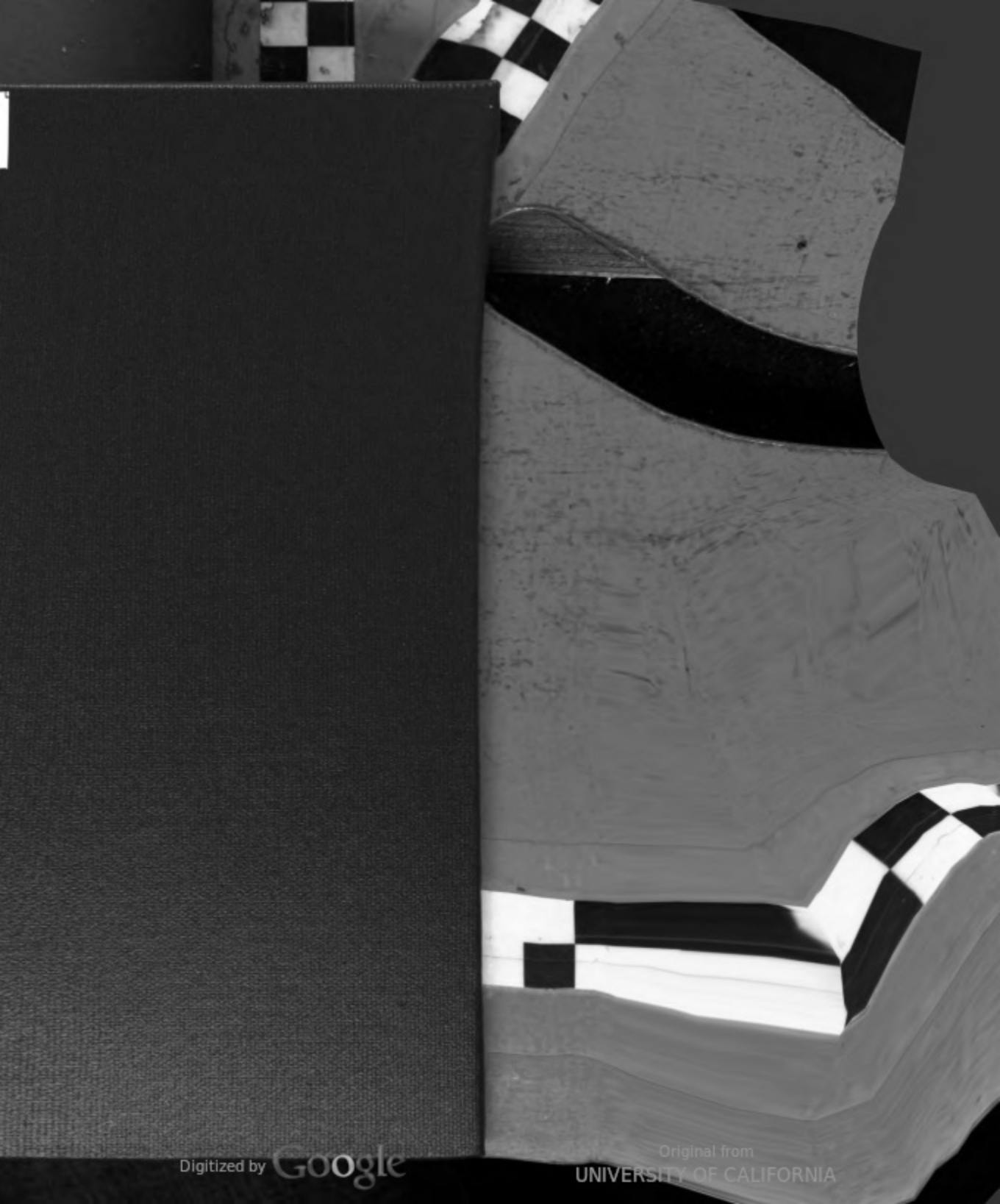

Digitized by Google
Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

...GRAPHY
...SITY OF CALIFORNIA
...CALIFORNIA
UNIVERSITY OF CALIFORNIA, SAN DIEGO
3 1822 03384 7229
ZI-KA-WEI OBSERVATORY
QC
948
C527

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH CHINA HERALD" OFFICE.
1893.

948
527
Digitized by Google
Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

SCRIPPS INSTITUTION
OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA
LA JOLLA, CALIFORNIA

QC948
C527

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

THE

"BOKHARA" TYPHOON.

8th-12th of October, 1892.

AMONG the more disastrous typhoons of the year 1892, there is one that caused so terrible a loss, that the blow with which it struck the minds of the residents of Shanghai and Hongkong will remain for a long time one of our most gloomy memorials. I need not say that I mean that terrible typhoon, which, originated on the 7th of October to the East of Luzon, passed on the 10th very near the South Cape of Formosa, and whilst crossing that island, wrecked in one night the Norwegian steamer *Normand*, and the English mail *Bokhara*, with an enormous sacrifice of so many precious lives.

Besides the interest which must attach to the history of that typhoon, on account of those disasters, the many lessons that may be derived therefrom, have induced me to take it as the subject of a lecture, to be delivered at a meeting of the S.M.S.

I think it advisable to begin its history, with a short account of the atmospherical state of our Eastern regions from the Northern Coast of China to Japan and Luzon, at the beginning of the typhoon. I will produce two tables, in which I shew the meteorological observations made on the mornings of the 7th and 8th of October, at 16 selected stations; and these tables are sufficient to perfectly serve the purpose.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

7th October, 1892, 9 A. M.

Meteorological Stations.	Barometer.	Variation for 24 h.	Temperature.	Wind.		Weather.
Tientsin	30.201	+ 0.090	64.4	W.	1	B
Cape Chan-tung	29.981	— 0.059	70.0	N.N.W.	2	...
Jenchuan	30.091	— 0.090	65.1	S.E.	1	OC
Nagasaki	30.032	— 0.079	73.6	N.	4	O
Tokio	30.276	...	...	N.W.	4	...
Shanghai	30.044	— 0.039	70.9	N.	1	O
Hankow	29.839	— 0.039	70.0	N.W.	1	O
Wenchow	30.571 ?	+ 0.197	76.1	N.W.	3	B
Foochow	29.969	— 0.083	73.0	W.	2	B
Amoy	29.949	— 0.090	73.9	N.E.	1	B
Anping	29.930	— 0.098	...	N.N.E.	3	B
South Cape	29.906	— 0.098	80.4	N.N.E.	3	BC
Swatow	29.930	— 0.130	80.4	N.W.	1	B
Hongkong	29.949	— 0.090	82.0	S.W.	1	B
Aparri	...	...	...	...		...
Manila	29.792	— 0.090	84.9	W.	1	CM

8th October, 1892, 9 A.M.

Tientsin	30.201	0.000	64.4	N.N.E.	2	B
Cape Chan-tung	29.989	+ 0.008	70.9	N.N.W.	1	BM
Jenchuan	30.020	— 0.071	64.4	N.N.W.	1	BM
Nagasaki	30.001	— 0.031	68.5	N.N.E.	2	B
Tokio	30.119	— 0.157	...	N.	2	...
Shanghai	30.087	+ 0.043	71.6	N.E.	2	O
Hankow	29.941	+ 0.051	73.0	N.E.	1	B
Wenchow	30.571	0.000	77.0	N.W.	1	CO
Foochow	29.969	0.000	77.0	N.E.	2	C
Amoy	29.949	0.000	77.0	N.E.	1	C
Anping	29.898	— 0.031	...	N.N.E.	3	B
South Cape	29.867	— 0.039	...	N.E.	4	BC
Swatow	29.922	— 0.008	79.5	N.	1	B
Hongkong	29.930	— 0.020	82.0	N.N.E.	5	B
Aparri	29.697	...	82.2	N.N.E.	5	C
Manila	29.701	— 0.090	82.6	W.	1	O

I.—Let us summarise these tables in the following manner :

During the morning of the 7th of October, a rather high barometric pressure prevailed over the Northern Coast of China, while an area of still higher pressure prevailed over Northern Japan. The isobaric lines crossing the Coast of China from East to West, the gradients were disposed, roughly speaking, from North to South and a moderate monsoon was blowing along the Coast of China ; only in the Formosa Channel the gradients began to inflect towards the South-East. Save the observations at Manila, no other bears in itself evident indication of the typhoon. There is, indeed, a falling of the barometer registered at Amoy and Foochow, and a still quicker one at South Cape. But the fall registered at Amoy and Foochow may very well be accounted for, without any typhoon, with the fall previously observed at Shanghai and over Northern China. The fall

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

registered at South Cape could be also accounted for in the same way, though it may have been due partly to the action of the typhoon, already slightly felt at that place. In the morning of the 8th, there was very little change in the atmospherical state. The steadiness of the barometer at Pagoda and Amoy, since 9 a.m. on the 7th, confirms the above interpretation of the precedent fall. But the increasing fall of the barometer at South Cape of Formosa, with an increasing North-East wind, gives a clear evidence of some Southern atmospherical disturbance. The three observations at Manila, Appari and South Cape are even sufficient to give a fair indication of the bearing of the typhoon. Before ascertaining this position, and entering into the narrative of the typhoon we will consider some of the phenomena known to precede a typhoon.

