town.
1894 Mally, L., 8, Shortmarket Street, Cape Town.
1898 Mansergh, C. L. W., Public Works Department, Cape Town.
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.
1900 Masey, F. E., Rhodes Buildings, Cape Town.
1899 Mason, W. G., *B.Sc.*, *F.H.A.S.*, Elsenburg, Mulder's Vley, C. C.
1899 Masson, J. L., Surveyor-General's Office, Maritzburg.
1896 Mayer, C., Stellenbosch, C. C.
1901 Meacham, C. S., Mariedahl, Newlands, C. C.
1897 Meiring, I. P. van H., Worcester, C. C.
1901 Melvill, E. H. V., Johannesburg.
1903 Menmuir, R. W., *A.M.I.C.E.*, Woodstock, C. C.
1902 Mennell, F. P., Rhodesian Museum, Bulawayo.
1899 Millar, A. D., 298, Smith Street, Durban, Natal.
1903 Milligan, A., D'Urban.
1900 Milner, H. E. *Viscount*, *G.C.B.*, *G.C.M.G.*, Johannesburg.
1899 Moffat, J. B., Mafeking, C. C.
1898 Molengraff, G. A. F., *Ph.D.*, P.O. Box 149, Johannesburg.
1902 Moorsom, C. J., Bloemfontein, O. R. C.
1896 Morrison, J. T., *M.A.*, *B.Sc.*, *F.R.S.E.*, Victoria College, Stellenbosch, C. C.
1892 Muir, T., *C.M.G.*, *LL.D.*, *F.R.S.*, Department of Education, Cape Town.
1902 Muirhead, J. M. P., *F.S.S.*, Selwyn Chambers, St. George's Street, Cape Town.
1903 Nobbs, E., *Ph.D.*, Department of Agriculture, Cape Town.
1901 Noorden, P. M. van, Willowmore, C. C.
1902 Notcutt, H. C., *B.A.*, Victoria College, Stellenbosch, C. C.
1899 Oakley, H. M., The Colonnade, Greenmarket Square, Cape Town.
1901 Ohlsson, O. A., 10, Adderley Street, Cape Town.
1902 O'Neil, *Rev.* J. A., *S.J.*, Dunbrody, Uitenhage, C. C.
1900 Orpen, J. M., Bulawayo.
1899 Pakeman, *Capt.* A. E., East London, C. C.
1902 Palmer, *M.A.*, *LL.B.*, Cape Town.
1901 Payne, E., Sir Lowry Road, Cape Town.
1885 Péringuey, L., *F.E.S.*, *F.Z.S.*, South African Museum, Cape Town.

1901 Perry, T. W., Public Works Department, Cape Town.
1902 Pickstone, H. E. V., Groot Drakenstein, Paarl, C. C.
1899 Piers, C. E., *M.D.*, Camp Street, Cape Town.
1901 Proctor, J., College House, Cape Town.
1895 Purcell, W. F., *Ph.D.*, *M.A.*, South African Museum, Cape Town.
1899 Queckett, J. F., *F.Z.S.*, The Museum, Durban, Natal.
1899 Quentrall, Thomas, Kimberley, C. C.
1894 Raffray, A., Consul-General for France, Cape Town.
1901 Reunert, T., *M.I.C.E.*, Johannesburg.
1896 van der Riet, B., *Ph.D.*, *M.A.*, Victoria College, Stellenbosch, C. C.
