PAPERS.

I. *Report of Thomas Maclear, Esq., F.R.A.S., &c., her Majesty's Astronomer at the Cape of Good Hope, to the Lords Commissioners of the Admiralty, July 23, 1850.**

Read January 10, 1851.

I propose to divide this Report under the following heads:—

I. Personal Establishment, and Regulation Register.
II. Instruments.
III. Astronomical Work effected.
IV. Arc of the Meridian.
V. Reductions and Printing.
VI. General Remarks.

I. *Personal Establishment.*

In the year 1834, the establishment consisted of the Astronomer, Mr. Maclear; of Lieutenant Meadows, Assistant to the Astronomer; and a Labourer. On the 1st of December, 1834, Lieutenant Meadows left the observatory on leave, and shortly after resigned his appointment. He was succeeded by Charles Piazzi Smyth, who arrived at the observatory on the 9th of October, 1835. In the year 1839, their Lordships were pleased to appoint William Mann as Second Assistant, who took up his residence on the 23d of October, 1839.

In the year 1845, Mr. Smyth quitted the Cape, being appointed to succeed

* This memoir, and those which follow by the same author, are printed at the expense of the Lords Commissioners of the Admiralty.

the late Mr. HENDERSON as Professor of Practical Astronomy at Edinburgh; and in November 1845, Mr. MANN met with an accident which unfitted him for duty, and compelled him, in the following March, to proceed to England on sick leave. He returned as First Assistant on the 24th of December, 1847. On the 22d of June, 1846, the Rev. GEORGE FREDERIC CHILDE, M.A., arrived at the observatory to succeed Mr. MANN as Second Assistant. In the spring of 1846, the Magnetic Observatory, hitherto in charge of the Honourable Board of Ordnance, was transferred to the Lords Commissioners of the Admiralty, who were pleased to appoint GEORGE ROBARTS SMALLEY, B.A., as Third Assistant, to enable the Astronomer to carry on the magnetic observations: Mr. SMALLEY arrived at the Cape on the 8th of September, 1846.

The actual force on duty at the observatory, from January 1834, has been as follows:—

From January	1834,	to December	1st, 1834,	the Astronomer and one Assistant.
,, December	1st, 1834,	to October	9th, 1835,	the Astronomer.
,, October	9th, 1835,	to October	23d, 1839,	the Astronomer and one Assistant.
,, October	23d, 1839,	to October	22d, 1845,	the Astronomer and two Assistants.
,, November	18th, 1845,	to June	22d, 1846,	the Astronomer.
,, June	22d, 1846,	to September	8th, 1846,	the Astronomer and one Assistant.
,, September	8th, 1846,	to December	24th, 1847,	the Astronomer and two Assistants.
,, December	24th, 1847,	to the present time,		the Astronomer and three Assistants.

This statement refers to the Establishment; but it is proper to mention that in 1845, when I was left alone, the Commander-in-chief granted me the temporary services of an intelligent midshipman, HERBERT CAMPION, Esq., a gentleman whose name will be often mentioned in connexion with the arc of the meridian.

While the Astronomer had only one Assistant, the routine of business was arranged by personal communication, without any other register than the observing journals.

During the measurement of the arc of the meridian, one officer only was left at the observatory: but when that operation terminated, and the scraps of back work were cleared off, the weekly register and order-book was set on foot, of which a copy was lately transmitted to the Hydrographical Office. This register shows the work assigned to each officer, and will serve for the base of future annual reports.

II. *Instruments.*

Until 1847, the fixed instruments were meridional, viz. a 10-feet transit-instrument by DOLLOND, and a 6-feet mural circle by JONES; the former having a 5-inch and the latter a 4-inch object-glass.

The other instruments were,—

A 13½-inch reflecting telescope, by Sir WILLIAM HERSCHEL.

An excellent 46-inch achromatic telescope, with an aperture of 3½ inches, by DOLLOND, mounted on an equatoreal stand, and provided with four micrometers, viz. a spider-line position, an annular, and two of rock crystal; to which has been since added a flat wire position-micrometer, by SIMMS.

A 5-feet achromatic, by JONES, having a 3½-inch object-glass of inferior quality.

A portable altitude and azimuth-instrument, by DOLLOND, which is described by Mr. DOLLOND in the first volume of the Royal Astronomical Society's *Memoirs*, p. 55.

A 6-inch theodolite, by JONES, of peculiar construction.

A 30-inch portable transit-instrument, by JONES, with a 2½-inch object-glass, mounted on a cast-iron frame.

A 20-inch portable transit, by DOLLOND, on a cast-iron frame.

A reflecting circle, and

A 5-inch sextant, both by JONES.

In the autumn of 1847, the 46-inch achromatic was mounted on a polar axis obtained from the Greenwich Observatory, and placed under a revolving dome; and in August 1849, an equatoreal by MERZ, having a telescope of 8½-feet focus and 7 inches aperture, with a driving clock, was erected in a suitable building. These instruments are described in another memoir.

Of the larger instruments, the object-glasses of the 10-feet transit-instrument, 8½-feet equatoreal, and 46-inch equatoreal, are of unquestionable excellence.

There are four clocks and a journeyman, which I will mention according to their order of merit:—

MOLYNEUX (the number inside), with GRAHAM'S dead-beat escapement and mercurial pendulum. The performance of this clock is first-rate. The beat, however, is so low, that during strong winds the coincident beat of the journeyman is required. This is the present transit-clock.

Barraud, No. 1190, having Graham's dead beat and a mercurial pendulum. This clock was received with the $8\frac{1}{2}$-feet equatoreal, and is placed in the equatoreal-room.

Hardy, with Hardy's escapement and a mercurial pendulum. This was meant to be the transit-clock (for which it is peculiarly fitted by its loud, sharp beat), and was employed as such for several years. The rate, however, has varied in a way to unfit it for that position, and with reluctance it has been placed in the circle-room. At the last minute examination of its parts, a crack or flaw was discovered in one of the detent springs, and Mr. Adams of Cape Town placed a thin piece of spring over the part, but without producing any improvement in the performance. I propose, therefore, to send the clock home for examination and repair, which I hope may be successful, as its excellent beat renders it a most desirable observing-clock.

Molyneux, No. 159, originally provided with a gridiron, but at present with a mercurial pendulum. This timepiece is totally unfit for astronomical purposes. I am informed that it never kept a respectable rate. It seems to be very old, and has undergone divers alterations in hope of making it useful. It is placed in the 46-inch equatoreal-room, where it is not of much use.

A journeyman-clock, by Grimaldi, which rings at every half-minute.

The following instrumental changes have occurred:—

An altitude and azimuth instrument, by Ramsden, of primitive construction and inferior power. The late Mr. Fallows employed this instrument in Cape Town, previous to the erection of the observatory. This instrument was sent to the Royal Observatory, Greenwich, in exchange for the polar axis now attached to the 46-inch achromatic.

The original mural circle, which was faulty in figure and pivot, was exchanged in the year 1839 for the present circle, but the object-glasses were not changed. Mr. Airy kindly allowed me to retain that of the otherwise faulty instrument, which, though not good, is superior to that formerly attached to the present Cape circle. This, the present Cape circle (Jones, 1824) was, I am informed, originally constructed for the Cape; but, on the representation of the late Mr. Pond, it was retained at Greenwich to enable him to carry out his well-known system of observation with two circles, and another was ordered of Jones for this observatory.

