Alfred Lee.

Case ..... *Shelf* .....

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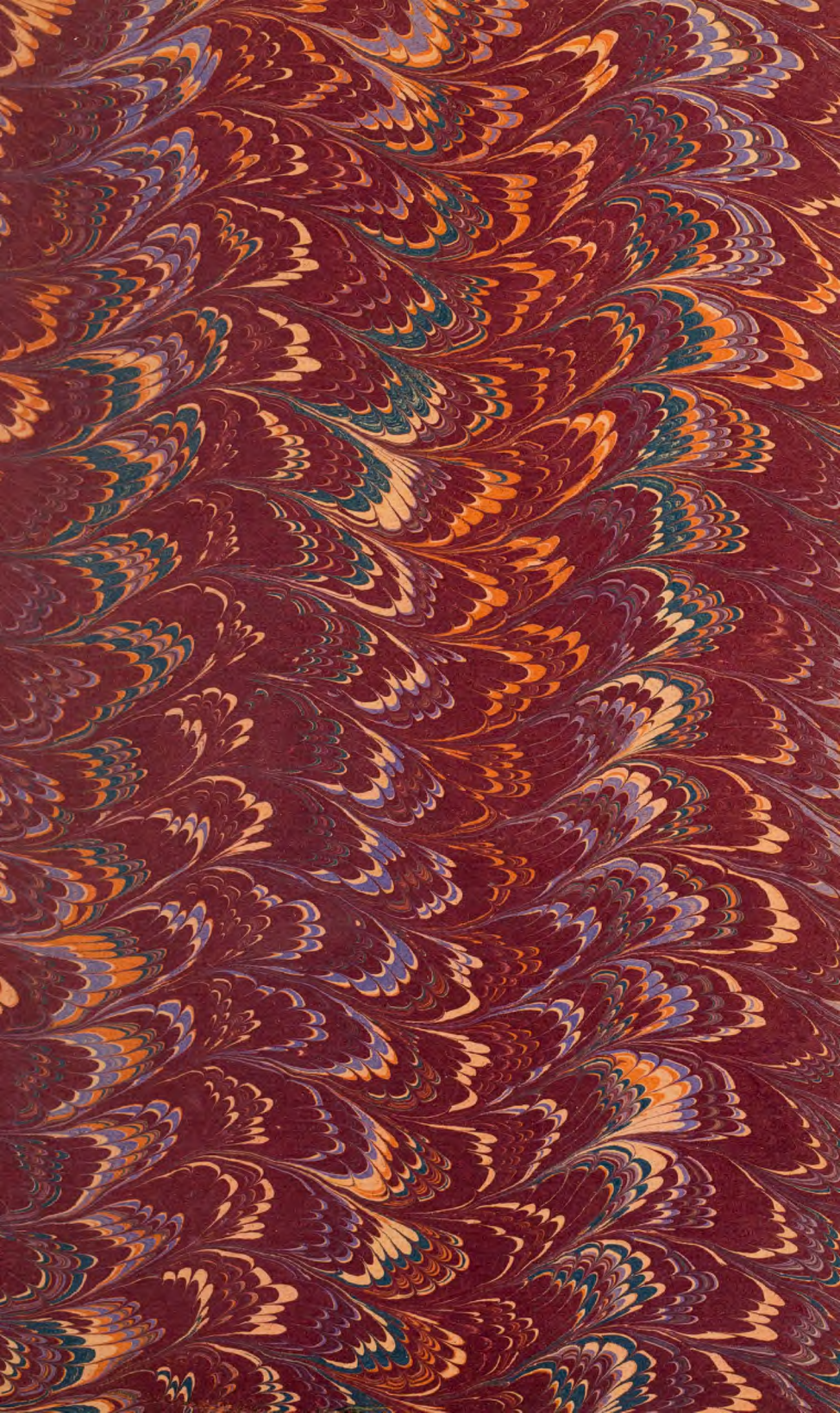

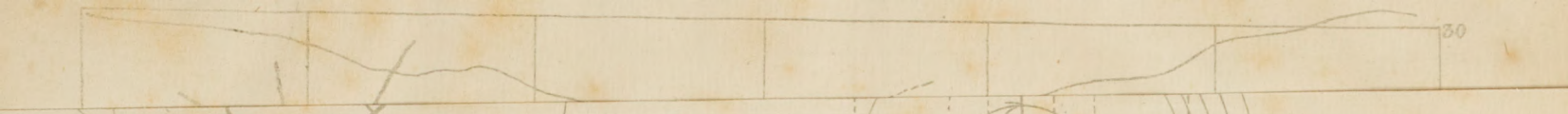

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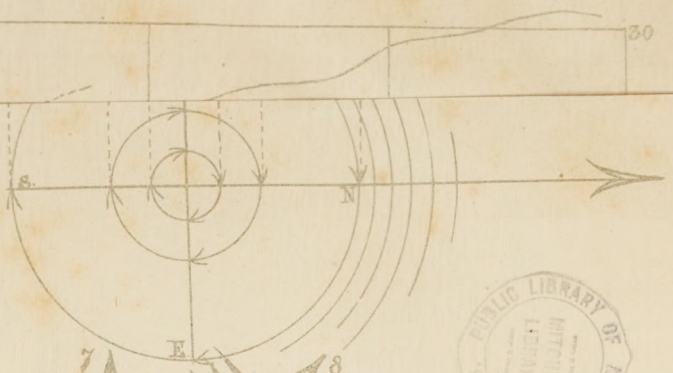
Fig II.



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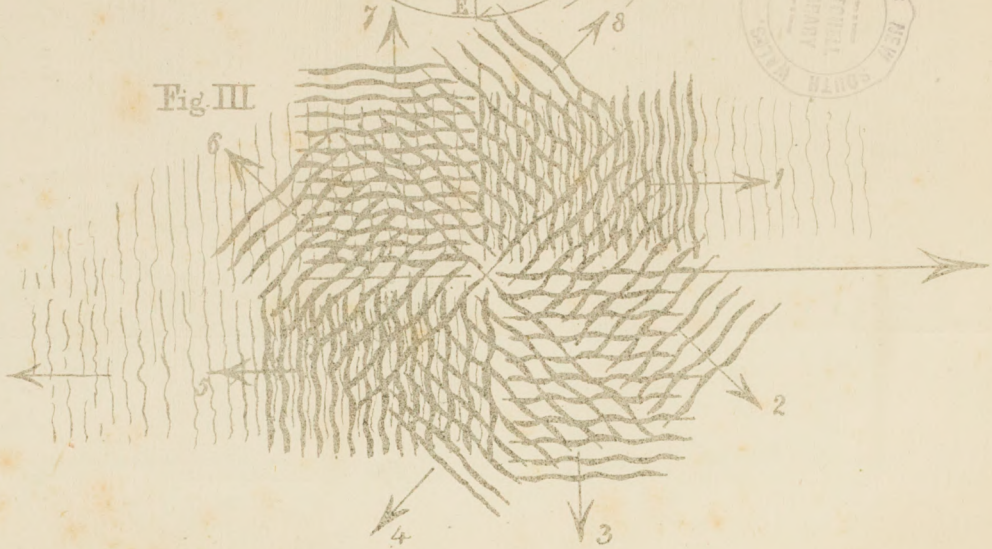


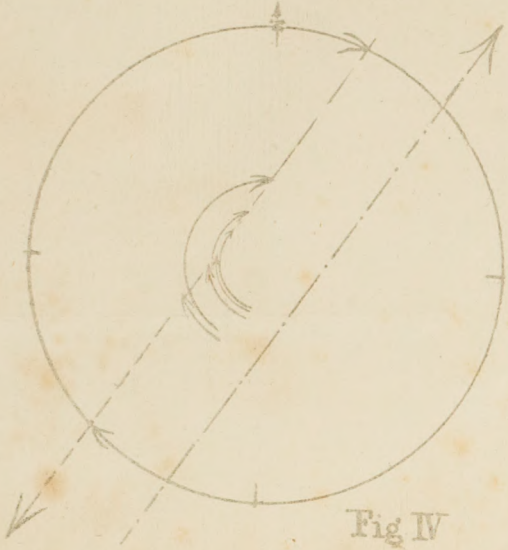
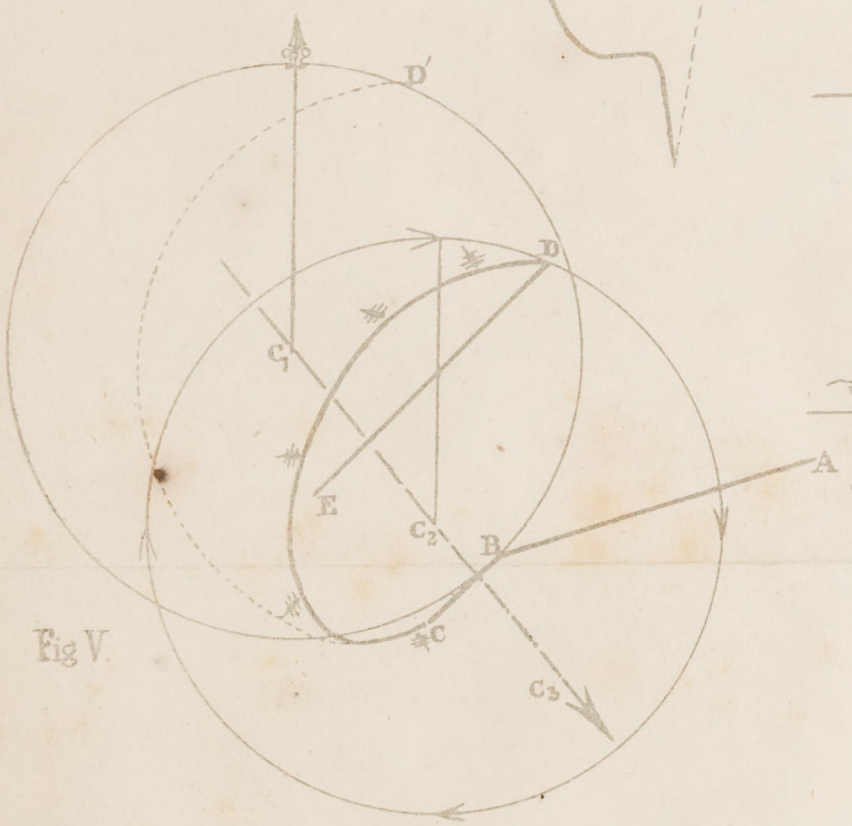


Fig IV

Fig. VII.



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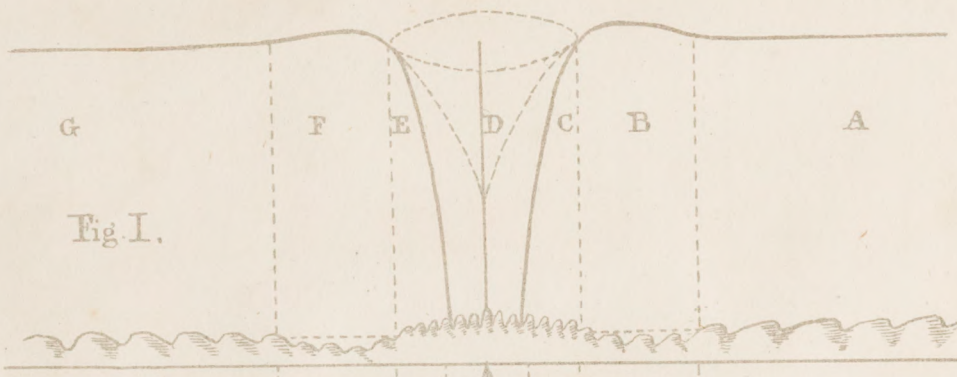
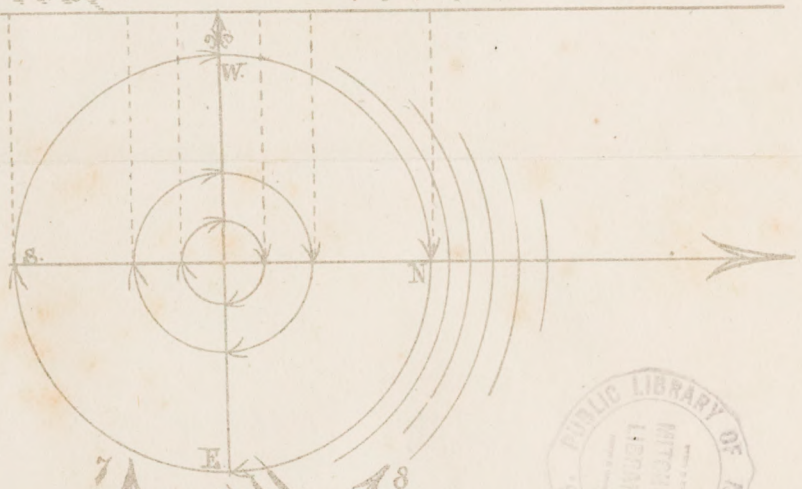


Fig. I.



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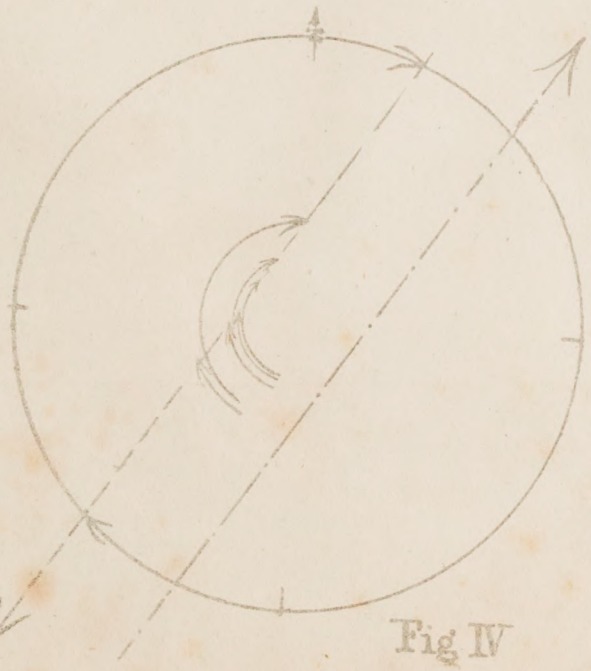

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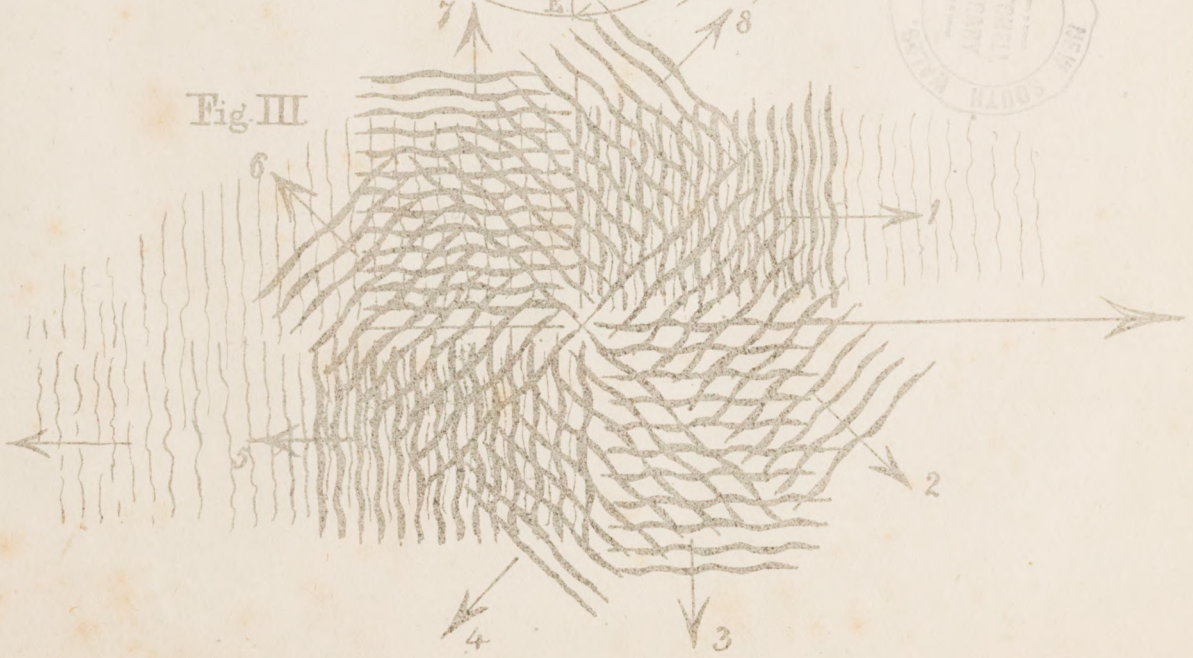

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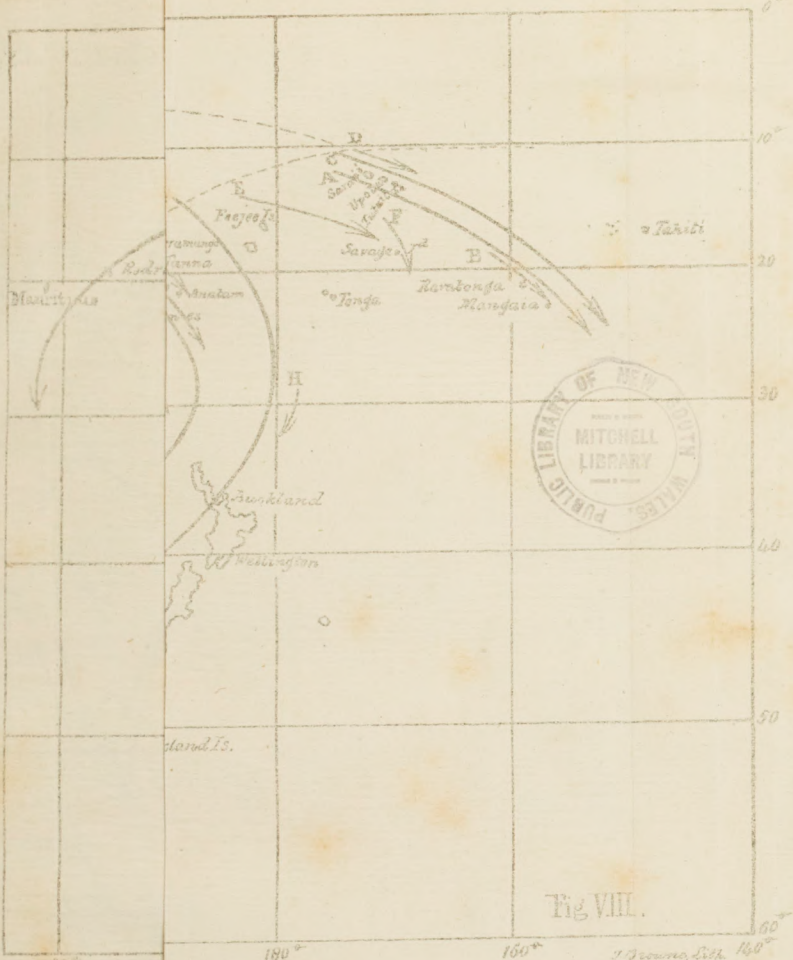

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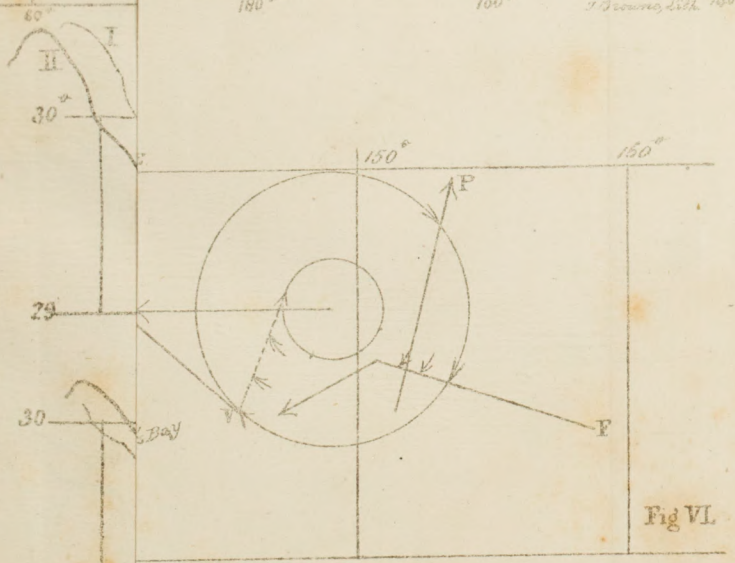

Fig VI.

Vincennes. 1840.

Fig VIII.

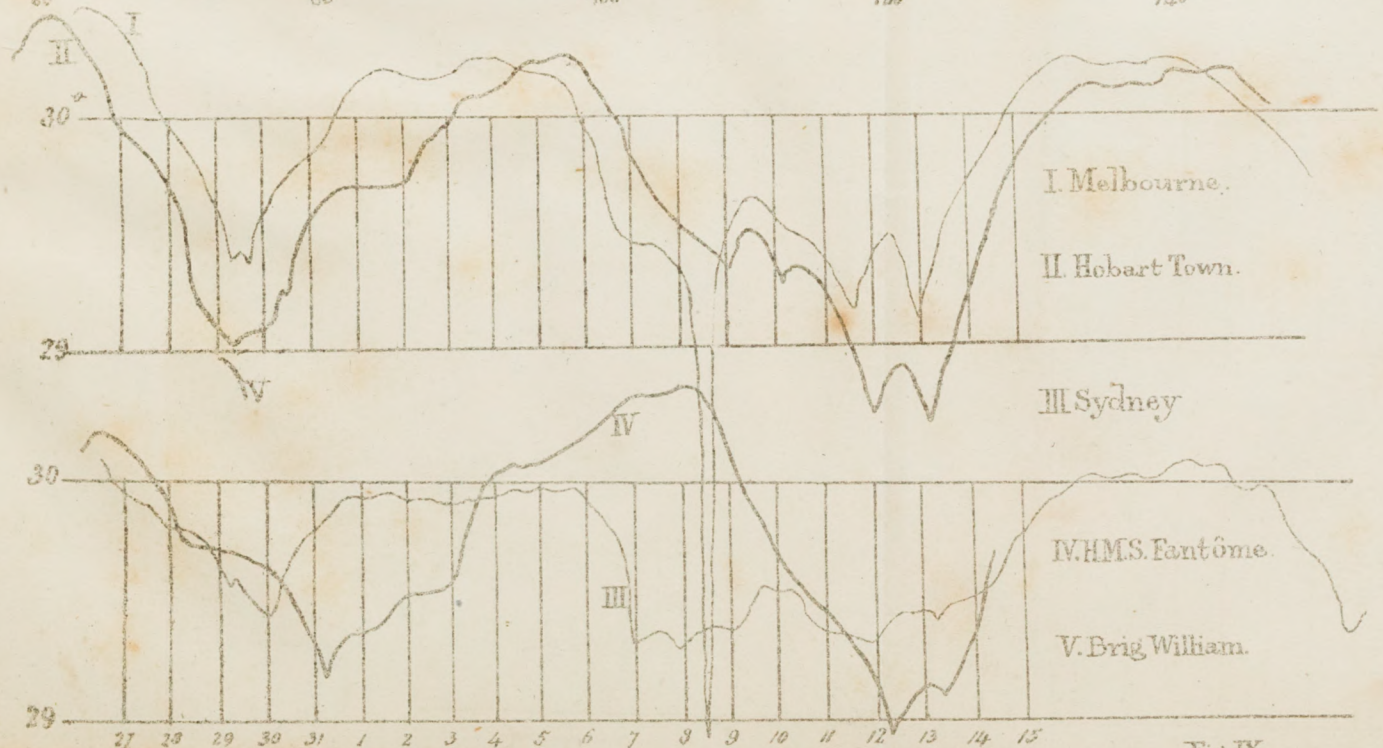

Fig IX.

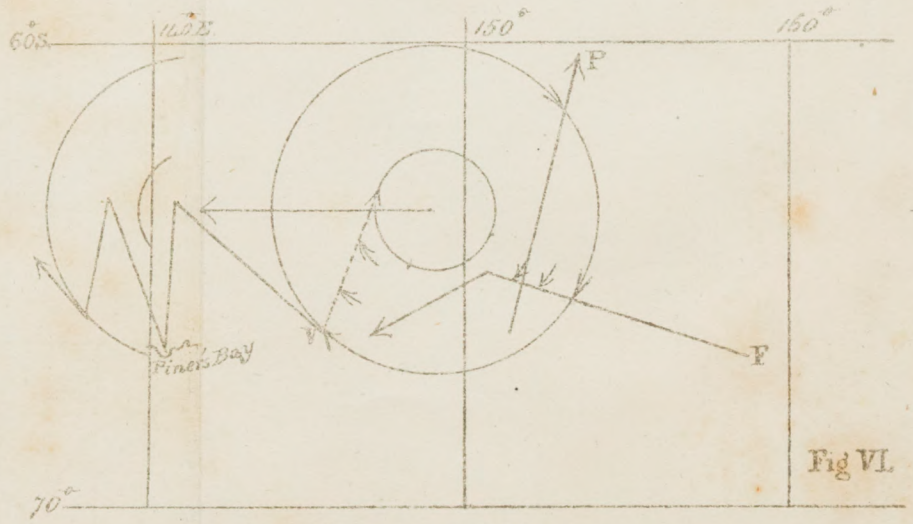

Fig VI.

Vincennes. 1840.

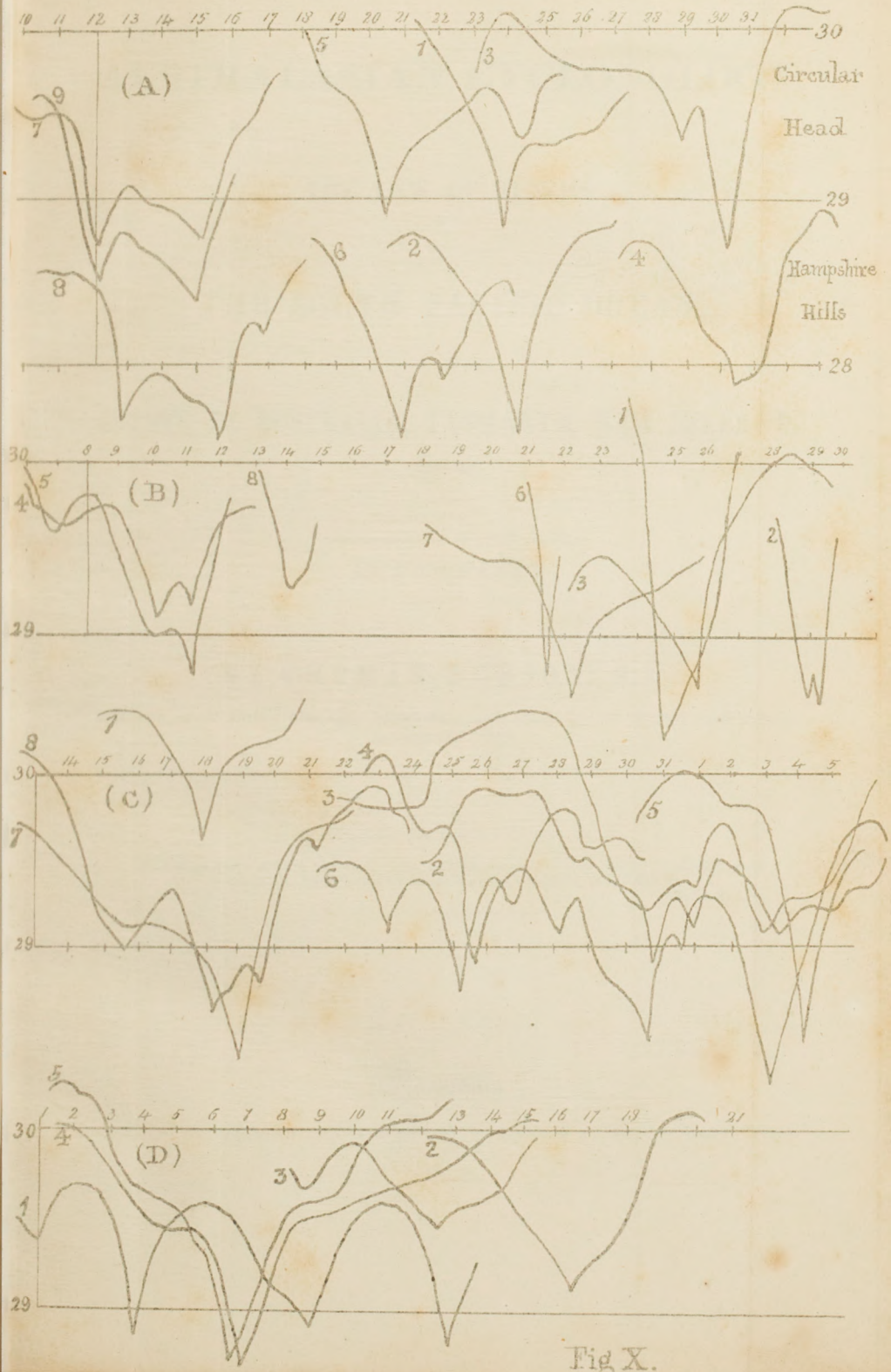

Fig X.

AUSTRALASIAN CYCLONOLOGY:

OR

THE LAW OF STORMS

IN

THE SOUTH PACIFIC OCEAN,

AND ON THE

COASTS OF AUSTRALIA, TASMANIA, NEW ZEALAND,

&c. &c.

IN TWO PARTS.

BY THOMAS DOBSON, B.A.,

SCHOLAR OF ST JOHN'S COLLEGE, CAMBRIDGE, AND HEAD-MASTER OF THE HIGH SCHOOL OF HOBART TOWN.

"The wind goeth toward the South, and turneth about unto the North; it *whirleth about* continually, and the wind returneth again, according to his *circuits*."

ECCLES. i. 6.

Tasmania:

PRINTED BY WILLIAM PRATT & SON, 67, ELIZABETH STREET, HOBART TOWN.