It has been often asserted, and it is generally thought, that an area of high barometric pressure, or anticyclonic area, precedes a typhoon ; such area is even asserted by many as prevailing all around the typhoon.

Mr. Doberck, for instance, begins his pamphlet : *The Law of Storms in Eastern Seas* with the following statements :

"In the Eastern seas the earliest signs of a typhoon are "clouds of a Cirrus type, looking like fine hair, feathers or small "pale white tufts of wool, travelling from the East or thereabout, "their direction backing towards the North, a slight rise of the "barometer, clear and dry but hot weather and light winds. "The Cirrus clouds which frequently assume fantastic shape, "make their appearance within 1,500 miles of the centre of the "typhoon, the barometer is generally rising beyond from 600 to "1,000 miles of the centre."

As to Cirrus clouds, I will only remark that in our latitude they are of little or no value in prognosticating either the bearing or the existence of a typhoon ; although in lower latitudes they are the first and best sign of a typhoon ; not only as far as they make appearance within 1,500 miles of the centre, travelling from the East, but in a much more distinct way. According to informations I received from the distinguished director of the Manila Observatory R. Father Saderra, S.J., when the centre of a typhoon is distant about 600 miles or three days of the observer, Cirri or Cirro-strati make their appearance as *radiating* from the same point on the horizon. That point of radiation betokens precisely the direction of the centre of the typhoon. Therefore the motion of that *radiating point* along the line of the horizon, with its rising above or its dipping below it, allows a careful observer to understand the direction followed by the typhoon in its progress. This observation due to R. F. Saderra must be carefully attended by captains travelling on those lower latitudes.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

As to the high barometric pressure we must dwell upon it a little longer.

It is considered theoretically as a consequence of the ascending current of air, rushing upwards into the centre of the typhoon; and in a practical way it is given as a fair prognostic of a typhoon. Therefore a thorough investigation of the subject cannot fail to be very useful both in a theoretical and in a practical line. To ascertain how far such assertion is correct, I have drawn on this plate *(see 1st plate)* a barometric curve representing the whole register of the barometer at South Cape from the 1st of October to the 8th. In that barometric curve, is seen a high barometric pressure prevailing at South Cape on the 2nd of October, followed by a fall of the barometer. Subsequently to that fall, a new rise of the glass, which began on the 4th, reached its highest reading on the 5th; and then it began to fall again on account, as we said above, both of the typhoon and of a fall of the barometric pressure in Northern China. Is the first high pressure, which occured on the 2nd October, or the second one, on the 5th October, to be taken as the anticyclonic area asserted to be connected with every typhoon, and even to be a prognostic of it? Neither of them can in fact be asserted as having anything to do with the typhoon.

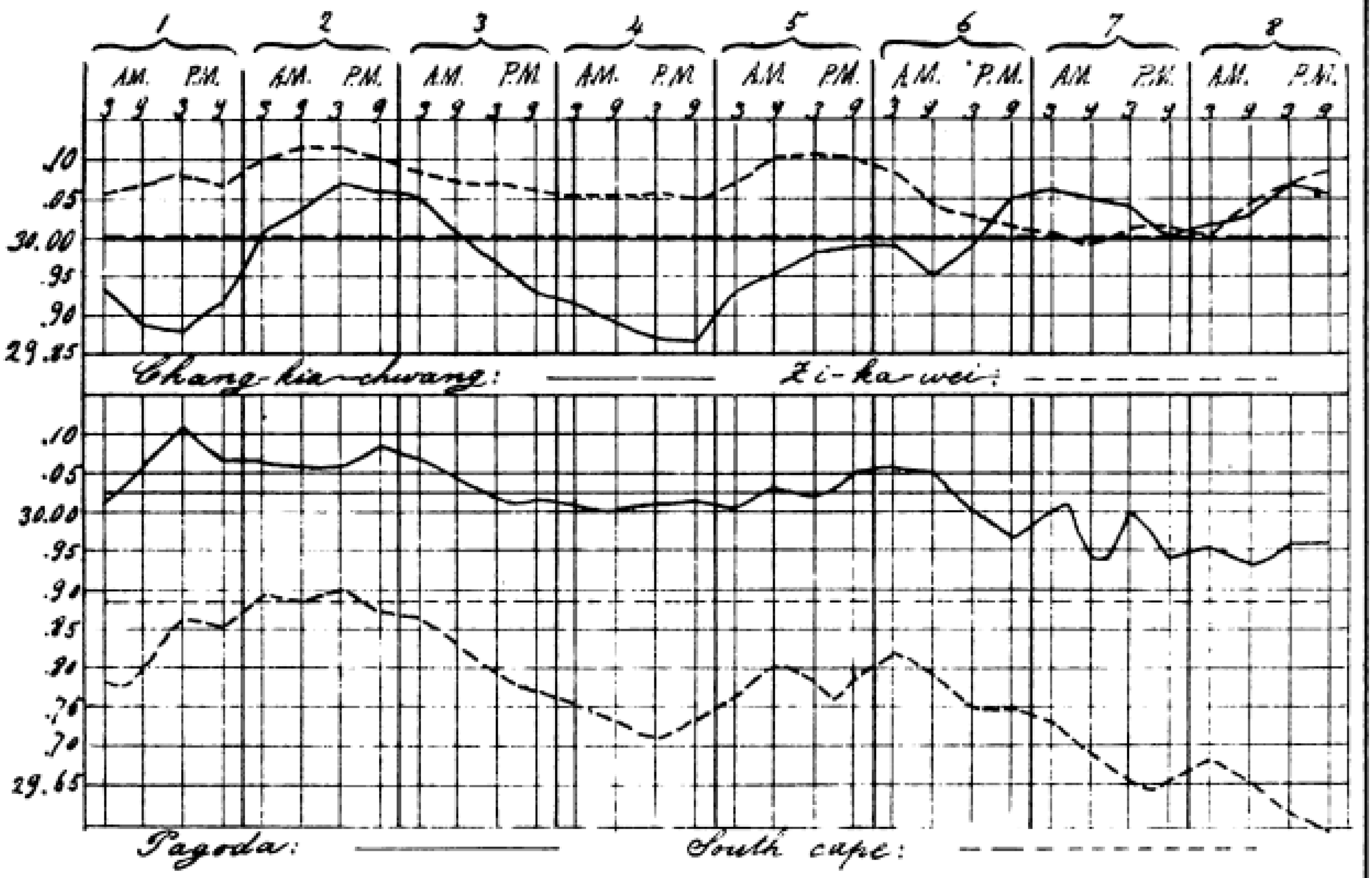
Not the former, because: 1st. It was surely followed by a fall of the barometer unconnected with the typhoon. 2nd. It was the consequence of a large area of high pressure having its centre to the North or North-west of Tientsin more than 1,000 miles from South Cape. 3rd. Very probably the typhoon was not yet formed at that time. Not the latter, because. 1st. The maximum or higher pressure, observed on the 5th, cannot be properly called a high pressure, since the barometer did not reach beyond its normal height, as it is obvious from the average pressure, at South Cape in October, represented here by an horizontal line. But the so-called anticyclonic area, asserted to exist beyond the limits of the typhoon, viz., between 600 and 1,000 miles from the centre, cannot be merely a pressure higher than within the limits of the typhoon; that would be unintelligible; but it must be a pressure higher than the normal pressure. 2nd—The rise of the barometer, which began on the 4th at South Cape, and reached its highest point on the 5th, had began first in Northern China extending from North to South, a contrary motion to the direction, that a high area originated from the typhoon would have followed. That is clearly shown by the barometric curves of Pagoda Anchorage (Foochow), Zi-ka-wei, and Chang-kia-chwang (a Chinese village 60 miles S.W. of Tientsin) shewn on the plate with that of South Cape. Therefore we may conclude that the anticyclonic area asserted to exist within 600 to 1,000 miles from