Bradley's zenith sector sojourned at the Cape from 1838 to 1850.

The several instruments are in good order, with the exception of the level

of the 10-feet transit. I was informed that it gave discordant results, shortly after my return to the observatory in July 1847. It has been closely examined from time to time without detecting the cause. The performance has been improved by a cover of glass over the tube, and by the adoption of an upper apparatus to lower it upon the transit-pivots.

A check on the level of the transit-instrument has been obtained by means of a nadir-point eye-piece, of low power, constructed at the Cape; and a stage has been erected, which envelopes the west pier, to facilitate its application. It is hoped that by the present time a new level and a good nadir-point eye-piece are on their way to the Cape.

In connexion with the transit-instrument should be described the means for discovering its collimation-error and for checking its azimuthal position.

For the former, two lenses of 133 and 33 feet focal distance are fixed to teak-wood bars screwed to the cheek-pieces (two inches thick) of the north and south chases, and adjustable marks are placed upon pillars in their foci. The firmness of this support is equal to what is required, and to little more, on account of hygrometric changes.

The azimuth-mark is a pillar in Blauberg, thirteen miles from the observatory, the centre of which is 3″ west of the meridian. Although the line of sight is in part over water, the pillar is too distant for distinct vision, except in favourable conditions of the atmosphere. At other times the probable errors of the readings are large and embarrassing; still it is a valuable mark, though not always available. The southern direction, towards the Camp ground and Wynberg, is covered with trees.

At the present time I have directed strong iron bars to be let into the chase walls, clear of the woodwork, for the support of the collimating lenses. The bars are to be covered with a non-conducting substance; and it is proposed to protect the pillars from the sun and weather; also to make arrangements for lighting the marks at night.

The result will be given in my next Report.

The pillars placed in the swampy ground near the observatory in 1829 are too unstable and too near to be of any use.

III. *Astronomical Work Effected.*

Comparing the number of meridian observations made in the several years since 1834, it is proper to note, that the sector-work for the verification of

Lacaille's arc of the meridian commenced in the year 1838: the measurement of this arc commenced in 1840, and was terminated in 1847. The number of observations made with each meridional instrument is as follows:

Year.	Transit Instrument.	Mural Circle.
1834	3678	2493
1835	2525	2759
1836	4457	3557
1837	3088	3541
1838	704	321
1839	2544	1095
1840	4312	2844
1841	748	....
1842	960	337
1843	606	1081
1844	662	2011
1845	1067	288
1846	2198	22
1847	3547	1757
1848	3131	3127
1849	2937	2226
To July 23d, 1850	1062	3389
	Total 38226	30848

Although the sector observations belong to the geodetic work, they come properly under the head of astronomical observations, and should be registered here. The sector list contains 112 stars.

Years.		
1838	Cape Town and Klyp Fontein	1133
1843	Heerenlogements Berg	735
1843	Kamies Berg	956
1843–1844	The Observatory	2371
1844	Zwart Kop	1330
1844–1845	Cape Point	710
1845	The Observatory	727
1847	Bushman Flat	1101
1848	The Observatory	1399
	Total	10462

It would be difficult to exhibit the extra-meridian observations in a tabular form, but the amount is considerable.

IV. *Arc of the Meridian.*

My Report, dated September 9th, 1842, described the operation from Cape Town to Picket Berg, the arc measured by LACAILLE. The present Report embraces the extension to Cape Point southward; from Picket Berg to the Kamies Berg northward; and from the Kamies Berg northward to a point in the Bushman Flat. There is a side triangulation to Cape L'Agulhas.

The prolongation southwards to Cape Point added twenty-four miles only to the length of the arc; but it was important, inasmuch as it evaded to a certain extent the disturbing attraction of the Table Mountain mass. Again, the northern extension into the Bushman Flat placed the sector on an elevated open plain, or table of primitive rock, nearly as unobjectionable, with respect to lateral deflection, as the open sea is.

LACAILLE's measure was vitiated, and rendered useless as an element in the determination of the figure of the earth, because his terminal points are affected by the sum of the attractions of Table Mountain and the northern end of Picket Berg.

The mountain ridge extending from Cape Hanglip to the northern end of the Cedar Mountains, consists of sandstone or slate resting on granite, varying in elevation from two to seven thousand feet. The ridge from Cape Point to Picket Berg is of the same structure, but more broken up and less elevated.

Eastward from Hanglip, the headlands, named Mudge Point, Danger Point, and L'Agulhas, are chiefly of limestone; at the base of the latter there is a small stalactite cavern.

The eastern side of the run from the Cedar Mountains to the Kamies Berg consists chiefly of granite table land, more or less undulating. The west, towards the sea, is comparatively low, and is also of granite. The granite masses of the Kamies Berg ascend to the height of 5100 feet. This range curves westward to the mouth of the Orange River, and forms the boundary of the Bushman Flat on the south and west sides. Towards the south-east they are lost in the Bokkeveld and Hantam Table Land, excepting two

insulated lofty peaks, named Kebiskow and Spion Berg, the nearest of which (Kebiskow) is 79½ miles from the Kamies Berg Station.

The Bushman Flat is a solid block of granite, of some nine thousand square miles area; a large portion of its upper surface is nearly as smooth as the sea in calm weather; it is elevated about 3600 feet above the level of the sea. Parts of it, particularly towards the Orange River, are frosted with quartz. In the vicinity of the river it declines some 2000 feet; there, residual masses topped with quartz appear prominent, though not more elevated than the general surface of the flat.

Close to the Salt Pans, named "Boschles" by the natives, there is a low ridge of boulders, formed, seemingly, at the expense of the adjacent surface; and in the line joining Boschles and Riet Fontein, there is, towards the latter, a group more elevated, called "Cowberg," also seemingly at the expense of the adjacent surface. Cowberg is the only nodule visible from the top of the Kamies Berg in the monotonous horizon given by the Bushman Flat.

Towards the centre of the Flat there is no index to guide the traveller other than the paths known to borderers and Bushmen. The highest point of the Kamies Berg (some 1600 feet above the Flat) is lost, except a small segment distinguishable in the horizon by the contrast of its blue colour during the maximum refraction. The waggon tracts to the Orange River and Namaquas Land, hug the mountains to the West.

A little to the north-east of Boschles is the locality where Mr. Borchends was lost for a time, as related in Sir John Barrow's work.

It is stated that sometimes several years pass without any rain. When thunder-clouds hang over the plain, the borderers collect their flocks, to take advantage of the nutritive grass, like dwarf buck-wheat, which springs up rapidly after rain from the sandy débris of the granite. The valued localities are the neighbourhood of hollows in the granite, wherein the water settles. The sand and more offensive matter collected in these hollows serve to prevent evaporation from beneath, when all appearance of moisture has vanished from the surface. These hollows become the resource of travellers, Bushmen and wild beasts, who make holes in the spongy mass for a supply of the green, disgusting fluid that filters in.

There is a remarkable feature on the surface near Boschles. The ground is strewed for a considerable extent with spherical-shaped hollow stones and pebbles of variegated hues. Here the surface undulates, and in the trough

of one of the valleys a spring of salt-water flows throughout the year. The result is, a deep incrustation of good salt of some miles in length. I have not seen the mirage lakes elsewhere so splendid and so tantalising as within the range of twenty or thirty miles of these salt pans.

