



THE
NEW ZEALAND GAZETTE
EXTRAORDINARY.

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Customs Department (Marine Branch),
Wellington, 14th May, 1873.

The following Report of a Storm in the Bay of Bengal is published for general information.

JULIUS VOGEL,

In the absence of the Commissioner.

BAY OF BENGAL.

REPORT OF THE STORM OF THE 28TH JUNE TO THE 1ST JULY, 1872, BY W. G. WILLSON, ESQ., OFFICIATING METEOROLOGICAL REPORTER TO THE GOVERNMENT OF BENGAL.

State of the Weather previous to the Storm, as shown by the Telegraphic Reports received in Calcutta. Warning to Shipping. Warning Signals hoisted.

ON the 16th of June the atmospheric pressure round the Bay of Bengal was unusually high, and its distribution abnormal. This will be seen from the following Table, in which the barometric heights, reduced for temperature and sea-level, are compared with the average heights in the month of June, for several years, similarly reduced:—

	Mean Barometer, 16th June.		Average Barometer of June.
Calcutta ...	29·766	...	29·570
Saugor Island	29·769	...	29·563
Cuttack ...	29·749	...	29·630
Chittagong...	29·804	...	29·628
Akyab ...	29·794	...	29·710
Madras ...	29·728	...	29·701

The barometric gradient between Madras and Saugor Island, which accompanies the south-west monsoon, was thus reversed in direction, and, as a consequence, light variable winds prevailed in the north of the Bay, and a great deficiency of atmospheric precipitation was experienced all over Bengal.

2. On the 16th of June a change took place. The barometer commenced to fall at Akyab, Cuttack, and Chittagong on that day, and on the 17th at Saugor Island and Calcutta. From this, with the exception of a very slight tendency to rise on the 19th, the barometer fell steadily in the north of the Bay, while at Madras it continued to range at about the average for the season.

3. There was nothing exceptional in this fall until June 22nd and 23rd. On the latter date the atmospheric pressure in the north of the Bay was considerably lower than the average for the season, and light variable winds had prevailed for some days;

at Calcutta from S.E. to E. by N. ; at Saugor Island from S.E. to E. ; at Cuttack from N.N.E. through N. round to W. On June 24th a slight increase of atmospheric pressure was telegraphed from Akyab. On the 25th a corresponding rise was reported from Cuttack.

4. The state of the weather round the north of the Bay, on the 25th of June, approximated to that which usually indicates the formation of a cyclonic disturbance. Combined with the unusually low atmospheric pressure, light variable winds prevailed ;—at Calcutta from E.S.E. to E. by N. ; at Saugor from S.S.E. to E.N.E. ; at Cuttack from N. through W. to W.S.W. ; and at Akyab, a south wind, almost completely saturated with moisture. There was no immediate probability, however, that a storm was approaching Calcutta. Along with the experience that cyclones formed in the north of the Bay, so late in the season, seldom travel inland, some of the indications that precede cyclones were absent, viz., strong gusts of wind from some point between E. and N.E., with frequent showers and masses of clouds drifting from N.E. to S.W.

5. On the evening of the 25th of June a sudden fall of the barometer was reported from Akyab and Chittagong. At Akyab the fall from 10h. of the 24th to 10h. of the 25th was 0·119 ; at Chittagong, for the same period, 0·133. The telegrams conveying this intelligence reached me between 7 and 8 o'clock in the evening. I then considered it advisable to draw the attention of the Master Attendant to the very threatening state of affairs in the Bay, and to suggest the adoption of any precautionary measures with regard to the shipping that he might consider necessary. I also communicated with the Deputy Harbour Master, in answer to a letter of his asking for information. I then proceeded to the Telegraph Office to get reports from Saugor and Cuttack, and to warn the Observers there to send hourly reports if any considerable fall of the barometer or increase in the force of the wind took place. The line to Saugor was closed. However, after some delay and difficulty, I got a report from Cuttack, which was not unfavourable. The barometer, though very low, was not falling. As before stated, there had been a slight rise up to evening of the 25th.

6. From the night of the 25th until after the cyclone had passed, I was in constant communication

with the Deputy Harbour Master, Captain Falle, who had requested me to convey information of any changes in the state of affairs to him direct, in order to save time in transmitting the intelligence to the shipping. I am informed by him that warning was given on the afternoon of the 26th, and all precautions considered advisable were taken for the security of the shipping.

7. Up to the evening of the 26th the barometer continued to fall steadily all round the Bay, except at Madras, where it was as steadily rising. The atmospheric gradient between Madras and the north of the Bay was now excessive. This accounts for the long-continued south-westerly gales which were prevalent for many days across the Bay, south of a line between False Point and Cheduba Island, and which forced up into the north of the Bay the tremendous sea which caused such disaster to the shipping.

8. From the 26th to the 27th an increase of pressure, occurring first at Akyab, was propagated northwards to Chittagong and then over Bengal. On the 28th the barometer rose considerably at Calcutta, very slightly at Saugor, and later on more considerably at Cuttack. Up to the evening of the 28th, the increase at Akyab and Chittagong had been rapid and excessive; there was, however, but a very slight corresponding improvement at Calcutta up to the 29th, and the barometer at Saugor Island continued very low and extremely unsteady, rising and falling alternately, but showing no improvement on the whole.

9. Notwithstanding the rapid rise of the barometer to the eastward, the slight rise at Calcutta, and the more considerable rise at Cuttack, the state of affairs on the 29th appeared much worse, as far as Calcutta was concerned, than it had previously been. The winds had increased in velocity and were blowing steadily in cyclonic fashion round and towards a focus of low pressure which had now evidently moved from the S.E. towards N.W. further from Akyab and nearer to Saugor Island. At Akyab the wind was S.; at Chittagong E.N.E.; at Saugor Island N.E., and at Cuttack W. and W.N.W. Showers were frequent at Calcutta, with heavy masses of clouds drifting from E. by N. During the day the following extra telegraphic reports from Saugor Island, showing that the wind there had almost increased in force to a gale, were received at the Meteorological Office:—

HOUR.	Barometer reduced to 32°.	WIND.	
		Direction.	Velocity.*
4	29.172	N.E.	22.6
6.30	29.215	E.	19.5
9	29.226	E.N.E.	40.6
10	29.208	N.E.	30.5
11	29.203	E.N.E.	40.6
12	29.172	E.N.E.	40.6
13	29.194	E.N.E.	40.6
14	29.208	E.N.E.	30.6

* Velocity in miles per hour.

Rainfall=1.5—Humidity=100—sky overcast—weather very threatening and ugly, with frequent heavy squalls and rain, scuds flying from the N.E.