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

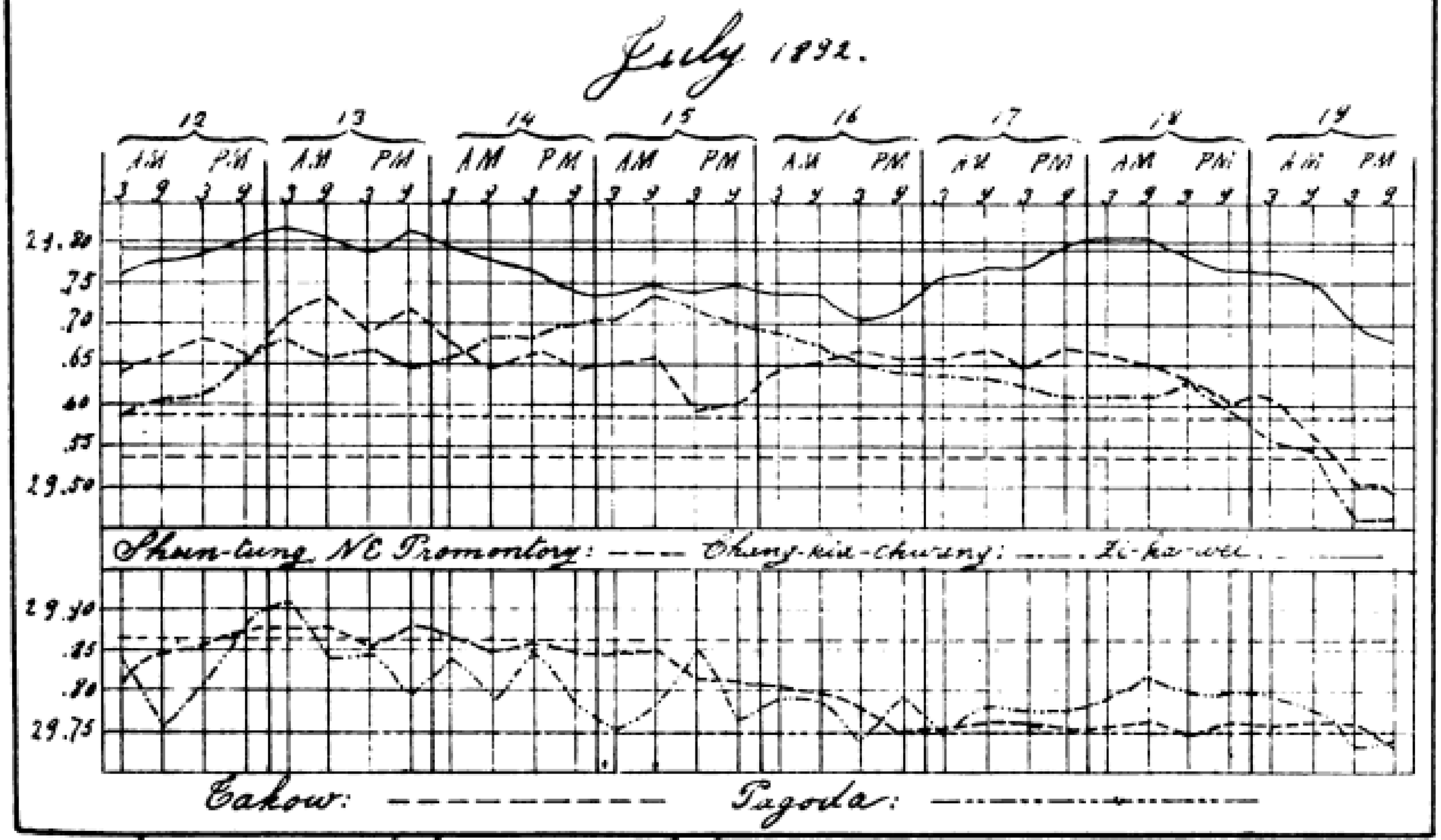
The Bokhara Typhoon.

I.

October 1892.



July 1892.



Zi-ka-wei — Catholic mission Lith:

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

the centre of the typhoon was not present in our case, and did not make its appearance either at South Cape or at Foochow or at any place before the typhoon. Whether the absence of anticyclonic area is a particularity of that typhoon, or not, is a question we must now consider. To answer it, let us look at the other typhoons experienced during the same year in Chinese or Japanese seas. The most terrible typhoons of the year were: two in July, one in August, two in September. To look successively at each of those typhoons, to dwell upon them as much as necessary to ascertain this fact would be a long task better left to the general study of the typhoons of the year which I do not propose to undertake at present. Let us only take a glance at one of them and conclude.

I take the first typhoon which made, in that year 1892, some havoc on the Coast of China, the centre of which passed over Takow on the 21st July at 10 p.m.

This typhoon made its first appearance on the China Sea on the 16th July, and was at that date travelling Northward. Looking at the record of the previous days we find that on the 10th a low barometeric pressure having its centre over Mongolia, was largely spread over the whole Coast of China and even Luzon. Subsequently a rise of the barometer took place at every station, except on the South-Western Coast of Japan. On the 14th a high barometric pressure prevailed over Northern Japan and Manchuria; a centre of lower pressure, in which the lowest reading was 29.64 lay over south-western Japan. Over China, the gradients were moderate from North to South between Tientsin and Shanghai; and still more so from South to North between Amoy and Shanghai, consequently on the centre of lower pressure on the south-western Japan. On that day, the 14th, the barometer began to fall slowly at Shanghai and at the southern Stations of the China Coast, while it was keeping on steady or rather rising at Manila until the 16th. On the 16th a decided fall began simultaneously at Tientsin and at the more southern Stations: Manila, Hongkong, etc., whilst a decided rise began at Shanghai, slightly felt at Pagoda and even at Takow. All those barometric variations are sufficiently represented by the barometric curves shewn on the accompanying plate; on which you will see the variations over the Northern Coast represented by the barometric curve of Chang-kia-chwang (a small village at 60 miles south-west of Tientsin). The other curves, below the first one, give the same variations of barometric pressure at Cape Shantung, Shanghai, Pagoda and Takow. I call your attention especially to the rise of the barometer at Shanghai on the 16th July, precisely whilst it was falling at Chang-kia-chwang, on account of a northern low pressure, and at the southern Stations Hongkong and Manila, on account of the coming or rather just formed typhoon (if, as it

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

is probable, it was formed at that date). The centre of the typhoon, if formed, must have been lying at that time over the China Sea by 14° N., about 1,000 miles from Shanghai. Hence the rise of the barometer at Shanghai at that date, if any, was surely the rise due to the anticyclonic area we are looking for, and of course the appearances shew that it was so. However, notwithstanding that first appearance, I venture to say, that such area was not in any way connected with the typhoon. The barometric curves above reported shew a rise of the barometer beginning first at Tientsin, and reaching its highest reading there on the 15th, subsequently the same rise reaching its highest reading at Shantung Cape, on 17th, at Shanghai on the 18th, and later on the same day, at Pagoda Anchorage. You will see it, at the same time, getting lighter, the more it extends towards the South. Then suppose it was an anticyclonic area depending on the existence and place of the typhoon, evidently it should have followed a Northward trajectory, as did the trajectory of the typhoon itself. Therefore as this area followed a contrary one and had originated far to the North, we must couclude that it was not in any way connected with the typhoon. The only connection between these two phenomena, was that this area of high pressure was prevented by the typhoon, from extending more towards the South. Let us therefore conclude that :

1st—The assertion of an anticyclonic area all around the centre of a typhoon is unfounded.

2nd—The assertion of an anticyclonic area preceding the typhoon so as to be felt at any place several days before the typhoon is also unfounded.

3rd—That there is such anticyclonic area somewhere, ahead or in rear, in the right or in the left, we can neither affirm nor deny, according the present considerations.