With this description of a locality, to me painfully interesting, I proceed to the more important subjects,—instruments, signals, and station marks.

The chief portion of the triangulation has been effected with the FULLER theodolite, the property of the Royal Astronomical Society, which was liberally consigned to their Lordships for the service. In general construction it resembles RAMSDEN'S first improvement on the great theodolite. The upper telescope is 30 inches in focal length; the lower, or tell-tale telescope, serves to check any movement of the trestle support or of the frame to which it is attached, but has no controlling power over a shift of the microscope arms from their position on the frame.

The circle is 20 inches in diameter, and is divided to every 10′. The subdivisions are read by three equidistant microscopes to single seconds. When adjusted for "run," one revolution of a microscrope screw is equal to 2 minutes. Accordingly, the screw-head is divided into 120 parts. The divisions are not good, nor the microscopes sufficiently firm; but an angle can be measured on any part of the limb, by shifting the microscope arms, and thus errors of division may be rendered insensible. During the shift, the construction of the clamp does not admit of the microscope arms and circle being held relatively fast, as is the case with the repeating circle. The contrivance is more of the character of the "repeating table;" and advantage was taken of it to repeat the measures on successive arcs, *without a divisional break*, for one or more circumferences, in the order of increasing readings, and the reverse. Also, to eliminate any residual level error which might affect signals unequally elevated, one half of the measures of each angle were made with the pivot bearings reversed. This instrument was supported on a heavy, well-braced trestle of teak wood, and screened by canvass from the action of the sun.

The other angular instrument is an excellent repeating theodolite by REICHENBACH and ERTEL, the property of Sir FRANCIS BEAUFORT, which that gentleman most liberally risked on this service, to facilitate and expedite the work. The instrument was deservedly a great favourite with the late Capt. KATER; for although the diameter of the circle is scarcely 8 inches,

and its telescopes only 14 inches in length, magnifying about 28 times, such is the beauty and accuracy of the divisions, the firmness of its clamps, and the strength of its parts, that, during good definition, a single measure could always be depended upon to the accuracy of $2''{\cdot}5$ or $3''$. The limb is divided to $10'$, and by means of the verniers (of which there are four) subdivided to $10''$; but $3''$ can be estimated with facility. With respect to the telescope, the light from a heliotrope, which exposed a circular reflecting surface of $3\frac{1}{2}$ inches in diameter, was seen like a sharp star of the third magnitude, at the distance of $79\frac{1}{2}$ miles (Sector Berg and Kebiskow).

The facility of measuring with this instrument, the absence of uncertainty or calculation of "runs," and, moreover, its portability, can only be fully appreciated by those who are feeling their way through trackless valleys, or sojourning on the tops of high mountains. This instrument was termed on the survey the "BEAUFORT theodolite."

The altitude and azimuth instrument by DOLLOND was used at some of the stations for experiments upon terrestrial refraction, and for general astronomical purposes. The levelling instrument by CARY has a telescope of 14 inches. BRADLEY's sector has been well described by the Astronomer Royal. Heliotrope, or more correctly heliostat, signals, were almost exclusively employed; these consisted of silvered plate glass, swinging in a steel frame, much on the plan of a common toilet glass.

Daily from sunrise until 10 o'clock, and from 3 o'clock until sunset, the signal-man kept the centre of the light reflected by his heliotrope upon a hole in the screen, by moving the reflector a small quantity in altitude and azimuth at intervals of about 40 seconds: this was continued until he received the well-known signal from the theodolite to "leave the station." For this and other communications there was a code of signals managed by means of the heliotropes, with a copy of which each man was provided. These signals in general were made at preconcerted hours. I am indebted to Captain WILLIAM JACOB, formerly assistant on the Indian Trigonometric Survey, and now astronomer at Madras, for the general plan of the heliotropes I employed.

Occasionally (but so seldom that their use was an exception, and always under peculiar circumstances), the signals were piles of stones in the form of truncated cones, painted white or black, to obtain the strongest contrast with the colour beyond. These were built round a directing pole centred over the station point. Their outlines were never certain in strong sunshine when

the distance exceeded 20 miles. During gloomy weather, or at sunrise and sunset, they answered very well for distances under 50 miles.

In accordance with their Lordships' instructions, the station points have been preserved; with two exceptions they are defined by plugs of lead, each having a brass pin in its centre, let into holes drilled in rocks, and each is covered with a conical pile of stones of about 14 feet in height.

The least of the many friendly acts of General Sir GEORGE NAPIER towards the survey and to science when Governor of the Cape, was a proclamation, in which, among other injunctions, he directed the inhabitants not to destroy or disturb the trigonometric points.

I will now proceed to the chronological details.

Chronological Details of the Operations from the Autumn of 1842.—Before entering into these details, I beg permission to acknowledge the facilities and assistance received from the flag-ship and dockyard, by order of the Hon. JOSCELINE PERCY, the Commander-in-chief, to whom, to Captain C. EDEN, and to the officers of the squadron, I am deeply indebted for material assistance and personal kindness.

My acknowledgments are likewise due to the Hon. J. MONTAGUE, the Colonial Secretary, for exercising the powerful influence of his office over the field cornets and inhabitants, to insure me assistance and the means of transport.

In the latter end of December 1842, the sector with the other instruments and stores were conveyed to St. Helena Bay in Her Majesty's ketch the Arrow, commanded by Captain ROBINSON, and were landed at the mouth of the Berg river, after a fruitless attempt to disembark them further to the north, at Elands Berg. At Elands Berg I was joined by Mr. MANN, and by Dr. WALLISH, the superintendent of the Hon. East India Company's Botanic Garden at Calcutta, who was residing at the Cape on sick leave.

Elands Berg is an oblong rise close to the shore and towards the north of St. Helena Bay, and is visible from Patris Berg, Picket Berg, Lambert Hoeks Berg, the Cedar Mountains and Heerenlogements Berg. The station is on the naked rocks, at the end overlooking Verlooren Valei.

We left it on the 2d of February, 1843, and detaching the sector to Heerenlogements Berg, we proceeded to Lambert Hoeks Berg, at the eastern extremity of Lang Valei. The station is on the crest of the eastern ridge, on a conglomerate mass of sandstone, whence the town of Clanwilliam and

the Olifants River are seen in the vale, which separates this mountain from the Cedar Mountains.

On the 4th of March we left this station for the ravines of the Cedar Mountains, in the hope of being able to occupy the highest point of that range, the practicability of which had been doubted. If this could be managed, the triangulation to the Kamies Berg over the Hardeveld might be effected with comparative facility.

The Cedar Mountain range is about 26 or 30 miles in length, and consists of ridge-shaped and rounded masses of various elevations. Three Kops towards the centre, and Joachims Neus to the west, are nearly of equal height, but Sneeuw Kop is the most commanding, particularly in the northern direction. From its summit, Table Mountain to the south, and the Kamies Berg to the north, are distinctly visible, embracing a range of 270 miles.

The march through the ravines with the instruments and stores consumed several days. On reaching the plateau under the Kop, a party of labourers were obtained from the Wupperthal Missionary Institution, situated at the eastern base of the mountains. With their assistance the instruments were conveyed to the summit of Sneeuw Kop on the 20th.