10. I received the 11h. and 12h. telegrams about 3.30 in the afternoon, and although the probabilities were still against the storm's approaching Calcutta, I determined to hoist the *warning* signals. My reasons for doing so were these:—The focus of low pressure was evidently unpleasantly near to Saugor Island; a cyclonic vortex might be in existence, although not

advancing, and if not in existence, the state of affairs showed that it might be formed at any time, and its advance might be sudden and with very little warning. If it did advance, it would do so along the line of least resistance, or lowest pressure, and there were no data sufficient to show that this line did not pass through Calcutta, where appearances had been threatening and the barometer very low and unsteady. It was probable that it lay north of Cuttack, from the previous rise of the barometer there. The warning signal at the Asiatic Society's building in Park Street was hoisted about 5 o'clock, directions having previously been forwarded to display the same signal (the double cone) at the Sailors' Home and the Khidderpore Dockyard. Shortly afterwards telegrams were received from Saugor showing a slight improvement, from about 2 p.m., in the state of affairs there. In Calcutta, the weather, which had been very threatening all day, cleared up in the evening, and the same change appears to have been experienced all over the Bay. (It is probable that a vortex was formed, or partially formed, on the morning of the 29th, but that it broke up again in the afternoon without advancing much, if at all.) This, however, was but a treacherous lull. Telegrams showing a fall of the barometer were received from Akyab and Chittagong; the barometer at Calcutta refused to rise; the wind directions had not improved in the least, and things became again threatening at midnight.

11. The morning of the 30th opened out brightly at Calcutta. Between 10 and 11 in the forenoon the appearance of the sky was wild and beautiful. Dark masses of low scuds flying past with great velocity from E.N.E. to W.S.W. seemed sometimes almost to touch the tops of the houses, whilst the sun shone out brightly between, and the snow-white flakes of rugged cirrus overhead appeared to float past in the opposite direction. As the day advanced, the sky became completely overcast; drizzling rain accompanied the scuds, which were now floating past in long black continuous masses. The evening telegrams showed a further fall of the barometer at Saugor Island, Chittagong, and Akyab.

12. Up to 8 o'clock in the evening the atmospheric tide at Saugor was not affected. The barometer was very unsteady from that hour, rising and falling rapidly and suddenly up to 9.30, from which time it fell steadily, reaching its lowest, 29.052, at 3 in the morning of the 1st July. During the night of the 30th and the morning of the 1st, I received the following special telegraphic reports from Saugor Island:—

STATION.	Month.	Date.	Hour.	Barometer reduced to 32°.	Barometer reduced to Sea Level.	WIND.		Weather Initials.	
						Direction.	Velocity.*		
Saugor Island	June	30	20	29.186	29.192	N.E.	40.4	n.	p, o, u.
			21	152	153	"	40.4	n.	
			21.55	187	193	"	40.4	n.	
			22	163	169	"	40.4	n.	
			0.30	111	117	E.N.E.	40.6	n.	
			1	100	106	"	40.6	n.	
			1.30	074	080	"	40.6	n.	
			2	071	077	"	40.6	n.	
			2.30	065	071	"	50.8	n.	
			3	052	058	"	50.6	n.	
Ditto	July	1	5	065	071	E.S.E.	51.0	n.	r, o, q, u, lr.
			5.30	095	101	"	51.0	n.	r, o, q, u.
			6	115	121	"	51.0	n.	
			6.30	153	159	"	41.0	n.	
			7	166	172	"	41.0	n.	
			7.30	197	203	"	41.0	n.	
			8	208	214	"	41.0	n.	
			8.30	235	240	"	41.0	n.	
			9	246	252	S.E.	41.2	n.	

* Velocity in miles per hour.

13. The wind thus increased in force with violent gusts, and between 3 and 6 in the morning was blowing a fresh gale. The veering was steady from N.E. to S.E., showing that the centre of the storm passed south of Saugor, from east towards west.

14. In determining the changes of position of the centre of a cyclone from the veering of the wind, it must be borne in mind that the direction of the currents is not round a circle, but in a spiral, differing about two points or more from the circular direction, although close to the centre the direction is probably more nearly circular. I use the following rule for the Northern Hemisphere:—To find the bearing of the centre, *stand with your face to the wind and measure round to your right hand side about ten points (not eight)*. (When the centre is at a distance, it may bear 11, 12, or 13 points from the direction in which the wind is blowing. For the Southern Hemisphere the 10 points would be measured round to the left.) Thus at 10 p.m. the wind was N.E., and the bearing of the centre consequently about S.S.E.; at 1 a.m. the wind was E.N.E. and the centre S.; at 5 a.m. the wind was E.S.E., the centre of the cyclone had moved on to S.W.; at 9 a.m. the wind was S.E., showing that the centre had moved on to W.S.W. The vortex was nearest to Saugor Island between 3 and 5 a.m., bearing then about S.S.W. From 5 a.m. the barometer rose rapidly and steadily.

15. The atmospheric tide was not affected at Calcutta during the passage of the storm. The barometer was very steady, and although falling at first, commenced to rise when things were looking worst at Saugor. There was never much apprehension during the night that the storm would come up to Calcutta. From a copy of the register kept at the Surveyor-General's Office Observatory, kindly supplied to me by Colonel Gastrell, I was enabled to compare the reading each hour of a standard barometer corrected to the Calcutta standard (Newman's No. 86), with the reading of the Calcutta standard at the same hour of the previous night. There was a fall up to about 2 in the morning, and from that hour a steady rise. The wind blew sometimes, particularly in the early part of the night, in strong gusts, and veered unsteadily from E.N.E. to S.E. This will be seen from the following register, kept at the Surveyor-General's Office:—

Station.	Month.	Date.	Hour.	J. Newman's Standard Barometer No. 86, reduced to 32°	Rise or fall since previous day same hour.	Direction of Wind.
Calcutta ...	June	30	17	29.276	—036	E. by N.
			18	284	—066	"
			19	304	—055	"
			20	313	—065	E. N.E.
			21	340	—050	E. by N.
			22	346	—066	E.N.E.
			23	332	—070	"
			Mid-night.	329	—073	"
			1	309	—070	"
			2	287	—083	E. by N.
			3	285	—071	E.S.E.
			4	279	—067	E.
			Ditto ...	July	1	5	295	—059	"
6	315	—058				E.S.E.
7	329	—054				"
8	336	—047				S.E.
9	347	—050				S.S.E.
10	366	—008				"
11	373	plus .004				"
12	379	plus .024	E.S.E.			
13	372	plus .044	S.E.			

16. About 10 o'clock on the forenoon of Monday the reports from Saugor showed that the cyclone had passed on to the westward, and appearances were so favourable both there and in Calcutta, that it was considered safe to take down the warning signals which had been hoisted since Saturday evening.