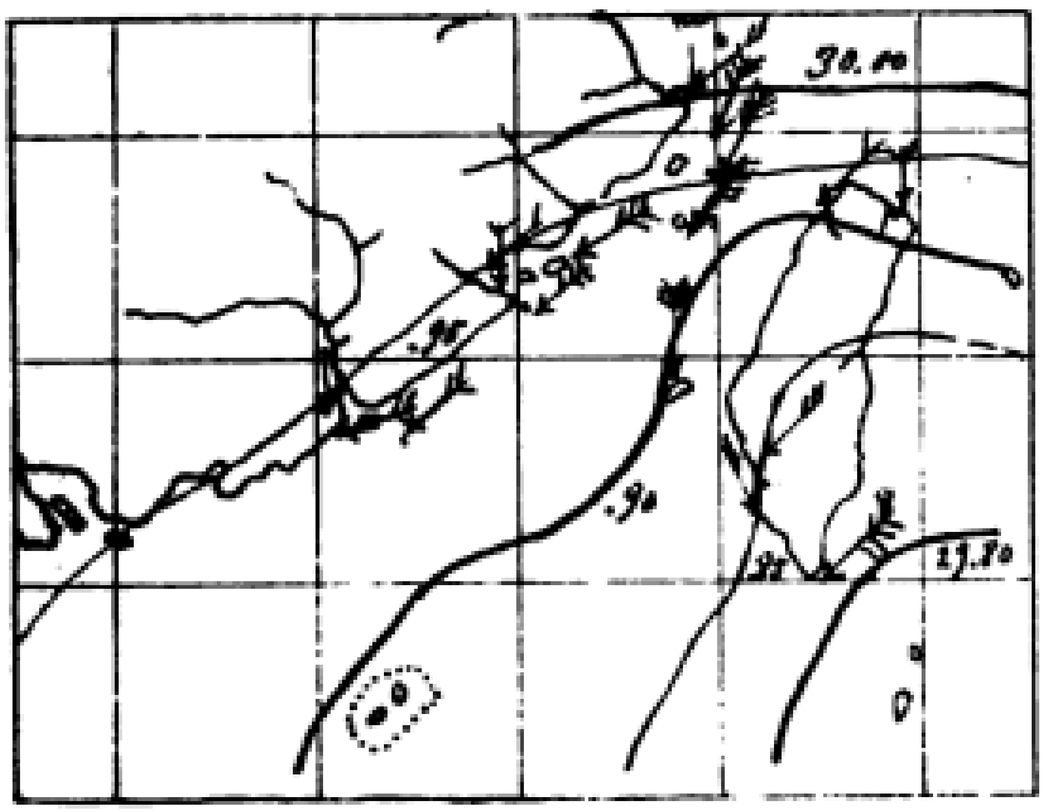
4th—The assertion that such anticyclonic area should be a prognostic of a typhoon, either coming on, or only existing somewhere is an assertion still more evidently unfounded. There are in fact numerous such rises of the barometer without any typhoon ; and there are typhoons without any such rise within 600 to 1,000 miles from the centre, and when such rise takes place within 600 to 1,000 miles from the centre it is very probably an accidental occurence. And one might as well describe as prognostic of typhoon every phenomenon which occurs from time to time outside the limits of a typhoon.

Having come to these couclusions on that important point we will return to our typhoon. The first intelligence of it came to Shanghai on October the 8th by a telegram from Manila, dated October the 7th, reporting a typhoon by the S.E. of Luzon. I doubt seriously whether this circumstance had been really

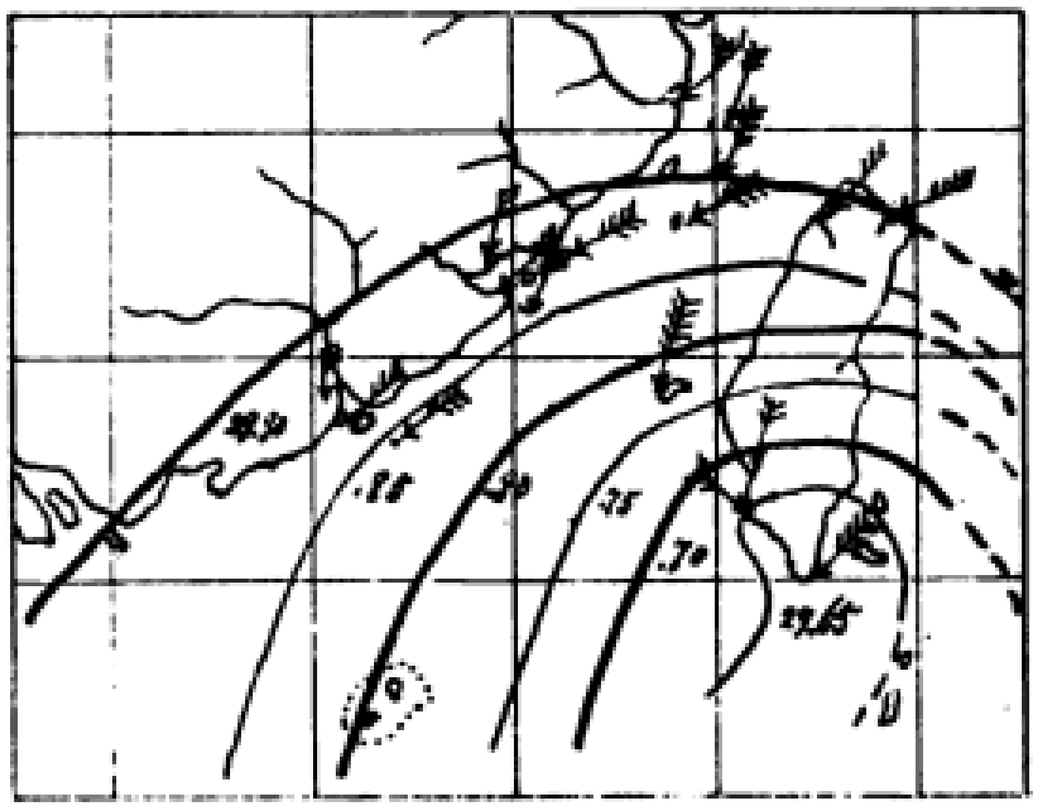
Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

The Bokhara Typhoon.

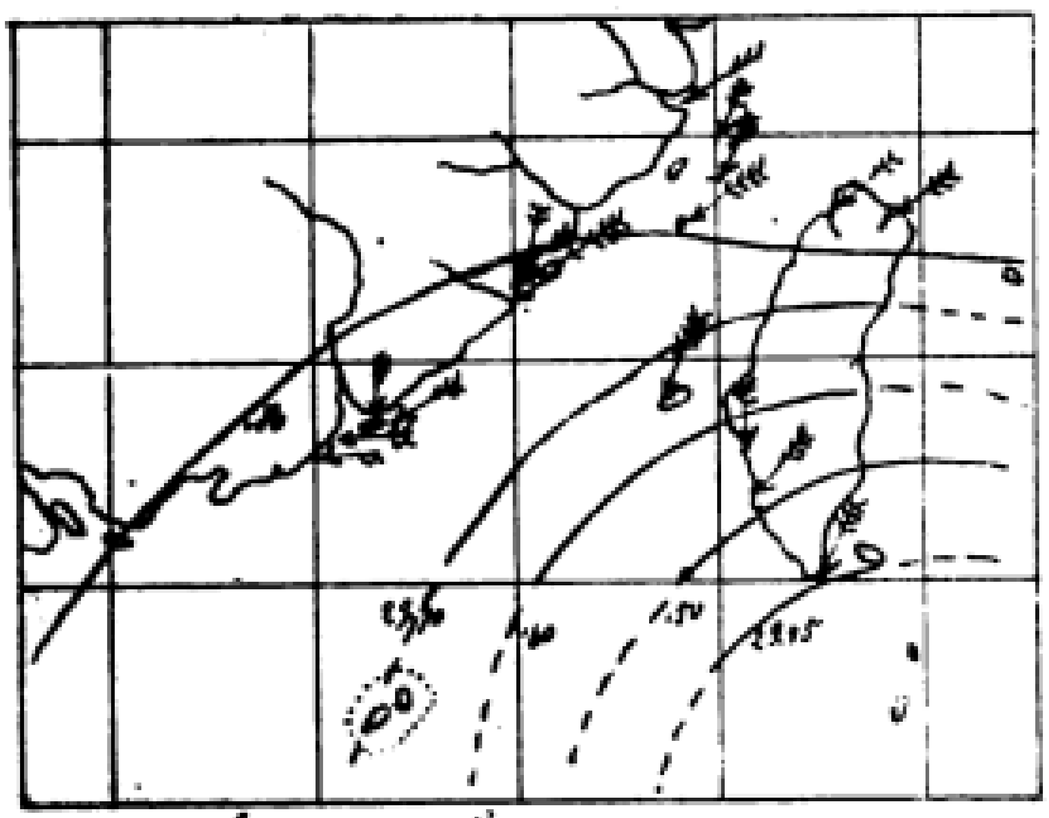
II.