The station is on the floor of a shallow depression, on the top of a mushroom-shaped bump of the naked sandstone which crowns the summit. Fearing the difficulties the signal men might encounter here, should the winter set in early (the thermometer was at 32° on the evening of the 20th of March, in clear weather), a large pile was built close to the station-point, and painted black; that pile, or the heliotrope, were to be employed according to circumstances, the azimuth and distance of the centre of the pile from the station point being taken into account.

We left Sneeuw Kop on the 4th of April, and reached Heerenlogements Berg on the 13th, having spent a couple of days at Clanwilliam while procuring waggons.

Heerenlogements Berg is an insulated sandstone mountain of considerable celebrity with travellers, owing to the north road passing close to it. The rocks, forming two sides of an open cave at its base, are covered with the names of visitors, among others that of LA VAILLANT, the celebrated naturalist, is deeply chiselled.

The top of the mountain is divided by a deep straight ravine, in the direction S.E. and N.W. The trigonometric station is on the highest point of the

northern crest. The sector was posted on a more secure part of the crest nearly 505 feet from the theodolite. The sector station is not entirely unobjectionable, because it is not over the centre of the mass of the mountain. Fortunately the greater part of the mass is to the west of it. In other respects Heerenlogements Berg is an important point for latitude, inasmuch as being situated about 50 miles meridional distance north of LACAILLE's station at Klyp Fontein, and little more than 30 from the end of Picket Berg, which is believed to have attracted his plumb-line towards the north, Heerenlogements Berg should exhibit a slight indication in the contrary direction. Mr. SMYTH arrived at Heerenlogements Berg on the 7th of June to replace Mr. MANN, who left with Dr. WALLISH on the 15th. On the same day I started with Mr. SMYTH for Lewis Fontein, in the Hardeveld, where we arrived on the 21st, having crossed the Olifants River with the sector and other instruments, near the Ebenezer Missionary Institution.

The Lewis Fontein station is a whale-shaped granite rise towards the west side of the Hardeveld. Here the FULLER theodolite was given over to Mr. SMYTH, and I proceeded with the sector to the Kamies Berg, which I reached on the 1st of July, and established my head-quarters at the Lely Fontein Wesleyan Missionary Institution two days after.

I took advantage of the intervals of fair weather between the 3d and 17th of July, to scour these mountains for the least objectionable sector station, and to remove the instruments and stores to the place selected, viz. a flat-topped naked bump of granite, seemingly near the centre of gravity of the neighbouring masses; but it is doubtful if the somewhat higher tops to the south-west would fill up the vale between them and Sector Berg. The sector observations, observations for azimuth and a local triangulation, detained me at the Kamies Berg until the 29th of September. In the meantime Mr. SMYTH had measured the angles at the stations on Lewis Fontein, Elands Hoogte, the Bokkeveld's Berg, an elevated table land on the east border of the Handevelde, and Klyp Rug, a low clayey hill south-east of Bokkeveld's Berg, in the western part of the Karroo. On my way to the observatory we met at the Olifants River, on the 7th of October, to make further arrangements; from thence he proceeded to the Kamies Berg with the FULLER theodolite.

I arrived at the observatory on the 23d of October, where the sector was

erected on the 25th, for observing the zenith distances of the stars observed at Heerenlogements Berg and Sector Berg. A large portion of the list now passed the meridian in the day-time, and being small could not be observed until the following spring; but independent of the sector, I had ample employment. Between the 17th and 30th of December I reconnoitred for stations, chiefly with the intention, if practicable, of turning the side triangulation to L'Agulhas, upon the stations Winter Berg and Sneeuw Kop, near Hottentot Holland; but in this I failed. Mr. Mann afterwards visited the intervening mountains, and failed also, owing to their great elevation masking the Zonder-end. I was consequently obliged to abandon the contemplated large triangle, and to turn upon Sneeuw Kop and Cape Point.

The sector observations were resumed in the spring and finished in June. On the 30th of that month, the sector and the Beaufort theodolite, which I received on the 22d of March, were removed to Zwart Kop, near Simon's Town, a position about the centre of gravity of the range on the west side of False Bay. The trigonometrical point is on the crest, 2031 feet above mid-water. Here, as at Heerenlogements Berg, the sector could not be placed upon the trigonometrical station, nor any instrument or tent, not admitting of removal at an instant's warning, so violent and so uncertain are the gales in this locality. The sector was, therefore, placed on a comparatively sheltered spot in the vicinity, 92 feet less elevated.

At this station the commander-in-chief was pleased to grant me the valuable services of Lieutenant, then Mr. Hornby, of the flag-ship, and a working party, to build a high circular fence of bush round the sector. The observations were commenced on the 25th of July, but were interrupted on the 20th of August by a violent gale, which destroyed the tent fastenings and drove the canvass against the sector. The scene for a time was frightful. Every gust tilted the tripod to the stretching limit of the windward guy-rope. The arch, micrometer, and object-glass, were detached with all possible speed, and the tube lashed to the spindle. Mr. Hornby then, with great intrepidity, climbed to the top and cut away the tent. I had fortunately also the assistance of Mr. Smyth, who was accidentally at the station. This scene occurred at about two hours after midnight; and it determined the kind of cover for the instrument afterwards adopted on the more exposed position at Cape Point. The tent was repaired by a party of sailors from the flag-ship.

The observations were resumed on the 29th of September and closed on the 2d of October, when the instrument was conveyed to Cape Point by a party of marines.

The Cape Point Station is on the saddle of the well-known promontory which distinguishes the west side of the entrance to False Bay, 688 feet above the sea. (The highest point of the promontory, that above the precipice, is 800 feet.)

The sector was placed a few feet west of the trigonometrical point, where a sufficient area of the rock was cut level, and holes sunk in to receive the legs of the tent tripod, into which they were keyed. Additional spars were fixed, to form the frame-work of a truncated cone, which was covered in with scantling, and made weather-tight by a further covering of canvass. The observations were commenced on the 16th of November, 1844, and closed on the 16th of January, 1845. The sector was then removed to the observatory, and erected there on the 23d.

At the last two stations several new stars were taken up, to prevent the mean of the zenith distances from being too northerly, a matter of no importance if instruments were perfect. These stars, in conjunction with the former list, were re-observed at the observatory between the 24th of January and the middle of June; the delay having arisen from a similar cause to that which occurred on returning from the Kamies Berg. About seven weeks of this interval was spent on Zwart Kop, Cape Point, and King's Block House Battery, with the BEAUFORT theodolite and levelling instrument. The latter instrument was employed between Zwart Kop and the Tide Guage in Simon's Bay, and between the station on Cape Point and the shore at the foot of the South Precipice.

Mr. SMYTH, whom I left on his way to the Kamies Berg the preceding year, measured the angles at that station. Then bending his course homeward, he re-occupied Elands Berg, to connect Sneeuw Kop, in the Cedar Mountain, with Heerenlogements Berg and Picket Berg. On reaching Picket Berg to carry down the eastern chain, he was obliged to take up a new point on that mountain near Kapitein's Kloof, to command Winter Berg. On Winter Berg he was engaged from the 9th of July to the 10th of October, a station little inferior in difficulty to the Cedar Berg Station, with the disadvantage of being shut up occasionally by snow. From the 22d of November to the 21st of July, 1845, he occupied Sneeuw Kop, near Hottentot's

Holland, before mentioned, elevated 5070 feet above the sea: he then returned to the observatory, to prepare for his departure from the Cape, having been appointed to succeed Mr. Henderson at Edinburgh.