17. The next intelligence of the further progress

of the storm came from Cuttack. The following special reports were received during the afternoon:—

Station.	Month.	Date.	Hour.	Barometer unreduced for Temperature.	WIND.	
					Direction.	Velocity.*
Cuttack ...	July	1	12	29.250	W.S.W.	10
			13	200	S.W.	39.5
			14	200	"	16.2
			15	220	"	25.5
			17	260	"	38.1
			18	330	S.S.W.	21.5

* Velocity in miles per hour.

From this table it will be seen that at 1 p.m. the vortex was north of Cuttack, passing on afterwards to N.N.W., and finally to N.W. The centre was probably nearest between 3 and 4 p.m., when its bearing was N.N.W. The wind never blew stronger than a stiff breeze. It will appear further on that the cyclone passed a little to the south of Balasore in a westerly direction about 9 o'clock in the morning. Coming in contact with the hills to the west of Balasore its westward progress was checked, and, as the Cuttack register shows, it curved round and moved slowly in a south-westerly direction, its energy being probably nearly exhausted when it passed at some distance to the north-west of Cuttack on the evening of the 1st. I have no accounts of its further movements.

Meteorology of the North of Bay of Bengal previous to the formation of the Cyclone. Tables Progress of the Storm. Logs of Ships. Weather Prognostics. Warning Signals.*

18. The atmospheric disturbance in the Bay of Bengal, preceding the formation of the cyclone, has been already partially discussed. The wind currents had been blowing for some days round and towards an area of low pressure, extending probably from about lat. 19° N. long. 91° E. in a direction a little north of False Point. The sudden fall of the barometer on the 25th at Akyab seems to indicate that the eastern focus of low pressure was then nearest to that place. From the logs of ships it appears that along and south of this area of low pressure, south-westerly gales, accompanied by continuous and excessive rainfall, prevailed, the wind directions being more westerly towards the western extremity and more southerly towards the eastern extremity. North of the area of low pressure, which probably extended towards Chittagong, following in some measure the configuration of the coast line, the winds were light and unsteady, mostly from S.E. to E.N.E., and accompanied by very little rainfall.

20. I had here purposed putting forward certain theoretical views, which I think are strongly supported by the evidence of facts and meteorological observations, with regard to the formation of cyclones and the reasons why they occur at different periods in different parts of the Bay of Bengal. Although the tables were constructed with this object in view, I found that it would be impossible to enter into sufficient details of all the evidence and data, and the account was necessarily only a sketch of a theory involving unsettled questions connected with the monsoons and the whole system of normal winds of India. Views, more or less new, upon such questions of meteorology, must be open in a great measure to dispute, and I have hence thought it better to withdraw them from this report and reserve them for presentation to some scientific society, where they can be advanced with all the evidence and data, and discussed in full detail.

* Logs of ships and weather prognostics, being lengthy tables, are not printed.

21. From the 25th to 29th a change took place in the position and extent of the belt of low pressure. Its eastern focus moved further to the north-west, and its western focus further north. This is shown by the rapid rise of the barometer to the eastward at Akyab and Chittagong, and afterwards the less considerable rise at Cuttack. It is also indicated by the gradual change of the directions of the air currents. At False Point and Cuttack the wind had veered round from N.E. on the 23rd through N. round to W. on the 25th, and W.S.W. on the 27th. At Saugor Island the wind directions, which had been mostly S.E. and E.S.E. up to the 25th, gradually became more northerly. A similar change took place at Chittagong. At Akyab the easterly directions had altogether disappeared on the 27th, the wind being almost steadily from the south, but occasionally going round to S.S.W. As the area of low pressure in the Bay concentrated and moved further north and west, the N.E. currents at its north-western extremity, as a consequence, became more powerful. At Saugor Island the daily velocity in miles increased from 236.6 on the 27th to 431.1 on the 28th, and 535.9 on the 29th. During the early part of the last day a steady gale was blowing from the north-east.

22. The following tables give an abstract of the meteorological observations of most of the ships that were in the north of the Bay for some days before and during the storm. The readings of the barometers are reduced for temperature, in all cases where the temperatures were recorded, and the mean of all the

readings taken during the day is given. As many of the ship barometers as I could obtain have been compared by me with a standard barometer (Casella's No. 636) at the Meteorological Office, whose error to the Calcutta standard (Newman's No. 86) is known. In such cases the corrections to the Calcutta standard have been applied. In many cases the latitudes and longitudes given are obviously incorrect. In some cases they would place the ship on dry land. Of course these would be merely errors in the copying of the extracts which I received. But more dangerous errors than these occur. For many days, owing to the continued bad weather, the ships were unable to obtain observations, and the latitudes and longitudes had consequently to be reckoned by account. These are not to be trusted. For example, on 29th June, the "City of Madrid" was by account in lat. 19° 7' N., long. 89° 53' E. By observations obtained the same day, she was in lat. 17° 36' N., long. 90° 28' E., thus showing her true position to have been much south and east of the position by account. The captain of the "Scimitar" states that from the 25th June to 3rd July no reliable observations could be obtained, and thinks it probable that the ship was much farther to the south and east than the latitudes and longitudes by account appeared to show. The pilot brigs do not seem to possess chronometers, and once they leave their stations, which they all did in the late storm and went southwards, "have to trust to any stray ship they may come across to give them their latitude and longitude." Hence their observations are of little use in determining the course of the storm.

TABLE I.

Barometers; Latitudes and Longitudes.