1853.

TO

WILLIAM HOPKINS, M.A., F.R.S.,

PRESIDENT OF THE GEOLOGICAL SOCIETY; PRESIDENT OF THE CAMBRIDGE PHILOSOPHICAL SOCIETY; PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE; &c. &c.

AND TO

THE REV. JOHN LILLIE, D.D.,

MINISTER OF ST. ANDREW'S CHURCH, HOBART TOWN; AND MODERATOR OF THE PRESBYTERY OF VAN DIEMEN'S LAND;

THIS LITTLE WORK IS DEDICATED,

AS A SLIGHT MARK OF THE SINCERE REGARD AND ESTEEM

OF

THE AUTHOR.

PREFACE.

At a time when Australia has become, not merely "the cynosure of *neighbouring* eyes," but the centre of attraction to the enterprising of all nations, both near and remote; and when multitudes are hazarding their lives and fortunes on the Ocean in order to reach her shores; I have thought that I should be rendering an acceptable and a well-timed service to Mariners, Merchants, Ship-owners, and Emigrants; and, indeed, to all who are interested in the rapidly-increasing intercourse between the Australian Colonies and the rest of the world, by publishing the results of my investigations into the nature of the Hurricanes which prevail at certain seasons in the Seas and Oceans circumjacent to Australia.

Hitherto little more has been known than that such hurricanes do occur; all beyond was vague conjecture.

While my researches have afforded me the satisfaction of confirming the anticipations of the writers who have preceded me respecting the Cyclones on the West and South Coasts of Australia, it will be seen that they have also imposed upon me the duty of demonstrating the incorrectness of former conjectures respecting the Storm-tracks of the South Pacific Ocean. The science of Cyclonology has been so recently developed, that a servile respect for Authority has not yet arisen to clog the independent action of the student's judgment; and, *as a pioneer in a new field of research*, I may appropriately adopt the assertion of Horace:

> Quid *verum* atque decens curo & rogo, et omnis in hoc sum;
> Condo & compono, quæ mox depromere possim.
> Ac ne fortè roges, *quo me duce*, quo lare tuter;
> Nullius addictus jurare in verba magistri,
> *Quocunque me rapit tempestas, deferor hospes.*—Epist. i. Lib. 1.

Instead of encumbering my pages with repulsive-looking tables of barometrical readings, I have preferred to exhibit the fluctuations of Atmospheric pressure during Storms by means of curves, of which

the variations are much more readily apprehended. The Atmospheric pressure being represented by vertical lines, the succession of *time* will be taken into account by passing the eye along the curve in a horizontal direction, and from left to right. Thus, in the figures marked IX. and X. respectively, each of the spaces included between the numbers 1, 2, 3, &c., denotes an interval of 24 hours of time, and would comprise three dots, in the case of three daily observations. The continuous curve is formed by drawing a line through the series of dots with as few points of contrary flexure as possible. In fig. VII. *time* is exhibited on a more enlarged scale.

These Curves have all been carefully plotted on machine-ruled paper; and are, I believe, quite equal in correctness to the readings from which they have been constructed, although they may not be relied upon to the thousandth part of an inch, as some readings *affect* to be.

In the course of my researches I have had access to valuable Meteorological Registers kept at the following places in Van Diemen's Land, viz :—

The Magnetic Observatory, Hobart Town...	From	1840 to 1852	inclusive.
At Circular Head, North Coast.....	„	1840 ... 1851	„
At the Hampshire Hills, by Dr. Milligan...	„	1835 ... 1841	„
At Launceston, by Dr. Pugh	„	1846 ... 1848	„

The last Register contains *two* daily observations; the others contain *three*.

Having examined these records carefully, and even constructed the Curves corresponding to 24 years of daily observations, I have met with no instance of a great Atmospheric perturbation which does not fully confirm the conclusions arrived at in the second part of this work.

To collate, compare, and interpret physical facts is the duty of the Investigator in any branch of Natural Philosophy, and the discovery of truth is his reward; but the facts which form the basis of the investigations of the Cyclonologist are so widely scattered, and so difficult to be collected, that he has a peculiar claim upon the spontaneous co-operation of *all who can assist him* by supplying information, but more

especially upon sailors, ship-owners, merchants, &c., who are directly interested in the results of his researches. I possess a mass of detached notices of Storms, &c., which have not been brought to bear upon the subject of my investigation, on account of their isolated and imperfect nature. Some of these, however, *may* yet become highly significant and valuable, when I shall be enabled to link them together by the receipt of information which may now lie buried in old logs or other, to me, inaccessible crypts : just as the descriptions, by Commander Wilkes, of the Feejee Islands Hurricane, and of the New Zealand Hurricane, of 1840, served to determine the first Storm-track ever laid down in the South Pacific Ocean, as soon as I had discovered an account of the intervening hurricane in Captain Morgan's Journal (page 29). With a view, therefore, to the more perfect development of the Cyclonology of the Southern Hemisphere, I shall feel obliged by having the opportunity of inspecting ship's logs of *any date ;* by the receipt of useful extracts from logs, or from the Captain's Journal (generally much fuller and more valuable than the *show-log*) ; or by the receipt of Newspapers containg Notices of Storms, Waterspouts, Volcanic Eruptions, Earthquakes, &c. When such notices are transferred from one Newspaper to another, care should be had to preserve the means of *fixing the date* of the event recorded. For want of this important element I have had to reject many otherwise valuable meteorological notices.

I beg to acknowledge with thanks the kindness of those Gentlemen who have exerted themselves to procure information to aid me in an undertaking of which the success so greatly depends on general and spontaneous co-operation.

Especially are my acknowledgments due to His Excellency Sir W. T. Denison, F.R.S., and to Lieutenant Clarke, R.E., his Private Secretary, for the very encouraging interest that they have taken in my researches, and the readiness with which they have, on several occasions, enabled me to obtain valuable information in quarters not easily accessible.

It will be a great satisfaction to me to find that the importance of the results already elicited from the data supplied to me satisfies my friends that their kind efforts have been turned to good account, and induces a continuance of them.

TABLE OF CONTENTS.

PART I.

On the Hurricanes of the South Pacific Ocean.

PART II.

On the Hurricanes of Torres' Straits, the West and South Coasts of Australia, Bass's Straits, and Van Diemen's Land; the Hot Winds of Australia, &c.

WHAT IS A CYCLONE?

———the dreadful spout
Which shipmen do the hurricane call.
—Troilus & Cressida.

In explaining the nature of Cyclones I have found it of considerable service to *begin* by endeavouring to convey a general idea of the phenomenon *as a whole* before treating of the several details, which, without such preparation on the part of the student, present an aspect somewhat complicated and even incomprehensible. It is true that our knowledge of Cyclones is not yet sufficient to enable us to do this with anything like certainty in describing some parts of the phenomenon; and that more than one assumption may be found in the following familiar description; but it has the advantage of presenting a connected and pretty correct view of the principal parts of a Cyclone in the Southern Hemisphere; and experience has convinced me that he who has fully mastered it, has made the first and the most difficult step in the study of the Law of Storms.

For the purpose of familiar explanation the Earth may be regarded as a huge globe, enveloped by a coating of air of about 40 miles in thickness, and having a definite exterior surface; and a Cyclone as an immense whirling *eddy* in the air, extending vertically from the surface of the Atmosphere down to the Earth, and moving bodily over the Earth's surface. In the Southern Hemisphere, this eddy invariably turns in the order N.E.S.W.; that is, in the same order as the hands of a watch; and in the Northern Hemisphere, in the contrary order, or N.W.S.E.

Let fig. I. be a vertical section, and fig. II. a horizontal section, of such an Atmospheric eddy, or Cyclone. The imaginary vertical line D is the *axis* about which the Cyclone revolves horizontally. The mere act of revolving (we do not enter *here* into the question what causes this revolving motion) tends to throw the air straight out from the axis D, just as water is thrown straight out from the

handle of a twirling mop. The air near the top of the Atmosphere is comparatively rare, growing more and more dense from the top towards the Earth. At the top, therefore, less resistance is offered to the air thrown outwards from the axis, and more and more resistance at points lower down the axis; hence the eddy will be wider at the top than below; and the surface of the Atmosphere will appear depressed into the form of an inverted cone.

In the space immediately below this conical surface, the air is much rarefied and very *calm*. In the adjoining portions, marked C and E, the rotatory motion is most violent, diminishing in intensity as the distance from the axis increases. The effect of the centrifugal force is to *heap up* the air in the exterior spaces, marked B and F. In the spaces marked A and G the Atmosphere is supposed to be in its ordinary state.

In the horizontal section (II) a comparative calm will reign in the space bounded by the smallest circle; the smaller annulus, or ring, will be that of the most intense rotatory action; and the exterior annulus, of much greater breadth than the interior, will exhibit a rotatory action diminishing in intensity from the inner towards the outer circle.

The	W.	N.	E.	S. Cyclone-points correspond to
the	N.	E.	S.	W. Compass-points respectively.

The quadrant, or quarter circle, between W. and N., is the N.E. quadrant, that between N. and E. is the S.E. quadrant, and so on. The outer-circle is sometimes called the *margin* of the Cyclone.

Fig. III. is intended to give an idea of the effect of a Cyclone upon *the surface of the sea;* both figs. II. and III. represent a Cyclone in the Southern Hemisphere moving due East.

In the spaces A and B, the mercury would stand at about 30 inches, and water would rise in a pump to a height of about 32 feet; the Atmospheric pressure would therefore be about 15 lbs. on each square inch of surface of the sea under A and B. In the spaces B and F, the air is made dense by accumulation, and the mercury will rise somewhat above 30 inches. Passing inwards from C or E towards D, the air becomes more and more rare, and the mercury falls rapidly, until, when just below D, it stands at between 27 and 28 inches. The pressure on the surface of the sea in the central space around the axis D will therefore be less than elsewhere by some two or three inches of mercury, or by about 3 vertical feet of

water; so that in the central space of a Cyclone, the *sea may rise a yard* above its ordinary level, by the mere diminution of the Atmospheric pressure there. But this alone is not sufficient to account for the "confused *cross* sea, rising in pyramidal heaps," compared in some logs to huge sugar-loaves, and church steeples, which is invariably experienced in the central space.

A little consideration of fig. III. will show how this *cross* sea is produced. The effect of a strong wind in a definite direction is to raise a heavy swell moving in that direction. Thus the numbers 1, 3, 5, 7, denote the several swells, or systems of parallel ridges, raised by the W., N., E., and S. winds respectively. The numbers 2, 4, 6, 8, those raised by the N.W., N.E., S.E., and S.W. winds respectively. The swells raised at intermediate points of the compass are omitted to avoid confusing the figure. The several systems marked 2, 3, 4, 6, 7, 8, which are not parallel to the track of the Cyclone, subside soon after the Cyclone has passed; but those marked 1 and 5, which are coincident with the Cyclone's track, are continually reinforced from the Cyclone's action, and therefore last longer, and extend farther than the others. At the centre, and for some distance around it, all these systems of swells become superimposed, and cross each other. If the dark ridge in the figure be the depressed part, and the white ridge the elevated part of a long wave, the white lozenge formed where two systems interfere will represent a *double elevation*, and the four points around it, where the black lines cross, will represent so many *double depressions*, and thus a pyramidal mass of water four times higher than the wave of any one system will be produced. Of the two more permanent swells, No. 1 is the more moderate, since it precedes the Cyclone, and therefore passes over an undisturbed part of the Ocean; No. 5 traverses the already greatly agitated Wake of the Cyclone, and is scarcely less dangerous than the central space itself.

Suppose a ship to sail from A through the successive spaces B, C. D, E. F. G.; that is, right through the centre of the Cyclone, passing along the line N S in fig. II. Her log would record facts somewhat like the following.

At A, Light Northerly Airs, head sea from westward, barometer 29·90, inclined to rise. Cloudy with mizzling rain. On entering B, wind increasing from N, barometer rising slightly. Middle of B, strong Gale at *North*, heavy head sea, dark cloudy weather,

barometer falling. On leaving B, and entering C, a complete hurricane, wind north, barometer falling rapidly, torrents of rain, hail and snow, and a tremendous sea. On entering D a sudden *calm;* sky, open and clear; barometer 28·10; a confused cross sea, huge seas tumbling on board on all quarters. Barometer inclined to rise. On entering E, a furious gale from *South*, if anything, heavier than before, with an awful cross sea, barometer rising very rapidly. Through F, Gale decreasing; and for some days in the space G, light southerly winds, and a very heavy *following sea.* When near the centre, lightning, and one heavy peal of thunder would probably be experienced.

This is an easy case, with only one shift of wind. In the body of this work will be found many examples of more complicated cases; but whoever wishes to make himself master of the *practice* of Cyclonology cannot do better than to study carefully Mr. Piddington's excellent "Conversations about Hurricanes," and "Sailor's Horn-Book of Storms."

WHAT CAUSES A CYCLONE?

If, after a Cyclone has been formed, we are obliged to have recourse in some degree to surmise and conjecture, in order to give a complete description of its peculiar features and properties, it may readily be imagined that an attempt to develope the *causes* of its formation must be premature and unsatisfactory. But ages may elapse before the Meteorologist is in a better position for undertaking the investigation. Meteorological phenomena cannot be reproduced at will like chemical experiments; nor are they, in general, susceptible of mathematical expression. Under these circumstances a little guarded speculation respecting the causes of Cyclones may be permitted, and may have the effect of directing the attention of observers to some apparently minor concomitant phenomena, which nevertheless are likely to furnish a key for solving this most difficult question. The theory, of which I shall here give an outline, embraces and explains the principal facts which characterize a Cyclone. It occurred to me on perusing, in the *Literary Journal* for February 1850, Professor Faraday's exposition of Quetelet's observations on the Electricity of the Atmosphere, which had been carried on continuously from August 1844 to October 1849, with Peltier's inductive Electrometer. The results are considered by Faraday to present a type of the perfection of observing. The most important are, that the electricity of the air is always positive; and that it increases as the temperature diminishes, and vice versâ, invariably following both the diurnal and annual fluctuations of temperature. In the same horizontal stratum of air, no change of electric condition was ever perceived; but the quantity always increased as the electrometer was raised vertically, the increase being proportional to the height. The electricity of the clear blue sky was enormous, the monthly means in degrees of force for January being, cloudy 263, and clear 1133. These conclusions warrant us in looking upon the upper and colder regions of the Atmosphere as an immense reservoir of electric fluid enveloping the Earth, which is insulated by the

intermediate spherical shell formed by the lower Atmosphere, of which the insulating power increases with its density and dryness. Now, whenever the upper Atmospheric strata are highly charged with electricity, and an opening is *suddenly* made through the lower strata, the electric fluid will rush down the vertical column of rarefied air, in a spiral form, and will produce a rotatory hurricane, or Cyclone, at the surface of the Earth. Let us examine whether nature possesses any adequate machinery for *tapping* the denser air, which envelopes and insulates the Earth. The fall of an avalanche from a sufficient height is generally succeeded instantaneously by a hurricane. In December 1819, the village of Randa, in Switzerland, was destroyed by a hurrricane caused by the fall of an avalanche, of which the volume was 360,000,000 cubic feet, from a height of 9000 feet. A *light* was seen as it fell. *(Edinburgh Phil. Journal*, 1820.*)*

This is an example of perforation *from without*. That hurricanes accompany Earthquakes and Volcanic Eruptions is a notion that has prevailed since the time of Aristotle; and in the sudden displacement of the vertical column of air, superincumbent upon the Crater of a Volcano just before a violent explosion of its long pent-up gaseous forces, we see a mode of perforation *from within*. Humboldt states that a mass of rock weighing 200 tons was projected from the crater of Cotopaxi to a distance of 9 miles, so that the paroxysm of a Volcano develops a force quite adequate to the effect supposed.

The hurricane season in the Northern Hemisphere extends over the months of July, August, September, and October; and in the Southern Hemisphere over the months of December, January, February, and March. These are also the seasons of greatest heat in the respective localities, when the processes of evaporation and vegetation are most active, and therefore the development of Atmospheric electricity most rapid. The electric fluid will consequently accumulate in the tropics at these seasons; and if we suppose a communication, possessing good conducting properties, effected between the surface of the Earth and its highly charged electrical envelope, by a sudden vertical perforation of the intermediate insulating air; it follows that a descending spiral current of positive electricity would instantaneously occupy the cylindrical channel of highly rarefied air, which is a comparatively good conductor. Now, the behaviour of such a current has been well determined, both theoretically and

practically, by Ampére, Faraday, and others; and we may compare it with that of a well-developed and carefully observed Cyclone. The agreement is most striking and conclusive. In all good treatises on Electricity, (Roget, L. U. K., Noad, Pouillet, &c.), an experiment is described in which a vertical cylinder of zinc, delicately suspended over the pole of a Magnet, is made to rotate by passing a continuous current of positive electricity down the cylindrical surface. When the cylinder is under the influence of the North Pole of the Magnet, (corresponding to a Cyclone in the Southern Hemisphere, because the South Pole of the Earth is a *North Magnetic Pole* since it repels the North Pole of a Magnet and attracts its South Pole), the rotation is in the direction of the hands of a watch, or N.E.S.W. When under the influence of the South Pole (the Northern Hemisphere) the rotation is in the contrary direction. Pouillet states that the sensibility of the apparatus can be made sufficiently great to produce rotation by the influence of the Magnetic Action of the Earth alone.

The gyrations of a descending electrical current will therefore perfectly account for the peculiar rotations of Cyclones on either side of the Equator.

The distinguished philosopher Ampére in his "Théorie des phénomènes électro-dynamiques," has proved, by means of a profound mathematical analysis confirmed by well-devised experiments, that all the effects of magnetism may be produced by currents of electricity. The observed effects of Terrestrial Magnetism may be equally well accounted for by supposing the Earth to be a huge Magnet, of which the North Pole is in the Southern Hemisphere, and the South Pole in the Northern; or by supposing the existence of a certain system of electrical currents. This system may be either at the surface of the Earth, or in the Atmosphere, or near its exterior surface. Or there may be electrical currents in all these localities; but it is probable that the currents near the superior limit of the Atmosphere form the *predominating system* in terrestrial electro-dynamical phenomena.

According to the principles of electro-magnetism, and the actual polarity of the Earth, the requisite conditions to be fulfilled by such a system of currents of positive electricity are; 1st—that they should flow from East to West; 2nd—that they should flow from the Equator towards the Poles. The discovery of Thermo-electricity has shewn that the incessant changes of temperature caused by the

Sun's daily motion must give rise to electrical currents satisfying the first condition. This system of spirals is, in fact, the channel through which any unusual increase of electricity is distributed over the electric envelope of the Earth, and its ordinary condition restored.

By the nature of electrical currents, they will always cross the Magnetic Meridian at right angles; or, to speak more correctly, the needle will always place itself at right angles to the predominating system of electrical currents at any place; hence Cyclones should progress *towards the Magnetic West.* For, the electrical current which forms a Cyclone is moving in a westerly direction and towards one Pole, before it is diverted from its course by a Volcanic explosion. After its descent it will retain this motion. Hence arises the progression to the Westward of the Cyclones of the Mauritius and West Indies. Near Java, the Magnetic variation vanishes, and gradually increases from 0° to 20° W. from Java to the Mauritius. Hence a Cyclone, starting from Java Head, like the Rodriguez Hurricane (Y fig. VIII), will move at first to the Westward, and then gradually make to the South of West. Near the Little Antilles, where the West Indian Cyclones commence, the variation is nothing, and increases gradually to about 10° E. about the western extremity of Cuba, causing the Cyclones to move at first Westward, and then to the North of West.

Tropical Cyclones always begin near active Volcanoes, and are sometimes accompanied by Earthquake Shocks; but the Volcanic paroxysm is the proximate cause both of the Earthquake and the Cyclone.

The theory here enunciated enables us to answer the principal questions in, what may be termed, the philosophy of Cyclonology; these are,

1st—Why tropical Cyclones occur at certain *seasons* only?

2nd—Why Cyclones accompany or follow *Volcanic Eruptions*, and the fall of Avalanches?

3rd—Why they *rotate*, and why always in one certain direction in the Southern Hemisphere, and in the opposite direction in the Northern?

4th—Why tropical Cyclones *progress*, and why to the *Westward?*

5th—Why *luminous meteors*, and other *electrical phenomena*, abound in a Cyclone?

But this theory offers, as yet, no explanation of the *recurving* and *retrograding* of Cyclones, or of the anomalous tracks of the South Pacific Ocean. This explanation is probably to be sought for in the different electrical conditions of the Atmosphere above an Ocean and a Continent.

PART I.

ON THE HURRICANES OF THE SOUTH PACIFIC OCEAN.

In attempting an investigation of the Storms of the South Pacific Ocean by means of the scarce and rude data available for that purpose, it appears natural to begin by assuming that these storms obey laws similar to those which are now known to prevail in the South Indian Ocean.

Bearing in mind the chief circumstances which characterize the class of Mauritius Cyclones, and relying on analogy and the generally uniform character of homogeneous phenomena when subject to conditions apparently similar, we should conclude :—

1st.—That the hurricanes of the South Pacific Ocean are *Cyclones*, or revolving Storms.

2nd.—That the order of rotation is N.E.S.W. ; or, in the direction of the hands of a watch.

3rd.—That they begin near the Equator, in the North East portion of the South Pacific ; progress first to the Westward, then towards the South West; and finally, recurving, pass off in middle and high latitudes towards the South East. (See the *dotted* track in VIII.)

These probable conclusions, deduced from analogy alone, comprise all that the science of Cyclonology has hitherto been able to offer to aid the Navigator of the South Pacific Ocean. Thus, Mr. Piddington, in his Sailors' Horn Book, (1851), page 137, directs the careful seaman to be guided in the Pacific Oceans by "analogies drawn from what is known of the other parts of the world. For the South Pacific, and for the present, I can only then recommend to him the careful study of what is said of the South Indian Ocean, both as to tracks and stationary storms."

Thus, too, Captain Stokes in the voyage of the Beagle, vol. ii. p. 441, and a writer in the "Nautical Magazine" for 1845, p. 425, treating of the Cyclone met by H.M.S. Favourite, off Mangaia, in 1842, and apparently anxious to make it conform to the law of progression, state that it was moving towards the *South West*, whereas its actual path was towards the *South East*.

In fact, it will be found that the Cyclones of the South Pacific are in some respects of a peculiar nature; and the preservation of the valuable lives and property which may be endangered by them will evidently depend, in a great measure, on the previous determination of this peculiarity.

In a matter of so much practical importance it would not be prudent to rest satisfied with inferences drawn from analogy, and unsupported by facts; and it would be extremely hazardous to *act* upon such merely probable inferences. With much labour I have succeeded in collecting information, which, though comparatively scanty, and imperfect, is yet amply sufficient to warrant the assumption of the *truth of the first and second* of the preceding conclusions; and to render imperative the *rejection of the third*, so far as regards the *direction* of the Progressive motion. A little consideration will show the necessity of demonstrating, or refuting, the existence of the anomaly just indicated. The science of Cyclonology is as yet only in its infancy, and there remains some disposition among seamen to disbelieve its laws. Now, if seamen should be induced to act upon the presumed application of these laws to the South Pacific Ocean, and be led into danger in consequence of their failure in that region, the previous disposition to incredulity would be confirmed, and disastrous consequences might ensue if they should be afterwards involved in Mauritius or West Indian Cyclones, to which the laws are undoubtedly applicable. The discrepancy in question is likewise interesting from its tendency to lead to a more intimate knowledge of the proximate cause of Cyclones, and of the agent by which they are formed and sustained; as well as to a more comprehensive expression of the Laws which govern their motions.

The prospect of obtaining materials sufficient to conduct the present investigation to a successful issue was at first somewhat discouraging. Until very recently the South Pacific has been comparatively unfrequented by vessels of a large class. The logs of the few small traders for sandal-wood and biche-la-mer among the

islands, and of whale-ships, were difficult of access; and seldom contained any information of use in such an inquiry. Colonial newspapers are of a very ephemeral nature, and not distinguished for attention to scientific subjects. The notices of hurricanes that occur in the works of literary men and Missionaries are generally so deficient in accuracy, and in essential facts, as to be of little value. But we are now, fortunately, able to bring to bear on the imperfect data derived from such unsatisfactory sources, the certain and definite information acquired from the Cyclones of other regions, which have been observed under more favourable circumstances; and that Analogy which would prove a perilous guide to the Navigator, becomes of eminent service when employed to suggest and direct the enquiries of the Investigator.

As no particular advantage appears to belong to the arrangement of Cyclones in the order of the *time* of their occurrence, I have preferred to give priority to those which tend to elucidate the three hypothetical conclusions with which I set out. I shall first consider one of the most recent of the Tropical Hurricanes of the South Pacific; which has been observed with care, and of which we possess a full and satisfactory description. The examination of this hurricane fully bears out the first and second of these conclusions, but throws no light on the third. It occurred in 1850 at the Navigators' Island, or the Samoan Group, of which Upolu is the principal, from its possessing the best harbour Apia. Captain Courtenay, at that time commanding the brig the *Two Friends*, has given a graphic narrative of his passage through the hurricane as it progressed to the southward, after it had left Samoa, in the following letter to Captain Ashmore, of Sydney, dated Upolu, 16th April, 1850.

"We left Auckland on the 23rd March, passing through Outer Barrier about midnight. It was my intention to have gone to the Eastward of Pitcairn's Island, as I thought it possible we might encounter a hurricane, but at the same time not very probable, as it was getting so late in the season; though I had been in one so late as April, at the time that the Anastatia and two American ships foundered. I was baulked in my intention of going to the Eastward by a hard gale at S.E., so I compromised the matter by standing to the Northward. Everything had gone on well until Thursday, the 4th April, wind then strong at S.E. Tutuilah at noon

N. b. E. 65 miles. Strong winds at S.E. and squally; 1 P.M. split fore-top-mast studding sail. 2h. 30m. P.M, took in main-royal. 5 P.M. thick and squally; in flying-jib and top-gallant sails. Not seeing the land at sunset, took in boom, and square main-sail, and double-reefed. Steered N. b. W. At 8 P.M. steered North. At 9 P.M. steered N.N.E., and at 9h. 30m. N.E.—considering the ship then between Upolu and Tutuilah. At 10 P.M., just after a heavy squall, the look-outs shouted 'land, and breakers on the lee-bow!' jumped to leeward, and there they were, breaking as high as the lower yards, not more than 300 yards off. Luffed, and the brig came up to East. Got boom and square mainsail on her; she reached out, and soon lost sight of them. Shortly afterwards she broke off N.E. b. N. Wore to the Southward. Now blowing very hard, with tremendous squalls. Fore-top sail blew away. Barometer 29·80. Wind S.E.

Friday, 2 A.M. The top-mast stay-sail blew away. Barometer 29·40. Wind S.E. Brig's head S.S.W. Barometer gradually falling until 9 A.M., when it was 29·00, wind still steady at S.E. Cut the fore-sail from the yard and saved it, wind steady at S.E. until midnight, barometer 29·00, brig doing well under close reefed main-top-sail.

Saturday, 1 A.M. Every appearance of a hurricane. Barometer 28·90. 2 A.M. main-top-sail blew to ribbons; brig then gunwales in. At this time a sea broke over the quarter, carried away the wheel ropes, broke the main boom, took the boat from the stern, broke the pilot's boat's keel and stern-post, and smashed the gig lying on the port side of the quarter-deck. At 4 A.M. barometer 28·85. Wind then began to shift to S.S.E. and S., brig's head to S.W. At daylight a sea broke over the bow; stove in the fore-scuttle; took away the cabouse, stove, and coppers; leaving nothing but one frying-pan; washed away tarpaulin from the after hatch-way, and a considerable quantity of water got below. With difficulty got all secure again, sounded and found three feet water. Hands to the pumps and sucked her. 9 A.M. Barometer 28·60, wind S. b. W. Brig gunwale in. At 10 A.M. top-gallant-sails and main-sail blew out of the gaskets; main-top-gallant-mast blew off by the cap; the yard likewise going in the slings. Brig now frequently leading-blocks in the water. Stove the lee-water casks and got rid of the deck load. Harness casks, full, washed over the lee

rail. Noon, hurricane awful; upper part of round-house in the water, companion and sky-light stove, much water going below, and in through the lee dead-lights, which were completely under water. At this time two full casks of water were washed over the main boom and gaff, which were lashed to the main rigging about ten feet from the deck. At 1 P.M. barometer 28·60, wheel ropes and relieving tackles carried away again; got them secured. 2 P.M. barometer 28·50. 3 P.M. barometer 28·45, wind S.W. Brig's head N.W. b. N. At 4 P.M. barometer 28·35, hurricane howling. Lee bulwarks, part of rails and stancheons going; wind complete drift. At 5 P.M. barometer 28·20; wind W.S.W.; head N.W. At 6 P.M. barometer 28·10; awful, expecting to see the masts go; but although prepared to cut, wished to hang on to them as long as possible. Half of deck in the water, sea a complete drift; unable to see the jib-boom. At this time the remains of main boom, gaff, and boom mainsail washed away. Cut off all, to clear the wreck of the stern. Not able to stand against the wind without holding on. At 7 P.M. the barometer began to rise, although there was no apparent abatement of the wind. 8 P.M. wind W., head N.N.W. 10 P.M. wind W.N.W., head N., barometer 28·50. Midnight, barometer 29·00.

Sunday. Still blowing very hard, with squalls and a high sea. Employed clearing the wreck, got some tea made in a pitch-pot. I stood the first watch until one hour past midnight, (the Chief Officer being laid up) and then turned in for the first time for 90 hours. We got a fore-sail bent and steered to the Eastward, then bent two old top-sails, and found our way in here. Had we had more than one suit of sails we could have proceeded on our passage.

We found three vessels stranded at this island,—the Favourite, of London; the Hercules, of New Bedford; and the schooner Clara; high and dry on the reef.

They had the storm here on Friday, the wind shifting suddenly round from N.W. to S.W. with barometer 27·15; and I think near the centre of the storm, the barometer with us must have been about 27·80, as my barometer ranges high.