The loss of Mr. Smyth materially influenced my plans. He had a happy talent, with the assistance of his pencil, in conciliating the inhabitants. He was well acquainted with the Kamies Berg, and his robust constitution fitted him for taking an active share of the triangulation in the Bushman Flat.

During the short interval before he embarked, and while he had charge of the observatory, I resolved, if possible, to effect the side triangulation to L'Agulhas. Accordingly, Mr. Mann started with the Fuller theodolite for the Zonder-end station on the 23d of July, and on the 25th I took the direction to Cape L'Agulhas with the Beaufort theodolite, where I established myself on the 1st of August.

The Zonder-end station is on the highest point of the range of mountains which extends from French Hoek by Genadendal towards Zwellendam. It is on the naked rock, 5330 feet above the sea.

The L'Agulhas station is on the highest point of the rise above the present Lighthouse, from which it is nearly north, distant 4372 feet, and 458 above the level of the sea. An oak pile was driven into the soil (which there covers the limestone) to define the point.

To assist the Colonial Government in case they should prolong the triangulation eastward, a signal man was sent to Potte Berg, near the mouth of the Breede River, elevated 1920 feet above the sea: this point is marked in the usual way by a 14 feet pile of stones.

Two theodolites were now simultaneously at work on the same triangle, a plan admitting of increased despatch without diminution of accuracy; for the relative precision of the theodolites can be derived from their individual precision, and the errors distributed accordingly. The reciprocal heliotrope can be lined a few feet from the adjacent theodolite point by means of the theodolite over the point with as much precision as the theodolite can be centered over that point.

On the 12th of August, the Beaufort theodolite was upon the Danger Point Promontory, elevated 1055 feet above the sea. On the 27th, upon Mudge Point, elevated 1467 feet; and on September 9th, upon the Tower of Babel, elevated 3720 feet, from whence it was removed on the 14th, to be conveyed to the observatory.

The pile on Gunner's Quoin Promontory, situated between L'Agulhas and Danger Point, and elevated 882 feet, was fixed by intersection.

A pile on Zwart Berg was also fixed by intersection: the village of Caledon and the hot spring are at the southern base of the latter mountain.

During the occupation of the stations above described, 17 days only were entirely, or in part, fine; perhaps equivalent to 12 days of working weather. On the other hand, the transparent, steady atmosphere that prevails in the intervals between Cape north-westers, makes up for the interceptions. Moreover, the travelling between the stations was expedited by the employment of a horse waggon.

While I was thus engaged, Mr. MANN occupied the Zonder-end station; where, enveloped in snow, he encountered the severity of a northern winter, with the piercing cold peculiar to great elevations. From this station he proceeded to Kogel Berg, on the east side of False Bay, elevated 3988 feet above the sea. From Kogel Berg he returned to the observatory on the 23d of October. On the 17th of the following month, I had the misfortune to be deprived of his services also, in consequence of a fall, which produced concussion of the brain. He remained at or near the observatory for three months without any decided indication of recovery; then sailed for England to try the effect of his native climate.

Mr. SMYTH had sailed for England on the 22d of September.

From the 25th of September to the 9th of October, I was stationed on Tyger Berg; and from the 15th to the 25th of November, on Simon's Berg, near French Hoek. The chief value of these stations consists in their command of Simon's Town.

About this period, the premises in Cape Town, where LACAILLE lodged, became the property of JAMES SEAWRIGHT, Esq., who removed the low tenements from the Fishmarket end of the yard, and the partition wall of the high store supposed to stand over the position of LACAILLE's Observatory.

Mr. SEAWRIGHT being aware of my investigations, kindly afforded me the opportunity of excavating the floor. I found the soil to consist of clay and sand, remnants of bricks and mortar. A narrow wall was traced parallel to the outer wall of the yard, and a square-shaped block, of about 4 feet area, near the wall, both built with small stones and pot clay, like the common cheap buildings at the Cape, and bearing no resemblance to the strong masonry described by LACAILLE. At the depth of $2\frac{1}{2}$ feet from the surface of

the floor, the old yard pavement was found, which I caused to be laid bare for a considerable extent. The piece of wall before mentioned did not rest on the pitching, but passed through it; from which I infer that the wall was at least as old as the pavement. The store was built more than 40 years after Lacaille left the Cape.

Although I did not discover any certain remnant of the observatory, I referred the square block to the roof of the store, and connected it with the neighbouring trigonometrical points, particularly with Capoc Berg and Reibeck's Casteel.

The time now approached for the contemplated triangulation into the Bushman Flat. My resources for such a service were materially crippled by the loss of Mr. Smyth and Mr. Mann, gentlemen experienced in the details of the meridian work, and unflinching in hardships. There was little chance of Mr. Mann's return before 18 months. If even he should return in time, the illness which drove him to England would have precluded his employment on such a service. There was little chance of his successor having any practical knowledge of field-work. The signal-men and labourers were in pay, and most of them veterans on the work. If discharged for a time, they must seek other employment, and might not be available when wanted.

After mature consideration, I decided to instruct two gentlemen, who would then be fit to set out with me on the arrival of the new assistant, to whom the charge of the observatory during my absence would be given. My reasons for employing two were, to reduce the time of working the Fuller theodolite by nearly one-half, and to guard against interruption from any casualty to one observer. The Beaufort theodolite and the sector I proposed to take myself.

The first gentleman I applied to was Mr. Herbert Campion, whose services had been granted to me by Admiral Percy, when I was left without any assistant. On obtaining Mr. Campion's consent, I applied to Vice-Admiral Dacre, the Commander-in-Chief, who, considering the circumstances in which I was placed, most cordially granted the request.

The other gentleman pitched upon was Mr. George Montagu, the present active and talented Second Assistant-Surveyor-General, with whom I took an introductory trip to Capoc Berg in February 1846, leaving Mr. Campion in charge of the observatory. At Capoc Berg I joined the Patris Berg Station with the stations taken up by Mr. Smyth in Picket Berg and Winter Berg,

and the point over LACAILLE's observatory. On the 6th of April, both gentlemen were placed upon survey duty, and began their acquaintance with the FULLER theodolite, by a series of experiments for determining its errors of division and by the measurement of stations visible from the observatory. In the meantime, the magnetic observations had been transferred from the charge of the Ordnance Department to that of the Admiralty; and Captain WILMOT and the Artillery party daily expected orders for returning home. Captain WILMOT, aware that I had not the means for carrying on the magnetic observations, and also of my arrangements for the field-work, considerately allowed the Artillerymen to remain on duty at the magnetic observatory.

On the 11th of July, the Rev. GEORGE FREDERIC CHILDE, M.A. arrived as successor to Mr. MANN, the latter having been appointed First Assistant, *vice* Mr. SMYTH; and on the 16th, I had the honour to receive their Lordships' announcement of the appointment of GEORGE ROBARTS SMALLEY, B.A. as Third Assistant.