		23rd.	24th.	25th.	26th.	27th.	28th.	29th.	30th.	1st.
"Sophia Joakim"	Barometer b	29.28	28.66	29.23	29.53	29.53	29.50	29.22	28.66	28.73
	Latitude	20° 40'	20° 5' ac.	20° 47'	21° 4' ac.	20° 40' ac.	20° 52' ac.	20° 38' ac.	20° 30' ac.	20° 35' ac.
	Longitude	88° 5'	89° 40' ac.	90° 21'	91° 2' ac.	91° 45' ac.	90° 37' ac.	89° 1' ac.	88° 33' ac.	88° 30' ac.
"Coldstream"	Barometer b	29.50	29.47	29.41	29.39	29.17	29.17	29.25	29.05	29.31
	Latitude	15° 26' ac.	16° 19' ac.	16° 54' ac.	18° 51' ob.	...	...	...	...	20° 54'
	Longitude	86° 28' ac.	87° 23' ac.	87° 23' ac.	...	...	...	...	...	88° 58'
"West Ridge"	Barometer b	29.67	29.53	29.43	29.38	29.27	29.29	29.39	29.24	29.46
	Latitude	11° 5' ob.	14° 37' ob.	18° 24' ob.	...	20° 30' ac.	20° 19' ob.	20° 19' ob.	21° 0' ac.	20° 59' ac.
	Longitude	83° 58' ch.	83° 38' ch.	84° 36' ch.	...	88° 7' ac.	88° 45' ac.	89° 24' ac.	89° 3' ac.	89° 47' ac.
"King Harold"	Barometer b	29.41	29.41	29.44	29.39	29.40	29.44	29.41	29.47	29.43
	Latitude	19° 18' ob.	19° 53' ob.	...	20° 20' ac.	20° 20' ac.	19° 48' ob.	20° 40' ac.	20° 50' ac.	20° 56' ob.
	Longitude	87° 0' ch.	87° 50'	...	88° 27' ac.	89° 27' ac.	90° 0' ac.	89° 40' ac.	90° 30' ac.	89° 45' ac.
"Scimitar"	Barometer b	29.31	29.31	29.28	29.20	29.32	29.33	29.36	29.43	29.46
	Latitude	20° 0' ob.	20° 28'	...	20° 38' ac.	20° 15' ac.	19° 50' ac.	20° 15' ac.	19° 45' ac.	19° 28' ac.
	Longitude	86° 50' ch.	87° 20' ch.	...	88° 8' ac.	83° 2' ac.	88° 45' ac.	88° 27' ac.	88° 58' ac.	89° 12' ac.
"Nagpore"	Barometer b	29.37	29.42	29.48	29.52	29.48	29.39	29.32	29.26	29.27
	Latitude	16° 32' ob.	15° 42' ac.	14° 58' ac.	15° 31' ac.	15° 18' ob.	16° 14' ob.	17° 39' ob.	19° 21' ac.	18° 54' ob.
	Longitude	85° 27' ac.	86° 2' ac.	86° 49' ac.	86° 56' ac.	87° 15' ob.	87° 30' ob.	87° 20' ac.	87° 30' ac.	87° 22' ob.
"Centaur"	Barometer b	29.44	29.36	29.44	29.43	29.43	29.47	29.60	29.46	29.43
	Latitude	20° 2' ob.	...	...	20° 31' ac.	19° 39' ac.	18° 25' ob.	...	...	...
	Longitude	87° 17' ob.	...	...	88° 7' ac.	89° 4' ac.	89° 50' ob.	...	...	...
S. S. "City of Cambridge"	Barometer b	30.15	29.85	29.75	29.85	29.85	29.64	29.45	29.35	29.45
	Aneroid a	29.87	.87	.77	.76	.66	.52	.27	.27	.37
	Latitude	7° 11'	6° 7'	6° 1'	8° 47'	12° 12'	15° 37'	19° 0'	19° 33'	19° 18'
"Pearl of India"	Barometer b	29.96	29.86	29.76	29.56	29.46	29.36	29.51	29.66	29.66
	Latitude	10° 38'	14° 41'	17° 34'	...	Pilot Ridge	...	...	18° 47' ob.	...
	Longitude	84° 33'	84° 50'	85° 8'	...	Light Ship	...	...	...	...
F. L. V. "Meteor," Lower Gasper Station	Barometer a	29.40	29.35	29.30	29.26	29.21	29.19	29.16	29.13	29.23
	Aneroid a	.54	.48	.43	.40	.35	.31	.31	.26	.38
"Walter Baine"	Barometer b	...	...	...	...	...	...	...	28.65	...
	Latitude	20° 0' ac.	20° 11' ob.	...	...	...	...	...	...	...
	Longitude	86° 3' ac.	87° 12' ob.	...	...	...	...	...	...	28.45
"City of Madrid"	Barometer b	29.50	29.39	29.43	29.41	29.36	29.42	29.55	29.35	29.50
	Latitude	19° 58'	...	...	...	19° 34' ac.	19° 10' ac.	17° 38' ob.	19° 6' ac.	19° 9' ac.
	Longitude	86° 46'	...	...	...	89° 0' ac.	89° 20' ac.	90° 28' ch.	89° 13' ac.	89° 46' ac.
"Carlisle"	Latitude	19° 45' ac.	20° 35' ac.	...	...	...	19° 11' ac.	19° 20' ac.	...	20° 22' ac.
	Longitude	86° 40' ac.	87° 41' ac.	...	...	...	...	89° 51' ac.	...	89° 3' ac.

TABLE II.

Wind Directions—continued.