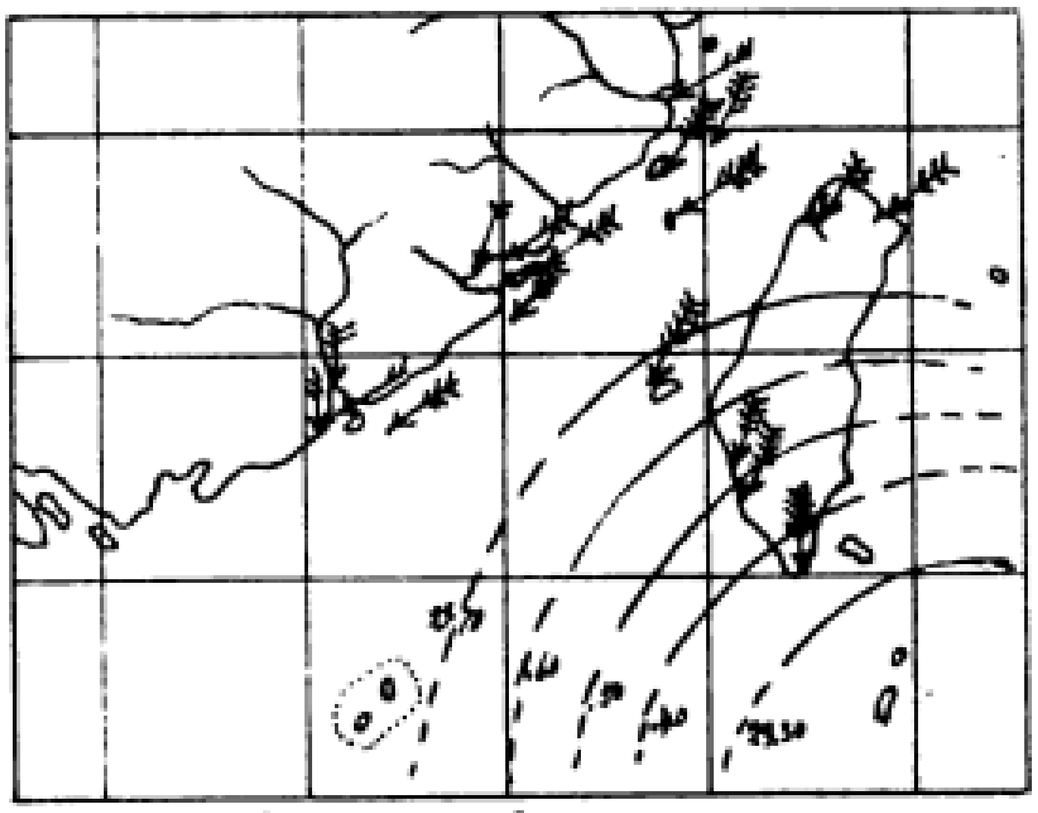
8th October 1892. 9.A.M.



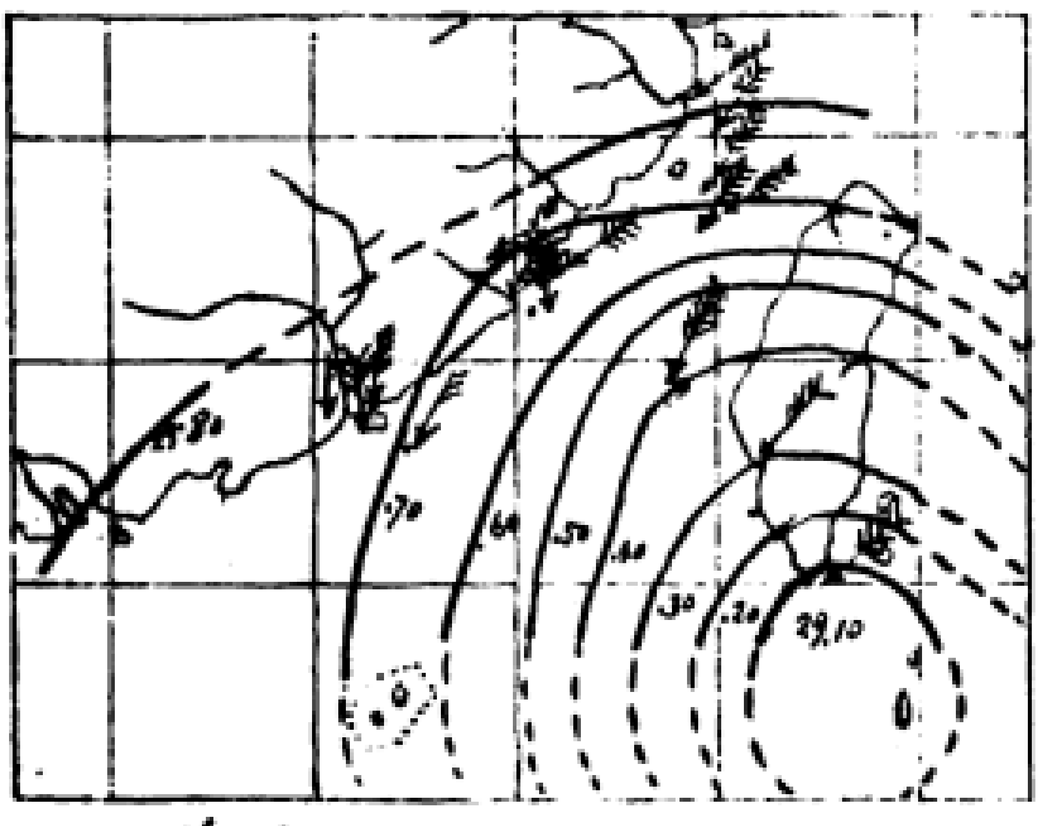
9th October 1892. 9.A.M.



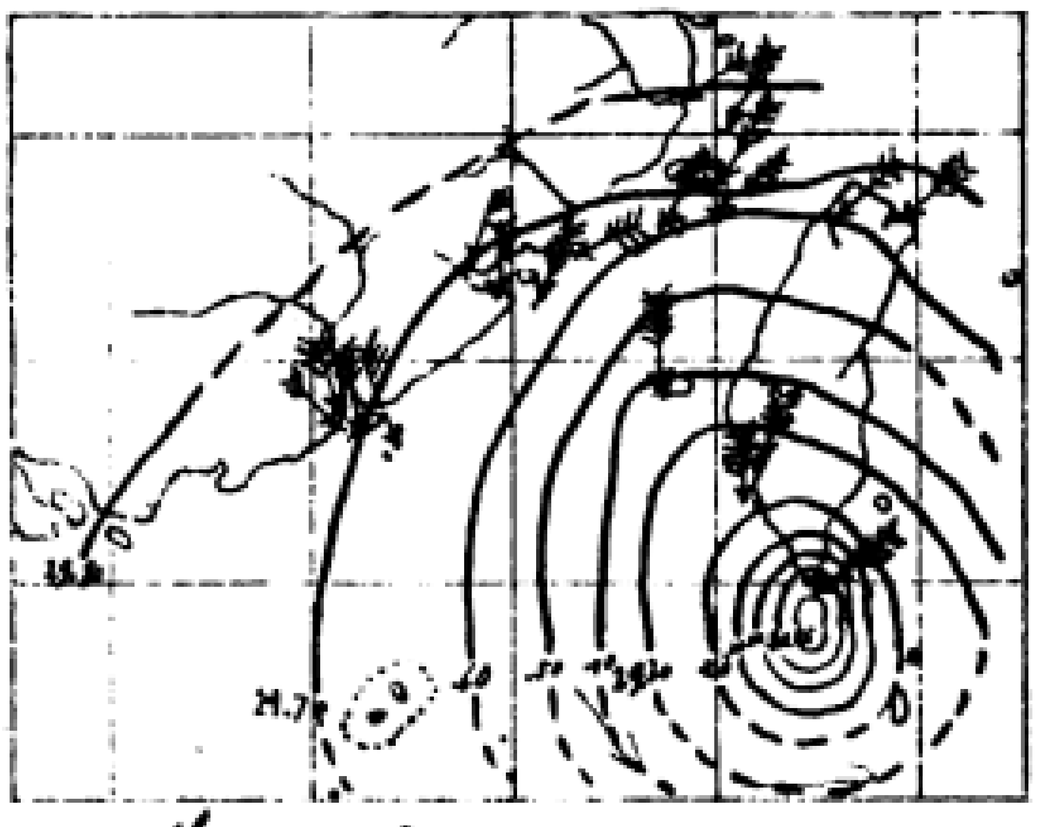
9th October 1892. 3.P.M.



9th October 1892. 9.P.M.



10th October 1892. 3.A.M.



10th October 1892. 9.A.M.

Zi-ka-wei. — Catholic mission lith:

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

indicated by the Manila Observatory. I felt decidedly perplexed at the receipt of the telegram, in as much as, the direction of the wind, reported at the same time as prevailing at Manila, would have rather indicated a typhoon North-East of Manila. Consequently on my doubts, although I reported the telegram in my daily bulletin, I did not hoist the flag-signal. Had I got at that moment the meteorological observations of South Cape of Formosa, I should have felt confident enough, in spite of the telegram, to point out the typhoon to the North-East of Luzon ; I insist on that point because on that very day, at noon, the *Bokhara* left Shanghai, with inaccurate information, supposing she had any, about the typhoon. Of course knowing that she became unmanageable at a very great distance from the centre, we may well doubt that such a short notice of the presence of the typhoon to the North-East of Luzon would have been sufficient to prevent the terrible disaster ; yet, it is doubtless too, that such advice received before leaving, might under any circumstances have proved very useful, and would in many cases save a vessel from total wreck. It is reported in the *finding of the Court of Inquiry*, that the *Bokhara* "left Shanghai with fresh North-East breeze, that she soon found it increasing and on the following day she was running with a fresh gale on the port quarter," these assertions are not consistent with the meteorological reports of the lightlouses outside the Yangtze river, according to which moderate breezes prevailed on the 8th, and the evidence of the chief officer, Mr. G. H. Prickett, stating that even at midnight on the 10th the force of the wind was as near a gale as possible.