On the 10th of August, Messrs. CAMPION and MONTAGU started for the frontier with the FULLER theodolite, but with directions to take the Patris Berg Station on their way, for the purpose of joining Kapiteins Kloof with the other stations, while I waited the arrival of Mr. SMALLEY, to take charge of the magnetic observatory. He arrived on the 8th of September, and I set out on the 26th, with the sector, BEAUFORT theodolite, and convertible pendulum. The Kamies Berg station, called Sector Berg, is the northern angle of the triangle formed by Lewis Fontein to the west, and Bokkeveld's Berg to the east, and commands the Bushman Flat. Retaining Sector Berg as the central station, a point was required west of it, near Roewall Bay, and another on the most commanding elevation of the north-western range, from whence the centre of the Bushman Flat should be visible.

On the east side, the Peak, called Kebiskow, about 80 miles from Sector Berg, offered the only extensive prospect of the Flat and command of Bokkeveld's Berg. One station only was desirable on the Flat, from whence Kebiskow, Sector Berg, and the Western Kamies Berg Station, should be visible.

Journeying from the observatory, I was overtaken by Messrs. CAMPION and MONTAGU, near Picket Berg. We separated at Heerenlogements Berg. They took the eastern route for Bokkeveld's Berg, there to deposit their

instrument and party, and then cross to join me at Sector Berg, for the purpose of jointly scouring the Bushman Flat. We met at Lely Fontein on the 20th of October. On the 23d we entered the flat on horseback, and made direct for Pilla, on the left bank of the Orange River, which we reached on the 28th. Here we found a deputy-captain, with his handful of half-castes and Hottentots, and a few Bushmen, living in mat houses near the ruins of a missionary chapel. From the captain we obtained a Bushman guide, and ascended the Pilla mountain on the 29th, where we remained until the following morning, to obtain a view of the horizon given by the flat during the maximum refraction. From Pilla, retracing our steps towards Riet Fontein, we traversed the western part of the flat, and then proceeded to the Koper Bergen and the other most elevated mountains in the required direction. We returned to Lely Fontein on the 10th of November, and arranged that Messrs. Campion and Montagu should occupy Kebiskow next after Bokkeveld's Berg; in the mean time that I should measure the corresponding angles in Sector Berg, select the station on the flat, and then measure the angle between Kebiskow and Sector Berg. From Kebiskow they were to cross westward to Lewis Fontein, while I proceeded to Roewall to measure the angles at that station, returning to Sector Berg to measure the angle between Lewis Fontein and Roewall. From Lewis Fontein they were to come on to the Kamies Berg, that we might have mutual assistance in conveying the instruments and stores through the kloofs into the Flat. Then Messrs. Campion and Montagu were to diverge westward, while I made the observations on the Flat. The latter part of this arrangement was attended by a somewhat unforeseen circumstance. They set out for their first station on the 12th. On the same day, accompanied by the Rev. Mr. Bailie, the superintendent of the Lely Fontein Institution and a guide, I penetrated the Flat from the eastward at a place called "Cowgoed Flats," and by rapid travelling reached a spot called "Nourby's," about forty miles from Sector Berg, the same evening. Next morning before sunrise the top of Kebiskow was visible, but none of the western mountains. We could not penetrate so far as Boschles, owing to the intense heat and want of water.

Between the 19th and 23d I scoured the neighbourhood of Roewall Bay, and selected the station in that locality. Shortly after my return to Sector Berg, the Kebiskow and Bokkeveld's Berg lights were seen, and the theodolite work was commenced.

It was now absolutely necessary to decide upon the locality on the Flat, and to establish a signal party.

By experiment, Boschles could not be reached on horseback during hot, dry weather without secondary means. On the 7th of December I started with three horses and an ox-waggon loaded with provisions, water-casks, and a signal party. The casks were filled at Cowgoed Flats, from whence we pushed on, travelling night and day in the expectation of reaching Boschles on the 11th.

At sunset, however, on that day, the guide acknowledged that he had mistaken the direction. The safety of the men, who were not provided with horses, depended partly upon the oxen, then sinking from thirst and fatigue. To them, therefore, the remainder of the water in the casks was given, and when the moon appeared above the horizon we retraced our waggon track with all possible speed, and reached Kobus the following forenoon, where, by digging in the sand, sufficient water was obtained for two or three days' consumption. Here the party was left, while, with the guide, I made a fruitless traverse of some sixty miles in search of Boschles. On the 14th I rode back to Cowgoed Flats, where I obtained another guide, who led the party direct to Boschles: this proved to be close to a point of my traverse two days before. The oxen drank the salt water with avidity, which, after a few days, ceased to produce the usual effect.

This rather uninteresting description of the journey is given to illustrate the character of the flat.

From Boschles, as head-quarters, the party commenced a search for the most commanding swell of the surface, which Adam Cairns, the leading signal-man, hit upon by watching for the locality last illuminated by the setting sun. Then, taking its direction with a pocket-compass, he marched towards the spot until night came on. At dawn he pursued the route, and was repaid by finding himself close to a gentle swell which the rays of the rising sun first struck. From this locality the top of Kebiskow was visible during the maximum refraction; also Sector Berg and the top of Cowberg; but Vogil Klyp, in the north-western range (which commands Roewall), was below the horizon, likewise the common surface about Cowberg. Any move further westward lost sight of Kebiskow. Boschles was therefore forced upon us, as an intermediate station between Kebiskow and Cowberg.

Although named the Boschles station, the latter is about twelve miles

east of the salt-pans. The swell consists mainly of sand, clothed with tufts of the dwarf grass before mentioned. A long picket was driven deep into this soil to mark the point.

While thus engaged, Messrs. Campion and Montagu were establishing themselves on Kebiskow.

On my return to Sector Berg, another waggon-load of water and supplies were forwarded to Boschles; and on the 1st of the following month (January 1847), I started for Boschles with the Beaufort theodolite in time to relieve Adam Cairns, whom I found sinking into fever, brought on by the intense heat of the sun, while signalising during the preceding fortnight. The severity of this exposure I was taught to appreciate during the following ten days. I left Boschles for Sector Berg on the 11th, where I was engaged with accounts and divers matters until the 31st. On that day I set out with the Beaufort theodolite and level for the Roewall station, where I was engaged from the 6th of February until the 5th of March, having had in the interval about eleven days only of clear or partly clear sky. Heavy thunder-clouds or fogs enveloped the mountains throughout the remainder.

The station is on the centre of a huge protruding block of granite on the top of a gentle rise, about two miles from the sea-shore, and about seven south of Roewall Bay. From this station a small part of the summit of Vogil Klyp is visible in the distance, through a narrow kloof in the intervening range of mountains: but for this niche, two very ill-conditioned triangles must have been adopted.

From the 14th to the 21st of March I was engaged upon Sector Berg, and from the 26th to the 29th upon Ezels Kop, near Sector Berg, a precautionary point taken up previously, to guard against mountain masking between Vogil Klyp and the latter. The stations proved, however, to be reciprocally visible.

Messrs. Campion and Montagu left Kebiskow on the 25th of January, to reoccupy Bokkeveld's Berg for clearing up a doubtful point. From the latter they crossed the Hardeveld to Lewis Fontein, where they commenced theodolite work on the 3d of March, and finished on the 17th of April; but a part of the time Mr. Montagu was with me at Roewall, engaged in levelling from the station to the sea-shore.

While on Ezels Kop my health began to fail: a remarkably strong constitution was not proof against the great labour of mind and body, under the

variations of temperature in quick succession, between the heat of the Flat and the piercing cold of the mountain-tops. I remained at the camp near Lely Fontein for some days, engaged with the survey accounts, until Messrs. CAMPION and MONTAGU arrived from Lewis Fontein.