I never saw so much change as there is in the appearance of this island,—before, it was a complete garden, and green to the summit of the hills; now, it looks as if it had been swept over by fire, all the trees are stripped and dead, and cocoa-nut trees lying in all directions. There is hardly a house standing on the island.

It will make about 15 days difference in our passage, but with barometer at 27·80, we ought to be thankful we escaped so well, especially as we were hove to on the breaking-off tack. The American ship will soon go to pieces, her stern-post and keel being out. The Favourite might be got off, had we the means here. The Clara is high and dry at low water, and there is not more than 4 feet rise. We have got our sails bent, and top-gallant masts on end, and shall be on the road again on Saturday, and you may depend she shall not want the muslin."

The Rev. G. Stallworthy, of Upolu, gives the following notice of the storm in the Missionary Magazine for February, 1851 :—

"During the 4th April a strong S.E. wind had blown, with rain. That, however, is not the quarter from which gales blow here, and therefore no apprehension was felt. Between 8 and 9 A.M. of the 5th the wind shifted to about S.S.W. and a furious blow began. At the same time a heavy sea came rolling in. There was all the time what appeared to be a driving rain, but which our taste informed us was largely charged with salt water. Trees and houses were falling all around. About noon the wind suddenly fell and there was *a dead calm*. An occasional gentle breath of air assured us that the wind had changed. About 2 P.M. the wind had travelled round by East to about N.W. It again blew as heavily, and some think more heavily, than before; and continued through the afternoon and night with much rain. A large number of houses and trees, which had resisted the southerly blow, fell before this. Only about one house in ten was left standing. The wind blew occasionally during Saturday and Saturday night, Sunday was squally and rainy, but the gale had spent itself; out of more than 30 chapels only one remains."

The Rev. W. Mills, of Apia, Upolu, says, *(idem.)*

"All our former storms appeared but a gentle zephyr to this. I have never seen a Gale like it. The whole came upon us so suddenly that there was no time for preparation. A little before sunrise, nothing unusual indicated a storm, light puffs came across the island, which soon changed into squalls. In less than an hour they became thick and strong. By mid-day the storm began, and was truly awful. The iron Bethel Chapel stood out the hurricane, one

end is somewhat bent in. Long before the hurricane was at its height, three ships which lay at anchor went on shore. Torrents of salt water poured down with little intermission for 48 hours."

The "Samoan Reporter" is published at Upolu half-yearly by the Missionaries. In the number for July 1850 the hurricane of the preceding April is thus described :—

"Between November and March we have generally a gale of wind for a few days on these islands. In January last, we had some high winds and bad weather. On the 5th of April we had a hurricane, not only unusally late in the season, but also very sudden and severe. It was scarcely felt on the island of Savaii, one side of Manono escaped, but all along both sides of Upolu it raged with fearful violence, gathering strength apparently as it advanced in *its course from the West towards the East end* of the island. It extended to Tutuilah, (S.E. of Upolu) but was not felt there to the same extent as on Upolu. It began in the morning from the South, shifted to the West about mid-day, and by 2 P.M. bread-fruit and other trees innumerable were laid low. Upwards of 2000 native houses, chapels, and other buildings, were in ruins; and three vessels in Apia harbour were driven on shore among the rocks. Parties of natives sailing along the coast were overtaken by the Gale, and had their Canoes wrecked. Some were almost dead before they reached the shore; others were carried out to sea and drowned. At Tutuilah a large part of a mountain broke down near a native village, by which four persons were killed. The storm made sad havoc at Apia, the vessels wrecked there were the whaling ships, the Hercules, of New Bedford; and the Favourite, of London; and also the Roman Catholic Mission Schooner Clara. All on board the vessels were saved except a Rarotongan, who leaped overboard in the night, thinking he might reach the shore.

Captain Courtenay, of the brig Two Friends, reported to us that he was about 60 miles to the South of Tutuilah during the gale, that they had it strongest 24 hours later than we, and that not one on board expected to be saved."

Captain Ashmore has published in the "Nautical Magazine" for November, 1851, the following interesting extract from the log of Captain Cuthbert, the commander of the above-mentioned barque the Favourite.

"*Friday*, 5th April, 1850, at 12h. 30m. A.M. (midnight of Thursday), heavy rain, with lightning and thunder. 6 A.M. strong breeze

at South, barometer 29·25. At 8h. 30m. let go the starboard anchor; then 50 fathoms out on the port bower, barometer 28·50, down royal and top-gallant yards. At 9h. 30m. A.M. gale increased, gave 10 fathoms more starboard bower cable. Barometer 28·10, falling fast The American went on shore, the keel coming up alongside. At 11 A.M. strong hurricane at S.W. striking the ship, when she struck on the starboard side, but not heavy enough to do any harm. At 12h. 45m. P.M. shifted suddenly to N.W. catching the ship on the starboard side, when she instantly swung round, head in shore. Tried to set fore-top-mast stay-sail, but it instantly blew to ribbons. She then fell foul of the American ship Hercules, unshackled the starboard cable to clear the American ship. She forged ahead, and carried away her bow-sprit, then struck heavily and fell over on her larboard beam-ends. Cutting away, the hurricane increasing with terrific fury. At 3h. P.M. barometer 27·50. At dark barometer still falling, and the hurricane on the increase every hour. Made fast from the sea flying over. Barometer 27·30."

Saturday, April.—1 A.M. dreadful gusts, hurricane still on the decrease, (?) barometer 27·30. At 2 A.M. struck by a sea, when she bilged and filled. At 2h. 15m. the height of the hurricane, barometer 27·05. At 2h. 20m. A.M. barometer began to rise."

The sudden shift to N.W. at 12h. 45m. agrees with the dead calm and change to N.W. about noon, mentioned by Mr. Stallworthy, and shews that the central space passed over Upolu about noon on Friday. The barometer, (fig. VII.) of the Favourite, continues to fall during the afternoon and night of Friday, instead of rising, immediately after the change of wind, as might be anticipated. But as this took place while the ship was bumping on the rocks, it is probable that the repeated shocks sustained had vitiated the vacuum, or otherwise deranged the Barometer's action. Mr. Williams, the American Consul at Apia, informed Captain Ashmore that there was no barometer *on the island* when this hurricane occurred.

On board the Two Friends the barometer (fig. VII.) *began to rise* at 7 P.M. on Saturday, and the wind changes soon after, indicating the passage of the central space over the ship at that time. The central space was therefore undoubtedly moving *towards the South*. Nothing more definite than this can be legitimately deduced from the observations at Upolu, respecting the direction of progression, on

account of the modification and irregularity to which Cyclones are subjected in the neighbourhood of high land. The continuous veerings of the wind, and the concurrent falling and rising of the mercurial column, so carefully recorded by Captain Courtenay, prove this hurricane to have been a *true Cyclone*. The fact of its southerly progressive motion demonstrates that the rotation must have been in the order N.E.S.W., for the contrary order, viz : N.W.S.E. would require the Cyclone to move *towards the North*, which it certainly did not. The diagram (IV.) shews the successive shifts of wind on the supposition that the brig was perfectly *stationary*, and makes the Cyclone appear to move to the West of South. The exact track of the Cyclone cannot be determined, until we possess notices of its appearance a few days sooner or later than the 5th April, in other localities.

Analogy would indicate for the Samoan class of Cyclones a mean track to the *South Westward*, passing to the North of the Feejee Islands, over New Caledonia, recurving a little to the North of Sydney, and then passing off to the South Eastward towards New Zealand, (dotted curve in fig. VIII.) But the facts which my researches have brought together, all concur in refusing to verify the suggestions of Analogy ; and agree in indicating that Cyclones travel from the Navigators' Islands, in 13° 50′S. and 171° 40′ W. to Raratonga and Mangaia in 21° 57′ S. and 158° 7′ W., and therefore pursue a *South Easterly* course for about 1000 miles.

In the " Sydney Morning Herald" it is stated that, " Upolu was visited by a hurricane on the 16th March, 1846. The vessels at anchor in the harbour (Apia) were, H.M.S. Juno, the French missionary schooner Clara, and the Tahitian trader Lucy. Both the latter were driven high and dry on shore. The Juno with difficulty held her ground, with four anchors a-head. Fortunately the falling of the barometer indicated an approaching storm, and gave her time to lower her top-masts, &c., so that she rode out the gale without damage. On shore, houses were overturned, large trees torn up by the roots, and the crop of bread-fruit entirely destroyed. The island had not been visited by a similar calamity for seven years. It blew hardest from N.W. to N.N.W. The following American whalers touched at Upolu during the remainder of March. The Ganges had lost three boats, top-masts, &c., had her decks swept, and was twice

on her beam-ends. The Lalla Rookh damaged her rudder and lost one boat. The Mount Vernon lost main top mast, and one boat. The Eliza Adams lost main-top-gallant mast, and three boats. The Howqua lost one boat. The Timor lost two boats. The Crescent lost fore-top mast and two boats. The Lexington, rudder carried away. The Newton, lost her jib-boom, and two boats."

Since Upolu suffered chiefly from the N.W. gale, it was in the northern portion of the annulus, and the central area lay to the southward of Samoa on the 16th. It seems then to have travelled rapidly towards the South East, since we find it passing almost directly over Raratonga about 1 A.M., and over Mangaia about 10 A.M. of the 17th. For the following interesting facts I am indebted to the Rev. A. Buzzacott, of Raratonga, the friend and fellow-labourer of the Martyr Williams. For some days previous to the great hurricane at Raratonga, the wind had blown strong from the East. On Monday the 16th there was a furious gale from the Eastward. At 1 A.M. of the 17th there was *a dead calm* which lasted a few minutes, and then the wind shifted suddenly to the South West. A vessel from Tahiti was driven by the rising sea over the Palm Trees; the Captain told Mr. Buzzacott that he felt the tree tops grating against the bottom of the vessel. At Mangaia, 40 miles South East of Raratonga, there was no barometer, but it blew strongest there, and the change of wind occurred at 10 A.M. of the 17th. At Raratonga, the actual violence lasted from 9 P.M. of the 16th to 3 A.M. of the 17th, the storm passing away more quickly than it came on. On board a vessel between Raratonga and Mangaia, the barometer was lowest at 5 A.M.

The track of the central area is thus determined by four points over which it passed at consecutive times, viz: a point to the S.W. of Upolu on the 16th March, a point a little N.E. of Raratonga at 1 A.M. of the 17th, a point between Raratonga and Mangaia at 5 A.M., and Mangaia at 10 A.M. of the 17th. The change from East to South West shews that the Cyclone was gradually inclining towards the South, and approaching the vertex of its track. (A fig. VIII.) The fluctuations of the barometer at Raratonga on the 16th and 17th March, are thus given in the "Samoan Reporter"—

16 March.....10 A.M.....29·50	17 March.....1 A.M.....27·70
„ ..... 7 P.M.....29·00	„ .....2 A.M.....28·00
„ .....10 P.M.....28·50	„ .....4 A.M.....29·00
„ .....12 P.M.....28·00	„ .....6 A.M.....29·50

In the course of the day, it rose to 29·90, its usual height in fine weather, (Fig. VII.)

The inspection of the depression of the barometric curve suggests that this was a Cyclone of great violence. Its diameter appears not to have been above 200 miles, for the hurricane did not extend to Aitutake, about 130 miles north of Raratonga, as I am informed by Captain Morgan, who touched at Aitutake shortly afterwards.

The Missionary Brig, John Williams, met a hurricane here in 1845 travelling *towards the South East*, (B fig. VIII.) It is thus recorded in Captain Morgan's log:—

"1845, Jan. 16, P.M.—Brisk gales and heavy rains.
Jan. 17, 10 A. M.—Barometer fell rapidly, shortened sail.
10½ A.M.—Gale increased to a hurricane, the wind veered eight points, from North to West; and then to S. W. 11 A.M. head sea running so high that we carried away our jib-booms. 11½ A.M. abated and fell calm. Cleared the wreck. Raratonga bore W.S.W. 30 miles. 18th, wind from the *Southward.*"

The Cyclone of H.M.S. Favorite, in 1842, (C fig. VIII.)

The Rev. W. Day, of Hobart Town, has given me the following extract from a Journal kept by him at Sagano, about 6 miles west of Apia, Upolu:—

"Before daylight of 15th December 1842, the wind set in from the North East. Some guests who were with us started at 5 o'clock, anxious to be at home, and had a dangerous ride. Before 10 A.M., the natives, who are familiar from childhood with these hurricanes, were urgent with us to leave the house. We left it about 10, and took refuge in the village in a low hut, which they nearly buried in bread-fruit branches, to break the fury of the wind. Trees were falling around us in our way to the village, but we received no injury. Towards afternoon the storm abated, and rain fell in torrents. It became calm, and even fine, an hour or two before sun-set. During the hurricane the wind came on in blasts, and got round from N.E. to S.E. b. S. Great devastation was done in the grounds around our dwelling. On surveying the fallen trees, we found that they had been prostrated in very opposite directions. The storm raged extensively on the islands of Upolu and Savaii, throwing down many of the largest native houses and chapels. An American whaler has been in since the storm, the Captain states that they encountered it

when about 200 miles distant, blowing from the West, at the same hour that it blew hardest here."

Here the central area lay on the North side of Upolu, and the whaler must have been still farther to the North. The Cyclone was moving towards the South East, since the wind veered form N.E. to S.E. b. S. This is confirmed by the appearance of the Cyclone on the following day, off Mangaia, where it was met by H.M.S. Favourite, which left Tahiti for Sydney on the 11th December. In the following extract from the log of the Favourite, the want of barometrical observations is, in some measure, supplied by the recorded force of the wind, (12) being the maximum in the scale of intensity, as usual :—

" 1842, Dec. 16.—A.M., (b.c.) wind N. 4 A.M., wind N.b. E. set royals. Noon, 20° 42′ S. 204° 9′ E., Mangaia S. 59° W., 145 miles. P.M. wind N.N.W. (4). 8 P.M. *wind N.E., in studding sails.*

Saturday, 17th.—A.M. wind N.E. (6). 5h. 30m. A.M. saw Mangaia S.W. ½ W. 7h. 45m. A.M. hove to. Mangaia N.N.W., one mile off shore. 10 A.M. wind E.N.E (6). P.M. wind E.N.E. (7). Split mainsail. 4 P.M. wind E.N.E. (12) 8 P.M. wind S. b. W. (12) Carried away main-stay sail, battened down hatches, first gig lost, a man drowned, jib blew to pieces, and split driver. 12P. M. wind W.S.W. (10).

Sunday, 18th.—Wind W. (10, 8). 3 A.M. wind W.N.W. (4) Noon W. b. N. (5). 1 P.M. wind W. (5). 5 P.M. wind W.S.W. (5). 11 P.M. wind W. (3). Out reefs."

The first indication of the Cyclone here is at 8 P.M. of the 16th, when the wind shifts to N.E.; the centre passes on the N.E. of the ship, but moving in a South Easterly direction, between 4 P.M and 8 P.M. of the 17th, when the wind is of hurricane violence (12), and shifts from E.N.E. to S. b. W.

A writer in the " Nautical Magazine" for 1845, p. 425, overlooking these indications, and misled by a supposed analogy between the progressive motions of the Cyclones in the Pacific and Indian Oceans, has made this Cyclone move towards the South West.—Captain Stokes, who was at Sydney when the Favourite arrived there, has fallen into the same error. The following are the data

and remarks given by Captain Stokes, at p. 441, vol ii., of the Voyage of the Beagle :—

" At noon of the 17th Dec. 1842, the Favourite was in 21° 58′ S. 158° 2′ W. Mangaia distant 5 miles, S.W. b. W., steering W. b. S. ½ S. in a moderate gale from E.N.E., with cloudy rainy weather. 3 P.M. had run 27 miles, wind having increased to a strong gale, veering to N.E., course now S.W. At the end of another hour, having run 8 miles, wind increased to a storm, veering again to Eastward. Ship brought to the wind on *port tack* under a main-try-sail. For the hours 5 and 6 she *headed from S. to S.W.*, which would give for the direction of the wind about S.E. b. E. At 6h. 30m. a man washed away with the lee quarter boat. At 8 the wind had veered to S. b. W., having blown a hurricane with constant rain for the last hour. At 9 most of the half-ports were washed away, the sea making a clean sweep over the decks. By midnight the wind had subsided to a whole gale, *but still the veering had reached the W.S.W. point*, and at 3 next morning it was blowing only a moderate breeze from W.N.W., with tolerably clear weather. Sail was now made, and a S.W. b. S. course held for 28 miles, when, at noon, observation gave 22° 1′ S. 158° 44′ W. The day after the hurricane the wind was moderate from Westward, and the day before, it was moderate from Northward. The ship's position at noon on the day before the hurricane was about 130 miles to the N.E. b. E. of Mangaia Island. The duration of this storm, then, may be considered to have been from 4 P.M. to midnight, in which eight hours the wind had veered gradually from E. round by S. to W.S.W. The veering being much more rapid between 8 and 9 P.M., when the Storm was at its height, the ship must at that time have been near the focus. The tack on which the Favourite was hove to, carried her into the course of the hurricane, or rather placed her in a position to be overtaken by it, *as it passed along to the Southward and Westward.* But as the ship *broke off to the Westward and Northward*, she fell out of its North Western edge. Doubtless, if a W.N.W. course had been pursued in the first instance, or at noon on the 17th, the Favourite would have avoided the storm. It is to be regretted that the barometer was broken in the commencement of the hurricane, when it was unusually low, having been falling for some time beforehand. Besides

this, there was ample warning in the unusually gloomy lurid appearance of the sky; the weather also was misty, with showers of rain, as the ship approached the course of the storm."

The data given in the above extract are at variance with the interpretation which Captain Stokes has applied to them. If the wind veered gradually from E., round by S. to W.S.W., the progressive motion would have been S. b. E., and not to the South Westward. But it will be observed that the veering is continuous from N.E., round by East, South, and West, to W.N.W.; and it will be instructive to seek an explanation of this fact. On a chart (fig. V.) mark the point A in 21° 58′ S., and 158° 2′ W., draw A B = 27 miles, in the direction W. b. S. ½ S., and B C = 8 miles, in a S. W. direction. Mark another point E, in 22° 1′ S., and 158° 44′ W., and draw E D = 28 miles, to the N.E. Then A is the position of the Favourite at noon of the 17th, C her position when hove to, and D her position when she again made sail. In running from the N.E. to A the wind is Northerly, at B it is N.E., veering to Eastward at C, with a falling barometer. The ship is in the S.E. quadrant of a Cyclone. If the Cyclone is moving towards the S.W., she is on the *left side*, and therefore should heave to on the *port tack*; but if it is moving towards the S.E., she is on the *right side*, and the *port tack* is the *breaking-off tack* The wind along B C being N.E., the centre lies at some point C_1, to the N.W. With the Cyclone moving to the South Westward, and hove to on the port tack at C, the ship would soon have been clear, both of the advancing Cyclone, and of the mountainous sea left in its wake; but the wind at D being W.N.W., the centre now lies at some point C_2, to the S.S.W. of D, the progressive motion is therefore *to the South Eastward.* By the united action of the wind, and the radial swell, she drifts round the advancing centre to D, breaking off gradually, as shewn in the diagram, as the wind veers from N.E. round by East, South and West, to W.N.W.; the beaming sea in the wake of the Cyclone making a clean sweep over her decks. The dotted line C D represents the course of the drifted vessel when the centre is supposed stationary at C_1. A B C D E is the actual track of the ship, and C_1, C_2, C_3 the track of the Cyclone's centre. It will be seen that the Favourite would not have avoided the storm by pursuing a W.N.W. course from A, as suggested by Captain

Stokes. When at A the best course was to wait, or to stand back, until the Cyclone had passed.—When at C, if she had stood on to the S.W. she would have passed in front of the Cyclone uninjured. The misfortunes of the Favourite arose from two errors, which were perhaps unavoidable in 1842, she hove to when she ought to have made all sail to the S.W.; and she hove to on the wrong tack. The course (W.N.W. from A) suggested by Captain Stokes would certainly have made the matter worse, for the Northerly Winds would have taken her right into the central space.

A storm-track has now been shown to exist between Samoa, Raratonga, and Mangaia. The Rev. Mr. Darling, a Missionary at Tahiti, informs me that hurricanes are unknown there, but sometimes occur to the Westward of the Island. I have only met with one such instance, and the notice is very defective. It occurs in the work called "Rovings in the Pacific, by a Merchant, long resident in Tahiti." The notice is written at Maupiti, an island about 30 or 40 miles west of Borabora and Raiatea:—

"1843, 19 Dec. thick and hazy, a complete gale, hove to. During the night the wind suddenly and absolutely *ceased*. 8 P.M. a very tempest raging. The gale increased fearfully, with lightning at night. Houses, trees, &c., were blown down. Not a house entire, nor bread-fruit tree standing. The beach strewed with wreck, and all the small craft of the natives destroyed. A boat with natives blown dead before the wind to Raiatea. The hurricane passed over Raiatea, but did little damage at Huaheine."

The Samoan and Raratongan storm-track appears to pass to the Southward of Tahiti. Capt. Morgan left Tahiti on the 7th Dec. 1840, in the Camden, and arrived at Tutuilah on the 23rd Jan. 1841, without meeting with the following Cyclone, which must have passed to the Southward of him, as it advanced towards Raratonga:—

"1840, Dec. 16. A violent hurricane blew down many trees, and damaged the fruit at Apia, (Upolu.) The S.E. wind increased until the 16th when there were heavy squalls from N.E. At 2 A.M. wind very heavy from S.E. with rain, some houses down. 2½ A.M. gusts heavy from S.S.E. Barometer, though an injured one, fell to 24 inches, its ordinary standing being 28 inches. Thermometer 88°. 6 A.M. wind again rose rapidly, blowing down houses, trees, &c., blasts very severe at intervals of 10 minutes. 8 A.M. *a sudden shift of wind to S.W.*, after which it moderated.

Noon, clear, wind still S.W. The houses were generally blown down after the change of wind. A similar gale occurred about 9 years before, and changing in a similar manner." (D fig. VIII). (*Wilkes*, vol. 5, p. 19.)

The changes N.E. to S.E. and then to S.W. indicate progression to the South East, and accordingly we find the Cyclone at Tutuilah on the following day.

"1840, 17th Dec.—A hurricane such as the islands had not experienced for eight years. On Thursday the 17th, from forenoon to midnight, it blew a fearful gale, shifting from the usual course (S.E.) of the Trades to about N.W., and again to S.W. Pago-Pago was sheltered by the hills, but Leone, 15 miles off, and many other villages, were completely laid desolate." (*Missionary Life in Samoa*, p. 179).

"1840, Dec.—A very violent hurricane laid waste the island of Vavoo." (*Sir E. Home, in Naut. Mag.* 1850. p. 37.)

The storm-track here passes to the North East of Samoa, and to the South West of Tutuilah, passing between the islands.

The following notice renders it highly probable that this Cyclone came from the immediate neighbourhood of New Guinea, and Torres' Straits, the Laughlin Group being in 9° S. and 154° E. :—

"During the whole of the 1st Dec. 1840, the whaling barque Mary, of Sydney, was buffetted about in an unmanageable state in a typhoon. On the 2nd she struck on a reef of rocks at the S. E. extremity of the Laughlin Islands. The sea swept overboard six of the crew, the rest reached the land, but only one escaped the natives, and reached Sydney in the Woodlark, whaler."

The distance between the Loughlin Islands and Samoa is about 2100 miles, which, for 15 days, would give an average daily velocity of 140 miles.

We have thus an indication of a continuous storm-track of the tropical hurricanes of the South Pacific extending from New Guinea to the Navigators' Islands, or Samoa, in an Easterly direction ; and thence to Raratonga and Mangaia in a South Easterly direction ; over about 50° of longitude, or 3000 miles. This forms an exact counterpart to the track, from Java to the Mauritius, of the Cyclones of the South Indian Ocean. In fact, the region around Torres' Straits is the common starting place of both classes of Cyclones.

By way of illustration, we may regard this locality as the northern extremity of the minor axis of an elliptical track, of which the islands of Rodriguez and Mauritius form the western extremity of the axis major, and the islands of Raratonga and Mangaia, the eastern extremity. Beginning near Torres' Straits, the Cyclones of the Indian Ocean traverse the Western half of the Ellipse, and those of the Pacific Ocean the Eastern half. This may be regarded as the maximum, or exterior, ellipse of its class; for, it will be shewn that within this ellipse, there is a series of smaller ellipses, along which the centres of Cyclones in both oceans travel; the minor axis of all these imaginary ellipses being nearly coincident in direction with the mean meridian of Australia.

The hurricane alluded to above as having taken place 9 years before, was that experienced by the Rev. J. Williams on the 21st Dec. 1831, at Raratonga, which likewise devastated the Navigator's Islands, though Mr. Williams has unfortunately omitted to mention the date of its occurrence at the latter place. Since it veered in the same manner as that in Dec. 1840, which was moving to the Eastward, it may be fairly inferred that it passed from Samoa to Raratonga. The following is the substance of Mr. Williams' description:—

"Dec. 21st, 1831, Raratonga, Saturday morning.—A heavy sea rolling into the harbour of Avama; the atmosphere threatening, and ocean agitated. Fastened the vessel by a chain-cable to the main post of the large school-house, which was upon a bank 10 feet high, and 40 or 50 yards from the sea. Sunday, a day of gloom and distress. The wind blew most furiously, and rain fell in torrents. Towards evening, the storm increased. 9 P.M. the sea a most alarming height, over the bank to the school-house. A resistless gust burst in the *East* end of the chapel. Monday morning, rain, lightning and thunder. The whole island trembled to its very centre as the infuriated billows burst upon its shores. The crisis had arrived, for the wind *shifted suddenly* a few points to the West (from North?) the sea retired, and the storm was hushed. Bank, school-house, and vessel, had all been washed away. The vessel carried over a swamp, and lodged amongst a grove of chestnut trees. No spot escaped, for the gale *veered gradually round* the island.

This dreadful hurricane extended to the Navigators' Islands, and was most destructive. At Savaii it was accompanied by a violent shock of an Earthquake." (*Williams' Missionary Enterprize.*)

As the wind blew first from the Eastward and then veered a few points to West, the Cyclone was moving to the Southward.

I shall record here, with a view to future use, some isolated and imperfect notices of Cyclones, apparently belonging to this class :—

"A desperate hurricane occurred at Tonga in the latter end of March, 1830. A Spanish brig drove ashore near the reef, with loss of cargo and nine lives. The Lloyd Whaler rode out the gale. The Wolf, English Whaler, was forced to cut from two large whales, with loss of boats, &c."

The information collected at Tonga respecting its hurricanes, by Lieutenant Wilkes, merit insertion here. He says, in vol. 3. p. 32, "Hurricanes are frequent in this group, and occur in February and March, but have also taken place in November and December. The Missionaries say that the storms begin at N.W., thence veer to the Eastward, and end in South East. (This would make the Cyclone progress *towards the Equator*, which I regard as *an impossibility*, T. D.) Houses are levelled, trees torn up by the roots, vessels driven on shore, canoes lost or driven hundreds of miles away to other islands. In these storms the wind is frequently observed to change from one point to its opposite, (marking the passage of *the centre*, T. D.) and in the same group of islands trees have fallen during the same gale, some to the South and others to the North. (Cyclone moving to the Eastward, T. D.) They are local in their effects, and fall chiefly upon Hapaii and Vavao; (to the North of Tonga.) If the fury of the storm be felt at Vavao, Tonga generally escapes, and vice versâ; but Hapaii is more or less the sufferer in both cases, situated as it is between the two places. A very severe hurricane was felt at Lefooka, Hapaii, in 1834. They vary in duration from 18 to 36 hours; after a destructive one a famine generally ensues: it destroys all their crops, and numbers of the natives die. The most severe are called "Afa hija fagi," the hurricane that throws down the banana trees. Earthquakes are frequently felt here."

The following is from the "Samoan Reporter," March 1849 :—

"1848, Dec. 26.—The islands were visited by a severe gale which lasted during the two succeeding days, and was severely felt

both at the Society and Hervey groups. The sea was far beyond what the oldest natives remember to have seen. Large islands have been raised on the reef on the northern side of Upolu, several feet above high water mark, and composed of dead coral.

Contrary to the general direction of the winds during gales which visit this group, it blew from the East, going round to the North, and N.W."

In the "Sydney Morning Herald" it is stated that the schooner Marian Watson was at Erromanga on the 28th December, 1848, with 17 tons of sandal-wood, bound thence to the Sandwich Islands. She had encountered a heavy gale from E.S.E. *a few days previous*, accompanied with thunder and lightning, which split the whole of her sails; and from the effects of the electric fluid, the Captain was blind for four days.

The Marian Watson was probably to the North of Erromanga during the gale: she appears to have been in the Southern Margin of the Cyclone as it passed on towards Samoa, which suffered from the passage of the North East Margin. (E fig. VIII.)

In the "Seaman's Friend," published at Oahu, I find the following accounts of Cyclones, probably connected with the Samoan class:—

"1847, June 16.—The American Whaler Factor, from New Zealand towards Talcuanha, met with a typhoon, and put into Tahiti in distress."

"1848, April 12.—The barque Junius, off Savage Island, 18° S. and 169° W. for several days had strong gales from S.E. and E. and was compelled to lie to. 12th April, 2 A.M. wind increased, in topsails. 3 P.M. a sea struck and stove the larboard boat. 6 P.M. fore-top-mast stay-sail torn in pieces. Blowing a perfect hurricane, with a heavy sea, lee-rail under water. April 13, 7 A.M., cut away fore and main top-gallant backstays, a sea carried away the boat. 9 P.M. top-masts and jib-booms gone; vessel nearly a complete wreck. 14th, wind and sea increasing. Barometer fell fast. At 5 P.M. the hurricane at its height. Barometer 27·70. Daybreak, if possible, the wind blew harder, the clouds looked blacker, and the rain fell faster, than on the previous evening. Through the day, a slight rise of the Barometer, about 0·30. 15th. At daylight, wind and sea somewhat abated. At sun-set, weather quite moderate, sea

falling fast, made Savage I. 10 miles distant. The hurricane commenced with wind at E. or E.N.E., and veered round to the Northward and Westward, dying away to W.N.W., or West."