From the Meteorological observations at Manila, Appari (Northern Meteorological Station of Luzon) and South Cape of Formosa, as registered in the above tables, the centre of the typhoon on the 8th, at 9 a.m., must be placed by 17° 30′ N. and 126° 30′ E.

The isobaric line 29.70 was passing East of Appari and Manila to inflect afterwards to the South-East ; that of 29.82 was passing near South Cape running from North-East to South-West ; and that of 29.92 was passing over Hongkong, Amoy and the Northern Formosa. Therefore the gradients were of a moderate rate in the whole channel, and consequently the prevailing winds would have been rather moderate. The accompanying map will in fact show that the monsoon blowing at that time with force of a light breeze over the Coast, still moderate in the Channel and even at South Cape ; was approaching the force 7 of a moderate gale at Turnabout and Fisher Island.* The following observations made at the Meteorological Station of Appari (Northern Station of Luzon) by 18°.22′ N. will enable us

* See plate II., 1st map.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

to determine with greater accuracy the position of the typhoon at 2 p.m. on the 9th of October.

APPARI (Luzon Island, Lat. 18° 22), October 1892.

Date.	Hours.	Barometer.	Wind. Direction.	Wind. Force.	Clouds. Quantity.	Clouds. Species.	Clouds. Direction.
8th	6 A.M.	29.68	N.N.E.	3	6	...	N-E.
	10	29.70	N.N.E.	5	8	...	N.E.
	1 P.M.	29.61	N.N.E.	6	8	...	N.E.
	4	29.56	N.N.E.	7	8	Nbus.	N.E.
	6	29.54	N.	7	10	,,	N.N.E.
	8	29.54	N.	7	10	,,	N.N.E.
9th	6 A.M.	29.31	N.W.	11	10	,,	N.N.W.
	10	29.16	N.W.	12	10	,,	N.W.
	1 P.M.	29.09	N.W.	12	10	,,	N.W.
	4	29.07	W.	11	10	,,	W.
	6	29.11	W.S.W.	9	10	,,	W.S.W.
	8	29.17	S.S.W.	9	10	,,	W.S.W.
10th	6 A.M.	29.42	S.S.W.	4	10	,,	S.S.W.
	10	29.54	S.S.W.	4	10	,,	S.W.
	1 P.M.	29.54	S.W.	4	8	...	S.W.
	4	29.57	W.S.W.	1	8	...	W.S.W.
	6	29.62	N.W.	1	10	...	S.W.
	8	29.67	W.	1	10	...	S.W.

Indeed, they plainly show, that the centre passed at its shortest distance from that spot, at or about 2 p.m. on the 9th; its bearing being at that time to the North-East of Appari.

To determine the distance of the centre, which is the only difficulty in the matter, we may avail ourselves of the observations made at South Cape. The centre having from the beginning travelled directly towards that last station, and passed very near to it, on the 10th, at 1 p.m., a rough determination of its velocity will enable us to determine with sufficient accuracy the distance of the centre from the South Cape, when the height of the barometer at that station was precisely the lowest reading made at Appari. The lowest reading of the barometer at Appari was 29.06, the same reading of the barometer at South Cape was taken at 5 a.m. on the 10th. Then, by a rough estimation of the velocity of the typhoon at 8 miles per hour, we see that the lowest reading of Appari was observed at South Cape when the typhoon was distant about 65 miles. Then taken as granted both that the isobaric lines were roughly circulars round the centre, and that the central low pressure remained unchanged, from the 9th, at 2 p.m., to the 10th, at 5 a.m., we must conclude that on the first of those dates, the centre of the typhoon was 65 miles to the North-East of Appari. That position, as well as the assumed

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

velocity of translation at 8 miles per hour, is quite consistent with the before determined position for 9 a.m. on the 8th, and quite consistent also with the perfectly ascertained position on the 10th, at 1 p.m.

Before proceeding to ascertain the trajectory of the typhoon we must stop here and look at the atmospheric state of the Formosa Channel on that day, 9th October.

Here you have two tables in which I have indicated all the meteorological observations made in Formosa Channel at 9 a.m. and 3 p.m. on that day, with two synoptic maps showing for the same two hours, the isobaric lines with the direction and the force of the wind as reported by the various meteorological stations of the Channel.*

FORMOSA CHANNEL, Meteorological Report for 9 A.M., 9th October, 1892.

Meteorological Stations.	Barometer.	Variation 24 h.	Wind. Direction.	Force.	Weather.
Pagoda	29.94	— 0.03	N.E.	3	BC
Middle Dog	29.91	— 0.02	N.N.E.	6	BCM
Turnabout	29.96	— 0.03	N.N.E.	9	OM
Ockseu	29.88	— 0.09	N.E.	7	BCM
Dodd Island	29.85	— 0.06	N.E.	7	BCM
Amoy	29.86	— 0.09	N.N.E.	3	C
Pescadores	29.63	— 0.19	N.N.E.	9	CMG
Kelong	29.91	— 0.02	E.N.E.	5	OC
Tamsui	29.88	— 0.04	N.E.	2-3	R
Anping	29.74	— 0.14	N.N.E.	4	O
Takow	29.66	— 0.18	N.W.	5	C
South Cape	29.65	— 0.22	N.E.	7-8	BCMG
Lamocks	29.87	— 0.08	N.E.	7	BCM
Swatow	29.84	— 0.08	N.	3	B
Cape of Good Hope ...	29.88	— 0.09	N.E.	4	O
Breaker Point	29.87	— 0.06	N.	2	BC
3 P.M., 9th October.					
Pagoda	29.86	— 0.06	N.E.	3	C
Middle Dog	29.86	— 0.03	N.N.E.	6	BCM
Turnabout	29.87	— 0.07	N.N.E.	10	CM
Ockseu	29.78	— 0.12	N.E.	8	BCM
Dodd Island	29.78	— 0.07	N.E.	8	CMQ
Amoy	29.74	— 0.11	N.N.E.	4	C
Pescadores	29.59	— 0.24	N.N.E.	10	CMQ
Kelong	29.83	— 0.06	N.E.	6	O
Tamsui	29.84	— 0.05	N.E.	5	R
Anping	29.56	— 0.20	N.	5	O
Takow	29.49	— 0.26	N.N.E.	8	R
South Cape	29.46	— 0.33	N.N.E.	7	OGMDQ
Lamocks	29.73	— 0.12	N.E.	5	C
Swatow	29.72	— 0.09	N.	3	C
Cape of Good Hope ...	29.74	— 0.12	E.	4	BCM
Breaker Point	29.71	— 0.15	E.	2	BCM

* See plate II., page 8.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Though many stations, as Pagoda, Amoy, Tsing-tseu, Swatow, Cape of Good Hope and, on the Northern Formosa, Tamsui and Kelung report moderate or light breezes, it appears that a fresh gale was blowing in the Channel from Turnabout to South Cape. The height of the light-houses above sea level may perhaps partly account for the strong gale reported by light-keepers, but the *Empress of Japan*, Captain G. A. Lee, which was not at that time running through the most stormy part of the Channel, reports:

"Increasing gale, with high head sea, and very thick weather in the morning. At noon, head gale, very high head sea; wind steady at N.E. 9 to 10; misty weather."

Abstract from the meteorological log of the *Empress of Japan*, Captain Lee.
Storm of the 10th October, 1892.