We set out with the sector and other instruments for the Bushman Flats on the 22d of April, and succeeded in conveying them through the rugged descents in safety.

At Riet Fontein, on the 27th, an engagement was forced upon the occupier, GIRT BUIKES (who evidently viewed our invasion of the Flat with distrust), through the significant agency of a Government order, after persuasion failed, to forward a supply of water at stated intervals to our intended position near Cowberg. Here we were encamped on the 1st of May.

Hitherto the FULLER theodolite had been worked by Messrs. CAMPION and MONTAGU conjointly, mainly for despatch. Now two instruments were to be employed in a locality where, from its peculiarity, the greatest possible despatch compatible with accuracy was imperative. For this reason and the uncertainty of my strength continuing, I retained Mr. MONTAGU at the station, and placed the FULLER theodolite in charge of Mr. CAMPION, who departed for Vogil Klyp on the 2d. He commenced measuring on the 8th, and finished on the 10th of June. He next crossed over to Boschles to measure the angle there between Sector Berg and Cowberg. The Vogil Klyp station is on the bare granite cupola which crowns the top. The copper-mine now worked by Messrs. PHILIP and KING is about eight miles north-west of this mountain.

The small insulated granite ridges named Cowberg became essential to the triangulation, because, as before stated, their tops were visible from Boschles. On each side of them are depressions below the common surface, as if the matter composing them had been scooped out from thence.

The theodolite station is on the middle elevation, on a block of quartz. It was connected with Sector Berg and Vogil Klyp, although essential only to Boschles and Sector Berg.

The sector and trigonometrical stations on the flat about three miles to the east of them are commanded by Vogil Klyp.

The angles at Cowberg, except one, having been measured, the camp was moved, on the 12th of May, to the sector station, which is upon a scarcely perceptible swell of the flat. Here sand and a substance like chalk covers the granite, and affords a nidus for small stunted bush.

To protect the sector against wind, particularly the petty tornadoes peculiar to such localities, a circular pit, 6 feet deep and about 30 in diameter, was sunk to receive the lower end. The feet of the tent tripod, butting against the side at the floor, could not be dislodged by a side force applied above without fracturing the spars.

The BEAUFORT theodolite was placed exactly west of the sector axis, distant 35 feet 4 inches.

The theodolite work began on the 22d May; the pit was not ready to receive the sector before the middle of June. On the 18th the observations for latitude were commenced with a list of 62 stars, and were carried on with vigour until the 1st of July by Mr. MONTAGU and myself conjointly: he, stationed upon the stage above, adjusted the plumb-line over the upper dot for each observation, while I managed the micrometer work below. By the 1st of July about 500 observations were secured. The remainder I found it expedient to consign to Mr. MONTAGU, who completed them on the 11th.

As long as I had an opportunity for resting at night, my strength and wonted elasticity were gradually returning. Continuing up throughout every night reduced me to a condition of wretched debility; and under the impression that I had held out too long, I was obliged to return to the observatory, but not before the successful termination of the operation was virtually secured.

Mr. CAMPION accompanied me on the journey, and then went back to meet the FULLER theodolite at Heerenlogements Berg.

Mr. MONTAGU, having completed the sector work and the observations for azimuth on the 17th of July, placed the following memorandum (enclosed in a sealed bottle, which had been prepared before my departure) in a two-gallon cask, and buried it in a hole made in the bottom of the pit under the position of the sector-axis:—

> "This marks the position of BRADLEY'S zenith sector during the observations for latitude in the month of June 1847, and the northern limit of the arc of the meridian.
>
> (Signed) "THOMAS MACLEAR.
> GEORGE MONTAGU.
> HERBERT CAMPION."

The pit was then filled in, and a small pile placed over it. It was thought

desirable that nothing should be erected likely to attract the particular attention of Bushmen. The spot can be found by more permanent means.

On passing the defiles of the Kamies Berg, Mr. MONTAGU gave the sector in charge to JOSEPH GIBBS (who brought it direct to the observatory), and proceeded to Sector Berg. Hence, returning southward, he reoccupied Sneeuwkop; while Mr. CAMPION, with the FULLER theodolite, reoccupied Heerenlogements Berg, to complete the connexion of the eastern chain. Mr. CAMPION returned to the observatory, and on the 20th of November rejoined his vessel, carrying with him my most sincere esteem and gratitude for the able and zealous way he performed his duties on the survey, and for his attention to myself under very painful circumstances.

Mr. MONTAGU returned to the observatory early in December, where he was engaged on a variety of survey matters and triangulating about Blauberg and the neighbourhood, until the 10th of April following (1848), when the operation closed. I consider myself exceedingly fortunate in the selection of this young gentleman.

The zenith distances at the observatory, of the stars observed on the Bushman Flat, were observed by myself in the months of June, July, and August, 1848.

V. *Reductions and Printing.*

Before the commencement of the arc of the meridian, the reductions and printing were gliding into systematic order. One volume had been published, the original transit and circle observations for 1835, and the circle observations for 1836 and 1837 were printed. During the continuance of the triangulation, either Mr. MANN or Mr. SMYTH was in charge of the observatory, and observed with one or other of the meridian instruments, but no reductions of any consequence were attempted. By the abstract before given, the number of observations made during this interval is considerable, yet they were not made in systematic accordance both in right ascension and declination. I would propose, therefore, to publish these in one volume (viz., the observations from 1838 to 1847 both inclusive), and in a form adapted to the circumstances under which they were made. The observations made in 1848 and 1849 are comparatively systematic. Those of the current year perfectly so.

With respect to the arc of the meridian. Besides other field books there are twenty-seven containing theodolite measures alone. These are copied in

duplicate. Each copy consists of six folio ledgers closely written, and contains the original instrumental readings and corrections in detail.

The number of measures for each angle made with the Fuller theodolite varies from 40 to 120, viz., from 20 to 60 couplets or more. The corrections for the "runs" of the microscopes have been applied to each measure according to the ordinary method pursued with the mural circle. The rule in the field, which was understood to be unflinchingly adhered to, was, to take the means of the microscopes, and to apply the corrections current with the measures. The calculations were to be repeated for greater security against errors. Notwithstanding, several errors were afterwards detected. In consequence of this the three first folio volumes have been recomputed, and it is proposed to recompute the remainder.

The general system with the Beaufort theodolite, was to read off at every tenth repetition. One hundred repetitions constituted a set, and to each set its probable error and weight were annexed. Every step of the small amount of arithmetic required, admitted of a direct check.

The original sector observations are contained in one folio volume and part of a second, and have been copied in duplicate. These are posted into ledgers in the usual form for computation and the press.

Thus, all the work is registered in a way which admits of particular investigation, and of being moulded into whatever form their Lordships may deem fit to command for publication.

If it is asked why I did not devote the entire force of the observatory, at the termination of the survey, exclusively to the reduction and publication of all arrears, including the survey; I reply, that in so doing I should not, I think, have forwarded the real interests of astronomy, nor the usefulness of the observatory. There was a variety of matter that could not be set aside. Moreover, without touching the subject more closely, I felt, that the organisation of the regular functions of the observatory ought not to be longer delayed.