In this case, if the vessel could be supposed to have remained nearly stationary during several days of such weather, the order of veering would lead to the conclusion that the Cyclone was moving due South; but to infer the direction of progression from the shifts of wind alone, without regard to the various positions of the ship, would generally lead to fallacious results. (F fig. VIII.)

I shall now consider the Cyclone-tracks which fall *within* that of the Samoa and Raratonga class, or those which traverse the western regions of the South Pacific. This class is of considerable importance on account of the proximity of its locus to the Australian Colonies.

In the Narrative of the United States Exploring Expedition, by Lieutenant Wilkes, we find that, at the Feejee Group, from November to April the winds prevail from the E.N.E. to the S.E. quarter, at times blowing a fresh trade wind. From November to April, northerly winds are often experienced, and in February and March, heavy gales are frequent. They usually begin at the N. E., pass round to the N. and N.W., from which quarters they blow with most violence; then, hauling to the Westward, they moderate.

A very heavy gale was experienced from the 22nd to the 25th of February, 1840. The only data I could get, to be at all depended upon, were from Captain Engleston, whose ship was lying under Toba Peak, on the north shore of Vitileva. The gale began from the N.E. with heavy rain, on the morning of the 22nd. During the night and morning of the 23rd, it was more to the N., increasing with heavy gusts. They let go a third anchor, and sent down the top-masts and lower yards. On the 24th the gale was the same, with much rain, the wind hauling to the westward at mid-night of the 25th. It became N.W. in the morning, and began to moderate, the wind hauling gradually to the Southward, when it cleared off. This gale was not felt at Tonga, although they had strong winds there at the time.

The veering of the wind from N.E., by N. and W. to about S.W. makes the Cyclone move towards the South East, the centre passing on the South of Vitileva. A strong northerly wind at Tonga would shew the proximity of the eastern margin.

Captain Morgan has favoured me with a perusal of his Journal, and of the log of the Missionary Brig Camden, at that time on a voyage from Sydney to Tutuilah. The following extracts determine another point in the track of the Feejee Cyclone :—

" 27 Feb. 1840, lat. 31° 45′ S., long. 171° 52′ E. Wind shifted suddenly from N. to S.W., and then to S.E. 28th Friday. Increasing breeze from Eastward. Barometer falling gradually. Midnight, under double-reefed topsail and foresail, 31° S. 174° 7′ E. 29th Saturday, wind increased from S.E., till 10 A.M., when it blew a perfect gale—yea, a hurricane. Barometer 28·40. Took in all sail and lay on our side ; kept the pumps sucking. The water came up the skin into the cabins between decks. The sea stoved the whale boat triced up in the rigging, and we were forced to cut her away. At noon, it began to abate a little, and at 2 P.M. the gale had subsided. Sent down top-gallant yards, with fore-top-gallant mast. At 7 P.M. wore round, the wind at S.W. ; set main-top-sail and fore-sail, steering N.E. 1st March, a light S.E. wind."

Captain Morgan adds, " I have known it to blow as hard, but never harder ;—we could not look to windward for a second at a time."

Mr. G. A. Lundie, a passenger by the Camden, in a work entitled " Missionary Life in Samoa, 1849, thus refers to this Cyclone : " A few days since we met a fearful and long-continued hurricane. Friday (28th) was a day of rough and restless calm ; the barometer fell gradually. In the evening a fresh breeze set in, increasing gradually till 4 A M. (29th). Lay to under a small sail to keep the vessel from rolling. 8 A.M. without a stitch of canvas, at the mercy of the fierce wind and infuriated waves. The lee bulwarks and nearly half the deck under the boiling waters. The day-time darkness rendered more dismal by the burning of a solitary lamp. Boat, bulwarks, &c., carried away. At 11h. 45m. A.M. the mercury began to rise. At 1 P.M. the rain had ceased, but the wind had not perceptibly abated. The sun shone out at 4 P.M., the wind subsided, and continued to abate till Sunday morning."

The centre of this Cyclone lay considerably to the East of the Camden, since the wind veers from S.E. to S.W., and was also moving to the Southward; consequently *from* the Feejee Islands, and *towards* New Zealand.

At page 381, vol. 2, of Wilkes' Narrative it is stated that on the 29th Feb. 1840, there was a violent gale at the Bay of Islands, New Zealand, said by the Missionaries to have been the severest they had experienced, with perhaps the exception of one which took place shortly after their arrival. Many vessels suffered great damage. The Thom, of Sag Harbour, which sailed a few days before, bound home, was obliged to put back in consequence of the damage received, and was condemned as unseaworthy; as was also the Tuscan, an English whaler. The barque Nimrod arrived, having lost her topmast. Several Coasters were missing, supposed to have been lost. Most of the vessels lying off Kororarika dragged their anchors. The Harriet was driven ashore at Tipoona; she parted her cables during the night, and next morning was found a complete wreck; the crew barely escaped with their lives. On land, fences were carried away, houses and grounds deluged, and the extensive embankment of the Missionary establishment at Pahia nearly demolished. The tide rose six feet during the night of Saturday beyond its usual mark. This gale was experienced at the Thames, on board H.M.S. Herald, 140 miles to the South, also by the Flying Fish, off Cook's Straits, on the East, and by the barque Achilles to the North. Mr. Hale was a passenger in the Achilles, and took barometrical observations and notes, from which it appears that the change took place at the two Northern and two Southern positions in opposite directions, proving that the gale was a rotatory one, and that its centre must have passed between the Bay of Islands and the River Thames. The greatest force of the gale was between 1 A.M. and 3 A.M. of the 1st March. At the Bay of Islands, a *calm* was observed by Mr. Dana and others, which lasted fifteen minutes, after which the wind rapidly hauled round to the Westward, and blew with increased violence. On board the Herald, the barometer fell to 28·75, and as the gale was experienced first to the Northward and Eastward (of New Zealand), it is certain that it came from that quarter, and passed over New Zealand in a S.W. direction. The width of its track was about 500 miles.

On the 29th February the Flying Fish was in 40° S. and 178° 30′ E. At noon the wind hauled to S.E., and by midnight blew a most violent gale, hauling to the Eastward until about 8 P.M. (1st March), when its violence moderated.

About this time the Vincennes was in 50° S. and 135° E., and escaped the Cyclone, which probably passed to the Southward of her.

The "Colonial Times," Hobart Town newspaper, for April 1840, attributes the following disasters to this Cyclone, at New Zealand :— The Harriet lost. The Navarino, from Kaipara, a total wreck. The schooner Falcon lost in the Bay of Plenty, on the night of the 29th February. The Fair Barbadian lost. The Diana on shore. The schooner Ulitea lost, with all hands. The schooner Trent wrecked at Tegedoo. The schooner Phœnix foundered at sea, and all hands lost. During the hurricane a heavy flood inundated the site of the proposed capital of the New Zealand Colonization Company.

At page 64 of "Rovings in the Pacific," we learn that the Author met with a most violent gale from the Northward, on the 29th February, when off the Three Kings, at the Northern extremity of New Zealand. The vessel was thrown on her beam ends. Next day the wind moderated, and gradually veered round to the S.E. The vessel had drifted to the Southward of the Bay of Islands,—hundreds of red bream were floating about, killed by the gale.

A note to page 61, of Piddington's valuable "Horn Book" supplies some additional information respecting this Cyclone; thus : It is said to have passed between the Bay of Islands and the River Thames, which lie about S.S.E. $\frac{1}{2}$ E. and W.N.W. $\frac{1}{2}$ W. of each other; hence the track may have been either to the Northward or Southward of S.W. Its track to the South Westward, or perhaps S.S.W. after crossing the Island, I am enabled perhaps to corroborate from a log in my possession of the Adelaide, which vessel, between the 1st and 2nd of March, about $3\frac{1}{2}$° due West of Cape Egmont, experienced a smart gale, commencing at about E. b. S., or E.S.E., and veering to S. b. E., reducing her to close reefs, with a heavy cross sea. This, roughly calculated, gives 340 miles for 36 hours, or about 10 miles per hour. Commodore Wilkes suggests that this New Zealand Cyclone may possibly have been the same as that which occurred at the Feejee Group, which is very probable.

The identity suggested by Commodore Wilkes has now been satisfactorily demonstrated by the account of the hurricane of the Camden. It is important to observe that at Vitileva the Cyclone was moving to the South East, due South when passing to the East of the Camden, and to the South West at New Zealand. The distance from Vitileva to New Zealand is about 1200 miles. The vertex of the Cyclone's track lay considerably to the Eastward of both islands; so that the distance described from one island to the other was probably not less than 1500 miles. (G fig. VIII.) By continuing the track below New Zealand it will be found to pass through the place where the American Expedition met with a severe hurricane in the preceding month, and which, in all probability, had travelled over nearly the same route. As this is the only instance of a well-observed Cyclone in a high latitude, and as it appears to determine another point in the Feejee and New Zealand track, a short account of it may not be out of place here.—(fig. VI.)

The United States Squadron; consisting of the Vincennes, a first class sloop of 780 tons; the two brigs Peacock & Porpoise; and the schooner Flying Fish, left Sydney for the Antarctic Ocean, on the 26th December, 1839. A few days before the hurricane all the vessels were near the latitude 66° S. and long. 150° E., or about 1300 miles to the Southward of Van Diemen's Land.

The Peacock was standing to the Northward for Sydney, to repair damages received among the ice; the others were making to the Southward and Westward, along the icy barrier, and the supposed Antarctic Continent. A full report is given by Lieutenant Wilkes, of the proceedings of each ship during the storm, in the 2nd volume of his interesting narrative. He does not appear to have been aware of its rotatory character, but thinks it remarkable that, while the Peacock had a strong gale from the N.W., the Vincennes, 450 miles to the S.W. of her, should have met with *another gale* from the S.E. Apparently not recognising the obvious truth that these subordinate gales were consistent parts of the same great whirlwind storm.

The proceedings on board the Vincennes are recorded thus:—

"1840, Jan. 27.—142° 40′ E., 66° 54′ S. Porpoise in sight. Midnight, wind shifted to South East.

28th.—11 A.M. land in view, weather thickens, breeze freshens.

Noon, hove to, so thick that everything was hidden. Barometer began to fall. 5 P.M. a gale coming on, in three reefs of topsails. 8 P.M. blew very hard, a violent snow-storm, barometer still falling. Midnight, the gale was awful,—all hands called on deck.

29th.—1 A.M. gale terrific; sea so heavy that sail was further reduced. 4 A.M. hove to, all hands still on deck. 7 A.M. appearances of weather moderating. The wind veered to the Southward. The whole strength of the gale was from S. E. By noon, the gale was over, and it *cleared off* towards four o'clock. 60° 30′ S. 140° E. Wind now hauled to the S. W., and we again made sail to the South, to pass over the very route we had just traversed.

30th.—Morning, a brisk breeze from Eastward, sea quite smooth. A brisk gale ensued, ran at 9 or 10 miles an hour, one reef in topsails, stood directly for the most Southerly part of Piner's Bay. Noon, 66° 45′ S. 140° 2′ 30″ E. Wind increased to a gale. 1 P.M. reduced to storm topsails, top-gallant-yards on deck. Barometer had again declined rapidly. Wind S.E. All the canvas we could shew to this gale at one time were a close-reefed mainsail and fore-storm-staysail. It blew tremendously; the sea was a short disagreeable one, but nothing compared to that which accompanied the first gale.

31st.—Gale unabated. Noon, gale continued, lowest reading of barometer 28·59. 6 P.M. After lasting 36 hours, the gale moderated a little."

The circumstances under which the Porpoise had the storm are:—

"January 27.—65° 41′ S. 142° 31′ E. Making for 105° E.

28th.—Noon, strong winds from Eastward. Close-reefed topsails 3 P.M. hove to. 65° 16′ S. 8 P.M. blowing very heavy with snow. Have seldom experienced a heavier blow; towards the end the squalls were severe and frequent.

29th.—3 A.M. a heavy sea, thick snow, barometer 28·20, lowest reading. 8 A.M. gale abated. 64° 46′ S. 137° 16′ E.

30th.—4 A.M. Stood to S.W., wind increased, shortened sail. During the day a heavy gale of wind, and a very heavy sea running. Noon, hove to under storm-staysails. Wind South Easterly.

31st.—7 A.M. Gale moderated. Made sail to the Westward."

In the log of the Flying Fish we have:—

"29th Jan.—Thick snow, wind N.E. 9 P.M. a heavy gale, lay to.

30th.—Morning, gale abated. 65° 15′ S. 150° 16′ E.

31st.—Thick snow, heavy sea, wind North."

The Vincennes found the Peacock at Sydney on 12th March. On 29th Jan., the Peacock was in 61° 30′ S. 154° 9′ E., and had a strong gale from the N.W., which increased until midnight, and then moderated.

The barometrical fluctuations on board the Vincennes are given for intervals of an hour, with a few exceptions, from January 28 to Feb. 2. I have expressed these in a curve (fig. VII.), which forms a graphic and instructive record of the various phases of the Cyclone. The Vincennes sails first into the central space, the gale moderates, and the weather clears off; then, the wind hauls from S.E. to S.W., and the barometer has been falling. She now returns to the South, and has a brisk gale from E. The barometer rising. This Cyclone appears to have been moving very slowly, and to the westward.

On the 17th March, 1849, the Levi Starbuck, Captain Nye, met with a severe hurricane off French Island in 32° S. and 179° W., which lies in the track of the Feejee and New Zealand Cyclones. It came on first from N.E., and then veered round to S.W. The intermediate shifts are not given; and the change from N.E. to S.W. implies progression to the S.E., as if the Cyclone belonged to the New Caledonian class. But I find from the log of the Prince Regent, whaler, that there was no heavy weather on the South Coast of New Caledonia just before the 17th March. If the Levi Starbuck was hove to, the Easterly gale may have drifted her to the Westward of the centre, when she would have the winds from the South and South West, as the Cyclone moved to the Southward. (H fig. VIII.)

Several other vessels were in company, and some damaged severely. One was capsized, and all hands lost.

A third definite storm-track appears to extend from New Caledonia, and the small islands to the East of it, by Norfolk Island, to

New Zealand. The Cyclones here also all seem to come from the N.W. of New Caledonia, *i.e.*, from the Neighbourhood of New Guinea, and Torres' Straits.

On the 23rd January 1849, the barque Nimrod, Capt. Espinasse, sailed from Sydney for China, and returned to port on the 7th March, under jury-masts. The following particulars were furnished to the "Sydney M. Herald" for publication :—

"Feb. 10.—17° 38′ S. 161° 26′ E. Wind N.E., heavy head sea, standing N.W. 0h. 30m. P.M. increasing breeze, double-reefed the topsails, 1h. 30m. P.M. furled mainsail, stowed jib and mizen. 4 P.M. fresh gale, with increasing wind and sea. Wore ship to E.S.E.; furled fore-topsail, down royal yards, top-gallant studding-sails and booms, and unrove all the studding-sail gear. The sun set fiery, and heavy dense clouds extended from E.S.E. to N.E. Still there was no very threatening appearance. 8 P.M. blowing fresh, in close-reef of main-topsail. 9 P.M. gale increasing, furled foresail. Midnight, hard gale, with a rugged sea.

Feb. 11.—Steady gale, wind E. 9 A.M. wore ship to N.N.E., stowed fore-topmast staysail. Noon, more moderate, no observation. 2 P.M. heavy squalls following one another, with torrents of rain, sea breaking more, and gale increasing fast. Housed top-gallant mast and mizen topmast with great difficulty. Wind E.S.E. Hard gale, with no intermission between the squalls.

Feb. 12.—Daylight, blowing a very hard gale; the flying jib-boom carried away in the iron. 10 A.M. tremendous puffs from S.E., moderating a little after a very severe squall. At 3 P.M. wind S. 4 P.M. wind S.S.W., increasing again with hard squalls. 5 P.M. moderating, refurled all the sails for the night, and secured them with the studding-sail gear. 8 P.M. wind W.S.W., *sky open, stars shining, quite moderate*; kept the ship away to the North Eastward to endeavour to run out of the approaching and expected hurricane, agreeable to the Law of Storms! 8h. 30m. P.M. increasing with heavy squalls, rounded the ship to again, with her head to the S.S.E. under the main trysail. 10 P.M. *sudden shift to N.W., and the gale now became a hurricane.* 11 P.M. the lacing and tack-lashing of the main trysail carried away, all hands in the ship unable to brail it up; it blew to ribbons. All the Lascars sent into the cabin to be ready in case of being wanted.

February 13.—Daylight, wind N.W. to W., hurricane terrific, lying in the trough of the sea. 6 A.M. cut away the rigging of the fore-top mast; but the mast, &c., did not go over the side for a considerable time. The ship now felt much relieved. Noon, the hurricane blowing gradually stronger; nearly dark, scud very low, impossible to look to windward; the rain, from the force of the wind, cut like needles. 2 P. M. hurricane increasing, very dark, ship labouring fearfully in a tremendous sea. As much as one could do at times to hold on, men at the pumps lashed. 3 P.M. the ship being on her beam-ends, the glass still falling, and the hurricane increasing, determined as a last resource to cut away the mainmast, with the greatest difficulty got the fore braces cut from the main-stay and weather rigging. 4 P.M. cut away the mainmast, from the force of the wind, it went overboard without touching anything, and did the ship no injury. The rigging crushed both the whale-boats and one of the skids. The ship righted, and felt much relieved. 5 P.M. a heavy sea struck the ship, and washed the long boat out of the chocks, &c. The jaw-lashing of the gaff carried away; could not get the gaff down, lashed it into the mizen rigging, and secured the mizen-mast. The jib-boom being sprung, and part of the jib still blowing about, cut away the weather-gear to let the boom carry away. The hurricane continued increasing, if anything, in strength till 7½ P.M., after which it lulled a little at times between the squalls. Before the mainmast was cut away, the main-topsail, mainsail, and jib, had blown away from between the gaskets. The mizen blew away during the night, and, at day-light next morning, only a small part of the foresail remained.

February 14.—Daylight, wind S.S.W., blowing a strong gale. Got the men with great difficulty to go on the fore-yard to cut away the remains of the foresail, as the fore-lift blocks had been carried away when the fore-topmast was cut; sent the fore-topmast studding booms on deck, got tackles on the fore-yard, and secured the fore-truss. Found the mast much cut, bent the gaff topsail for a storm mizen. Noon, moderate, bent the second foresail and second driver. Bent the fore-topmast staysail on the fore-stay. Ship rolling very heavily. No observation. Bore up for Sydney.

February 16.—In 18° 33′ S., 161° 12′ E."

I have constructed, from the numerous barometric readings given

by Captain Espinasse, a curve, (fig. VII.), which shews that the centre passed the Nimrod about 4 P.M. of the 13th, and as the Storm began at N.E. and ended at S.S.W. it was progressing towards the South East. This inference is confirmed by the statement of Captain Rule of the wreck of the brig Scamander, and the loss of seventeen lives.

"February 15.—3 A.M. a heavy gale commenced from Eastward, which by 11 A.M. had increased to a hurricane and veered to Southward. Noon, ship hove to in 23° 38′ S. and 167° 40′ E., the Isle of Pines bearing N.N.W. about 58 miles. 10 P.M. the vessel struck on the South reef of New Caledonia ; a sea, as high as the main-top, broke over the ship, and swept away all hands except two."

The Marian Watson, at the Isle of Pines, had the hurricane at the same time, and veering in the same manner, that is, from E. to S., shewing that it continued to travel towards the South East, (1 fig. VIII.)

The track of the Cyclone being thus determined, it will be instructive to endeavour to ascertain the cause of the Nimrod's disaster, and the proper course to be taken in the same locality, under like circumstances, in future. At first, steering to the N.W., and therefore meeting the centre, the mercury falls; she then stands to the E.S.E. for 12 hours, and the mercury rises; she is sailing before, and faster than, the Cyclone. Having reached the Southern part of the Cyclone with the wind at E., she stands to N.N.E., and on this course sails round the western half of the advancing Cyclone, the winds veering from E. to E.S.E., S.E.; S.; and W.S.W.; she is then near the northern edge of the calm central space, the sky is open, stars shining, and weather quite moderate. She is now kept away to the N.E., and sails into the N.E. quadrant. Of course, she has a sudden shift to N.W., and the gale becomes a hurricane. On her beam-ends, in the trough of the sea, the Northern Margin of the Cyclone passes over her, veering from N.W.; by W.; to S.S.W. When the gale came on at N.E. veering to E. the vessel should have been kept to the South of West, by which both the Cyclone and the confused sea in its wake would have been avoided. By standing to the N.E. the vessel actually ran into the Cyclone, which was receding from her, and instead of pursuing her voyage, as she might have done before this unfortunate manœuvre, she returns to port a crippled wreck.

On the 2nd February, 1848, the barque Isabella Anna left Sydney on a sandal-wood voyage, and was condemned soon afterwards at New Caledonia. From her log it appears that the bad weather began on leaving Howe's Island :—

"6th to 11th Feb. strong gales. 12th. hove to for three days. On the 14th wind terrific; sea running very high. On 15th, gale over. 16th, again blew terrifically."

At Anatam, the brig Alfred and schooner Rosetta were driven ashore by this hurricane.

The brig Sarah and schooner Castlereagh were wrecked in Lefoo Bay, Loyalty Islands, 21° S., 167° E.

The log of the Castlereagh shews that the Southern part of the Cyclone passed over her :—

"10th February, fresh from S.E. 11th, noon, wind increasing. 12th, strong gale from S.E. : heavy sea rising. 4 P.M. heavy gale from E.S.E., and a heavy sea. Midnight, heavy gusts of wind with much rain. 13th, 4 A.M. saw the Sarah drive broadside on the beach, the sea breaking completely over her. 4h. 30m. A.M. struck aft, and unshipped the rudder. Daylight, blowing a complete hurricane; cut away the lower masts. At 10 A.M. went broadside on the beach."

The Eleanor encountered the same hurricane on the west coast of New Caledonia, 25 miles W.N.W. of Port St. Vincent, with two anchors out, and drove on shore. The brig Spy on the East coast rode out the gale, but lost two whale boats. The cutter Georgiana and three of the crew were lost. The natives at New Caledonia and Lefoo state that such a terrific hurricane had not occurred for the last 18 years : during the height of it, the Eleanor's barometer fell to 28·40. (*Sydney Morning Herald.*)

The late Captain Tanner informed me that at that time he commanded the brig Sophia, and was between Erromanga and Tanna, on Feb. 10, barometer was 28·30, having fallen from 28·80 between 3 and 4 P.M., wind N.W. right off the land, 80 miles from Erromanga. At 6 P.M. vessel on beam-ends *and drifted* 30 *miles to the S.E.* The gale continued at N.W. till 4 A.M., when it shifted to S.E., and blew harder than before, and with a heavier sea, for two days, during which the vessel *drifted* 50 *miles to the N.W.* On

the fourth day, the wind fell light, but the sea kept up for a week. On the 17th made Erromanga and Tanna.

The Sophia was at first in the N.E. quadrant of the Cyclone. While she was drifting to the S.E. the centre, moving Eastward, passed over her, and she then was in the S.W. quadrant, and was exposed to the "heavier sea" of the Cyclone's wake, and the S.E. wind and swell, before which she drifted back 50 miles. The centre having passed between Tanna and Erromanga, the Southern margin would fall on New Caledonia, and the winds there be E. and E.S.E. as they were experienced by the Castlereagh, &c. (K fig. VIII.)

Mr. Piddington, at page 61 of his "Sailor's Horn Book" (1851) gives an isolated notice of a Cyclone, the consideration of which will be instructive. His remarks are :—

"The sea to the westward of New Caledonia (perhaps the whole extent of it to the barrier reefs) is certainly subject to Cyclones; and they, moreover, appear at times to pursue curved tracks, so this may, not improbably, like the corresponding latitudes of the Indian Ocean between Mauritius and the South end of Madagascar, be one of the usual curving tracks for the Cyclones of the Southern Pacific. From a log of the barque Rifleman, sent me by Captain Hammack, it appears that in running up to pass between the western coast of New Caledonia and the Bampton Shoals, she encountered on the 2nd March, (the hurricane season also at the Mauritius) a Cyclone in 21° 22′ S. and 157° 10′ E. The wind veered with her from E. b. N. by S.E. and S.W. to W. and N.N.W. in 3½ days, *while she was hove to;* her barometer falling from 29·40 to 28·80. Being then obliged to bear up from about 19° 30′ S. *to the South East, she again fell in with the northern quadrant* of the Cyclone, which left her only in 24° S. and 164° E. From apparently some error in copying, I am unable to say with perfect certainty that *this was a curved track*, as there is a remote possibility that there may have been two Cyclones, but I am inclined strongly to take it as an *instance of a recurving track* in the Southern Pacific." (L fig. VIII.)

This is certainly a seductive case for the application of analogical reasoning, although the explanation offered is not without its difficulties; but the instances, already investigated, of the Favourite,

the Sophia, and Nimrod, suggest an explanation much more satisfactory than either that of a double Cyclone, or that of a recurving track. In fact the shifts of wind while hove to, and the track while drifting, are in kind, precisely alike in the cases of the Favourite and the Rifleman. The Rifleman's Cyclone, like that of the Favourite, was undoubtedly moving to the S.E., like the Nimrod's and others in the same locality, for its western and northern parts passed over the Rifleman, which then stood to the S.E., and *again* fell in with the northern quadrant. In the diagram of the Favourite's Cyclone (V), suppose the Rifleman to have drifted from C to D, and the Cyclone to move from C_2 to C_3. In pursuing a South Easterly course from D, she would again overtake the northern margin of the retreating Cyclone. To adapt the diagram to the case of the Rifleman, the letter D should be brought down the circle nearly to where it is cut by the line A B, but this does not affect the correctness of the explanation.

In the following recent instance the Cyclone appears to have been for some time nearly stationary among the Islands on the east coast of New Caledonia. As it passes down to the eastward of Norfolk Island, we observe the allied phenomena of Electric Nimbus, thunder, and the shock of an Earthquake on the East Coast of New South Wales; succeeded by the Southerly swell left in its wake, and Southerly Gales (M fig. VIII.) The first notice of its appearance is contained in a letter by the Captain of the Deborah, which I have slightly abridged from the columns of the "Sydney M. Herald"—

"Anatam, 5th March, 1852.

"Gentlemen,—I send you an account of the loss of the schooner Deborah. On Monday, Feb. 16, I was attacked at New Caledonia, the natives making an attempt to take the vessel. I had upwards of 60 of them on deck, but fortunately got them all away. On the 17th left New Caledonia to come on to Sydney. On the 18th and 19th had a heavy gale, with a fearful sea; ship making a good deal of water. Bore up, intending to take the passage at the North end of New Caledonia, when the wind, from blowing a strong gale at S.E., chopped round and blew from the Westward. I then stood across for Anatam, and came to an anchor on the 21st. The next morning it blew a strong gale from the N.W. with a heavy sea.

Noon, let go the best bower, veered to 60 fathoms starboard cable, and 30 fathoms port ditto. Sent down fore-top gallant yard and mast, and housed the mainmast. Barometer 29·04. Next day (23rd) moderated a good deal. Missed stays, let go both anchors, and took in all sail. Anchors came home like scrapers. Struck aft, unshipped the rudder, and broke the stern-post; the sea making a clean breach over her, smashing the launch and third boat. Compelled to leave her, a complete wreck. Saved 28 out of the 45 tons of sandal-wood on board. We were warmly aided by the Rev. John Geddie, resident Missionary.

P. J. WHITE."

This Cyclone was moving slowly, beginning on the 18th, and not passing over until the 23rd. The Deborah, while standing to the North, sailed out of the S.W. quadrant into the N.W. one. She then stood across to the Eastward to Anatam, and fell into the North East quadrant. The barometrical observation 29·04 appears to have been taken during the N.W. gale, when the mercury would be *rising rapidly*.

The Government Barque Lady Franklin had a Cyclone on the 5th and 6th of March, 1852, when to the S.E. of Norfolk Island. The following particulars have been furnished to me by Captain Willett:—

"1852, March 5.—Norfolk Island bearing N.W. distant 70 miles. Midnight, till 6 A.M. very strong E.S.E. wind. Under close-reefed topsail and foresail. 6 A.M. in foresail and fore-topsail. Hove to, wind at East, veered to about S.E. Continued blowing a very heavy gale. Top-gallant yards on deck, and all snug. Barometer 29·57. 6 P.M. began to moderate, gradually veering to E.N.E., and then dying away to *a calm* at 2 A.M. of Saturday, the 6th. Barometer still low. 6 A.M. still calm. 7 A.M. breeze from the Westward, gradually freshened, and blew a heavy gale from W.N.W., but not so heavy as from East. The barometer commenced rising as soon as the wind changed. 8 P.M. moderate. Norfolk Island N.W., distant 90 miles. The barometer rose to 30·35, and stood there for seven days. Wind S. and S.E."

The changes of wind indicate progression to the W. of S. A New Zealand paper states that the American brig General Worth,

was overtaken by the gale when about 100 miles to the Eastward of Norfolk Island, and sustained damage in her sails and spars while it continued.

The barometric curve (fig. VII.), constructed from the four daily readings at Sydney, distinctly recognizes the passage of this Cyclone, though Sydney must have been at the extreme western margin, since the calm central area passed over the Lady Franklin when about 800 miles East of Sydney.

The meteorological remarks at Sydney indicate the Southward progress of the Cyclone, and notice the consequent remarkably heavy swell from E. b. S. These remarks have also a certain significance respecting the agency of electricity in Cyclones :—

"Friday, 5th March.—Very light W. airs. P.M. increasing to strong breezes from N.E. During the afternoon, *electric nimbus* kept rising in the W. and S.W., and passing over to the E. and N.E. with *thunder*. About 9 P.M. a dark range of clouds swept over to Northward, with a Southerly squall, and it continued to blow heavily from South through the night.