Date.	Hour.	Position.	Course.	Wind. Direction.	Force.	Barom. Aneroid.	Temp.	Clouds.	Remarks.
8th,	1 P.M.	...	North	N.E.	...	29.96	74°	...	1 p.m. left Hongkong.
		...	North	E. by N.	...	...	...	...	Light easterly wind, clear weather.
		...	North	N.E.	7	29.85	68	...	10.5 p.m. Breaker Point abeam, wind increased to a gale, head sea.
	Midn.	...	N.50°E.	N.E.	...	29.90	...	...	
	4 A.M.	...	...	N.E.	...	29.90	...	...	2.10a.m. Lamock abeam.
		...	...	N.E.	...	29.84	...	...	Increasing gale; high head sea, reduced speed of engine as occasions require.
	8	...	...	N.E.	...	...	...	...	
	Noon	24°33 N. 118°52E.	...	N.E.	...	29.82	...	...	Hard gale and very high head sea. Wind strong at N.E.
9th,	4 P.M.	...	...	N.E.	9	29.77	...	...	
	8	...	...	N.E.	9	29.77	...	...	
	Midn.	...	...	N.E.	9	29.76	...	...	Very strong gale and thick misty weather.
		...	...	...	10	...	...	...	Very high head sea.
	4 A.M.	...	...	N.	10	...	...	10	Ship pitching and straining heavily.
		...	...	N.	10	29.70	...	...	Heavy gale, dangerous sea, overcast.
	8	...	...	...	...	29.67	...	...	
10th,	Noon	25°41 N. 120°15 E.	N.45°E.	N.	11	29.62	...	...	Strong gale, furious squalls with heavy rain.
	4 P.M.	...	...	...	...	29.51	...	...	Tremendous sea.
	8	...	...	...	...	29.48	...	...	
	Midn.	...	...	N.E.	10	29.45	...	10	Hard gale, violent squalls.
	4 A.M.	...	...	N.N.E.	10	29.43	...	...	Severe squalls at time with much rain.
	8	...	...	N.E.	10	29.55	...	...	
	Noon	26°10 N. 120°48 E.	...	...	...	29.58	...	...	
	4 P.M.	...	...	N.N.E.	10	29.62	...	...	
	8	...	...	N.	9	29.72	...	...	

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

The gradients during such a gale, as shown by the isobaric lines, were only roughly speaking 0.10 for 60 miles and do not appear to have much changed between 9 a.m. and 3 p.m.

The centre of the typhoon was about 450 miles from the Northern part of the Channel. As the barometric pressure over the Northern Coast of China, which was normal or nearly so, cannot account in any way for such a gale, we must draw as a general rule the following conclusion : *After the Northern monsoon is settled along the Coast, a typhoon in the South, even when travelling far in the South of Formosa or over the Northern China sea, will bring on a strong N.E. gale in the whole Channel.*

According to the meteorological observations made at South Cape, shewn in the following table, the centre of the typhoon from the place, at which we left it raging on the 9th at 2 p.m., viz., 65 miles to the N.E. of Appari, went directly towards the South Cape of Formosa passing at a short distance from it, on the 10th at 1 p.m.

SOUTH CAPE, October 1892.*

Date.	Hour.	Wind. Direction.	Force.	Barometer.	Rain.	Weather.	Remarks.
8th	Midt.	N.N.E.	4	29.69	...	BCP	
	3 A.M.	N.E.	3	29.69	...	BC	
	6 A.M.	N.E.	3	29.68	...	BC	
	9 A.M.	N.N.E.	4	29.69	0.55 2.10m	BC	
	Noon	N.N.E.	4	29.64	...	BC	
	3 P.M.	N.N.E.	5	29.61	...	BC	
	6 P.M.	N.N.E.	5	29.59	...	BC	
	9 P.M.	N.N.E.	7	29.60	...	BC	
9th	Midt.	N.E.	8	29.59	...	BCMG	
	3 A.M.	N.E.	8	29.54	...	BCMG	
	6 A.M.	N.E.	8	29.48	...	BCMG	
	9 A.M.	N.E.	8	29.47	...	BCMG	
	Noon	N.N.E.	7	29.38	...	BCMG	
	3 P.M.	N.N.E.	7	29.28	...	OGMDG	
	6 P.M.	N.	8	29.25	...	OGMGR	
	9 P.M.	N.	10	29.21	...	OGMGR	
10th	Midt.	N.N.E.	10	29.09	...	OGMGR	
	3 A.M.	N.E.	10	28.92	...	OGMGR	
	6 A.M.	N.E.	10	28.84	...	OGMGR	
	9 A.M.	E.N.E.	10	28.70	6.30 16h.¾	OGMGR	10 a.m. 28.61
	Noon	E.	12	28.27	...	OGMGR	11 a.m. 28.48
	3 P.M.	S.	12	28.47	...	OGMGR	1 p.m. 28.15
	6 P.M.	S.W.	10	28.99	...	OGMGR	2 p.m. 28.27
	9 P.M.	S.W.	9	29.22	...	OGMGR	4 p.m. 28.77
11th	Midt.	W.S.W.	9	29.32	...	OGMGR	
	3 A.M.	W.	9	29.39	...	OGMGR	
	6 A.M.	W.	8	29.45	4.70 18h.	CGMG	
	9 A.M.	W.	7	29.52	...	CGMG	
	Noon	W.N.W.	8	29.54	...	BCG	
	3 P.M.	W.N.W.	8	29.54	...	CG	
	6 P.M.	N.W.	8	29.58	...	OGMG	
	9 P.M.	N.W.	8	29.60	...	BCMG	

* In this table the barometric readings are not reduced to sea level.

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

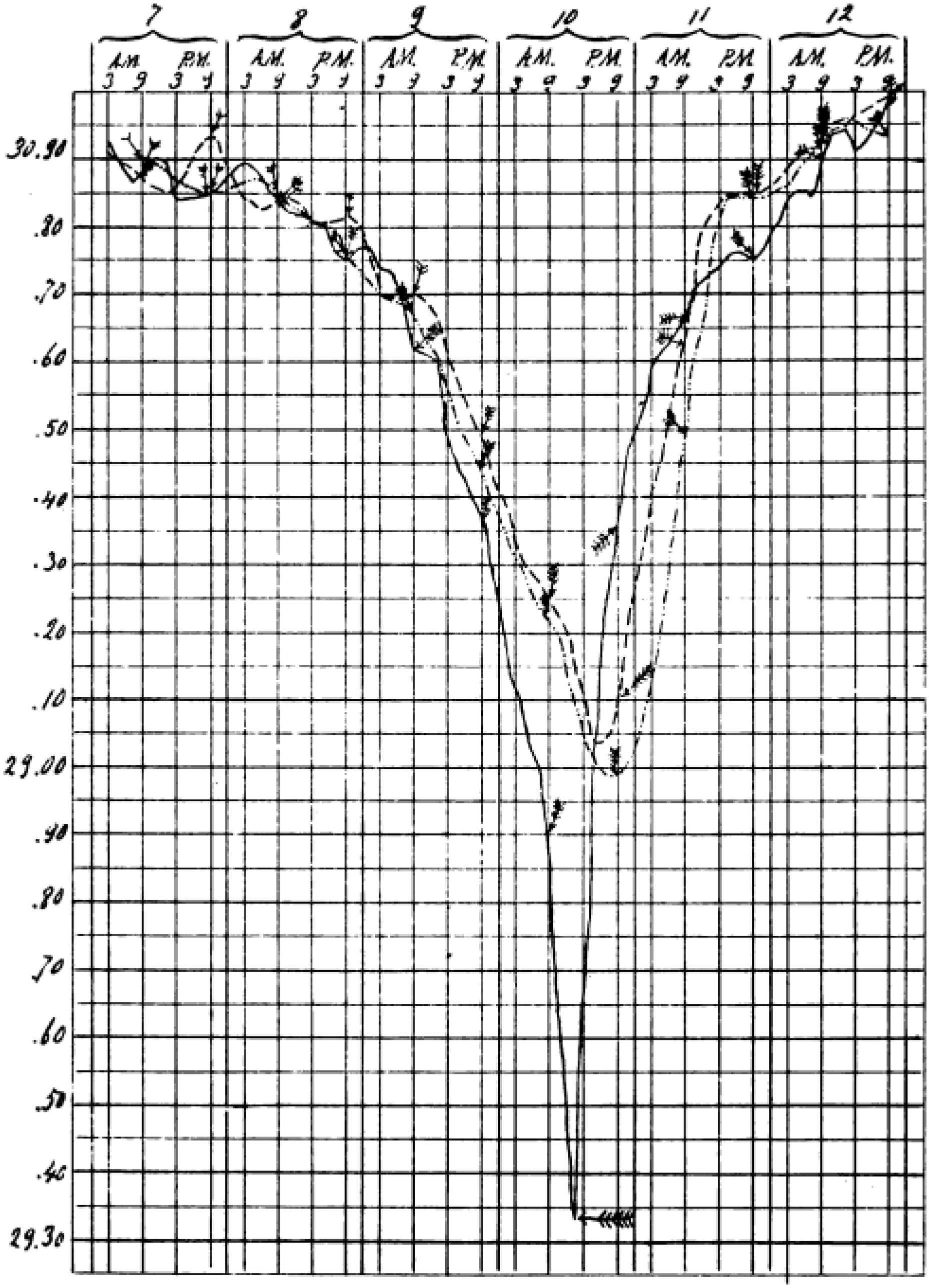
From the very regular fall of the barometer, we are disposed to infer that the trajectory of the typhoon was quite direct towards the Cape; that is direct from South-East to North-West. Nevertheless as the meteorological report of South Cape proves that the direction of the wind was changing at that place, not regularly and gradually from North-East to East, as the theory of typhoons would indicate, but with oscillatory movement from North-East to North-North-East, and from this to North-East again, and so on, some doubt may well arise about the asserted regularity of that course. Indeed, from that oscillatory movement we should conclude that either, the angle of the direction of the wind with the radius vector (the straight line from the observer to the centre) keeping constant, the centre of the typhoon was deviating from its trajectory, now to the Northward, now to the Westward of it; or, the typhoon keeping a straight course, as we have said, the angle of the direction of the wind with the radius vector was changing with such oscillatory movement. On looking closely to those variations, we see that the wind hauled North-East in the morning to back in the afternoon to North-North-East; besides, that the same remarks are to be applied to the observations made at Amping, we see further, that the same oscillatory movement is also to be observed during the first days of the month; thence we may conclude that this oscillatory movement depends on some unknown local conditions and by no means on an alteration in the course of the typhoon. It follows of course that the angle of direction of the wind with the radius vector was changing in the same way. The question of the angle, between the direction of the wind and the radius vector, is so important, that we must dwell upon it further; but not to break off the discussion of the trajectory of the typhoon, I postpone that question.