	23rd.	24th.	25th.	26th.	27th.	28th.	29th.	30th.	1st.
"Centaur" ...	E. by N. N. Var.	N.E. W. Var.	S.W. " " W.	W.S.W. " " " "	W.S.W. " " " "	W.S.W. " " " "	W.S.W. " " " "	W.S.W. " " " "	W.S.W. " " " "
S.S. "City of Cambridge" ...	S.W.	S.S.W. S.W.	S.W.	W.S.W. W.	W.S.W.	W.S.W.	S.W.	W.S.W.	S.W.
"Pearl of India" ...	W.S.W.	W.	W.S.W.	S.W.	W. by S. to S.W. by W.	S.W. by W.	S.W. by W.	S.W. by S.	S.S.W.
F. L. V. "Meteor" (Lower Gasper Station) ...	E. E.S.E. S.E. S.S.E.	S.S.E. E. S.E. S.S.E.	W.S.W. E.S.E. S.W. W.S.W.	W. " " " " S.W.	N. E.S.E. S. E.	E. E.N.E. S.E. E.S.E.	E.S.E. E. E. by N. E.N.E.	N.N.E. N.E. veered to E.N.E. then to E.	S.E. E.S.E. S.E. " "
"Walter Baine" ...	Var. N.W. to W.S.W.	Var. S.W. to N.E. W.S.W.	S.W. " " " "	W. to W.S.W.	W. " "	W.S.W. to W. N.W.	N.W. to W.N.W.	W.S.W. veered to E. and W.	... ... ... S.W. by S.
"City of Madrid" ...	Var. from E.S.E. & E.N.E. N.W.	W. by S. W.S.W.	S.W. to W.S.W. W. by S.	W. by S. W. by S.	W. by S. W. by S.	W. by S. W. by S.	S.W. by W. S.W. by W.	S.W. by S. W. S.W. S.W. by S.	S.W. by S. S.
"Carlisle" ...	W.S.W.W. N.W. N.N.E. W. S.E.	W.S.W. S. S.S.W. S.W. Var. from S.W. and S.	S.W. W.S.W. " " W. by S. W.S.W.	W. by S. " " " " W. W.	W. by S. W.S.W. " " S.W. by W. W.S.W.	W. by S. W.S.W. S.W. " " S.W. by S.	S.W. by W. " " S.W. S.S.W. " "	S.W. by W. " " S. S.S.W. S.S.W.	S. S.W. S.S.W. S. by W.
"Kedgerae," P. V.	E.S.E.	and S.	S.W.	" "	... Southerly.	S.S.W. South.	... S.W.	... South	S. South.
"S. S. Orchis" ...	...	...	...	...	W.	W.S.W.	Westerly. S.W.	South Westerly.	South. Westerly.
"Coleroon," P. V.	...	...	...	W.	W.S.W.	W.S.W.	S.W.	S.S.W.	S.S.W. to S.W.
S.S. "Golconda" ...	...	...	S.W.	W.S.W.	W.S.W.	W. by S.	W.S.W.	W.S.W.	W.S.W.
"Atmosphere" ...	S. W.S.	S.W. W.	S.W. W. W.S.W. S.W.	S.W. " " " " " "	W.S.W. " " " " N.E.	W.S.W. S.W. W. S.W.	" " " " " " " "	W.S.W. " " " " " "	W.S.W. W. " " " "
F. L. V. "Star" (Ridge Station) ...	...	...	...	...	...	...	N. to N.W. S.W. N.E.	N.N.E., N. Veering to N.N.W.	W. W.S.W. S.W.
F. L. V. "Comet" (Mutlah Station) ...	...	...	...	...	...	S.W.	S.	N.N.E. and W.	S.W. by S. E.S.E. E.
F. L. V. "Planet" ...	Eastern Channel Station ...	...	...	...	...	S.S.E. S.E. S.S.E. S.E. by S.	S.E. by S. S.S.E. E.S.E. E.	E. veering to N.E. then to N. and N.W.	W.S.W. S.W. " "
S. S. "Madras" ...	...	...	...	...	...	...	N.E. by E.	N.E. by E.	E. by N. veered to E., E.S.E. then S.E. and S.
S. S. "Singapore" ...	...	...	...	...	...	...	South Westerly.	S.W. South Westerly.	South South Westerly.
"Mermaid" (Upper Gasper Station) ...	...	...	...	...	...	E.S.E. E.N.E.	...	E. E.S.E. S. S.E.	S. S.W.
"City of Vienna" ...	...	...	...	...	...	...	S.W. to W. Clouds from N.E. to S.W.	W.S.W. " " " "	S.W. by W. W.S.W. East.
"Foam," P. V. ...	...	...	...	W. to S.W. Northerly. E. to E.S.E. N.E.	N.N.E. to N.E. E. to E.S.E. S.S.E. S.E. to E.S.E. N.N.E. to N.E.	N.N.E. to E. S.E. to E.S.E. N.E. to S.E.	E.N.E. E. by N. E.N.E.	N. N.N.E. N.E.	Veering to E.S.E. then to S.E. and S.

23. It will be more convenient first to trace the course of the cyclone in the N.W. corner of the Bay, where we have land observations* and those of the floating light-ships to guide us, and afterwards to follow it back as far as possible to its origin.

24. On the afternoon of the 29th, Saturday, the wind moderated, and a lull was experienced north of the area of low pressure in the Bay. This was probably due to the breaking up of a vortex, which the log of the "Coldstream" seems to show was formed, or partially formed, on the 28th and the morning of the 29th. This lull, however, was of short duration. At the Mutlah floating light station, the wind, which had moderated at noon, at 4 p.m. had increased to a strong gale, with very unsettled appearances. At midnight it was blowing a hard gale, with constant heavy rain. On the morning of the 30th, Sunday, a heavy gale was blowing from the eastward, with continuous torrents of rain. At noon the barometer was falling rapidly, the wind blowing with the force of a hurricane from the east. The barometer was lowest at 6.30 p.m., and between this and 8 p.m. the centre of the storm must have been nearest to the Mutlah light-ship, the "Comet;" but if the directions of the wind are correctly given, the "Comet" was outside the radius of the cyclone.

25. The observations of the floating light-vessel "Star" at the Ridge Station, latitude 20° 49' 45" N., longitude 87° 41' 19" E.; the floating light-vessel "Meteor" at the lower Gasper Station, latitude 21° 26' 53" N., longitude 88° 6' E.; the steam-ship "Madras" at anchor in Saugor Roads, and those at Saugor Island and Balasore, afford sufficient data for determining approximately the track of the cyclone, assuming that the latitudes and longitudes of the floating light-vessels (which were not given with the extracts of their logs which I received, but which I have since obtained from Captain Falle,) are correct.

26. From noon to midnight on the 30th the "Star" experienced terrific squalls, the wind being steady from N.N.E. up to 8 p.m., when it veered to N. The centre of the storm had been thus approaching the "Star" from S.E., and at 8 p.m. its bearing was about E.S.E. Two hours later the wind at the "Meteor," which had been steady at N.E., veered to E.N.E., the centre bearing consequently about S. At 10 p.m. the centre of the storm was about in latitude 20° 40' N., longitude 87° 55' E. At 11 p.m. the wind at the "Star" had veered to N.N.W., while the centre continued to bear about south from the "Meteor." The position of the centre at 11 p.m. was about in latitude 20° 50' N., longitude 87° 53' E. At 11.45 p.m. the "Star" parted and drifted from the station. At midnight she had the wind W., the centre bearing about N.N.E. At the same time the "Meteor" had the wind W., the centre bearing about S.S.W. Position of centre at midnight about in latitude 20° 55' N., longitude 87° 50' E.

27. At Saugor Island the wind had been steady all day from N.E., and did not veer until 12.30 a.m., when it went round to E.N.E., which was probably the first cyclone current. It continued steady at E.N.E. until 3 a.m., veering between this and 5 a.m. to E.S.E., at which point it remained until 8.30 a.m. At 3 a.m. the barometer was lowest, and between this and 4 a.m. the centre was probably nearest. The "Madras," at anchor in Saugor Roads, experienced the same winds and changes, and her barometer was lowest at 4 a.m. From midnight to 3 a.m. the storm was moving nearly northwards and approaching Saugor. I have no observations from the "Meteor" from midnight to 4 a.m. The lowest

recorded barometer is at 4 a.m., when the wind had veered to S.E. The centre, which had been approaching Saugor from about south up to 3 a.m., must have curved round between 3 a.m. and 5 a.m., from which hour it moved away towards west, bearing about S.W. from Saugor.