Saturday, 6th.—Coarse southerly wind and flying showers in forenoon. Between 2 and 3 P.M. storms of rain with thunder from S.W., and *atmosphere quite cold and chill*. Subsequently fresh S.W. wind, passing nimbus, cold and raw. After 10 P.M. a cloudless sky.

Sunday, 7th.—Light westerly airs till 9 A.M. N.B.—A *remarkably heavy swell* setting in all this day and night from the E. b. S., which has caused a great surf to break against the cliffs."

The "S. M. Herald" states that the Keera steamer left Sydney on the 6th March, at 8·5 A.M. against a strong *southerly* wind, and arrived at Woollongong at 4·45 P.M., although the *sea was running so heavy* that several craft, including the Shamrock steamer, lay snug in Watson's Bay until Sunday morning. The same paper states that, on the 5th March, while the Star, whaling barque, was running for the middle ground, she encountered a heavy gale from *South East*. Rounded the ship to on the starboard tack, the wind *suddenly veered to the South*, with a *heavy sea* running; which stove the lee quarter-boat, carrying away the davits, and starting the covering board, after stancheons, &c.; and being compelled to cut away the boat, Captain Eury put in to Sydney to repair.

The change from S.E. to S., with a heavy sea, confirms the Southerly progress of the Cyclone.

The brig Maukin was lost in Sandy Bay, near the North Cape of New Zealand, during the heavy gales of Saturday, the 6th March. Captain Eames describes the disaster in the "New Zealander" of 24th March :—

"On Friday, 5th March, the Maukin was 16 miles N.E. b. E., by compass, from Knuckle point, a stiff breeze blowing from the S.E. The vessel hove to under a close-reefed main topsail, and heading about N.E. b. E., thus making a N. or N. b. W. drift. A heavy sea running. Wind gradually increased towards night, got the quarter boats up to the davit-heads. About 10 P.M. wind *shifted to East.*

Saturday, 6th.—At 2 A.M. wind hauled two points more to the Northward, *i.e.*, E.N.E. Between 4 and 5 A.M. it blew very hard, so as almost to lay us on our beam-ends, and the lee quarter-boat was swept away. About 10½ A.M. saw the land on our lee beam, not more than a mile distant. Saw the North Cape on our weather bow. Determined to run into a little bay. As we went through the surf, one sea came aboard of us, smashing the starboard boat all to pieces, and deluging the decks. All hands, but two at the wheel, were in the rigging ; or many of them would, doubtless, have been swept overboard. The vessel then struck, and a succession of seas poured over us. One man was swept away and lost."

The Katherine Stewart Forbes, a barque from London, was off the North Cape, on Friday the 5th March and lost one man off the foreyard during the heavy gale of that day.

In the "New Zealander" of the 10th March, it is stated that,— "On Friday night, and during the whole of Saturday, the neighbourhood of Auckland was visited by a gale of unusual severity, the wind blowing for the most part E.N.E., and mounting to a furious storm at intervals. Much damage was done to fences, young trees, &c. ; but it was in the harbours that the most injurious effects were experienced. Two cutters and a schooner were completely wrecked, and considerable damage done among the small craft. We have had no intelligence from the East Coast, but we can scarcely venture to hope that the tempest passed over without producing injurious results in some places.

From the same paper we learn that during the gale, on Saturday, (6th), about mid-day, H.M. Surveying Schooner Pandora, then at anchor off Omokoite, in the Kaipara, parted both her anchors, and was driven on shore. Much fear for her safety was entertained until Sunday at noon, when the wind changed at high water, and she was got off, having sustained no material damage.

In the "Sydney Morning Herald" of 10th March, a Correspondent at Goulburn announces the occurrence there of an Earthquake Shock on Sunday.—"This morning, the 7th instant, a great number of the townspeople of Goulburn were awakened about 5 o'clock (rather before) by a shock of an Earthquake, which was preceded by a rumbling noise like distant thunder; so violently was everything near the wall shaken that it appeared as if robbers were pillaging the houses; the crockeryware on the wash-stands rung against each other."

The log of the Packet Brig Emma, then on her passage from Hobart Town to Sydney, shews the influence of the Cyclone on the winds off the East coast of Van Diemen's Land :—

"Friday, 5th March, 2 A.M.—Storm Bay. At 10 A. M. a heavy breeze from westward, veering to S.W., stowed top-gallant sails, and double-reefed topsails. Noon, hard breeze and rain.

Saturday, 6th.—P.M. gale from S.W. and rain. Cape Pillar N.E. 4 miles.

Sunday, 7th.—Hard gale from S. and thick weather. Midnight, moderating. 10 A.M. Cape Howe, S.W. b. S. 20 miles.

Monday, 8th.—Hard *South gales*, squalls, and heavy rain.

In the Journal of Lieutenant King, published in the 14th chapter of "Hunter's New South Wales," is a good description of a hurricane which seems to have passed over Norfolk Island in a South Easterly direction, (N fig. VIII.)

"The interval of fine weather was succeeded by a hurricane that was dreadful beyond description. In the morning of the 25th February, (1789) we had light winds from N. E. and very dismal, dark, cloudy weather; with constant torrents of heavy rain. Towards noon, the wind blew a gale, and kept increasing in violence. At midnight, it shifted to E.S.E., and blew with great fury, attended with constant

deluges of rain. At 4 A.M. of the 26th, several of the largest pines were blown up by the roots. From 4 until noon, the wind increased to a very severe hurricane, with the heaviest rain I ever saw, or heard of. Pines and oak trees of the largest size were blown down every instant; the roots were torn up, with rocks that surrounded them, frequently leaving pits at least 10 feet deep. Some of the very large trees, which measured 180 feet in length and 4 feet in diameter, were thrown, by the violence of the tempest, to a considerable distance from the place where they grew; and others, whose roots were too deep in the earth to be torn up, bent their tops nearly to the ground. The gale now raged with the most violent fury, which defies all description; whole forests seemed, as it were, swept away by the roots. By one o'clock in the afternoon, there were as many trees blown down round the settlement as would have employed fifty men for a fortnight to cut down. The swamp and the adjoining vale were overflowed, and had every appearance of a large navigable river. The surf ran mountains high; in the road the sea ran very high, often eclipsing Nepean Isle. Strong log-houses were blown down. The violence of the wind blew up cabbages, turnips, &c., by the roots; and what remained in the gardens were turned as black as if they had been burnt. At 3 P.M. the wind veered round to South, and moderated; and at sunset the weather was very pleasant. During the remainder of the month, we had very pleasant weather, the wind at South West, but a heavy surf kept still running."

The South West quadrant of the Cyclone passed over Norfolk Island, the central space being a little to the Eastward of the Island, as was the case also in March, 1852.

It may be useful to endeavour to form an idea of the rate of progression and of the magnitude of the preceding Cyclones, in such cases as afford data for computation.

In 1842, the central area travelled from Upolu to Mangaia, about 900 miles, in 54 hours, *i.e.*, from noon of the 15th to 6 P.M. of the 17th, which gives 17 miles for the mean hourly rate. In 1846, the central area passed from Raratonga to Mangaia, 40 miles, in 9 hours; the velocity was therefore 5 miles an hour. The rate *at* Mangaia being 5, and between Upolu and Mangaia 17 miles, the rate *at* Upolu would be 29 miles. These decreasing rates harmonize

with the observed gradual diminution of velocity as a Cyclone approaches the vertex of its track.

The distance between the Nimrod and the Isle of Pines, about 600 miles, was traversed in about 43 hours, *i.e.*, from 4 P.M. of the 13th to 11 A.M. of the 15th, which gives about 14 miles an hour for its mean velocity of transit.

From the Feejee Islands to New Zealand is about 1100 miles, which was passed over in 100 hours, viz., from midnight of the 25th February to 2 A.M. of the 1st March. The mean hourly velocity was therefore 11 miles.

The investigation of the magnitude of a Cyclone must, in general, be liable to much uncertainty. Indeed, their exterior limits scarcely admit of being distinctly defined; and their influence on the air seems to extend considerably farther in front than in the rear of the central space. Moreover, in the cases now under consideration, the average rates of progression just deduced can only be regarded as very rough approximations, derived from vague data.

The Favourite's Cyclone, in 1842, appears to have been 8 or 9 hours in passing over Upolu; which, at 29 miles an hour, gives about 250 miles for the chord extending from the Cyclone-points N.E. to S.E., and therefore subtending a right angle at the centre. Whence the diameter is found to be about 350 miles.

The velocity at Mangaia being 5 miles, the diameter there would come out somewhat larger, as it ought, since Cyclones generally expand as they progress.

At Raratonga, in 1846, the actual violence lasted 6 hours, and the chord extending from the Cyclone-points E. to S.W. was therefore 30 miles. The annulus of most intense action consequently had a diameter of about 50 miles; but, as the wind had blown strong from the Eastward for a day or two before, the diameter of the whole Cyclone was probably not less than 200 miles.

The time of transit of the Camden's Cyclone, in 1840, was about 50 hours, from E. to S.W., at about 11 miles an hour; making a diameter of about 600 miles, which does not differ materially, considering the approximate nature of the data, from that assigned to it by Lieutenant Wilkes.

On re-considering the whole of the information which has now been brought together, it will, I think, appear evident that the *Tropical Hurricanes* of the South Pacific are *Cyclones*, or *revolving storms;* and that the order of rotation is N.E.S.W.; or, in the direction of the hands of a watch. So far the results obtained fully confirm the indications of Analogy. But the conclusion respecting the direction of the progressive motion of these Cyclones does not confirm the statement of Mr. Piddington, "Horn Book," (p. 59,) that "they appear to come *from the Eastward* among the Islands," and is, indeed, altogether opposed to the conjectures based on Analogy. For, instead of satisfying the conditions announced in the third of the hypothetical conclusions with which this Investigation set out, they appear to *rise* in the *North West* region of the South Pacific, somewhere in the neighbourhood of Torres' Straits; they then travel *to* the Eastward; and between 10° and 20° S. are found, almost invariably, to be moving towards the South East. Between 20° and 30° they probably recurve, as they are generally moving to the Southward between these parallels: and in higher latitudes are found passing to the Westward of the South.

The general Storm track of the South Pacific Ocean appears to follow the curvature of the East coast of Australia; as the Storm track of the South Indian Ocean does that of the West coast of Australia. The West Indian Storm track also seems to be greatly influenced by the form of the coast around which it sweeps.

END OF PART I.

PART II.

ON THE HURRICANES OF TORRES' STRAITS, THE WEST AND SOUTH COASTS OF AUSTRALIA, BASS'S STRAITS, AND VAN DIEMEN'S LAND: THE HOT WINDS OF AUSTRALIA, &c.

THE hurricane that destroyed the Settlement of Port Essington (11° 30′ S. 132° E.) in Nov. 1839, may be regarded as a type of a West Australian and South Australian Storm in its *initial phaze*. (O, fig. VIII.) It is thus described by the late Captain Stanley, R.N., in the "Nautical Magazine," 1841 :—

"Monday, 25th Nov.—A strong breeze set in from S.E., with drizzling rain, but the barometer remained at 29·90, its usual point. Between 7 and 8 A.M. the wind drew round to the Southward, and the barometer began to fall rapidly. At 10 A.M. it blew furiously from S., barometer 29·10. Many trees were now blown down. At midnight, the wind drew round to Eastward, and blew a perfect hurricane, before which nearly every thing gave way; the trees came down in every part of the Settlement, the marines' houses were all blown down; the church, only finished a week, shared the same fate: barometer 28·52. About 2 A.M. the wind shifted suddenly to the Northward, from which point, for about half an hour, its fury was tremendous; the Government House, built on stone piers, was blown away from them to a distance of nine feet. The sea rose 10½ feet, by measurement afterwards, above the usual high-water-mark. H.M.S. Pelorus, having parted her cables, was driven on shore, and thrown over on her beam-ends, on the N.E. point of the Settlement, where, heeling over 82°, her starboard side was buried nine feet in the mud, leaving the keel three feet clear of the ground. (Afterwards dug out and got afloat.) At daylight, the barometer rose slowly to 29·90, the gale moderated, and the sea went down so fast, that between 7 and 8 A.M. we were able to send a boat to the assistance of the Pelorus; after

8 A.M. the wind blew strong from the Northward for two days, with heavy rain. The extent of the hurricane must have been very limited. At Coepang, a strong gale from the S.W. was experienced, and also between Java and Timor, on the 26th, but the wind did not change. Even 18 miles North, at Vashon Head, the *change* of wind must have been greater, though equal in force. There the first trees fell with the wind from W.S.W., a few fell when the wind was East, and most when the wind was N.W."

During November, 1839, the Beagle was lying in Victoria River (14° 40′ S. 129° 21′ E.), about 270 miles S.S.W. of Port Essington. The following observations are from vol. ii. of the work of Captain Stokes :—

" 1839, Nov. 3.—A thunder storm, followed by a tremendous fall of rain. This storm began at S.E., and drew round by E. to N.W. The torrents of rain lasted two hours, and cooled the air so rapidly as, in that time, to reduce the thermometer from 92° to 82°.

Nov. 7.—Night, several meteors in N. and N.W. falling perpendicularly.

Nov. 8.—7 P.M., a violent squall, sky threatening in S.E., wind veered from S.E. to N. It lasted an hour, accompanied by harsh screams of affrighted birds, moaning wind, awful rolling thunder, and fearfully brilliant lightning, with drenching showers of rain. About 8 P.M. we noticed a singular meteor in the E.S.E. darting perpendicularly upwards. It lasted 10 seconds. Before midnight we saw a great many, passing chiefly from S.E. to N.W.

Nov. 9.—P.M., a squall like that of last night.

Nov. 13.—Midnight, a sharp squall from S.E.

Nov. 19.—Barometer at ship had ranged from 30·08 to 29·97. Meteors were numerous between the 7th and 11th November.

Nov. 25.—A very extraordinary change in the winds. Instead of the usual N.W. breeze after 10 A.M. there was *a moderate one from E.S.E., which drew round gradually by E. to N.* At sunset, gloomy ; barometer as usual. At midnight wind changed suddenly from light N.N.W. to a fresh breeze from S.E., with rain. Morning, veered to E.S.E., with squalls from E.N.E. and heavy rain. Dense masses of cloud covered the sky. Thermometer down to 75°. Barometer, 30·06, and at 2 P.M. of the 26th *barometer* 29·98. Night, squally.

Nov. 27.—Barometer *lower all day than it had been at all.* At 2 P.M. barometer 29·91.

The fact of the *time* when the weather was worst having been the same at Port Essington and in Victoria River, and of the *French Discovery Ships meeting it in Torres' Straits first*, shews the westerly course of the storm.

Its Northern edge did not reach Coepang, but a strong S.W. gale on the 26th shewed that it was passing. We were informed at Timor that hurricanes were never felt there, but occur once in four or five years to the Southward of it. A vessel lost her topmasts in the Port Essington Hurricane near Sandal-wood Island."

Fiery meteors, and hurricanes, are the usual concomitants of Volcanic eruptions; and it is probable that some Volcanic paroxysm gave rise to this Cyclone. Its westerly motion through the Straits is shewn by the veering of the wind both at Port Essington and at Victoria River. That the S.W. gale at Coepang was not followed on the 26th by gales from W. and N.W., shews that the Cyclone was not then moving due West, but that its track was inclining to the Southward of West.

The fact stated by Captain Stanley respecting the changes of wind at Point Vashon, proves that the centre lay only a few miles to the North of Port Essington; and the Southern Margin extended to Victoria River: hence the diameter was not less than 500 miles. The exact position of the French ships, and the time when the Cyclone passed them, would enable us to calculate the rate of progress. The following additional details are from an account given in the "Perth Gazette," Swan River:—

"The Settlement of Port Essington swept away by a Hurricane.—On Sunday, the 24th November, 1839, there was no indication of a change of weather. About 7 P.M. a squall from the Southward worked gradually towards the Settlement, and extended itself in a very heavy thunder-storm, with the most vivid forked lightning, rain, and wind, for about 3 hours. The sky became clear, but more than usual sheet lightning was seen during the night. On Monday the sky was heavy and lowering, with a fresh breeze and spitting rain. At 8 A.M. the wind moderated, but the sky was lowering, and threatening rain. At noon the wind increased, and it was dangerous to venture in a boat to the shipping. 5 P.M., a strong gale.

8 P.M., a heavy gale, *barometer still falling.* At 10 P.M. the hurricane commenced. Trees were torn up, and falling in every direction. Large branches were carried by the force of the wind some hundred yards. The very stones were flying, Every house in the Settlement, except the Officers' Mess-house, Store, and Hospital, was blown down. Government House was thrown from the piles on which it was built upwards of 10 feet. The harbour was one sheet of foam. H.M.S. Britomart was seen to drift before dark, and H.M.S. Pelorus was riding heavily at her anchors. From 10 to daylight the hurricane raged with unabated fury. At midnight the wind changed from *South to East, and in a few minutes afterwards from East to North, blowing with redoubled effort.* At daylight the Pelorus was ashore on her broadside at Minto Head, having lost eight men. Many of the men were up to their necks in water, and others holding on by the weather rigging, the sea breaking violently over them. The church was blown down, and all the houses, boat-sheds, armourer's shop, &c, destroyed. All the boats in the Colony, about 20, were complete wrecks. The Pier, with great quantities of provisions, tanks, casks, &c., were all washed away. The banana, plantain, and all other trees, and plants, were destroyed. The tide rose 10 feet higher than usual, and the wells were salt for three months afterwards. The Britomart drove with the gale, with three anchors a-head, during nearly the whole time of the hurricane, though the bottom is a soft tenacious clay. Since the hurricane not a bird of any kind has been seen,—many were found dead after it. Port Essington is now a perfect wilderness. What has been done during the last 18 months by 100 men is entirely destroyed."

The centre of this Cyclone was a few miles to the North of Port Essington, and was moving to the Westward. The following notices *probably* indicate its track to the Eastward, after recurving in the South Indian Ocean:—"On the 13th December, 1839, the Beagle had a strong breeze from Northward, while at anchor in Gage's Roads on the West coast of Australia, and had to let go an extra anchor".—Captain Wickham, R.N.

On the 24th December the centre of a Cyclone passed the meridian of Circular Head, Van Diemen's Land, the barometer falling more than an inch between the 21st and 23rd.

At the Hampshire Hills, Van Diemen's Land, on the 23rd December, 1839, there was thunder and lightning and a fall of ·41 inch of rain. On the 24th constant heavy rain, 2·30 inches in the day, with much thunder and lightning; the wind changing from N. E. to S.W., (fig. X. A., 1 & 2.)

At the same time that this Cyclone was passing over the French Expedition in Torres' Straits, and the British ships at Port Essington and Victoria River, another Cyclone, probably from the same source, was passing to the Eastward over the American Expedition in the South Pacific Ocean. On the 24th November the Expedition was in 22° 27′ S., and 172° 10′ E., and experienced a remarkably severe storm of thunder and lightning with much electric fluid; and a violent gale beginning from N.W. and shifting to S.W. On the two following days head-winds (S.W.) and a heavy cross-sea, (P fig. VIII.)

In Mr. Thom's work on Storms are imperfect notices of two hurricanes, the first at Timor on the 21st April, 1843, and the second below Java on the 24th April, which were probably due to the passage to the Westward of *one and the same* Cyclone, issuing from Torres' Straits. The "Morning Herald" states that "on the night of the 21st April, 1843, there was a terrible hurricane at Timor (10° S. 124° E.), which was especially destructive in the island of Rottee, where vast numbers of trees and many houses were blown down. Seventy-five persons lost their lives. In Timor some trees were thrown down, but the damage was not so considerable." (Q fig. VIII.)

The island of Rottee lies at the S.W. extremity of Timor; hence the preceding facts show that the centre lay to the South of Timor. The second appearance of this Cyclone is recorded in the log of the Swedish barque Artemise :—

"1843, April 24.—Strong wind N.E, barometer 30·44. Thick, dark, gloomy weather. 9 A.M. wind S.W. b. W. Hove to. Noon, under bare poles. 10° S. and 106° E. Thick, dark atmosphere, barometer 29·78.

April 25.—2 P.M., wind shifted from N.E. to S.W. in a small squall. About midnight, a hard squall; wind then shifted to N.E. and E.N.E. Ship lying on her beam-ends. A.M., ditto wind and weather. Barometer 27·30 at midnight, and 27·40 at 9 A.M.

April 26.—Blowing very hard, a regular hurricane, with thick, dark atmosphere. Ship's head to W. driving S.W. At 4 A.M. wind shifted to S. At 5 A.M. all three topmasts went, with the head of the mainmast. Fore-yard went overboard. Barometer 27·80.

April 27.—1 P.M., wind again shifted round by Southward to Eastward; blowing hard, with a heavy high sea. Ship labouring hard. Barometer 29·20. A.M., the wind a little more moderate, and continued decreasing. Barometer 30·4. Clearing the wreck."

The barometric curve (fig. X., B 1) shows that the central space passed the meridian 106° E. about midnight of the 25th, and it passed that of 124° E. about midnight of the 21st; it had therefore traversed 18° in 4 days, and was moving to the westward at about 270 miles a day.

The following also occurs in Mr. Thom's work :—

"The brig Maguasha, from Swan River to Sandal-wood Island, was in 18° 30′ S. and 116° E. on the 27th Feb. 1843 steering N. E. At noon, strong S.S.E. breezes. 9 P.M. increasing breezes, in second reef of topsails. Midnight, wind S. strong and squally, with heavy rain. Furled mainsail and foresail.

28.—6 A.M., wind S. increasing to a perfect hurricane, fore and main-topsail gave way, furled the remains, and scudded under bare poles. 8 A.M., wind S.W., still blowing, with continued heavy rain. 10 A.M., a heavy sea struck the vessel, and she broached to. 1 P.M., wind W.N.W., a heavy gale, and continued rain.

March 1.—6 A.M., moderate breezes, and clear. 8 A.M., light breezes, with a confused sea. Noon, moderate and fine. 16° 9′ S."

The Cyclone here begins at S.S.E., and veers to S.S.W. and W.N.W., but as the brig sails about 130 miles to the N.E., the progressive motion was not so much to the South of West as the shifts of wind would imply, (R fig. VIII., and fig. X. B 2.)

The following Cyclone, of which the account appeared in a local Newspaper, seems to belong to the Port Essington Class :—

"On the 15th April, 1849, the Guardian, from Manilla to Sydney, was in 18° S. and 105° E. At 1 A.M., increasing E. gales and sea, hove to. 10 P. M., lay to under bare poles. Midnight, gale increased to a hurricane.

April 16.—Daylight, hurricane still raging with great fury, foresail &c., blown from the yards. 7 A.M., a heavy sea struck the vessel, broached to, on beam-ends, cut away mainmast and the ship righted. About noon, the hurricane began to abate, but still blew a violent gale. Pumps kept going. The hurricane lasted 12 hours without intermission, during which the wind veered from East (the point at which it commenced) to South, and W. b. S. The barometer fell from 29·60 to 28·89. The gale continued unto the 20th, with rain, and a terrific sea running from Southward."

The veering here would imply that the Cyclone was moving to the East of South, but the Guardian must have drifted considerably, first to the Westward and then to the Northward; so that the Cyclone had in all probability issued from Torres' Straits, and was moving towards the S.W. The following notice, dated 17th May, from Singapore, confirms this suggestion :—

"Two days after passing the Leuwin the Candahar rolled top-gallant masts over the side from a very heavy westerly sea. At same time, 10° to the Northward, it was blowing a tremendous hurricane, by which several vessels were dismasted, and others damaged."

A storm in which the wind veered from N.W. to S.W. passed Circular Head on the 25th and 26th of April.

The great depression in the barometric curve (fig. X., B 3), shows that this was a Cyclone of considerable violence, moving to the Eastward; but I have not met with any intermediate observation which could enable me to decide that the latter was identical with the Cyclone of the Guardian.

Mr. Piddington gives an imperfect notice of a Cyclone which appears to have come from Torres' Straits in December, 1847, and to have been moving to the S. of W., when it was avoided by the Dutch ship Roompot, although others suffered by it for want of proper management.

The very remarkable Cyclone in January, 1848, by which the American ship Howqua was dismasted in 15° S. and 115° E. was undoubtedly of the Port Essington class. This ship met with a Cyclone of terrific violence in which her barometer fell 2·25 inches, and she was near foundering. She first ran up with a South Westerly gale till she had a shift to South, which broached her to, and she shortly fell into the calm centre, with the wind at S.E. and East. She then had it North Easterly and North.

Mr. Piddington says "we can only account for these shifts and lulls by a track travelling up from the South, and then curving away to the North West." (S fig. VIII.)

Now, there does not exist, *and in my opinion there never can be*, a well-authenticated instance of a Cyclone travelling *towards the Equator*, and therefore the track assigned is a priori a highly improbable one. It is, moreover, unnecessary. The Howqua, sailing to the South Eastward while the Cyclone was moving to the S. of West, would pass through the S.W. quadrant, where the winds from S.W. would become S., then S.E., and E. with a calm. The S.E. quadrant then passed over the dismasted ship, the winds being N.E. and North.

Mr. Thom states that on January 6th, 1812, the Abercromby, a 1200 ton ship, was dismasted, and very nearly foundered in a gale in 14° S. and 115° E. The wind began at N. and veered to E. and S.E., then suddenly chopped round to N.W. This is too vague to be of much use; but if the change from S.E. to N.W. occurred *after* the vessel was dismasted, it shows that the Cyclone was moving towards the S.W. (T. fig. VIII.)

In February, 1839, a violent Cyclone passed over the exploring party of Captain Grey at Shark's Bay, in North Western Australia; moving from the Continent in a South Westerly direction into the South Indian Ocean. (U fig. VIII.)

The following abridged account contains the principal features of the phenomenon :—

"Bernier Island, Shark's Bay, 25° S. 113° E., 1839, Feb. 26.—Throughout the day blew nearly a gale from S.E. Same throughout the 27th. During the evening and night heavy squalls, with rain, and much thunder and lightning. Feb. 28, sailed to Dorre Island, wind had fallen perceptibly, only alarming sign was the peculiar look of the sky. About 11 P.M. blowing a terrific gale of wind from S.E. with occasional vivid flashes of lightning. The gale became a perfect hurricane. The storm now appeared to lull a little, and in a few minutes (about 5h. 30m. A.M. of 1st March) *it suddenly dropped.* The wind, which had hitherto been from S.E., shifted instantaneously to N.W. We all quailed, or fell before it, for it came with sudden and indescribable violence. There was not

a tree on the island; but the bushes were stripped from the ground, and I found it impossible to keep my legs. At 2 P.M., the storm lulled considerably. The sea rose 53 yards above high water-mark. During the height of the storm, about 7 A.M. of the 1st, I caught a Cormorant on the beach, the bird not even attempting to fly, being, in appearance, completely appalled at the violence of the wind."—(*Grey's Journals of Expedition to N. W. Australia*, chap. xiv.)

Several whalers in the neighbourhood of Shark's Bay suffered considerable loss of masts, sails, &c., by this Cyclone; which was moving to the South West. After recurving, and passing to the South East, it crosses the meridian of Van Diemen's Land on the 30th March, the wind at Circular Head being Easterly, and very boisterous for some days before, with lightning, and then changing to S.W. The barometric curves for Circular Head and the Hampshire Hills, shew that the Cyclone had not lost much of its violence, and the shift from Eastward to S.W. indicates an Easterly progression, (fig. X. A. 3 & 4.)

An extract from the log of the Eudora, Captain Addison, will shew the weather that prevailed from the 14th to the 30th March, along the South Coast of Australia :—

"1839, March 14.—41° 21′ S. 100° E., fresh gales from W.N.W. thick weather, and a heavy sea.

15.—Wind light from the S.W.

16.—Fresh breeze, N. b. E. to N.N.W.

17.—Strong from N.

18.—Strong breeze, cloudy, with rain. *Wind round from N.W. to S.W.*

19.—Strong breeze from W. and S.W.

20.—Fresh breeze, S.W., with hard squalls.

21.—Hard squalls, *S.W. to N.W.*

22.—Strong West gales, hard squalls, rain, and a very heavy sea.

23.—Ditto ditto. P.M., moderate, S.W.

24.—Moderate. P.M., round from *S.W. to N. strong.*

25.—Strong, N. b. W.

26.—Light S.E. Mewstone, V. D. Land, N. 80° E. 104 miles.

27.—Light airs from S.E.

28.—Light S.E. and calm.

29.—Strong from E.S.E.

30.—Squally, with rain, W. and W.S.W. Arrived at Hobart Town."

The barometrical fluctuations on board the Eudora, coupled with the changes of wind in the above, show that, in sailing to the Eastward, she sometimes overtook, and sometimes was overtaken by, the Cyclone. On the 21st and again on the 24th she sailed past the centre.

The examples already produced are sufficient to demonstrate that a class of Cyclones exists (which, for distinction's sake, I have styled the Port Essington class) which issue from Torres' Straits, and progress to the South of West. That they recurve to the Southward, and then move to the South East, can scarcely admit of doubt.

Colonel Reid has furnished a good instance of the Southerly motion of a Cyclone when passing the vertex of its track in the case of the H.E.I.C.S. Bridgewater, which encountered a severe hurricane in March, 1830, about 20° 55′ S. and 90° E. (V fig. VIII.)

Sailing to the Westward, the Bridgewater met the storm with the wind blowing at North East, and when it abated the wind was at North West; but the intermediate points are not stated in the log. The log states that a heavy swell from the Northward preceded the storm. On the 2nd March the barometer was 29·75. On the 4th, the wind being Easterly, the ship hove to on the larboard tack under the trysail, until that blew to pieces; after which she hove to under bare poles, heaving her guns overboard. The barometer fell until it was at 28·80, with the wind increasing in violence, so that the ship was in much danger of foundering. After the gale, the Bridgewater was left with only her foremast, and the stump of her mizen-mast.

Here the motion is due South. The ship sailing to the Westward first encountered the Northerly swell, which precedes the East side of the Cyclone. The wind N.E. she is hove to, and the wind would veer by N. to N.W., while the Cyclone passed over her. She would then have a confused cross-sea, ending with a heavy swell from South, forming the wake of the Cyclone.