1900 Ritchie, W., *M.A.*, South African College, Cape Town.
1902 Ritso, B. W., *F.G.S.*, Public Works Department, Cape Town.
1898 Rix-Trott, H., Umtata, C. C.
1892 Roberts, A. W., *D.Sc.*, *F.R.A.S.*, Lovedale, C. C.
1901 Roberts, R. O. W., Town House, Cape Town.
1901 Robertson, J., Boys' High School, Wynberg.
1900 Robertson, W., *M.D.*, Dept. of Agriculture, Cape Town.
1896 Rogers, A. W., *M.A.*, *F.G.S.*, South African Museum, Cape Town.
1899 Rohden, M. F., Oudtshoorn.
1897 Ross, A., *F.Z.S.*, P.O. Box 1,461, Johannesburg.
1900 Russell, W. A., *M.A.*, Education Department, Bloemfontein.
1890 Ryan, P., Rosebank, C. C.
1895 Saunders, H. P., Arderne's Bldgs., Cape Town.
1890 Schönland, S., *Ph.D.*, *M.A.*, Albany Museum, Graham's Town, C. C.
1896 Schreiner, *Hon.* W. P., *K.C.*, Lyndale, Newlands, C. C.
1878 Schunke-Hollway, H.C., *F.R.G.S.*, Simondium, Paarl, C. C.
1895 Schwarz, E. H. L., *A.R.C.S.*, South African Museum, Cape Town.
1896 Sclater, W. L., *M.A.*, *F.Z.S.*, South African Museum, Cape Town.
1901 Shepperd, H. P., Stellenbosch, C. C.
1877 Silberbauer, C. F., 4, Liesbeek Villas, Rondebosch, C. C.
1896 de Smidt, H., *B.A.*, The Treasury, Cape Town.
1877 Smith, The *Hon. Sir* C. Abercrombie, *M.A.*, Wynberg, C. C.
1901 Smith, *Rev.* E. W., Aliwal North, C. C.
1902 Smith, *Hon.* G. D., Cape Town.
1900 Stanford, W. E. M., *C.M.G.*, Umtata, C. C.
1897 Stewart, C. B., *B.Sc.*, Meteorological Dept., Cape Town.
1833 Stewart, T., *F.G.S.*, *M.I.C.E.*, St. George's Chambers, Cape Town.
1895 Stoney, W. W., *M.D.*, Kimberley, C. C.
1903 Stott, C. H., *F.G.S.*, Pietermaritzburg, Natal.
1899 Struben, A., Westoe, Mowbray, C. C.
1897 Sutton, J. R., *B.A.*, P.O. Box 142, Kimberley, C. C.
1898 Tennant, David, 102, Wale Street, Cape Town.
1902 Thomson, A. E., *M.D.*, Burg Street, Cape Town.
1895 Thomson, W., *M.A.*, *B.Sc.*, *F.R.S.E.*, University Chambers, Cape Town.
1882 Tooke, W. Hammond, Department of Agriculture, Cape Town.
1903 Travers-Jackson, G. H., P.O. Box 365, Cape Town.
1896 Tredgold, C. H., *B.A.*, *LL.B.*, P.O. Box 306, Bulawayo.
1896 Turner, G., *M.D.*, Government Buildings, Pretoria.
1896 Veale, H. B., *M.B.*, Pretoria.
1897 Versfeld, J. J., *L.R.C.S.*, Stellenbosch, C. C.
1877 de Villiers, The *Right Hon. Sir* J. H., *K.C.M.G.*, *P.C.*, Wynberg, C. C.
1900 Waldron, F. W., *A.M.I.C.E.*, Public Works Dept., Cape Town.

1900 Walsh, A., Port Elizabeth, C. C.
1900 Watermeyer, G., Supreme Court, Cape Town.
1898 Watermeyer, J. C., *B.A.*, Windhoek, German S.W. Africa.
1893 Westhofen, W., *M.I.C.E.*, Public Works Dept., Cape Town.
1878 Wiener, L., Newlands, C. C.
1898 Wilman, (Miss) M., Kenilworth, C. C.
1900 Wilson, H. F., *M.A.*, Groenhof, Bloemfontein.
1897 Wood, J. Medley, Berea, Durban.
1903 Wilson, Marius, *M.D.*, Cape Town.
1902 Young, E. W., *M.I.C.E.*, Rondebosch, C. C.
1902 Young, A., South African College, Cape Town.