28. The following notes on the cyclone were forwarded to me by Mr. Richards, Civil Surgeon at Balasore:—

Date.	Hour.	Barometer unreduced and uncorrected.	Winds.	Remarks.
July 1	5 a.m.	28.70?	W.N.W.	Blowing very hard. Increasing.
"	7.30 "	28.62	N.W.	
"	8.30 "	28.28	N.E.	Blowing in terrific gusts.
"	9.30 "	28.41	E.N.E.	
"	11.30 "	28.50	E.	Still blowing very hard.
"	12 noon	28.74	E.	
"	1 p.m.	28.90	E. by S.	Decreasing. Subsiding.
"	2 "	29.05	S.E.	
"	3 "	29.09	S. by E.	Blowing.
"	4 "	29.13	S. by W.	

Rainfall 6 inches.

29. In applying these observations to determine the track of the centre, it should be observed that the directions of the wind are probably only very approximate, and that before Balasore came within the cyclone's radius the prevailing wind must have been north-westerly. It is probable that the first recorded cyclone wind was from N.E. at 8.30. At all events it is tolerably certain, from the directions of the wind at Saugor Island and at the "Meteor," that the centre of the storm could not at any time have been north of a line drawn between Balasore and Saugor. Storms generated in the north of the Bay so late in the season seldom possess sufficient energy to travel inland, and generally burst up when they come in contact with the land. The present storm was not one of great violence, and was unusually small in dimensions, its radius probably never exceeding 40 or 50 miles. It advanced in a northerly direction very slowly from midnight, retarded by friction with the land. Turning round to the westward, along a path of less resistance, with probably a much smaller radius, it increased in extent and velocity of propagation as it moved over a freer course towards Balasore.

30. The following table shows the approximate track of the centre in the N.W. corner of the Bay. I have already indicated the course which it pursued after passing Balasore:—

Hour.	Latitude N.	Longitude E.
10 p.m. ...	20° 40'	87° 55'
11 " ...	20° 50'	87° 53'
12 midnight ...	20° 55'	87° 50'
3 a.m. ...	21° 8'	87° 45'
5 " ...	21° 10'	87° 35'
8.30 a.m. ...	21° 9'	87° 10'
9.30 " ...	21° 8'	87° 0'
11 " ...	21° 7'	86° 45'

31. The "Coldstream," running E.S.E. from 1 p.m. on the 27th, encountered on the 28th and the morning of the 29th what appears to have been the southern quadrant of a cyclone. Her position is, however, unknown. At 1 a.m. on the 29th her course was changed to N. by E., and at 9 a.m. to N. by W. A south or S.E. course, if such had been possible, would then, apparently, have taken her completely out of the influence of the cyclone. She had a W.S.W. and S.W. by W. wind. At 9 a.m. the gale had moderated slightly, but at 1 p.m. was "increasing, with heavy rain and every appearance of

* Land observations not printed herewith.

drawing near the centre of a cyclone;" the course was changed to N.W., and from this until noon of the following day the "Coldstream" seems to have kept up steadily with the cyclone on its southern quadrant, steering throughout a N.W. course. 8 p.m.—The "cyclone burst on us with great fury, with one continued blue flame of lightning and a heavy sweep of rain; ship in one complete mass of foam; could not see a yard from ship." Wind, sea, and rain increased until noon of the 30th. At 1 p.m. "ship's course west to south, the wind veering rapidly to S.E., and barometer falling rapidly from 29.40 to 28.50. 3 p.m.—Wind fell very light, ship being in the centre of cyclone. At 8 p.m.—Wind about W.N.W., cyclone again burst on the ship with greater fury than ever, with one blue flame of lightning all round the horizon, and rain coming down in one sheet of water." Thus at 1 p.m. the "Coldstream" had got round to the N.E. quadrant of the storm, and then went right through the vortex, arriving at the S.W. quadrant at 8 p.m. At daylight the wind began to moderate and the barometer to rise.

32. The "Sophia Joakim," from Saugor to Chittagong, was, on the 26th, by account, in latitude $21^{\circ} 4' N.$, longitude $91^{\circ} 2' E.$, near her destination, with a light S.W. wind in the morning, which afterwards shifted to S.E. at noon. We find her the next day near Akyab, by account, in latitude $20^{\circ} 40'$, longitude $91^{\circ} 45'$. From this she seems to have made a course for Saugor, and on the morning of the 29th encountered a strong south-easterly gale, which continued to increase up to midnight, with a falling barometer. The "Sophia Joakim" was now in a difficult and dangerous position, with a lee shore to the north and a cyclone to the south. According to Colonel's Reid's rule for lying ships to in a hurricane, the best thing to do would seem to have been to heave to on the starboard tack. This course was, however, probably dangerous on account of the proximity of the lee shore, and the "Sophia Joakim" seems to have been obliged to make a fair wind of the cyclone, and to have run before it. Running round a cyclone is always dangerous, more especially in those of small radius, and it is liable to be forgotten that the winds do not revolve round the vortex in circles, but along in-moving spirals, so that a course before the wind must inevitably bring a ship sooner or later to the centre. There seems to have been much more sea room to the north of the storm than the position of the "Sophia Joakim," by account at noon on the 29th, latitude $20^{\circ} 38' N.$, longitude $89^{\circ} 1' E.$, would indicate. The ship was probably much more to the southward. The "King Harold," the "Orchis," and the "West Ridge" were all north of the storm on the 30th, and escaped unharmed. At 7 a.m., June 30th, the northern quadrant of the cyclone overtook the "Sophia Joakim," the wind blowing with hurricane force from E.N.E. At noon the wind had fallen lighter from north, the centre bearing consequently about E.S.E., latitude by account $20^{\circ} 13' N.$, longitude by account $88^{\circ} 38' E.$ The ship was now near the centre of the cyclone, whose position at that hour would hence be determined if the position of the ship as given by account could be relied on. I think, however, she was further south and east. "After noon the wind fell light, and gradually drew round to the N.W.; sea very troubled, and great quantities of birds flying round the ship. At 4 p.m. wind increased suddenly from the N.W." The ship had now got round to the south-western quadrant, and the wind continued to blow with tremendous fury throughout the night and the early morning.

33. About the same time that the storm had overtaken the "Sophia Joakim," the "Hindustan"

encountered its south-eastern quadrant. At noon on the 30th the "Hindustan" was by dead reckoning in latitude $19^{\circ} 27' N.$, longitude $89^{\circ} 16' E.$ "5 p.m.—Barometer 29.25. Strong gale, with very heavy squalls. Concluded we were on the S.E. quadrant of a cyclone, and slowly following it up. Put ship on the other tack. Wind S.S.W.; ship's head S.E." This conclusion was undoubtedly correct, and, considering the position of the "Sophia Joakim" about the same time, it is probable that the position of the centre of the cyclone at noon on the 30th was about in latitude $20^{\circ} N.$, longitude $88^{\circ} 50' E.$, near which place I think the storm was generated. I should state that I have only got the extract from the log of the "Hindustan," which appeared in the *Englishman* of July 4th.