In the year 1850, the Baretto Junior, female convict ship, arrived at Hobart Town, having suffered considerable injury from a most severe hurricane in 46° 30′ S. and 82° 40′ E. The following particulars are from the ship's log:—

"July 10th, 8 A.M.—Light winds, inclining to calm. 9h. 30m., wind light and variable, trimming sails as requisite. 11 A.M., light variable airs, almost a calm, and snow falling fast. Barometer 29·50; thermometer 40°. Noon, moderate breezes *from*

Eastward, tacked ship to N.E., snowing heavily. 1h. 30m. P.M., barometer 29·40, wind increasing, shortened sail to a double-reefed topsail, stowed jib, &c. 3h. 30m. P.M., barometer down to 29·20: at this time there was not more wind than all sail could have been carried with; but from the rapid falling of the barometer, with a *Southerly wind*, it was considered advisable to stow the fore-topsail and mainsail, and reef the foresail. At 5h. 30m. light airs, *almost calm*, but the barometer still falling rapidly; took in all sail but the main-topsail, trysail, and fore-topmast stay-sail, and secured mizen boom and gaff upon the deck. 7 P.M., strong winds, coming in squalls; sent hands aloft to stow the reefed fore-sail, but before it was made properly fast, the gale burst upon them with tremendous fury, and the hands were called off the yard, lest it should be carried away, and take the men with it. At 7h. 30m., blowing a tremendous gale, barometer falling very fast. Finding that the ship's masts must inevitably go, if exposed to the whole fury of the blasts, kept ship away before the wind to the E.N.E., the wind having *veered to S.S.W.* 9 P.M., blowing a complete hurricane, kept the ship right before the wind as nearly as possible, and at the same time tried to square the main yard. Finding that the main-trysail prevented the ship from steering, attempted to take it in, but it was blown entirely away. 10 P.M., blowing a very heavy hurricane, the night so exceedingly dark that it was impossible to distinguish anything two yards away. Snow and hail falling heavily, and freezing hard. At this time the situation of the ship was one of great danger, in consequence of the difficulty of steering; the sea was very confused and high, owing to the rapid veering of the wind, at times tumbling over the taffrail in upon the poop. The binnacle lamps were continually blown out by the wind forcing itself into the binnacles, and even when alight for a few moments, the compass was with great difficulty distinguished, from the glasses being covered with snow; the ship at the same time rolling so heavily that the compass-cards were tossed off the pins. Had the vessel broached to, nothing could have saved the lower masts, and the consequence of their going would most likely have been the loss of the ship, as it would have been impossible to have cut the wrecks away, the darkness being so intense. At midnight, the hurricane was at its height, barometer 28·042, and the wind and sea such as the oldest sailors had not experienced before. At this

time, it is supposed that the head of the main-topmast cap, cross-trees, &c., were blown away, carrying the main-top-gallant mast and yards with them, which, for the remainder of the night, were swinging about, hanging by the rigging. The fore-top-gallant mast was luckily off deck. At 1 A.M. the barometer began to rise, but the hurricane continued with unabated fury, the sea bursting in the cabin dead-lights, bulwarks, &c., curling and waving up over the quarters, as the ship yawed in her course, threatening every minute to broach to, there not being anything to steer by but the whistling of the tempest, as it rushed past. Towards daylight the wind somewhat abated, and the snow ceased falling. At daylight, still blowing very hard, with a *fine long run of sea*, which was very welcome, after the *high confused one* of the night. Noon, blowing a common gale from the *Westward*, which continued for two or three days."

The barometer in this case fell an inch and a-half in 14 hours. The shifts of wind from E. to S., S.W., and W., give a progressive motion to the Southward, the centre lying to the East of the ship; but as the vessel sailed to the N.E., the Cyclone was undoubtedly moving to the South Eastward, after having passed the vertex of its track. (Fig. VIII. V.)

The following extract from the journal of the Surgeon Superintendent on board the barque Mahomed Shah, with emigrants from London to Port Phillip, is a striking example of the dangers that beset the track from the Cape of Good Hope to Australia:—

"1849, Sept. 3.—40° 28′ S. 63° 45′ E. Therm. 56°, barom. 28·82. A dreadful disaster occurred this afternoon. All hands were aloft. They had been close-reefing the fore-topsail, some of them were reefing the foresail, and the remainder on their way down to assist on the fore-yard, (in all, twenty-five men aloft), when suddenly a tremendous squall, or whirlwind, struck the ship nearly dead aft, carrying away the three masts, and precipitating the whole of the 25 men into the sea! 17 were rescued, but the remaining 8 perished. Of those saved, 11 were disabled, 2 severely. The mass of cordage and spars fell to starboard. The foremast went about 15 feet above the deck, the mainmast by the eyes of the rigging, and the mizen-topmast by the cap. Saved nothing of consequence but

the main-yard; obliged to cut away everything else for the safety of the vessel. The whole afternoon was occupied in clearing away the wreck. The ship hove to under the mizen, the only sail left, while she strained and rolled fearfully. The night closed in gloomily, with heavy squalls and rain."

In September, 1849, the Barham and Bucephalus experienced the Northern quadrant of a Cyclone in this neighbourhood; but Mr. Piddington has not given the particulars.

After having passed the vertex, and recurved towards the South East, this class of Cyclones may be expected to bear down upon Swan River, the South Coast of Australia, and Van Diemen's Land, the storm beginning with a Northerly wind and a falling barometer, and ending with a Southerly wind and a rising barometer.

The rapidly-increasing communication between Europe and the Australian Colonies fully justifies, and may even be said to call for, a minute and extended investigation of the nature of the hurricanes and gales which prevail over the region just alluded to.

In 1838, H.M.S. Beagle, Captain Wickham, was at Swan River, and experienced a Storm which has been thus described by her Commander:—

"May 24, 1838.—Wind strong and squally from N.E. b. N., sympiesometer 30·74, falling slowly until the 30th, when it was 30·16. On the evening of the 30th, a fresh breeze set in from N.E. On the 31st it blew hard all day between N.N.E. and N.N.W. with dark squally weather; much lightning in the S.W., with heavy rain, that continued all night. On the 1st June, gale at its height; at 8 A.M. symp. 29·93, blowing a hard gale, with heavy squalls from N.W. Towards noon, wind veered to West, but still blew very hard. Symp. now began to rise. In the evening, wind W.S.W., and had moderated considerably. Next morning, symp. had risen to 30·26, but began to fall, and wind veered to W. and N.W., and on the 3rd blew harder than ever, with heavy rain, thunder, and lightning, which continued until the 10th. This gale caused a heavy sea upon the coast; the oldest residents said they had never experienced so heavy a sea before. On the 10th the mercury commenced to rise steadily, and the weather was fine until the Beagle sailed, on the 20th."

The veering shews progression to the South East. (W, fig. VIII.) The central space passed the meridian of V. D. Land, about the 20th June, as shewn by the barometric curves at Circular Head, and the Hampshire Hills. The registers at the former station record the weather to have been stormy and tempestuous, with lightning; the wind changing on the 20th from W. to S. W.

At the Hampshire Hills, on the 20th, there were high W.N.W. and S.W. winds, with thunder and snow-showers, and on the 21st at midnight *one* loud peal of thunder, with frequent showers of rain and snow. (Fig. X. A. 5 & 6.)

In 1840, on the 8th July, the Samuel Wright, the North America, and the Endicott were wrecked in Coombana Bay, Swan River.

From an official letter to the Surveyor-General, dated 15th July, we learn that there was a continuous heavy rain at Vasse, on the 6th. On the 7th it was mild, and in the evening it blew fresh from N.E., increasing to a perfect hurricane from N.N.E. at midnight. About sun-rise on the 8th it shifted to North, without moderating. At 8 A.M. shifted to N.N.W., and blew with unmitigated fury. About noon, it suddenly shifted to the Westward, and S.W., and moderated so quickly that by 4 P.M. there was not more than light airs from Southward, with frosty weather. Geographe Bay had a tremendous sea setting in to it during the gale, which subsided in an hour or two to perfect smoothness, the water having been above high water-mark.

The centre of this Cyclone passes the meridian of V. D. Land between the 10th and 11th of July. At Circular Head (4) it is very boisterous and rainy, the wind veering from N.W. to W. on the 11th, and then to South. The barometer falls lower at Hobart Town (5) because the centre lay to the South of the Island. On the eleventh a gale of wind occurs, and torrents of rain fall there; and the Isabella is wrecked in a Bay near the Schouten's passage. (Fig. X, B, 4 & 5.)

In the "Perth Inquirer" newspaper, I have met with an interesting account of a Storm at Swan River in 1842:—

"In the night, between the 17th and 18th of June, the Leschenault district was visited by a furious storm, which made a lane through the forest from 300 to 400 yards wide. (X fig. VIII.) For about 200 yards in the middle of this lane, nothing is now

standing but bare trunks of trees. The storm crossed the narrow belt of land between the sea and the Leschenault Estuary, levelling and stripping the trees in its course. It appears to have crossed the Estuary in a direction *from North West to South East*, and to have struck the low land on its Eastern shore, about a mile to the South of the Town of Australind, and proceeded in the same direction through the forest, following the inequalities of the ground, and levelling the trees in the valleys, as well as those on the hills. I followed its course for some distance across the Collie and Preston Rivers. The young healthy trees were generally broken off about two or three yards from the ground, and laid from N.W. to S.E. I was at Vasse on the night in question, which was exceedingly stormy, with much thunder, lightning, and rain. The trees on either side of the lane stand up like a wall, and are free from injury."

Vasse is about 120 miles to the South of Perth, where, however, there occurred at the same time a very heavy storm, with hail, rain, and lightning. The wind there on the 17th was N., and on the 18th it changed to W.S.W. and S.W., and on the 19th to W. and S. The barometric depression on the 18th, (1) as well as the changes of wind, shew that this was a true Cyclone, and of considerable extent, the centre of which actually engraved its track through the Leschenault forest.

Severe gales were experienced at Circular Head (2) and at Hobart Town (3), from the 28th June to the 6th July. The respective barometrical curves exhibit the passage of a violent and extensive Cyclone. (Fig. X, C, 1, 2, 3.)

From the 24th March to the 13th April, 1843, Mr. Thom has shewn that the Rodriguez hurricane was passing between Java Head and a point to the South of the Mauritius, (Y fig. VIII.)

The following Cyclone at Swan River may have been an off-shoot from the larger one:—

"On Tuesday, April 11th, 1843, Perth was visited by a most terrific gale from the N.W., amounting indeed to a perfect hurricane. We have frequently during the winter months very strong gales from this quarter; but this gale was most unusually severe, although lasting but for a short time, the oldest boatmen on the River

declaring that nothing like it has been experienced in their recollection. It set in about 6 P.M., and lasted until nearly 10 P.M., when it gradually lulled. The gale was so sudden and tremendous as to force the Success, lately from London, to drift ashore with two anchors down.

At Australind (120 miles south of Perth) on Tuesday evening there was a short, but most severe storm, which threatened alarming consequences, laying prostrate some fine trees, &c.

At Bunbury, the day had been lowering, with the wind from the Eastward. In the afternoon a squall of wind and rain brought the wind round to N.E. About 7 P.M. it began to blow in gusts with great violence, and between 8 and 10 P.M. it increased to a perfect hurricane. The fury of the gusts was irresistible. The tide rose upwards of four feet in perpendicular height, and then in the course of 20 minutes fell two feet. The North America, United States' whaler, 400 tons, drove with two anchors down, and grounded on the bar, as did the Chance, schooner."

The centre here lay between Perth and Bunbury, the wind being N.W. at the former, and N.E. at the latter. At Perth, on the 12th, the changes of wind were N.W. to W. b. N., and on the 13th they were from S. to S.W., indicating the Easterly motion of the Cyclone.

The Newspapers record the occurrence of the shock of an Earthquake at Swan River on the 4th August, 1849, together with a severe gale, which drove the cutter Frolic over the bar, and very high and destructive floods. At Circular Head and Hobart Town the barometric curves indicate the passage to the Eastward of a Cyclone, on the 11th, the winds at the former place being "severe," and changing from N.W. to W.S.W. and S.W.

The schooner Harlequin left Adelaide for Singapore on the 3rd August, 1850. After leaving King George's Sound, she experienced a heavy gale off the Leuwin, so strong that it was impossible to hoist sails, as they were blown to ribbons almost immediately. The vessel drifted towards West Cape Howe, and at 3 A.M. of the 4th September, struck upon the rocks of that headland, and went to pieces in 20 minutes. Three lives were lost.

This gale was probably from the North Westward, since West Cape Howe is about 3° to the S.S.E. of Cape Leuwin.

From the journal of Captain Harmsworth I find that the barque Derwent was in 48° S. 102° E. on the 28th August, 1850 :—

"August 29—Dark cloudy weather, strong Northerly wind. Noon, strong N.N.W. gales, thick, with heavy rain. 4 P.M. strong gales, thick hazy weather, and rain. 6 P.M., cleared up, wind shifted to W.N.W.

30.—A.M., squally, unsettled, showers of snow. 8 A.M., moderate N.W. wind, and cloudy. Noon, strong Northerly, and clear. 4 P.M., came on to blow very hard suddenly from N.N.E., with heavy rain. Hove to under close-reefed maintop-sail. 8 P.M., shower of hail; cleared up, wind shifted to W. b. N., in a squall. Midnight, fresh Westerly wind, freezing hard. 48° 27′ S. 109° 44′ E.

31.—Strong Northerly gales.

Sept. 1.—A.M., strong Northerly gale and heavy rain. 8 A.M. blew and rained very hard, when the wind shifted suddenly to W.N.W., and made a very disagreeable, turbulent sea. Noon, moderate breeze. Midnight, *calm* and cloudy, a westerly swell, course E. 180 miles. 48° 22′ S. 118° E.

Sept. 2.—A.M., *calm*. 4 A.M., light E.S.E. 8 A.M., moderate, hazy, with snow. Noon, strong S.E. 4 P.M., calm, and heavy rain. 6 P.M., strong N.E. 47° 50′ S. 119° 40′ E. N. 61° E. 74 miles.

Sept. 3.—A.M., strong N.E., constant heavy rain. 4 A.M. *quite calm* a short time, when the wind sprung up from S.W. 8 A.M., strong W.S.W. wind, thick weather, heavy rain, and a *cross sea*. P.M., strong W.N.W. 4 P.M., cleared up, wind light. Midnight, fresh westerly wind. Saw the Aurora Australis.

Sept. 4.—Fresh W.S.W. gales, squalls and hail. P.M., strong gales and squally, and a heavy sea. 47° 4′ S. 126° 35′ E.

Sept. 5.—A.M., strong W.S.W. 6 A.M., steady at W.; first fine day for this last month.

6th.—In 45° 43′ S., and 135° 35′ E."

The curve of Captain Harmsworth's barometrical observations (4) and the above facts, shew that the centre passed the meridian (120° E.) of the ship about midnight of the 2nd September. At Circular Head (5), the gale on the 3rd was N.W., and on the 4th W.N.W. and moderate, and on the 5th W. and S.W. (Fig. X. C. 4 & 5).

The log of the Emma shews the effect of this Cyclone on the East Coast of Van Diemen's Land :—

"Sept. 4.—5 P.M., strong W.N.W. wind. Midnight, N.W., moderate. 2 A.M., veering to N. b. E., set port studding sails. 5h. 30m. A.M., wind *suddenly shifted to W.S.W.*, took the vessel aback, and increased to a gale. Cape Howe W.N.W. 28 miles.

Sept. 5.—Heavy gale at W.S.W., and a *heavy cross sea* running a continual wash over the vessel. 7 P.M., heavy bitter squall with hail. 4 A.M., increasing N.W., rain and lightning to S.S.W., split topmast-staysail, and parted sheets and main-top-gallant backstays. Served the mast with a warp.

Sept. 6.—S.W. gale, abating a little."

In November, 1842, the Candahar, when off King George's Sound, had a storm which is described by Captain Ridley as forming with a densely black sky to the W.N.W. in an incredibly short space of time, and, within an hour, "bursting upon us like a clap of thunder, and blowing a perfect hurricane," which lasted for about fifteen hours, and must have dismasted the vessel if not prepared, as she was laid with her gunwale in the water. The wind does not appear to have veered more than from W.N.W. to W.S.W. Unfortunately, Mr. Piddington has not stated on what day of November this happened, but the Cyclone evidently came *from* the W.N.W.; and, from the shift of wind, the Northern Margin passed over the ship, on the South of which the centre was moving Eastward.

I find that at 11h. 45m. P.M. of Friday, the 25th November, 1842, the Dusty Miller was totally lost off Port Fairy in a heavy S.S.W. gale. Since leaving Launceston they had nothing but strong Westerly winds, compelling them to put into Circular Head twice. At noon on Friday they were 35 miles from Portland Bay, when the wind *suddenly flew from N.W. to S.S.W.* in a complete hurricane, and a heavy roll of sea got up.

The barometric curve shews that the centre passed Circular Head about midnight on Friday, the 25th. (Fig. X., C, 6.)

The Candahar probably had this Cyclone about the 15th of November.

In 1843, the barque Rebecca left Batavia for Sydney on the 19th August. On 21st September, when in 39° 38′ S., and 127° E.,

she had a hurricane. It came on to blow hard about noon from N.N.W., barometer 29·90, and increased till 8 P.M., when there was a furious N.W. gale, with thunder and vivid lightning. The ship scudding with close-reefed main-topsail, reefed foresail, barometer 29·30, and falling rapidly. At 10 P.M. it *flew round in an instant, hurricane-like, from N.W. to S.W.*; threw ship on beam-ends nearly, where she lay for 14 hours, and blew the sails to atoms. At midnight it blew terrifically, with *the sea all in pyramids*, barometer 28·90, with furious hail-squalls. At 4 A.M. of the 22nd, it began to cease a little, barometer 29·00, and rising. At 8 A.M. more moderate, barometer 29·50; got her kept away from that time till we made King's Island. The last correct sights we had were on the 20th at noon, long. 123° 25′. On the 25th we were, by account, in 40° S. 142° 12′ E. Steering E.N.E. Ran from noon till 2½ A.M. of 26th, 121 miles. Look-out cried "breakers a-head!" anchored in 5 fathoms, wind still N.W. At 11 A.M., wind *West*, coming round fast to the *Southward*, with all appearance of a gale. 1h. 30m. P.M., wind S.W., blowing fresh. 2h. 30m. P.M., wind S.S.W. In heaving up the best bower, she drove, and struck heavily, slipped both anchors and chains. 4 P.M., wind working round to N.W. (where it was as black as ink), and getting very light, although the barometer was falling fast. 5 P.M., North point of King's Island, E. b. S., distant 1½ mile, wind W.N.W. 6 P.M., wind N.W. b. W., and increasing fast, barometer 29·40, and falling. 6½ P.M., blowing hard N.W. b. W., and increasing. Barometer 29·30, falling rapidly. Put off in the boats, one boat swamped, and all hands lost; ship drifted on shore; blowing a complete gale from N.W. all night. (6).

It is evident here that two Cyclones passed over the ship, and this is confirmed by the curve at Circular Head (7). The centre passed over the ship at 10 P.M. of the 21st, and reached Circular Head about 20 hours afterwards; the distance is about 800 miles *East*. The Cyclone was therefore progressing to the Eastward at the rate of about 40 miles an hour. (Fig. X., B, 6 and 7).

In 1845, the Cataraqui, 800 tons, an Emigrant vessel from Liverpool to Port Phillip, was wrecked on the west coast of King's Island; of 423 persons only 9 were saved. The chief officer,

Mr. Guthrie, was one of the latter; and gave the following particulars:—

On 15th July, when 40 miles south of St. Paul's, they had a strong gale from N.N.W., with a heavy sea; hatches battened down. Heavy gales *from N. to S.W.*, with heavy rain and dark weather, till July 31st, lat. 39° 20′ S. On 1st August, a strong gale from N.W., increasing to a perfect hurricane. Under close-reefed topsails and reefed foresail until Sunday, 3rd. At 7 P.M. hove to, ship's head N.E., estimated position 39° 17′ S. 143° 22′ E. Midnight, wore ship, head S.W., gale blowing fiercely. 3 A.M. gale moderated, bore away E. b. N., expecting to make land about Cape Otway. 4½ A.M., struck on reef, cut away masts, about 200 were now washed off by the sea,—every sea sweeping away some of the survivors. Noon, ship parted amidships, and about 100 more perished. One emigrant and eight of the crew were washed through some chasms of the reef on to the island, and saved; 414 persons perished!

The barometric curve at Circular Head for August shews that a series of Cyclones passed through Bass's Straits in that month at intervals of a few days. (Fig. X, D 1).

The following Notices, in connection with the cotemporaneous barometric curves at Circular Head, illustrate the nature of the gales in Bass's Straits:—

"On the 1st April, 1850, the barque Jane left Adelaide, and put back dismasted on the 13th. At 3 A.M., on Monday, the 8th, while lying to, a very high sea running, and a terrific gale from W.S.W. in 124° E., about three days' sail East of Cape Leuwin, she lost her mainmast about six feet from the deck, her fore-top, gallant, and mizen topmasts."

This storm reaches the Straits on the 14th, a Northerly gale. On the 16th the gale is W.S.W. and on the 17th S.W. (Fig. X. D 2).

The log of the Emma shews its action on the East Coast of Australia:—

"April 14.—Beat out to sea from Sydney. 5 P.M., dark squally looking weather to Southward, with thunder and vivid lightning.

8 P.M., wind checked from N.W. to W., with a smart squall, and heavy rain. Midnight, clear, with heavy squalls from W. Noon, strong breeze from S.S.W.

April 15.—Strong from S.W. 2 A.M., calm. 4 A.M., light breeze from N.W. 9 A.M., wind checked to S.W., with a heavy squall and rain. Noon, anchored in Twofold Bay, blowing very hard from S.W.

April 16th, 17th, and 18th.—Heavy squalls from S.W."

This Cyclone was followed in a few days by another. The "Launceston Examiner" of the 4th May states that there had been fearful weather at sea during the preceding fortnight. The Victoria Packet left Melbourne on 26th April, lost top-gallant masts, topmasts, and sails, and bore up for Kent's Group. On the night of the 24th April, the cutter Struggler was wrecked at the River Forth. The schooner Ida left Melbourne on the 24th, and on the next day shipped a sea which washed everything away, and threw the vessel on her beam-ends; came to an anchor on the 27th at Kent's Group, the wind blowing with unabated fury, drove her on shore. The Lady Denison left Adelaide on the 17th for Hobart Town, and was lost, with all hands.

The brigantine Elizabeth left Adelaide for Circular Head and the River Forth on the 17th April. She was in the wake of the first Cyclone, but experienced the whole of the second. On 24th April, she was off the River Forth, North Coast of Van Diemen's Land, with light breezes.

"April 25.—2 P.M., fresh breeze from N.W., with threatening weather. 6 P.M., hard gale from W.N.W., set a double-reefed mainsail and fore-topmast staysail. Midnight, split the staysail, took it in, and hove to under balance-reefed mainsail, head to N. Ship hove over almost on her beam-ends.

26.—A complete drift of wind and sea from W.S.W. 8 P.M., ballast fetched away, and ship in great danger. 4 A.M., Goose Island light bearing N. b. E., weather moderated. 9 A.M., came to under Swan Island.

27.—8 P.M., heavy squalls of wind and rain from W. 10 P.M., sent down main topmast and fore-top-gallant-yard. Midnight, gale

blowing fearfully, ship driving at times, sent down fore-top-gallant-mast, and gave her both chains to the bare end. 8 A.M., blowing a fair drift of wind and sea, tried to weigh the small bower, but could not. Ship driving to the Eastward. 10 A.M., gale blowing without intermission.

28.—Heavy sea running, shipped anchors and cables, and hove to. Gale continuing from W.S.W., bore up for Sydney."

On Sunday, the 13th October, 1850, there was a heavy gale from the Westward at Port Adelaide. At 4 A.M., next morning, the Grecian, just arrived from London, was cast away. The remarks of Dr. Schomburgh on this storm are of great interest :—

"Already on the morning of the 13th, the barometer fell four lines in the space of a few minutes shortly before the beginning of the gale and thunder-storm, and declined about 9 P.M. to 27 inches four lines, having stood in the morning at 28 inches $\frac{3}{4}$ line. After 9 P.M. the storm and gale increased, accompanied by a few hail-stones, until it reached its climax at 11. Shortly before that time we experienced *a wave-like moving of the Earth*, going from S.S.W. to N.N.E., setting tables and bedsteads in motion; after the lapse of an hour we felt a similar one, when the storm visibly abated. It was curious that the storm, during each of the earthquakes, changed to W., but resumed its course S.W. directly after the cessation of them. The duration of each was three or four seconds."

The "Portland Guardian" gives the particulars of the loss of the schooner Captain Cook :—

"On Sunday, the 13th, at 5 P.M., Cape Otway bore N.E., and Moonlight Head N.W., blowing hard from the Southward, with heavy thunder and lightning, course due West.

14.—3 A.M, wind veered to S.W., with heavy squall, sea running high, binnacle carried away. $6\frac{1}{2}$ A.M., vessel struck the rocks on west side of Cape Grant, and filled."

The brig Essington was off Cape Howe :—

"On the 13th, at 10h. 30m. A.M., wind sprang up light from N.E., and gradually increased after noon. 5 P.M., weather began to assume a threatening appearance. The sky became overcast, and heavy masses of blue clouds began to pile themselves on the land.

14.—Fresh breeze from N.E. b. E. Noon, sky overcast, and *everything had the appearance of night.* The wind veered to East, and increased very much. 2 P.M., took in mainsail and jib. The sea began to make. The rain commenced, with distant thunder and lightning. 4 P.M, blew very hard, with heavy squalls, close-reefed topsails. Judged the vessel to be a little to N. of Twofold Bay, and 16 miles off shore. From 4 P.M. till midnight, the thunder and lightning was fearful. At 9 P.M. the wind died away *to a calm* for about half an hour, when the wind sprang up *suddenly from the S.E.* and blew very hard, with *a heavy cross-sea.* It blew a hard gale, with a very heavy sea, until 3 P.M. of the 16th, when the gale abated, and the wind veered to the East."

The centre, which passed the meridian of Adelaide (139° E.) at midnight of the 13th, is at the meridian (150° E.) of Twofold Bay, at 9 P.M. of the 14th, having travelled in an Easterly direction, 11° in 21 hours, or about 22 miles an hour. The meteorological remarks from the 13th to the 16th at South Head, Port Jackson, are copious and instructive :—

"Sunday, 13th.—Early morn, calm and lovely; middle part, pleasant, light N.E. breezes. P.M., northed, got strong and gusty; latter part, cloudy and hazy.

14.—Before 9 A.M., light north airs; then freshened a little. A dark hazy gloom spread over during the forenoon, attended with some sultriness of atmosphere. About 1 P.M. stormy clouds came over from between N.W. and N.N.E,, with lightning and thunder, rain and squalls from the North. Storm kept gathering, and between 2·30 and 3·30 clouds bearing a most dismal murky aspect, came rolling over from N.W. and N. Thunder and lightning almost incessantly for several hours P.M. A heavy storm of rain, with a little hail at 2·40. About 3 and subsequently the clouds presented a truly dismal appearance in the S.W. and N.W. These swept over to E. and S.E., and about 5·30 the wind got S. of W., moderate, and the barometer immediately rose. Clouds after this passed off in the E. and S.E., and between 7 and 8 P.M. the sky presented a cloudless expanse. Incessant broad lightning in the eastern horizon after this for several hours. After 10 P.M. began to blow hard from S.W. Continued clear forepart night; latter part, heavily clouded again, and occasional rain; wind rising from E. of S. coarsely; mercury rising.

15.—6-7 A.M., weather exceedingly coarse, with violent squalls of wind, rain, thunder and lightning. Continued strong gales southerly until 9·30, when rapidly declined, and for a quarter of an hour there was *a dead calm*. Vane at S.E. b. E., then it *jumped round* to S.W., and black clouds bore up from S.W. b. S, sullenly, with thunder and lightning. Rain fell in very heavy showers, and almost continuous lightnings and thunderings all through the day; wind extremely coarse and squally from S.E. and b. S., and W. of S. After 3 P.M. wind more moderate for a short while, but towards sunset rose again in strong gales and squalls, chiefly from E. of S., with incessant rain; thunder and lightning still nearer and more awful than previously. After 7 P.M. the gale became quite furious from S.E. b. S.; rain constant, as well as the lightning and thunder, the latter breaking in louder claps. The lightning was of the most extensive general description I have seen here, pervading the whole expanse of the heavens, originating apparently throughout the upper regions of the clouds, scarcely any *streams* of the electric fluid being observable below the cloudal range, although at times, the clouds seemed, as it were, to sweep the earth. After 10 P.M. little change in wind, thunder-storms had passed over, and rain more moderate till midnight; then another most fearful storm of thunder and lightning, of the same continuous description, and rain, passed over from S.W. b. S..

16.—Strong coarse South Westerly wind and rain. Night, a strong wind from S. b. W.

17th to 21st.—Southerly winds."

On the 13th at Adelaide the gale was W. and S.W., with the Essington on 14th off Cape Howe, it was first N.E., then East, with a calm, and afterwards S.E., and at Sydney, it was Northerly on the 14th, and Southerly on the following days. The central track was to the North of Bass's Straits; this is confirmed by the comparatively small barometrical depressions at Circular Head (3) and Hobart Town. The valuable observations of Dr. Schomburgh, at Adelaide, and of that able meteorologist, Mr. Peacock, at South Head, give great interest to this Cyclone. (Fig. X. D, 3.)