This brings me to a point which deserves serious attention, and which I humbly submit for the consideration of their Lordships. It may be safely asserted that more than one-half of the observatory arithmetic can be performed by persons whose services may be obtained for five or six shillings per diem. Besides arithmetic, a large portion of time is consumed in copying and ruling ledgers and observing books. Gentlemen who are qualified by

education and specific information to tread the higher path of practical astronomy, can scarcely be said to be exercising their qualifications in the right direction, much less economically, when employed upon the kind of work I have mentioned. The misdirection appears prominent, when instruments are unoccupied during fine weather, and important observations omitted.

The details of the leading work on hand at this time will furnish an example; particularly as it is connected with a *system* of alternate watches, new at this observatory, but *meant to be continued*, as far as practicable, to prevent one-sided observations; a matter of serious moment with regard to the oppositions of the planets and the parallax investigations. The leading work is the comparison of the positions of the southern stars given in the British Association Catalogue with the heavens.

The mural circle, employed as a transit circle, determines polar distances exactly, and right ascensions approximately; the individuality, therefore, of the object is certain. Mr. MANN observes with the circle from nightfall until midnight. Mr. CHILDE then takes his turn and observes until sunrise. The next day Mr. MANN compares the observations with the Catalogue, and makes out a list of any discrepancies for re-examination. When verified, he endeavours to trace the origin by a scrutiny of the original catalogues from which they were extracted. This discussion and other occasional reductions, which persons inferior to Mr. MANN in talent and qualification cannot be trusted with, occupies about seven hours in the daytime; that is, he is engaged in observing and computing about thirteen or fourteen hours out of the twenty-four.

The kind of error determines the next step:—If no star is found in the assigned position, and the nearest stars are otherwise accounted for, there the matter rests: but if there is a star near the position not accounted for, its right ascension and north polar distance must be determined. A list of these is handed over to me from time to time, which I observe with the transit instrument. I observe also all stars having a reputed "proper motion" in right ascension worth notice. This and equatoreal instrument observations, together with the engagements peculiar to my office, require about sixteen out of the twenty-four hours.

Mr. CHILDE applies the instrumental corrections to my right ascension observations, and he reduces the apparent right ascensions to the mean.

This with collateral duties, detain him seven hours daily in the observatory, exclusive of his night watch.

With very trifling exceptions, Sundays and cloudy nights are the only omissions from this diurnal system, as respects Mr. Mann and Mr. Childe. This strain cannot be long continued without personal injury. Yet the remaining stars in the *Cœlum Australe* of Lacaille should be compared with the heavens in the same manner; also the southern stars in Lalande's Catalogue. The importance of the examination may be estimated from the fact, that about one-twelfth of the southern stars of the British Association Catalogue require a careful check, and that about one of every thirty-three is found to be erroneous.

A certain amount of reduction must be kept current with the observations. It would be very desirable to keep the reductions completely up, to prevent further accumulation of arrears. Of these (exclusive of copying and ruling), any common arithmetician, under superintendence, could apply the instrumental corrections, and compute the corrections for aberration, precession, nutation, &c. The effect would be a relief from the most unsatisfactory part of the pressure, and would ensure greater elasticity for the subjects which require mental energy and cheerfulness.

Of desultory reductions, those of the tide-guage measures are not unimportant. The interval between June 1840 and October 1848, has been completely reduced with respect to the times, and tabulated with the corresponding solar and lunar elements, and a copy transmitted to the Hydrographical Office. The heights were not tabulated, because a large portion of the curves at their culminations appear to be less rounded than the crest of the wave warrants, making due allowance for the marked dilatation of irregularities where the rise and fall is comparatively small. The float has been rendered more buoyant to overcome the sticking of the staff.

The observations of α *Centauri* for parallax, made at different times between July 1842 and January 1849, have been calculated, and give a result differing little from the former determination. But having examined a part of the calculations, I perceived that it would be prudent to recalculate the whole, and have got so far as the solution of the equations of condition at the date of this report. No matter how close the result may turn out to the former determination, the observations were not sufficiently systematic. The current observations are conducted differently. I take this opportunity to men-

tion that the orbit of the components of this noble binary is closely watched by means of the $8\frac{1}{2}$-feet equatoreal, and that their nearest approach in the plane of the orbit may be expected some eight or ten years hence.

VI. *General Remarks.*

I humbly trust that the amount of work exhibited in this report will show that the resources of the observatory have been administered with determination and energy; but, as might be expected in the Cape climate, observation has exceeded the means for reduction.

I have hinted at the kind of assistance which would place current observation and reduction more economically upon a balance. The same applies to the reduction and preparation for the press of the back observations. I do not presume in this place to press the subject further upon their Lordships' attention.

With respect to the proceedings for a general catalogue of the southern stars, I beg to offer a few remarks. The catalogues of LACAILLE, BRISBANE, RUMKER, JOHNSON, and TAYLOR, may be supposed to contain the major part of the stars down to the 7th or 8th mag. (I name the 7th or 8th that I may be within the limits of the tabular discordances, which are very great.) The British Association Catalogue contains a selection from these, aided by reference to the observations of my predecessors, discussed and arranged upon principles so clear as to peculiarly fit it, with its constants, for a foundation to build upon. For with such a catalogue at hand to perfect and extend, nothing would be gained by the adoption of specific numerals in relation to observations made at this or any other observatory, beyond what are necessary and subservient for reference.

The regular and systematic examination of this catalogue commenced nearly with the present year. The numerous errors already detected are found in the lower magnitudes, where they might be expected, and many of them admit of explanations upon hypothetic assumptions in relation to the instrumental divisions, divisions of the clock face, or transpositions in recording. No direct proof can now be had, other than might be gathered from a scrutiny of the original observations and reductions which still exist. When the examination of this catalogue shall have been completed, the remaining stars of the *Cœlum Australe* of LACAILLE, and of the catalogues of

BRISBANE, RUMKER, and TAYLOR, are to be compared with the heavens on the same plan, in preference to sweeping in zones, owing to the practical advantages a working catalogue affords, and the errors detected by inspection. By the uniform employment of a select list of fundamental stars for the right ascensions during the examination, there will be no difficulty in applying any small correction to the equinoctial point that may be thought necessary for connecting the right ascensions of the larger stars observed by my predecessors. The plan of the work I have proposed is of course exclusive of planetary and solar observations; the latter at the equinoxes and solstices.

The meteorological journal of the astronomical department, which was commenced in the year 1834, and is continued up to the present time, should be noticed here. The entries are at $8^h\ 40^m$ A.M.; noon; $3^h\ 20^m$; and $9^h\ 30^m$ P.M. These times (excepting noon) are supposed to correspond with the maximum and minimum atmospheric pressure within their limits. The columns contain the indications of the barometer, and the attached exterior, wet bulb and minimum thermometers. (There is no maximum self-registering thermometer.) Direction and force of the wind, quantity of blue sky, clouds, rain, and other phenomena deserving notice. The observations are made hourly on the 21st of March, 21st of June, 21st of September, and 21st of December, in accordance with the plan promulgated by Sir JOHN HERSCHEL.

I should likewise mention that a black disc, sliding on a rope attached to a high spar in front of the observatory, is dropped daily at one o'clock, Cape mean time, for the regulation of the chronometers of the vessels in Table Bay. The time of descent is watched by an independent observer.

THOMAS MACLEAR.

23d September, 1850.