34. The "Walter Bain" appears to have got into the cyclone on the evening of the 29th. The wind is stated to have veered from W.S.W. to E. and then to W. At midnight on the 29th the wind was E., which would show that the ship was on the northern quadrant; but how she got there does not clearly appear. Probably she was north-east of the storm and ran into it, going southwards on the evening of the 29th. Her position is altogether unknown. From midnight on the 29th until the morning of July 1st, she seems to have been in and round the storm. At some unknown time the wind was W., showing that she was then on the southern quadrant.

35. The "Champion," shortly after parting from anchor N.W. of the Mutlah light, was caught by the northern quadrant of the cyclone, on the night of June 30th. The wind went round from S.E., which had been the prevailing wind, to N.E., which was probably the first cyclone wind. The centre of the cyclone was then about S.S.E., and the "Champion" was on the right hand side of the storm. When the gale increased the ship was put on the port tack. It was probably impossible, or, if possible, dangerous, to put her on the other tack. She was then in a most difficult position, wedged in between a cyclone to the S.S.E., and the shore to the N. The rapidity with which she drifted round and before the storm, the wind veering through N. and N.W. to S.W., passing probably very near the centre, is an instructive example of the character of these storms. When a ship cannot get out of a cyclone, and is obliged to lie to, the well-known rule is:—"When in the right-hand semicircle heave to on the starboard tack, and when in the left hand semicircle, on the port tack in both hemispheres." A ship heaving to in a cyclone on the wrong tack must drift into the centre as it passes, and be taken back by the veering of the wind. The "Champion" went round and before the storm, and did get very near the centre. She was abandoned a wreck near False Point on the morning of July the 1st.

36. The loss of the "Rothesay" furnishes an example of the danger of putting to sea in weather when the pilot vessels must of necessity be all off their stations and down to the southward. The ship was obliged to beat about the Ridge, apparently in search of a pilot vessel, instead of getting to sea with all possible despatch, and running south out of the way of danger. The cyclone crossed the Ridge on the Sunday night, and the "Rothesay" was lost on Monday morning in Balasore Bay.

37. The loss of the "Omaha" furnishes an example of the danger of pressing northwards coming up the Bay with a south-westerly gale and a barometer falling rapidly. The only safe course is to keep south until the weather improves to the northwards and until the barometer rises steadily.

38. The floating light-vessel "Planet" having drifted from her station, the Eastern Channel, and parted from her anchors about noon on the 30th,

must have run south. She encountered the western quadrant of the cyclone about 5 p.m. The wind veered from N.N.E., through N. to W. and W. by S. She appears to have got out at the southern quadrant about midnight, without having been very near the centre, and turned up the next forenoon near False Point, just in time to save the crew of the sinking "Champion."

39. The "King Harold," the "Orchis," and the "West Ridge" had luckily got to the N.E. before the cyclone passed. On the 30th, at noon, the position, by account, of the "West Ridge," is given as latitude $21^{\circ} 0' N.$, longitude $89^{\circ} 3' E.$ This would place her near the Mutlah light-vessel, the "Comet." She had heavy south-westerly gales throughout the 30th, with terrific squalls; while the "Comet," close by, had an east wind blowing with hurricane force. It is probable that the "West Ridge" was then much more to the south and east. The "Orchis," at noon on the 29th, was in latitude $20^{\circ} 12' N.$, longitude $89^{\circ} 44' E.$, and experienced a heavy gale from S.W., veering to S. She was then east of the cyclone, and got away to the north into better weather.

40. The pilot vessels, with the exception of the "Foam," at anchor in Saugor Roads, were all well to the southward when the storm passed. The "City of Madrid," the "Centaur," the "Hindustan," the "Carlisle," and the "Scimitar," were south-east. The master of the "Scimitar" says:—"The barometer generally rose when standing to the south-east, and fell when standing north-west." This was the experience of all the fleet to the S.E., including the pilot brigs. The following extract from the log of the "City of Madrid" is instructive, and helps to determine a point of the cyclone's track:—"29th, 8 a.m.—Prepared to wear to the N.W., but as the clouds were banking up and looking very bad in that direction, deferred it. For the last three days it always looked better to the southward. Noon.—Weather looking much better; latitude $17^{\circ} 36' N.$, longitude $90^{\circ} 28' E.$; barometer 29.55; wore ship to the W.N.W. 4 a.m., 30th.—Blowing very hard from S.S.W.; tremendous gusts; barometer 29.33. 5.30 a.m.—Weather becoming rapidly worse; barometer 29.22; reduced sail and wore to the southward. Just before doing so, ship was caught aback, wind west, and back in a few minutes to S.W. 7 a.m.—Barometer 29.10; wind, hurricane force; rain in torrents. Ran ship off due east, as we considered we had approached the centre too close. At 7 a.m. latitude by account $19^{\circ} 6' N.$, longitude by account $89^{\circ} 13' E.$ " The "City of Madrid" seems just to have touched the southern quadrant about 6 or 7 in the morning, and not far south of the position of the centre at noon the same day. The cyclone must have been almost stationary, or moving very slowly, for some time after its formation. The "Golconda" and "Nagpore" were about this time well away to the S.W., and experienced heavy S.W. gales.

41. In conclusion of this examination of such extracts of logs of ships as I have been able to obtain, I find that the vortex of the Balasore cyclone of 1st July, 1872, was formed on the night of 29th June or morning of the 30th June, at or about latitude $19^{\circ} 50' N.$, longitude $89^{\circ} E.$ For some time after its formation it seems to have been almost stationary. It moved afterwards with a velocity of about ten miles an hour, as it passed the Pilot Ridge between 8 o'clock and midnight of the 30th. I have already described its course in the north-west corner of the Bay. It is probable that previous to the formation of this vortex, another distinct vortex had been formed on the 28th in about the same place; but it appears to have been almost stationary, and to have broken up on the morning of the 29th.

42. A slight storm wave was felt in the Hooghly.

The tides at Diamond Harbour and Kidderpore Dockyard rose about 4 feet above the average on 1st July. This I find from a tidal chart kindly lent to me by Captain Falle. From reports of damage caused by inundations of salt water, there appears to have been a storm wave felt somewhere south of Balasore. I have no information about it.*

43. It may be well here to draw attention to those indications of the formation of a cyclonic vortex in the north of the Bay, and some of the laws of such storms (determined by the researches and experience of Mr. Blanford, Colonel Gastrell, and others), which appear to have been specially verified by the experience of the late cyclone. These are all practical rules, and are independent of the various theories which may be set forward by different persons to attempt to account for the formation and course of a cyclone.