The Australian winter of 1851 was a period of unusual atmospheric perturbation. Early in May the Swan River papers state

that "the Beacon on Challenger Rock has suffered by the late stormy weather." A small coaster, the Bee, and some boats were wrecked. The barometers at Circular Head and Hobart Town shew that a powerful Cyclone passed over the meridian of Van Diemen's Land about the 7th May, (fig. X. D, 4 & 5). In the Straits, the gales began at E., and veered to N.W.; to West on the 7th, and were S.W. during the next few days. The effects of the great disturbance of the hygrometrical state of the atmosphere were unusual and disastrous. At Adelaide a regular waterspout was seen to form on the hills between Kooringa and the Sod Hut. The bridges were all washed away by the flood, and Gum Creek, between Kooringa and Clare, was impassable. On Monday afternoon, (12th May) an alarming and destructive flood appeared almost instantaneously at Kooringa. The houses were flooded; 1500 persons houseless, and much property destroyed. The Mine (Burra Burra) had only the tail of the spout about an hour before it came out to the township.

From the "Sydney Morning Herald" we learn that the district of Twofold Bay, 240 miles south of Sydney, and 160 north of the entrance to Bass's Straits, had been visited by one of the most destructive storms on record in this country:—

"Up to Saturday, the 9th May, there was but little to foretell the forthcoming storm: but on that day it began to blow a stiff gale from the S.W.; it moderated a little on Sunday, and was nearly gone on Monday, the 11th. (This was the passage of the western half of the Cyclone which had just come through the Straits.) On Tuesday morning it commenced raining, in the evening the gale from the S.E. set in; it increased in violence during the night, and on Wednesday morning became a hurricane of wind and rain. Immediately that the wind *lulled a little*, the rain descended more like the waterspouts of the West Indies than the moderate rains of our fair clime. The gale continued with unabated fury during Wednesday, Thursday, and Friday, and the Township of Panbula, from which this is written, became a lake. The whole of the Warragabra Stations (25 miles distant) were swept away, and several lives sacrificed."

During the remainder of the month of May, and beginning of June, there was a succession of gales and boisterous unsettled weather. Among the consequent disasters at sea, the most striking

was that of the total wreck of the French National Corvette l'Alcmène, 32 guns, commanded by M. le Comte d'Harcourt, during a heavy gale on the 4th June, midway between Kaipara and Hokianga Heads, on the West Coast of New Zealand.

The Emma, from Sydney to Hobart Town, was laid on her beam-ends by a S.W. gale on 22nd May, the water lying in a complete body from the top-gallant-sail to the combings of the hatchways; and again on the 26th May.

In the month of June occurred a most violent Cyclone, passing along the whole South Coast of Australia, from Cape Leuwin to Van Diemen's Land and New Zealand.

The Swan River papers of the 13th June report that the Beacon on the Challenger Rock has stood the test of the *late gales* most admirably, and there is now no fear of its living through the worst of weather.

At Port Adelaide there was a storm and an alarming flood on the evening of Tuesday, the 17th June. Tuesday night was a very stormy one, having been preceded by a sudden fall of the barometer; the wind had been blowing fresh from the West all day, and at night very much increased, at times rising up to a hurricane; the embankment gave way, and the whole of the western part of the town was suddenly inundated. The temporary wooden church was blown completely off the piles, and rendered useless. The gale continued unabated through the whole of Wednesday.

The Cyclone is at Portland on the Wednesday and Thursday. A correspondent of the "Melbourne Daily News" says: "It has never fallen to our lot to witness in Portland two such days as Wednesday and Thursday were for tempestuous weather. Rain and hail descended at times in torrents; on Wednesday especially, it thundered and lightened during the whole day and night. The wind was from the North and N.W. on Thursday afternoon, and blew at times little short of a hurricane. A number of trees were blown down. Thermometer all day on Wednesday was 43°, and only 44° on Thursday.

The barometric curves for Circular Head (7) and Hobart Town (8), shew a depression extending from the 12th to the 23rd June,

of which the minimum occurs on the 18th and 19th, when there was an unusual fall of snow in Van Diemen's Land. (Fig. X., C 7 and 8). At Circular Head, on the 18th, there was a severe N.W. gale, with heavy squalls, thunder, and rain; at 3 P.M. barometer 28·70, gale abating. On the 19th, a west wind, and then a severe W.N.W. gale, with thunder. On the 20th wind W.S.W., and from the 21st to the 24th, it is S.W.

The central track of this Cyclone lay a little to the South of Van Diemen's Land. The following notice indicates its appearance at New Zealand:—

"A very heavy gale of wind occurred at Port Lyttleton on the night of the 27th June. The Sir Harry Smith, riding with three anchors down, was nearly blown ashore. The Duke of Bronte and the Steadfast dragged their anchors. The Raven lost her bulwarks and two boats, the Eudora was much damaged, and the Jane Dixon lost her larboard bulwarks and bowsprit. The last three were on their way to Port Lyttleton. Three schooners were blown ashore, a cutter dashed to pieces, and the brig Torrington reduced to a mere wreck. The gale lasted 36 hours."

I possess accounts of numerous casualties among the coasting craft, &c., during the passage of this Cyclone, but they possess little meteorological value.

In October, 1851, a severe Cyclone was experienced by the barque Duke of Richmond, from London to Sydney, in 41° 35′ S., and 115° 41′ E. (Z, fig. VIII.) It is well-described by Captain Barclay:—

"The wind, which had for the two previous days blown from the N.N.W., with dark lowering weather, at noon of the 13th shifted to the N.E. Bar. 29·97. A dense fog then encompassed us, and continued until 8 P.M., when the moon, peering through a sky of a pale yellow tinge, partially dispersed it. Bar. 29·79, wind still N.E., blowing in gusts at intervals of from 15 to 30 minutes, with small rain. Midnight, wind increasing, gusts more frequent and severe. Bar. 29·50. Close-reefed topsails and handed the courses. 2 A.M., bar. 29·48, heavy rain, wind N.N.E. At 3 A.M. the sky had a very remarkable appearance, daylight appeared to have fully broke, all

the western quarter of the heavens being of a lurid red, while every other part, from the zenith round, was covered with a murky impenetrable haze, which the ocean appeared to reflect, for, instead of its usual colour, it appeared of a dirty green. At 4 A.M., bar. 29·33, made all snug in anticipation of a gale. At 8 A.M., wind still N.N.E., bar. 29·32, blowing strong. At 10 A.M., bar. 29·30, clouds lifting to the N.W., and weather looking fine, but the barometer said no! and fell at noon to 29·29. At 2 P.M. the hurricane burst upon us with tremendous violence from the North, forcing the ship's lee gunwale under water; fortunately we had only the close-reefed main-topsail set on the port tack. The sea, which had two hours before been comparatively smooth, now rose in pyramidal heaps from every point of the compass, while the roar of the wind could only be compared to the noise of the highly condensed steam escaping through the tube. 4 P.M., bar. 29·30, lee side entirely under water, all hands at the pumps; sea, if possible, higher and more confused. At 6 P.M., bar. 29·30, blowing with fearful violence, expecting every moment to see the masts go. But at 7 P.M. the barometer began to rise, and at 8 stood at 29·34, wind then N. b. W., blowing a heavy gale, an awful sea running, threatening to engulph our poor ship. 10 P.M., wind N.W. b. N., bar. 29·39, a tremendous sea rolling up, broke over the port quarter, stove the quarter-boat, hencoops, &c., and nearly filled the cuddy with water. Midnight, bar. 29·49, still blowing strong, set our trysail to steady the ship over an awfully high, but now more regular sea. At 2 A.M., bar. 29·60, and from this time until 6 A.M., when the wind gradually veered to West, it rose to 29·79, then blowing only a fresh gale. Kept away on our course, and at 8 A.M. got the pumps to suck after 12 hours' incessant labour. From the wind never having veered to the South of West, I conceive the Meteor's track to have been about S. b. E., or nearly in a line with the West Coast of Australia."

Captain Barclay's conclusion respecting the progressive motion of the Cyclone, deduced from the veering of the wind, would be correct if the vessel could be considered to have been nearly stationary during the 13th and 14th; but in small Cyclones, the run and drift of a vessel are very important elements in investigating the track. (Fig. X, B, 8.)

The preceding records of Storms are of much value in the investigation of a question which can only be determined satisfactorily by the cumulative evidence of concurring facts. They all agree in indicating the *Easterly progression* of the Gales of the South Coast of Australia; and nothing is wanting to prove that those gales are formed by passing Cyclones, but the observations of a vessel placed to the Southward of Van Diemen's Land. This link in the chain of evidence is fully supplied by the log of H.M.S. Fantome, of which Captain Gennys kindly favoured me with a perusal, on his return from the Auckland Islands.

The general nature of the gales that prevail on the South Coast of Australia, Bass's Straits, and on the Coasts of Van Diemen's Land, was correctly described by Flinders forty years ago. This description is the more valuable and trustworthy, inasmuch as Flinders was ignorant of the modern theory of rotatory storms. It occurs at pp. 244—5 of vol. i. of the "Voyage to Terra Australis," published in 1814. He says:—

"The progress of the gales is usually this: the barometer falls to 29·50, or lower; and the wind rises from the North-westward, with thick weather, and commonly with rain. It veers gradually to the West, increasing in strength, and the weather begins to clear up so soon as it has got to the Southward of that point. At South West the gale blows hardest, and the barometer rises, and by the time the wind gets to South, or S.S.E., it becomes moderate, the weather is fine, and the barometer above 30 inches.

Sometimes the wind may return back to West, or something Northward, with a fall in the mercury, and diminish in strength, or die away; but the gale is not over, although a cessation of a day or two may take place.

In some cases, the wind flies round suddenly from North West to South West, and the rainy thick weather then continues a longer time.

Such is the usual course of the gales along the South Coast, and in Bass's Straits; but on the East side of the Straits, the winds partake of the nature of those on the East coast, where the gale often blows hardest between South and South East, and is accompanied with thick weather, and frequently with heavy rain."

Mr. Piddington, in the "Sailor's Horn Book of Storms," has thrown out the very probable suggestion that these gales are the Northern portions of Cyclones, which have an Easterly progressive motion. So long as this remains a mere suggestion, few would have the temerity to *act* upon it, in cases where life and property were involved. To justify a practical application of the suggestion, a demonstration of its correctness is necessary. In the following investigation of the Storms of July and August, 1852, I have been fortunate in obtaining accurate data from the log of H.M.S. Fantome, the journal of Captain Major, of the ship Duke of Lancaster, of Liverpool; the log of the Packet Brig Emma, and the meteorological observations at the Magnetic Observatory, Hobart Town. The meteorological observations at Sydney, published in the "Sydney Morning Herald," are as complete and correct as could be desired. The barometrical observations at Melbourne, published in the "Argus" newspaper, are taken at midnight, and therefore only once in twenty-four hours; the barometrical curve for Melbourne consequently has not the same pretensions to accuracy as those for Sydney, Hobart Town, and the Fantome, which are formed from three, or more, daily observations. (Fig. IX.)

On the 28th July, the Duke of Lancaster, from London to Hobart Town, was in 43° 48′ S., and 121° 20′ E., that is, about due West of Van Diemen's Land, and South of King George's Sound:—

"From 9 P.M. of the 26th to 9 A.M. of the 27th, there was a calm. At noon, the wind was W.N.W. P.M., an increasing breeze from W. Midnight, strong increasing gales, W.S.W.

28.—3 A.M., strong S.W. gale and high sea. Noon, S.W. gales, squalls, and hail. P.M., strong increasing S.W. gale, squalls, and a high rising sea. Midnight, hard S.W. gales and frequent squalls.

29.—6 A.M., squalls terrific; hail and thick snow showers. 10 A.M., more moderate, sea dreadfully high. Noon, 42° 40′ S. 127° 11′ E. Strong S.W. gales, frequent violent squalls, very heavy sea from S.W.

30.—More moderate."

The barometer fell from 30·33 to 29·42, from the 27th to the 29th, and then rose gradually. The centre of this Cyclone passes the meridian (120° E.) of the ship early on the 28th, and the vessel

sails in the N.W. quadrant until it leaves her in 130° E. on the 30th. About the same time that the Duke of Lancaster is dropping behind the N.W. Margin in 130° E., the central area is passing over Van Diemen's Land in 147° E. The following is an abstract of a memorandum from the journal of the master of the brig William, which left Sydney on the 14th July for Launceston :—

"On the morning of the 28th got the wind strong from the Westward, and crossed the Straits, under all sail, hoping to get in before sun-down. At 5 A.M., the light-house in sight, bearing S.W., distant 10 miles ; the weather looked very threatening to the N.W. At 8 P.M. tacked in shore, and made another attempt to fetch the Heads, (George Town), but finding that impossible, and the gale having fairly set in, thought it prudent to keep what offing I had. At 10 P.M., wore off shore. Up to midnight carried all possible sail, hoping to be able to hang to windward till daylight ; but at midnight the gale had increased to such a fearful extent, that I was obliged to bring the brig under close-reefed topsails, after the main-try-sail gaff had been carried away. During the whole of Thursday, (29th), the gale raged with unabated fury ; but the barometer being stationary at 28·95, I hoped I had had the weight of the gale at sun-down, although the weather looked, if anything, even worse. At 8 P.M. the barometer again falling, and at 9 P.M. barometer 28·80. It was at this time blowing harder than I ever remember before, and a terrific sea was running. At 10 P.M. our decks were filled with lightning, and immediately after a peal of thunder burst close on our weather bow. We had then a calm for about a minute, which I well knew would be followed by something awful, and we were immediately struck by a squall which drove the brig's lee rail under. About 4 A.M. of the 30th the weather moderated a little, and continued so till noon, when it again assumed a threatening appearance, and, finding myself as far to the Eastward as Cape Portland (148° E.), I bore up for Swan Island, and anchored there at 2 P.M. Just when bearing up, we were struck by one of the furious westerly squalls, and snapped the starboard bower cable. The second anchor brought the ship up with 90 fathoms of cable. I remained here till Tuesday, the 3rd August, when the wind came away at S.E. ; then weighed, and ran through the Straits, and arrived at Launceston at day-break on the 4th, twenty-one days from Sydney, and through the severest gales I have ever experienced on the Coast."

The deck filled with lightning, the single peal of thunder, the calm, the minimum-barometric depression, and furious westerly squalls, are so many well-known marks of the passage of the Northern Margin of the central portion of the Cyclone. The extreme cold which is characteristic of the central space, extended over the whole of Van Diemen's Land. During the whole of the 30th, and the forenoon of the 31st, there were continuous heavy snow squalls. Eight years had passed since the last snow storm in Hobart Town. The hills in the neighbourhood were covered with snow; and at Oatlands, Jericho, &c., the snow was two or three feet deep. The thermometer at the Observatory was 37° at 6 A.M., 37° at 2 P.M., and 36° at 10 P.M., of the 30th.

The newspapers furnish the following corroborative notices :—

"The Charles Carter left Hobart Town for Sydney on the 28th July. On the 30th she fell in with heavy gales from N.N.W. to S.W., which continued for four days."

"At 2 A.M. of the 1st August, the brig Mary, of London, was lost on Kent's Group, Bass's Straits."

"On the 31st July the schooner Spy, of Hobart Town, was on shore at Kent's Group."

"The barque Gratitude, of London, from Sydney, the 26th July, was compelled to return to port on the 31st, the weather being most terrific."

"The schooner Gem left Launceston on the 26th July, and whilst trying to beat into Waterloo Bay on the evening of the 30th, had nearly the whole of her canvas blown away, and was compelled to bear up for Twofold Bay to refit."

H.M.S. Fantome was then lying at the Auckland Islands, in 166° E., *i.e.* about 18° to the East of Cape Portland. The barometer on board falls rapidly on the 30th, and reaches its lowest point early on the 31st. During this interval the direction and force of the winds are :—

July 30.—N.N.E. 4; N. b. E. 5; N.N.E. 6, 7.

July 31.—A.M., N.N.E. 6, 8, 9, 6.

shewing the passage of the South Eastern quadrant. From the 31st July to the 3rd August, the mercury is low and oscillates within moderate limits, and the wind is variable and moderate (4, 5, 2). On the 4th August the South Western quadrant

approaches, and continues its passage until the 7th, the wind being steady at E. and then at S.E. On the third there is a calm, and on the following days the force of the S.E. wind is 3, 4, & 5.

At Sydney on the 30th, the changes of wind were N.W., W.N.W., W.; W. by S., and W.S.W., indicating the transit to the Eastward of the extreme Northern Margin. That the track of the centre lay between the parallels of Van Diemen's Land and the Auckland Islands is shewn by the order of veering of the wind at each of these places. Consequently a shorter chord of the Cyclone passed over Melbourne and Sydney, than over Hobart Town. This accounts for the *great breadth* of the barometric depression at Hobart Town, indicating that the mercury began to fall sooner there, and was longer in rising, than at the more northern stations. The *Eastward progress* of the Cyclone is likewise demonstrated by the comparison of the several barometric curves, (fig. IX.); for, the minimum depression, which occurs almost simultaneously at Melbourne and Hobart Town, happens early on the next day at Sydney, (4° to the Eastward) and at least two days later at the Auckland Islands, (18° to the Eastward.) Since the Northern Margin extended to Sydney, and the Southern to the Auckland Islands, the diameter of the whole Cyclone was not less than 1000 miles.

Assuming the centre to have passed the Duke of Lancaster, in 120° E. early on the 28th, the meridian of V. D. Land early on the 30th, and that of the Auckland Islands on the 1st August, it would have traversed 45° in 5 days, or 9° a-day; that is, 9 × 42 miles in 24 hours, which gives a mean velocity of progression of about 15 miles an hour.

Now, from noon of the 28th to noon of the 29th, the Duke of Lancaster sailed to the Eastward at about 11 miles an hour; and I have shewn that the Cyclone overtook and passed her: therefore the velocity of 15 miles an hour is probably not far from the actual rate.

This Cyclone was followed in a few days by another, of which the central track seems to have been considerably to the Northward of that of the first. A correspondent of the "Adelaide Observer" states that on Saturday, the 7th August, there was a most fearful flood at Clare, (north of Adelaide), and no arrival of mails from the South, because of the floods at the intervening parts. In Clare the

rains commenced on the night of Thursday, the 5th, and continued till 5 P.M., on Saturday, when it poured down in torrents for 10 hours. All the houses were flooded, one man was drowned, and a settler had 1700 sheep drowned in the River Bremer. (Adelaide 35° S. 138° E.)

At Portland (141° 38′ E.) on Friday night (6th August) there was one of such fearful gales from the South East, that the oldest inhabitant had not known the like before. The Margaret & Agnes went on shore, and was wrecked.

At Circular Head (145° 20′ E.) a most severe gale was experienced on Saturday night (7th), and continued with unabated violence up to Sunday morning. The oldest inhabitants do not recollect ever witnessing such a gale and sea before, and with the highest tide. The schooner Toroa struck, and was driven up by the sea to a considerable distance. The schooner Antares, which had sailed for Launceston, put back from contrary winds (East.) The gale commenced with the barometer at 30·30, and the mercury fell to 29·30.

At Sydney the barometer begins to fall on the 6th, and continues low until the 15th. The corresponding meteorological remarks describe the passage of the N.E. half of the Cyclone :—

" Friday, 6th Aug.—6 A.M. rather heavy rains.

8 A.M., wind in squalls from S. b. E., then light, veering to E. Atmosphere raw and chill, and heavily charged with nimbus. P.M., became very coarse and squally from E. and N. of E., with driving showers. Towards evening, grew more and more boisterous from N. E., and continued to blow with increasing violence throughout the night. Strong gales and squalls, veering to almost due N., at times, and latter part sometimes W. of N., with driving rain occasionally. Night altogether dark and dismal.

Saturday, 7th.—At day-break, gusts quite furious from N.E. b. N. with hard rain, and increased after 7 A.M. to still more violent gales from the same quarter. Between 1 and 2 P.M., gales from almost due N. ; after 2, veered to N.W. b. N. with severe squalls and rain. After 3 P.M. the tempest abated, clouds began to open and shew patches of blue sky ; and, after some very heavy showers, the whole sky became most rapidly clear on all sides, and the wind fell as rapidly to moderate breezes. Evening and night, light N.W. wind, and clear sky."

During the 8th, 9th and 10th, the winds are moderate from N.W.; the *sky clear*, and the atmosphere *cold and wintry*.

On the 11th.—A dark dusky gloom all round; grew thicker during the forenoon. At 1 P.M. the N.W. wind arose, blew strong during the afternoon and night, and then shifted to about W. b. N. A heavy swell on the sea still.

12th.—Wind rapidly rose to strong gales from W. b. N. before 10 A.M., and subsequently kept increasing in force, and blew with extreme violence till about 4 P.M. Brisk gales all night.

13th.—Atmosphere dry and clear; no clouds. Strong westerly gales. Noon, wind a little S. of W., and rose to heavy gales before sun-set; after that, tacked to N. of W., and increased to most violent gales, by 8 P.M., and continued to rage till 4 A.M of the 14th. Between 9 and 11 P.M. of the 13th, there were some most furious gusts, and large stunted bushes and trees, which had withstood many heavy storms, fell a sacrifice to these, and were shivered or blown clean away by the roots.

14th.—Before 8 A.M. gales had again set in strong from W. by N. and blew with increasing violence all day, rising to heavy gales before noon. Atmosphere keen, and remarkably dry and clear. Gales continued with great violence till past midnight.

15th.—Moderately fresh breezes all day; clear fine weather, very sharp and dry. Wind W. b. S. and W.S.W.

16th.—Cold frosty air, wind W. b. S.; S. b. W.; S.; and S.W. Evening, light wind and clear sky."

A correspondent of the "S. M. Herald" writes from Goulburn on the 16th August:—"In the course of last week we had all the region of a Northern winter, in a blustering cold piercing wind, with frequent showers of rain, hail, and snow. Snow fell to a considerable depth on Saturday evening. On Sunday we had a keen frost, which prevented the white covering of the earth from disappearing; in some places it remained till the following day, (Monday, 9th). The rain which fell in the early part of last week caused the Woollondilly and Mulwarre Rivers to rise to such a degree as to prevent communication at the ordinary crossing places for several days, &c."

The Launceston papers contain long accounts of the disastrous floods of the South Esk at Longford, on the 9th, and at Perth and

Launceston on the 10th August. The stone bridges at Entally and Perth were destroyed, the coaches stopped, and the Royal Mail Coach washed down the River at Ross. Meanwhile, very little rain fell around Hobart Town.

The central area, which is accompanied by extreme cold, heavy rains, snow and hail showers, appears to have swept over Victoria, Bass's Straits, and the Northern portion of Van Diemen's Land, and this conclusion is confirmed by numerous notices of the weather at sea.

"On the 4th August, the Duke of Lancaster sighted the S. W. Cape of V. D. Land, distant 15 leagues N.E., having light variable airs and calms until Friday, the 6th, when, at noon, the wind was E.N.E.

7th.—Wind moderate, N.N.E. 7 P.M., strong increasing breeze. 9 P.M., violent squalls off the land. Midnight, barometer falling rapidly. 7 A.M., hard gales and squalls. The Mewstone W.N.W. 7 leagues.

8th.—Sunday, hard gales, E.N.E., violent squalls and a heavy sea. 11 A.M., found the main piece of the rudder sprung. Noon, a furious gale and sea.

9th.—Furious East gale, violent squalls and rain. 4 A.M., hove to. Noon, somewhat abated.

10th.—Strong increasing gales, E.N.E. 10 A.M., nearly calm, swell heavy. Noon, light Northerly airs, and clear.

11th.—Calm, a heavy swell from East.

12th.—Wind N. light, swell from E. 3 A.M., wind E.N.E. 9 A.M., wind S. and S.W. Noon, strong S.W. gales, thick, dirty, and rainy. A furious *cross-swell* from East, ship pitching *forecastle under*.

13th.—6 P.M., a severe S.W. gale, with furious squalls and rain. Midnight, moderated and hauled to the W.N.W. Noon, light and variable.

14th.—Variable—anchored in Storm Bay, below the Iron Pot Light-house. 1 A.M., suddenly a hard gale, furious squalls and snow. Ship began to drift. Squalls furious, with thick snow showers. 2h. 30m. A.M., anchored in harbour of Hobart Town."

The barometrical curve of the observations on board the Duke of Lancaster does not differ materially from that at Hobart Town.

The Emma left Hobart Town for Sydney on the 4th August :—

"On the 6th at 5 P.M., land was seen west of Cape Howe, wind E. inclining to E.N.E., the sea rising. Split the main-try-sail. Midnight, gale increasing.

Saturday 7th.—Wind steady at N.E. by E. 4 A.M. blowing very hard, hove to. Noon, gale increased to a complete drift, with a sea running mountains high. 4 P.M. mizzling rain. 7 P.M. rain fell very heavy, when a sudden gust of wind nearly tore the masts out, and immediately after it fell a "clock calm." The main-boom, secured with three tackles and a strong guy, tore all adrift, &c. A light N.E. wind and a heavy sea running.

Sunday 8th.—Light N.E.

9th.—Light W. throughout. Cape Howe N.E. Heavy swell from E.

10th.—Light, veering from W. to S. Midnight, rounded Cape Howe.

11th.—Off the Dromedary, strong N.N.W. gale, sea running heavy.

12th.—Veering to W. and W.N.W.

13th.—Off Wollogong, W.S.W. blowing a complete drift, hove to. 2 P.M., moderating. 7 P.M., entered Sydney Heads. 8 P.M., blowing a drift of wind from W. Both anchors down off Shark Island.

14th.—Midnight, blowing fresh ; the second officer fell overboard out of the boat, and was drowned."

The ship Falcon, 1106 tons, left Melbourne on the 5th and arrived at Sydney on the 18th August. On leaving she was three days with a strong drift from East (6th, 7th, and 8th) ; and on the 9th was to the W. of Cape Otway (143° 30′ E.), sea still very heavy. Light westerly winds through the Straits, when it again began to blow from the Eastward, veering round to N.W. On the 15th carried away her fore-top-sail and fore-sail, and split her main-sail. The wind set westerly, and continued so until the evening of the 17th.

The Duke of Cornwall was in the same gales as the Falcon, was for several days under close-reefed main-top-sail, and was driven as far as 154½° E.

The Clarence Steamer was compelled to return to Sydney by the heavy gales on Saturday the 7th August. The gale was principally from the E.N.E., and shifting thence to the N. W.

The Hawkesbury Lass, Captain Liddle, left Twofold Bay on the 7th August with an Easterly gale. Sighted the Sisters on the evening of the 10th, when it became calm, with a very heavy sea from E. At day-light, had drifted to leeward of the Sisters, blowing a strong gale from N.W. At 2 P.M. wind shifted suddenly to S.W. blowing very hard with heavy rain until 10 P.M., when the wind shifted round to N.W. Ship drove on shore on Babel Island, where the Captain and crew subsisted on penguins for 14 days, until taken off by the schooner Free Trader.

The Robert Syers, from Melbourne to Sydney, when off Twofold Bay on Friday the 6th, was hove to until Sunday evening, the wind veering N.N.W. to S.W. during that time.

The Miranda, of Hobart Town, was wrecked on Rabbit Island.

The Victoria Packet left Melbourne on the 5th August, with about 70 passengers, and 200 sheep. On Monday, the wind blew "great guns," and the sails were torn to pieces. All but 25 of the sheep were washed overboard. During the gale, a passenger jumped overboard, and was drowned. When the vessel got outside of the Heads early on the morning of the 6th, she had strong Easterly winds, which continued increasing until 9 P.M. when it blew a heavy gale from Eastward, with heavy rain and very thick weather. About midnight, they rounded to, vessel's head N.E. and directly after that the main-topsail and fore-top stay-sail were blown away. The Screw Steamer, the City of Melbourne, was in company all day until 8 P.M. when it came on thick, and she was last seen on the port tack looking up for the Tamar. The Victoria Packet had very severe weather until day-break, lying to all night, head N.E. At day-break they discovered the south end of King's Island close under their lee. The crew immediately wore ship, but could not weather the land on that tack, running into the breakers, and just clearing the eastern end of the Island. After getting the vessel on the port tack, they made sail, but it was all blown away, except the lee luff of the foresail, which brought her out. The gale continued until 11 A.M. on Saturday, when it lulled.

The Steamer City of Melbourne was beached, about the middle of the East Coast of King's Island (39° 47′ S.) at 4½ P.M. of the 7th August. By the admirable coolness and skill with which this difficult manœuvre was successfully accomplished under most trying circumstances, the lives of the 250 persons on board were all saved. When the Emigrant Ship Cataraqui was wrecked on King's Island, in 1845, only 9 lives were saved out of 423! The following is the statement of Captain Saunders, of the City of Melbourne Steamer:—

"August 6th.—8 A.M., left Port Phillip Heads, wind N.E. All possible sail set. 10 A.M., fresh breezes, in foretop gallant-sail, outer jib, and mizen. Noon, wind increasing, close-reefed the foretop sail, stowed the jib, and in two reefs of mainsail. 8 P.M., strong gale from E.N.E. with a heavy sea. Midnight, blowing very hard, with much rain. Close-reefed the mainsail, stowed the foresail, and foretop sail.

7th.—2 A.M., gale still increasing. 4 A.M., shipped a heavy sea. Carried away the weather main gangway, a great quantity of water went down into the Engine Room, and into the Cuddy. 5 A.M. wind East. At day-light repaired the gangway, and wore ship to the North; took in the fore trysail, which had split. Set the mainsail, close-reefed. Gale still increasing from East, sea running very high. 10 A.M., wore ship to S.S.E., the gangway having broken in again filled the deck with water, a great quantity going down below. At 1h. 30m. P.M. saw breakers on the lee bow, supposed to be Sea Elephant Rocks. Wore ship to the North, set fore trysail, and square foresail, to claw off the land. The gale at this time was awful. Obliged to call up about 60 of the passengers from below to get the fore-tack aboard. At 4 P.M, saw breakers a-head, and the land about two points on the lee bow. The weather was so thick that it was impossible to see half-a-mile from the ship. Finding that the vessel could not clear the land on either tack, for she was not more than half-a-mile from the breakers, and night setting in fast upon us, I determined, after consulting with the passengers, that the only way to save life and property, would be to run the vessel on shore while it was day-light.

I then went up to the mast-head to look out for the best place to beach the vessel. At 4h. 30m. P.M. the helm was put up, and the passengers called up from below. In ten minutes the vessel struck

the ground, and carried away the rudder and false keel. At the same time a tremendous sea broke over the poop, carrying all before it on to the main deck. The next sea took the vessel inside of the reef, about 50 yards from high-water mark, where she now lies, with her head to the North, on a rocky bed covered with loose stones."

In a published letter of one of the passengers, written on the 8th August at King's Island, it is stated that "the Captain ran the vessel ashore over a tremendous reef in the most seaman-like manner. She grounded firmly upright, about 200 yards from the shore. All the passengers are saved, 250 souls, but we have only three days provisions, &c."

The mate of the steamer arrived in a boat on the 12th at Circular Head, whence provisions &c. were sent. All the people, including several very fortunate gold-diggers, were got off the island; and the steamer itself was recovered about four months after. A testimonial was afterwards presented to Captain Saunders by the passengers expressive of their gratitude for, and admiration of, that calmness and presence of mind by which he was instrumental in preserving the lives of all on board.

The North Eastern quadrant of the Cyclone appears to have passed between Moreton Bay and Sydney. On the 13th August, the Thomas Lord left Moreton Island, in company with the Zone. She had heavy S.W. gales from the 13th up to the evening of the 19th. The Zone had strong S.W. gales for three days after passing Smoky Cape, and a strong set to the N.E.

The Fantôme sailed from the Auckland Islands on the 8th, and arrived at Hobart Town on the 13th August. The direction and force of the wind shew that she sailed into the S.E. quadrant of the Cyclone. These are:

On the 7th...S.E. (3); E. (1); N.E. (2).
8th...N.E. (2, 5, 6, 7).
9th...N.E. (8); E. b. N. (7); E. (7).
10th... E. (7); N.N.E. (6); N.W. (3); N. (1); W. (3) variable.

The barometric curves shew that the mercury began to fall on the 6th at Melbourne, Hobart Town, and Sydney; but not until the 8th at the Auckland Islands; demonstrating the Easterly progressive motion of the Cyclone. In the diagram VIII, the figures 28, 29,

and 1, are the positions of the Duke of Lancaster on the 28th and 29th of July, and 1st of August respectively. The lower Cyclone (a) is in the position assigned to the 30th July, when the weather was moderating at 29, where there had been "hard S.W. gales, terrific squalls, hail, and thick snow showers" on the preceding day. In the Straits, the brig William had furious westerly gales, a terrific sea, lightning, &c., on the 29th and 30th; and at the Auckland Islands the Fantôme had the wind from N.N.E. on the 30th and 31st July, and afterwards from E. and S.E.

The second, or upper, Cyclone (b), is in the position assigned to the 6th and 7th of August, causing a South East gale at Portland, an East gale in the Straits, and N. and N.E. gales off the coasts of New South Wales. The Duke of Lancaster, off the S.W. Cape of Van Diemen's Land, has hard E.N.E. gales, and the Fantôme, on the 7th, has the wind increasing in force from 1 to 5, 6, 7, 8 on the 9th, and veering from E. to N.E. By supposing the upper Cyclone to have moved a little towards the E.S.E., it will be easy to trace the origin of the strong S.W. gales encountered by the Zone and Thomas Lord to the North of Sydney, after the 13th August.

The reading of the barometer at Melbourne at midnight of the 8th August is 27·38, showing a fall of two inches in the preceding 24 hours, and there is a rise of two inches during the following day. If this is not an error of the press, 27 being printed for 29, such a great and sudden fall and rise would indicate that the very centre itself passed over Melbourne, which seems probable from other considerations.

The supposition of the passage of two successive Cyclones, in the tracks which have been assigned to them, will be found to explain all the meteorological phenomena that have been here recorded. No false theory could bear the application of such a host of independent tests without betraying discrepancies or contradictions.

Each of the Cyclones just investigated may be regarded as the type of a class to which Bass's Straits are obnoxious. The first producing the well-known gales described by Flinders 40 years ago, which change from N.W. to S. and S.W.; and the second those which change from N.E. to E. and S.E.

It is gratifying to be able to confirm, by such good and conclusive evidence, the suggestion hazarded by Mr. Piddington, one of the

best writers on Cyclonology, and certainly the best teacher of the practical application of the art.

Having now established a general rule for the motion of the Gales on the South Coast of Australia, we are enabled to interpret and explain the nature of isolated cases like the following, given by Sir James Ross, in his account of the Exploring Expedition, carried on in the Erebus and Terror :—

"1840, August 12.—Noon, S.W. Cape of Van Diemen's Land, bearing N.E. b. N., distant 9 or 10 leagues. The wind increased so suddenly and violently that we could hardly take in our sails quickly enough, and in a few minutes were reduced to close-reefed mainsail. At 8 P.M., when blowing a perfect hurricane, the lee maintop-sail sheet gave way, and in one instant the sail was rent into numberless ribbons, and soon entirely disappeared. The only sail then left on the ship, a new mainsail, was soon afterwards blown away. No canvas could stand against such a storm. At 10 P.M. barometer 28·16, and although it then began to rise, we could not perceive the slightest abatement of the hurricane until after midnight, when it gradually moderated, and at the same time *shifted from North to West*. It continued to blow a storm of ordinary violence, with only occasional furious squalls, throughout the 13th, 14th, and 15th, when, having been driven a great distance to the Southward, we again stood in shore ; we saw the land of Tasmania at 3 A.M., and anchored in Storm Bay at 11 P.M."

This Cyclone was moving to the S. of E. At Circular Head (7), at the Hampshire Hills (8), and at Hobart Town (9), the wind shifts from N. to W., and then to S.W. On referring to the barometric curves for each of these places, it will be seen that the depression increases at the Southern Stations, and was greatest at the ship, which lay farthest to the South. This fact, and the veering of the wind, shew that the centre lay to the South of Van Diemen's Land. (Fig. X., A, 7, 8, 9.)

The following two instances of Easterly progression in a high latitude occur at pages 167 and 181, vol. i. respectively, of the same work.

"1840, Dec. 25.—A strong gale, constant snow and rain as

usual, attended the *Northerly* Gale. Hove to. Noon, 62° 10′ S. 170° 24′ E.

26th.—Wind veered to *Westward*, hove to until 2 P.M. Stood to Southward.

27th.—A strong *South Westerly* Gale, clear weather, and violent squalls, with snow-showers. Early next morning the Gale moderated."

The centre of this Cyclone lay to the South of the ship; in the next case, the centre lies to the North of it.

"1841, Jan. 8.—8 P.M., increasing breeze from N. with thick snow.

9th.—Northerly breeze increased to a strong gale, reducing us to close-reefed topsails. Noon 69° 15′ S. 176° 15′ E. The wind veered round gradually to *Eastward*, and blew with great violence until 2 A.M. of the 10th, when it began to abate, and by 9 A.M. had moderated so much as to admit of our setting reefed courses. Noon, 70° 23′ S. 174° 50′ E. The wind soon afterwards veered to the S. E."

I regret that I have not been able to procure more information respecting the Gales which prevail at New Zealand, which appears to lie in the way both of the Cyclones of the South Pacific, and of those of the South Indian Ocean. Meteorological observations at this point would have an additional value on account of the occasional activity of the Volcanic forces in those islands. The following severe Cyclone experienced there by Captain Cook, seems to have belonged to the Port Essington Class.

After leaving the Bay of Islands in order to pass round the North Cape of New Zealand, Captain Cook appears to have fallen in with the Northern half of a violent Cyclone moving to the Eastward, and which had therefore probably passed along the South Coast of Australia previously. The details are given with Cook's usual precision, at page 159 of the First Voyage; the Storm began at N.N.W., veering to W., with a large swell rolling from Westward. On the 28th December, 1769, it veered to S.W., and increased from a gale to a hurricane, with a prodigious sea. Nothing is said of the behaviour of the barometer, but Cook's concluding observations shew the violent nature of the Storm: he says, "it is very remarkable, that in 35° S. and in the midst of summer, I met with a gale of wind, which,

for its strength and continuance, was such as I had scarcely ever been in before; and we were three weeks in getting 10 leagues to the Westward. During the gale we were happily at a considerable distance from the land, otherwise it is highly probable that we should never have returned to relate our adventures."

Captain Brown, of the brig Emma, has favoured me with his Journal of the voyage of the ship Strathisla, from Auckland, New Zealand, to London, in 1846, which enables me to trace this class of Cyclones far to the Eastward of New Zealand. On the 23rd Oct. the ship was hove to, in a heavy gale from the North. On the 24th the wind shifted from N. to N.W.; from N.W. to W.; and from W. to S.W., which *hove the sea up in sugar-loaves*, and caused the ship to strain and labour much. Position 52° S. and 131° W.

This exactly describes the passage to the Eastward of the Northern portion of a Cyclone, with the pyramidal seas caused by the interference of the superimposed ridges at the central area.

Colonel Reid has shewn that the gales in the neighbourhood of Cape Horn are probably produced by Cyclones passing to the Eastward, so that there seems reason to believe that Cyclones pass from South Australia across the whole breadth of the South Pacific Ocean. In the voyage of Captain Weddell towards the South Pole (1822-3) occur several instances of gales shifting "from N.N.W. to S.W., and leaving a most distressing sea." When off James Island, New South Shetland, in 62° 52′ S. and 62° 30′ W. they experienced a severe hurricane, in October, 1823. On the 26th Oct., A.M., wind shifted to North, and weather became foggy, and soon after freshened from N.W. to such a degree as to oblige them to take in the foretop-sail, and it was with difficulty they obtained an offing. On the 27th, a great Westerly swell; at midnight a gale at West. At 8 A.M. of the 28th the wind shifted suddenly into the S. W., and increased to a complete hurricane. Sail reduced to the size of a mere napkin, and cold intense. In consequence of the wind having shifted, the sea ranged on board *on the lee side*, sweeping everything before it. The gale continued with great violence from the S.W. by S. On the morning of the 29th it moderated, and afterwards continued at S.S.W. Lay to, many ice-islands rolling with the noise of an earthquake.

This Cyclone was clearly moving towards the E.S.E. When we see a

vessel near a dangerous and desolate coast, surrounded by huge icebergs, and on the point of being involved in a furious hurricane, we cannot fail to be forcibly reminded of the value of a Science which would enable her anxious commander to *foresee*, and therefore to *prepare for, and profit by*, a series of successive shifts of wind, which are certain to occur during the next few days in a fixed order. Among Captain Weddell's observations on the winds and weather in the neighbourhood of Cape Horn, the following quite establishes, both the Cyclonic nature of the prevailing Gales, and their Eastward progressive motion. At pp. 237-8, he says, "A North Gale comes on gradually, draws from the N.W., and brings rain, and presently shifts into the S.W., without ceasing to blow, and continues from that point 12 or 15 hours. A vessel may anchor anywhere for shelter from a S.W. wind, without fear of its *shifting to the Northward;* but the contrary must be guarded against, *as the wind shifts from N.W. to S.W.*, continuing to blow with great violence." Captain Weddell states that Bridgman's Island, in 62° 4′ S. and 56° 57′ W. is volcanic, having seen it emit smoke while passing it within 200 yards in 1821.

As little is known of the Cyclonology of this part of the track of the Australasian homeward bound Traders, I shall give here an extract from the log of the barque Berwick Castle, from Dundee to Valparaiso, from which it appears that she was carried around and in front of the centre of a Cyclone, to the North of the Falkland Islands in 1848; the Cyclone moving to the South-Eastward.

After several days of light winds, the barque was in 42° 22′ S. and 50° 33′ W. at noon of the 21st February, 1848.

"22nd Feb.—Midnight, increasing breeze, W.N.W.; rain, thunder, and lightning. 8 A.M., double-reefed topsails, strong wind and heavy sea. Noon, 44° 9′ S., 52° 6′ W.

23.—Strong gale, W.N.W., heavy showers of hail, hove to. Noon, 44° 47′ S., 51° 36′ W.

24th.—Strong Gale, W.N.W., hard squalls. 6 A.M., more moderate. Noon, 45° 10′ S., 51° 5′ W.

25th.—Variable, *clear*, out reefs. 6 P.M., *calm*. 10 P.M., increasing breeze, N.E. Noon, 45° 53′ S., 50° 31′ W.

26th.—Fresh breeze N.E. and hazy. 10 P.M., wind E.N.E. 6 A.M., strong *East* wind, and rain, in studding sails, &c. 10 A.M., E.S.E. Noon, S.E. 47° 35′ S., 53° 45′ W.

27th.—*Strong S.E. gale*, and heavy rain. 6 P.M., wind S.S.E. 10 P.M., South, hove to under maintop-sail. Midnight, more moderate. Noon, light S.S.W. wind, out reefs. 47° 7′ S. 54° 33′ W. Afterwards a heavy swell from S.W."

By marking off on a chart the successive positions of the ship, it will be seen to have actually described a track, nearly semicircular, to the Eastward, while the successive shifts of wind from W.N.W. to S.S.W. shew that it was carried through *three quarters* of a circle *relative to the moving centre* of the Cyclone. This relative track may be conceived by supposing in fig. V, the Berwick Castle to start from D, and to be carried round the *right hand portion* of the circumference until it reaches a point near to C 1.

In nearly the same position, in March 1849, the Berwick Castle met a Cyclone, in which the successive shifts of wind were N.E.; E.N.E.; E. b. S., with a lowering barometer and rain; S.E. and S.S.E, a heavy gale and a heavy cross sea running from South; W. b. S. with a heavy cross sea from S.W. Hove to. W.S.W., and S.W. gales, squalls, and showers of hailstones. Eight days afterwards sighted the Falkland Islands. The centre passes to the Eastward, and North of the ship.

In sailing from Australia towards Cape Horn, mariners have frequently observed a sudden and considerable barometrical depression without experiencing the usual gales of which such a fall is considered a certain prognostication. A detailed instance of this is given in a recent number of the Nautical Magazine, and I have met with another well-marked instance in the excellent Journal of Captain Harmsworth, of the barque Derwent. The following is suggested as a probable explanation of this apparent anomaly. Considering, for the nonce, a Cyclone to be a *conical spout* piercing the Atmosphere vertically, as in fig. I, it may be easily conceived that one of the Port Essington class may have become considerably exhausted by the time that it has reached the meridian of New Zealand; and that in passing on towards Cape Horn, the huge eddy may cease to reach down to the surface of the earth, and may therefore cease to create a *whirlwind* on the ocean; although the barometer will not fail to recognize the sudden removal of the superincumbent air, as the otherwise unnoticed eddy passes over the ship. This is, in fact no more than an extension of Mr. Piddington's

notion of the *lifting up* of a Cyclone, and is analogous to the *drawing up* of an exhausted waterspout. In such cases as these, the sailors, who have been called to make all snug, may grumble at the Captain's "barometer-gales," but the faithful instrument never gives a false alarm; the enemy was in reality hovering above the vessel, though his arm was not long enough to reach her.

An inquiry into the nature of the Gales of the Coasts of South Australia, Victoria, New South Wales, and Van Diemen's Land would be incomplete without such a notice of the peculiar *hot winds* that proceed from the interior of Australia, as may put the seaman on his guard against their effects. These winds occur three or four times every summer, and continue from 24 to 36 hours. They blow from the North Westward, causing the thermometer to rise to upwards of 100° F., and are succeeded almost instantaneously by a violent Southerly wind, which lowers the temperature so rapidly that the thermometer has been known to fall 25° in 20 minutes. Their arid parching nature not only injures the fruit and crops, but leaves the timber and herbage an easy prey to the "bush fires" which prevail, whether by accident or design, during the summer months.

The most fearful and destructive visitation of this kind occurred on Thursday, the 6th February, 1851; a day ever since distinguished in the Australian calendar as "Black Thursday." The loss of life was serious, but the loss of property was immense and extensive. The fires swept over a tract of country of upwards of 600 miles in length. A few abridged extracts from the newspapers of the period will shew the nature of this fiery tempest both on land and at sea.

The most striking features of the Cape Otway country are, the immense size and crowdedness of the timber trees, and the density and luxuriant growth of the fern scrub. This *scrub*, in ordinary circumstances, burns slowly; while a fire may continue for weeks in some parts of the *timber* without extending far. Such a fire was, in fact, known to have existed for a month past in the mountain ranges, but no alarm was felt in consequence. The hot blast of Thursday, however, playing upon the kindled nucleus, caused the fire to spread with such fury that the dense scrub was swept away like stubble, and the flames were carried along the tops of the trees,

leaving the massive trunks ignited wherever any decayed, hollow, or dead branch gave the fire a nestling place.

The body of flames came down with such rapidity from the mountain ranges towards the coast, that those who left their huts for a few hours found all swept away on their return.

At Portland there was a furious hot wind from N.N.W., and thermometer in the sun 116°. After noticing the destruction of much property on shore, we are told that, at sea, the weather was even more fearful. Captain Reynolds reports that, on Thursday, when twenty miles from the Laurence Islands (in Portland Bay) the heat was so intense, that every person on board was struck almost powerless. A sort of whirlwind in the afternoon struck the vessel, and carried the topsail, lowered down on the cap, clean out of the bolt-rope; and had he not been prepared for the shock, the vessel, he has no doubt, would have been capsized. Flakes of fire were at the time, flying thick all around the vessel, from the shore in the direction of Portland.

The Portland Herald states that the Master of the Henry Edward (Mr. T. Maybee) on arriving at the Laurence Island, on Thursday, experienced a hurricane of hot winds, which parted the vessel from her cables, riding at 100 fathoms on each cable. The fire flew above the vessel in large flakes, which burnt the running gear, so that the sails fell down on deck, and the great difficulty of the Master and crew was to prevent the sails taking fire. The lights below were lit from 11 A.M. to 2 P.M., and burnt as blue as possible. After this the gale ceased, and blew from the W.S.W. a moderate breeze.

The Geelong and Melbourne papers are filled with accounts of the wide-spread destruction of flocks of sheep, horses, crops, buildings, &c.

About 4 P.M., the black roaring tempest had crossed the Straits to V. D. Land. The ship Tasman on the evening of Thursday was off Cape Pillar and was covered with dust and burnt wood. The land was invisible, and the ship driven so far to the S.E. that she only sighted land again on Saturday.

The following notices occur of the passage of the tempest across the Straits.

On 6th February a Captain of a vessel, about 60 miles from Port Fairy, saw an ominous cloud on the horizon, and immediately took in sail. He had scarcely done so, when the vessel was laid on her

beam ends, and the atmosphere became oppressively hot. Hundreds of birds of all descriptions, driven by fire and wind across the sea, tried to alight on the masts."

Extract from the log of the Velocity, M'Veigh, from Sydney :—

"Thursday, Feb. 6.—Noon, light breeze from N.N.E. inclined to be hazy. 12h. 10m. rapid scud flying from N.W., took in all studding sails, reefed topsails and foresail. 2 P.M. wind roaring terrifically *over* the ship, a great quantity of sand and leaves falling on board, ship at this time *becalmed*. 3 P.M. the sky had the appearance of livid fire, the hands on deck looked more like demons than men. Quantities of burnt bark, leaves, and birds falling on deck. 3½ P.M. squalls. 4½ P.M. in total darkness such as I never experienced before, sun this evening set at 7, heat excessive. At 5 P.M. electric lights all over the ship, heavy squalls with lightning and thunder, which continued until 9h. 45m., ship under bare poles. The wind then came in squalls from W.S.W. At 5 P.M. barometer 29°. Wilson's Promontory bearing about W. b. N., distant 18 miles."

The ship Diana, 527 tons, Captain Fletcher, from Manilla to Sydney, was then off Kent's Group, to the Eastward of Bass's Straits. Captain Fletcher states :—

"At noon, Feb. 6, we were in 39° 3′ S. and 147° 26′ E. A clear sky overhead, but a strong haze all round. At 1 P.M. the haze increased in thickness from E.N.E., by N. to N.W., extending up to the sun and preventing it from casting a shadow. At 1·30 the breeze freshened, bringing more haze with it, which increased so fast that at 2 P.M. the sun was invisible; and at 3 P.M. it was difficult to read in the cuddy. Small dry dark burnt-looking leaves were borne along by the breeze; and a considerable quantity of dragon-flies. At 3 P.M. the breeze was light, the haze increasing in thickness in the W.S.W., and assuming a peculiar dark-looking colour. At 3·15 the haze began to disperse a little in the S.W., the breeze shifting to N.W., increasing, and bringing hot puffs of wind with it. Sail was at once reduced so as to prepare the ship for the worst. At 3·30 the haze thickened all round, increasing so fast that at 4 P.M. it was as dark as it ever is at night. The sun, however, made one more attempt to exert its power by tinging the haze red for about a quarter of an hour soon after 3·30 P.M. At 4·15, the whole heavens were darker than ever remembered by any one on board.

It was literally impossible to see even a mast whilst standing within half a yard of it, much less any of the upper spars; the boom, painted white, could not even be seen, the darkness was complete. The breeze from 3·14 to 4 was variable between N.W. and W., bringing with it a fine black dust very similar to powdered charcoal, in addition to hot wind, the hottest of which came from W. in gusts; in the face of which the thermometer rose to 98°, and no doubt would have risen much higher, had the gusts lasted long enough to affect the mercury fully before the colder portion of the breeze blew upon it again. At 4·15 the breeze settled down at N.N.W. increasing fast, so that at 4·30 it blew *a fresh gale*, continuing so until 5·45, when it began to lull and at 6·30 had fallen to a moderate breeze. During this period, viz: from about 4·30 to 5, we had an exhibition of the phosphoric lights, illuminating the points of the three top-gallant yards, the gaff, and fore-topmast studding sail boom ends, and the royal yard lifts, both to leeward as well as windward, these latter being quite covered with it.

This gale brought with it a great quantity of the fine dust, preventing any one from looking to windward.

From 7h. 30m. P.M. it blew hard again in squalls, the air becoming cooler during that time. At 8h. 30m., the breeze since 8 having been light and variable from N.W. to S.W., a most severe gust came from the W., lasting about a minute, when it settled down into a strong breeze from that quarter, bringing more hot wind; this breeze, however, only lasted till 8h. 45m., when another severe gust came from the *South*, settling down into a strong breeze from S.W., phosphoric lights again appearing on the royal-yard points, though not to the same extent as previously. The S.W. breeze continued steady until 2 A.M. of the 7th, when it veered to the Westward, and the darkness then for the first time began to show symptoms of decreasing, so that at 2h. 30m. A.M. the masts and yards could just be distinguished; at 3 the horizon pretty plainly; and at daylight the sky merely presented a very hazy aspect; the sun, however, was not at all visible until 6 A.M., when it appeared as a red ball, and at 7h. 30m. A.M. again cast a shadow."

Captain Fletcher has given 36 readings of the barometer from noon of the 5th to noon of the 7th; I have projected these in a curve in fig. VII. The mercury falls from 29·66 at noon of the 5th to its minimum 29·31 between 2 and 3 P.M. of the 6th, and rises to

29·645 at noon of the 7th. The shower of burnt leaves, &c., reached *New Zealand* (Otago) on the morning of the 7th February.

In V. D. Land on the night of the 6th a violent hurricane accompanied the hot wind. At Hamilton, the crashing and uprooting of forest trees was sublime, fences, palings, &c., were whirled in mid-air. The heat was intense. The whole of the "new country" adjacent to the Repulse and Gordon Rivers was in flames.

At New Norfolk property worth £1000 was destroyed. A verandah was blown some yards into the air, and alighted on the house.

Two seamen of the Alcmène, French Corvette, were drowned at Hobart Town, by the capsizing of a boat. The hurricane at Hobart Town was accompanied by vivid flashes of lightning, but no thunder nor rain.

In a hot wind the thermometer will be a much more sensitive index than the barometer. Though the hot wind was the proximate cause of the Atmospheric disturbance on the 6th February, yet the resulting phenomena both on land and at sea were undoubtedly greatly influenced by the immense area in a state of intense conflagration. The barometrical and thermometrical fluctuations were therefore the results of the combined action of the "bush fires" and the hot wind. The effect on the barometer of a *hot wind alone* I have shown by a curve of 18 readings during 15 hours, at Sydney, on the 23rd and 24th March, 1849. (Fig. VII.)

These comparatively inconsiderable barometric depressions tend to shew that the Atmospheric disturbance produced by a hot wind is not a Cyclone.

ADDENDA.

In the Addenda to the second edition of the "Sailor's Horn Book for the Law of Storms" is the following notice of a Cyclone met with in 1847 to the Eastward of Torres' Straits, and which Mr. Piddington supposes to have been moving toward the South West:—"The French brig Anonyme experienced on the 30th December, 1847, a severe Cyclone, commencing in 14° 23′ S., and in long., by account, 159° 41′ E.; in which, after scudding a short time with the wind at about S.E., or from S.S.E. to E.S.E., *she was hove to*, and had the calm centre passing over her. It is noted in the extract from her log (nothing more being sent) that at this time it was calm, with a heavy sea, and "the clouds were driving from the South East and North West, with equal velocity." It is not said, which would have completed the description, if they were on opposite sides of the horizon, or above each other, but in half an hour the breeze sprang up at North West, freshening to a hurricane from that quarter, in which the brig scudded till she could scud no longer, till she finally hove to, and the Cyclone left her. This decided shift at the centre from about South East to North West would indicate a track coming down *from the North East* in that quarter." A correct inference, *if the vessel had been nearly stationary.*

The position of the Anonyme during the Cyclone in 1847 was to the North Westward of the place where the Nimrod and the Rifleman encountered their respective storms (pages 35 and 39), which have been shown to have moved towards the South East. On referring to fig. V. it is easy to conceive how the Anonyme might drift *across the central space* out of the South West quadrant into the North East one, while the Cyclone was really advancing *towards the South East.* This case is similar to that of the Two Friends in April, 1850 (fig. IV.) which vessel, doubtless, drifted round the central space. By neglecting this drift both Cyclones would appear

to move towards the S.W., whereas all those of the Samoan and New Caledonian class, that present sufficient data for determining their track, have been shown to move towards the South East. The several instances given in this work of an erroneous track having been deduced in consequence of neglecting to allow for the circular drift of a vessel when hove to in a Cyclone show the importance of this element of the investigation.

By referring to fig. III. it will be seen that vessels in an Atmospheric Cyclone are at the same time involved in an immense *marine whirlpool*, (nantes in gurgite vasto), around which both the wind and current combine to drive them.

At page 23 I have recorded the occurrence of a hurricane in 1843 at Raiatea, one of the Society Islands. I have since found in chap. xiii. of vol. 2 of "Ellis's Polynesian Researches," a description of another hurricane in this locality, which was met by Mr. Ellis, when on a voyage from Huaheine to Raiatea in 1819. During the tempest "the sea rose, not in long heavy billows, but in *short, cross, broken waves*, and there were seen four large waterspouts, if not more, so that we seemed almost surrounded with them." Mr. Ellis adds that waterspouts are "often seen among the Society Islands." Dr. Thom and Mr. Redfield have shewn that Cyclones in the South Indian Ocean, and in the West Indian Seas, may contain *several waterspouts* within their circumference. We have here an analogous phenomenon in the South Pacific Ocean.

Respecting the Cyclones in the neighbourhood of Cape Horn, I have gleaned the following information from the Observations of Captain King, Captain Stokes, and Captain Fitzroy, during the voyages of the Adventure and Beagle :—

"When in the Straits of Magalhaens, on the 14th June, 1828, the barometer *fell* to 29·27, and the wind blew a hard gale from N.E.; but in the afternoon it veered round to S.W., and the mercury *rose* rapidly. A gale from S.W. followed."—Vol. i., p. 149.

Off Cape Corso, in April, 1828, Captain Stokes says, "the gale continued with unabated violence during the 6th, 7th, and 8th, from the N., N.W., and S.W., with a confused mountainous sea."—p. 161.

"The gales we have experienced generally commenced at North, thence drew round to the Westward, from which point to the S.W. they blew with the greatest fury, and hauling to the Southward, usually abated to the Eastward of South."—p. 162.

In April, 1830, while the Beagle was in Christmas Sound, there occurred a "barometer-gale," (see page 94.) The mercury fell to 28·94, and the oil in the sympiesometer to 28·52, "lower than I had yet seen them in this country. Struck topmasts, and prepared for the worst. 5th and 6th.—Two more fine days, with a very low glass, shook my faith in the certainty of the barometer and sympiesometer. During those days, the wind had been light from the N.N.W., and *twice before* I had known these instruments to be similarly affected during exactly similar wind and weather; once at Port Desire, on the coast of Patagonia, and once at Port Gallant, while I was in the Otway Water. 10th.—Still fine steady weather, notwithstanding the unusually low fall of the barometer. 12th.—The glasses had at last been rising. Wind strong, with much rain, shifted from the Northern quarter in to the Southern."—Captain Fitzroy, pp. 426-9.

On the 12th and 13th January, 1833, when in 56° 20′ S., and 69° 10′ W., the Beagle met with a tremendous storm, which was severely felt on all parts of the South American Coast, south of 48°, as Captain Fitzroy afterwards ascertained from sealing vessels; and at the Falkland Islands, a French whaler, called Le Magellan, was driven from her anchors and totally wrecked in that land-locked and excellent port, Berkeley Sound.

Throughout the 12th, the wind was N.W., and from 7 to 8 in force, barometer fell from 29·42 to 29·04. At 6 A.M. of the 13th, wind W.S.W. (11), barometer 28·91; at 6 P.M. wind is S.W. (8), barometer 29·28.

At 1 P.M. of the 13th three huge rollers struck the Beagle, and turned her over so far that all the lee bulwark, from the cat-head to the stern-davit, was two or three feet under water.

The Transport, an American sealing schooner, and two others, were wrecked during this storm, on the S.W. Coast of Tierra del Fuego.

It will be seen that the progressive motion in each of the above instances is towards the South East.

ERRATA.

Page 15, line 29, for "Rarotongan" read Raratongan; page 20, line 5, for "form N.E." read from N.E.; page 24, line 28, for "Loughlin" read Laughlin; page 60, line 21, for "fig. VIII. V." read fig. VIII. V′; page 74, line 7, for "top-gallant-sail" read top-gallant-rail.

WILLIAM PRATT AND SON,
PRINTERS,
ELIZABETH-STREET, HOBART TOWN, TASMANIA.