44. *Indications of the probable formation of a cyclone in the north of the Bay during the months of May and June:—*

- (1.) The barometer falls steadily for some days round the north of the Bay. The fall occurs first to the south-east at Chittagong and Akyab, and afterwards at Saugor Island, Cuttack, and Calcutta. The barometer at Saugor Island ranges lower than the barometer at Calcutta (normally, at this season, it ranges higher).
- (2.) At Calcutta the winds become light and variable from S.E. round to N.E. As the disturbance increases, masses of clouds drift from E.N.E. or N.E., and as the storm approaches, showers are frequent and the wind blows in gusts.
- (3.) At Saugor Island the winds are at first light and variable, working round from S.E. to N.E. As the disturbance increases, and as the storm approaches, the barometer continues to fall steadily; the wind increases in force, with squalls from the N.E., and masses of clouds float rapidly from the same direction. Outside there is a heavy southerly swell.
- (4.) At Cuttack, or False Point, the winds are at first light and variable from N.N.E., working gradually round through N. to W. and W.S.W. As the storm approaches, the wind increases in force, with squalls from W. and N.N.W.
- (5.) At Chittagong the winds are light and very variable, mostly from S.E. and N.E.
- (6.) At Akyab the winds are at first light and saturated with moisture, mostly from S. and S.E. As the disturbance increases, the wind increases in force, and works gradually round from S.E. to S. and S.S.W.
- (7.) In the Bay, along and south of a line drawn from about False Point to Cheduba Island, south-westerly gales, accompanied with torrents of rain, prevail. Standing northwards the barometer falls, and rises when standing southwards.

45. Under the circumstances above specified (3), it appears unwise for ships in a good anchorage at Saugor to put to sea. The great danger is that they may be caught in a cyclone before they have got sea room to avoid it. Moreover, the pilot vessels will, under the circumstances, be generally off their stations, and ships will be unable to land their pilots. It should be remembered also that generally the

* I have since heard that there were freshets in the river at Balasore. The lands were partially inundated, but the water subsided at 6 p.m.

worst part of a cyclone is the heavy cross sea which accompanies it. In the late cyclone it was this tremendous sea, which is reported never to have been equalled in the Bay, which did such damage. It is accounted for by the long-continued gales from the S.W. This danger would be avoided by not putting to sea until the weather improved. From (7) the following would appear to be a safe rule:—*Ships coming up the Bay in the months of May and June with fresh south-westerly gales, accompanied by torrents of rain and a falling barometer, should not press northwards until the weather improves and the barometer rises steadily.*

46. I wish to draw particular attention to the following modern development of the laws of cyclonic storms. Disregard of this law may lead, and has led, to many losses at sea. "The direction of the wind, specially at a distance, is far from being at right angles to the bearing of the centre. The wind does not revolve round the vortex in circles, but along in-curving spirals, differing two, three, or more points from the tangential circular direction." For example, a ship running up the Bay with a S.W. gale, squalls, torrents of rain, a barometer falling rapidly, and every appearance of a cyclone, has no right to conclude that the centre bears N.W., and that therefore a N. or N.N.E. course is a safe one. The centre, if at a distance, may bear N. or N.N.E., and a northerly course may run the ship into it, particularly as it may be then almost stationary. "The safest course seems to be to lie to and watch the barometer and wind till the bearing of the centre be known with some certainty." It must be borne in mind that before any vortex is formed, gales blow towards and round a considerable belt of low pressure. The following rule is I think a safe one when within the influence of a vortex. To find the bearing of the centre, *stand with your face to the wind, and measure round to your right hand side about ten points.* In the southern hemisphere the ten points should be measured round to the left.

47. The Meteorological Reporter in Calcutta, with daily telegraphic reports of the state of the weather at Akyab, Chittagong, Saugor Island, and Cuttack (False Point would, I think, be a better station than Cuttack), will always, I think, be able to give ample warning of the probable formation of a cyclone in the north of the Bay, and in most cases some warning of the approach of storms from more southern latitudes. The telegraphic stations do not, however, extend far enough south to afford certain information of the generation of storms about the Andaman Islands. There the cyclones of the greatest violence, and those which travel furthest inland, are generally formed. Telegraphic communication with meteorological observatories at the Alguada Reef and Port Blair would, I think, enable him to give warning of the formation of the latter.

48. The experience of the late cyclone, I think, suggests that more use might be made of the information of the state of the weather from the meteorological stations, as regards warning the shipping at Saugor Island of the probable formation of a cyclone,

more particularly when generated in the north of the Bay. According to experience, these storms seldom travel far inland (there are some exceptions, for example, the great storm of June 3rd and 5th, 1839), but they may cause great disasters to ships outward bound.

49. I think it would be practicable to make arrangements for the exhibition of warning signals at Saugor Lighthouse, from which they might be signalled to some of the light-ships, if considered necessary. The signals would be hoisted by orders from the Meteorological Reporter at Calcutta, by telegraphic communication with Saugor Lighthouse.

(1.) *A cautionary signal*, suppose a signal cone in the daytime, to indicate that bad weather is probable. It might then be left optional with masters and pilots whether they would put to sea or not.

(2.) *A warning signal*, a double cone in the daytime, to indicate that a cyclonic vortex is probably in course of formation in the Bay. It might then be made imperative on masters and pilots not to put to sea.

(3.) *A storm signal*, a drum in the daytime, to indicate that a vortex has been formed, and is probably approaching.

During the night coloured lights to correspond to these signals should be hoisted.

50. I do not know anything, however, about the safety of anchorage at Saugor Island. It is a question for those who are qualified to give an opinion, to consider whether it would, in all cases, be safer to ride out the storm at Saugor, or put to sea at once, if there was time, especially in the case of the more violent storms which come up from the Andaman Islands, and whether it is expedient to fetter the discretion of masters and pilots at all in the matter. The signals, however, might be hoisted in any case. The ships that put to sea before the late cyclone, and which were lost in it, would have been probably saved had they remained at Saugor; but I cannot say that such would always be the case.

51. Signals corresponding to those which I have recommended for Saugor Island lighthouse might also be hoisted, under similar circumstances, for the shipping in Calcutta. At all events, before the next cyclone period comes round, it would be well to arrange for night signals for the shipping, to correspond to the signals adopted by the Meteorological Committee (No. 296, from the Secretary to the Meteorological Committee to the Junior Secretary to the Government of Bengal, Fort William, the 18th December, 1867). There is at present, as I understand, only one night signal, and it corresponds to the *drum*, which is the storm signal, indicating that a cyclone is imminent, while the warning signal, the double cone, does not indicate the actual approach of a storm, but only that the state of the weather is such that there may be a storm. There seems to be a good deal of misconception about the meanings of these signals.

W. G. WILLSON.

15th August, 1872.