If our conclusion are well founded, the typhoon travelling from its bearing at 2 p.m., 65 miles to the N.E. of Appari, directly towards the South Cape of Formosa must have been at 9 p.m. of the same day, at 130 miles from that place. The accompanying map will show the atmospherical state of the Channel, where the gale blowing in the morning had still increased, especially near Southern Formosa.* Until that moment the *Bokhara* was outside the Channel, and had not yet entered into the gale. According to the evidence given by the chief officer, Mr. Prickett, she was at that time 10 miles South of Tung-ying steering South 24° West for Turnabout and until midnight she did not experience more than strong winds "*as near a gale as possible.*" After 9 p.m. the fall of the barometer increased at South Cape, and continued to

* See plate II., 5th map, page 8.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

October 1892.



Ki-Ka-wei — Catholic mission Lith:

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

do so very rapidly, as is well shown by the accompanying barometric curve.* The wind kept on blowing from North-East or North-North-East, with the same force 9 to 10, until 6 or 8 o'clock in the morning of the 10th. At 9 a.m. it increased in violence, veering to East-North-East; at noon it blew with hurricane force from the East; and at 3 p.m. it had veered to the South, blowing with the same violence. At 6 p.m. it had reached the South-West and was abating. From the quick fall of the glass and the veering of the wind from North-East to South-West in a few hours, it is evident, both that the centre had passed very near the Cape, and that it had recurved towards the North and North-East, instead of going on North-Westward. The meteorological observations kept at Takow, Amping and Fisher Island are so completely consonant with that deduction that we may hold it for settled. In the following tables are recorded the observations of those three stations.†

TAKOW, October 1892.

Date.	Hour.	Wind. Direction.	Force.	Barometer.	Thermometer.	Weather.
8th	9 A.M.	N.N.W.	4	29.82	82	C
	3 P.M.	N.W.	5	29.73	83	C
	9 P.M.	N.W.	4	29.74	80	C
9th	9 A.M.	N.W.	5	29.64	76	C
	3 P.M.	N.N.E.	8	29.47	75	R
	9 P.M.	N.N.E.	10	29.42	78	G
10th	9 A.M.	N.	10	29.19	74	R
	3 P.M.	N.N.E.	10	28.96 28.90	77	G
	9 P.M.	N.	10	28.97	73	R
11th	9 A.M.	N.W.	7	29.71	70	R
	3 P.M.	N.W.	8	29.73	76	G
	9 P.M.	N.N.W.	10	29.82	68	G

ANPING, October 1892.

Date.	Hour.	Wind. Direction.	Force.	Barometer.	Rain.	Weather.	Remarks.
8th	3 A.M.	N.E.	2	29.80	...	O	
	9 A.M.	N.E.	3	29.84	...	B	
	3 P.M.	N.	5	29.72	...	B	
	9 P.M.	N.	3	29.80	...	B	
9th	3 A.M.	N.E.	3	29.66	...	O	
	9 A.M.	N.N.E.	4	29.70	...	O	
	3 P.M.	N.	5	29.52	...	O	
	9 P.M.	N.N.E.	8	29.47	...	O	

* See plate III.

† In these tables the barometric readings are not reduced to sea level.

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

Date.	Hour.	Wind. Direction.	Force.	Barometer.	Rain.	Weather.	Remarks.
10th	3 A.M.	N.E.	7	29.28	...	ORQ	At 6 p.m. bar. stood 29.13, but slowly rose afterwards from 3 to 10 p.m. The gusts were blowing with full typhoon force.
	9 A.M.	N. by E.	9	29.25	0.14	OHQ	
	3 P.M.	N.N.E.	10	29.03	...	OGQ	
	9 P.M.	N.E.	10	29.10	...	OGQ	
11th	3 A.M.	N.	6	29.37	...	ORQ	
	9 A.M.	W.N.W.	7	29.69	2.67	ORQ	
	3 P.M.	N.N.W.	6	29.75	...	ODF	
	9 P.M.	N.	8	29.82	...	OG	
12th	3 A.M.	N.N.E.	5	29.84	...	O	
	9 A.M.	N. by E.	6	29.92	0.35	B	
	3 P.M.	N.	4	29.88	...	O	
	9 P.M.	N.	2	29.95	...	C	

Fisher Island, October 1892.

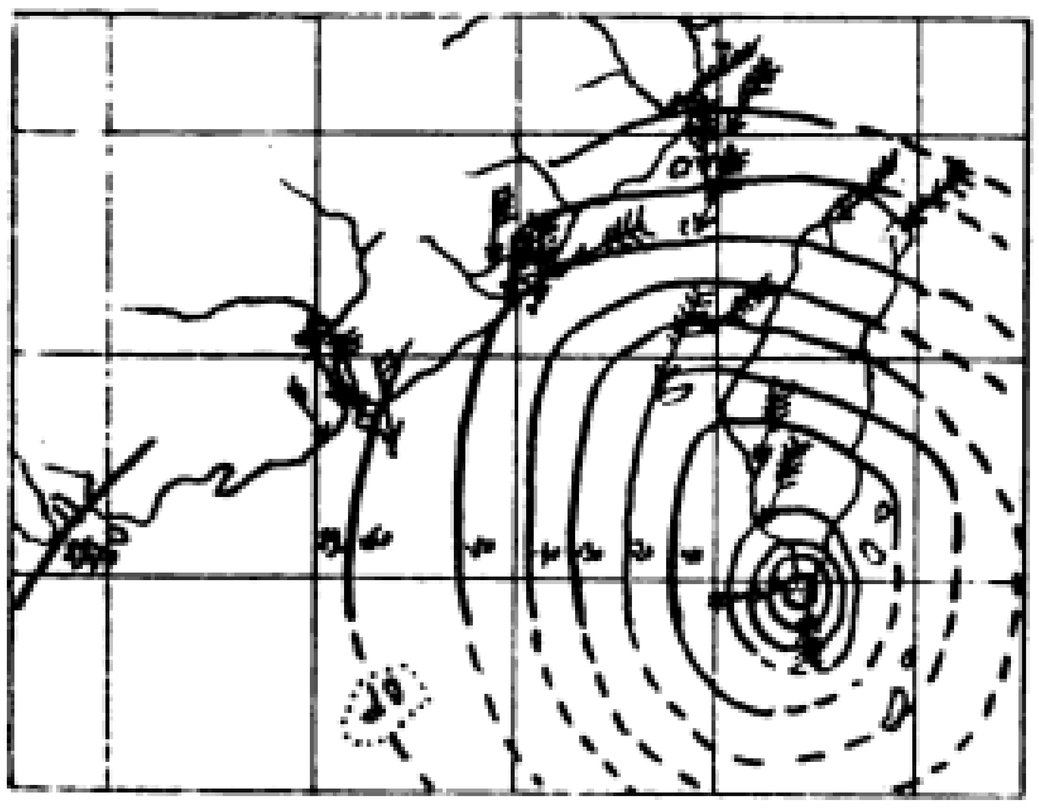
Date	Hour.	Wind. Direction.	Force.	Barometer.	Weather.
8th	Midt.	N.	7	29.64	OMQ
	3 A.M.	N.	7	29.59	OMQ
	6 A.M.	N.	7	29.61	OMQD
	9 A.M.	N.	7	29.66	OMQD
	Noon	N.	7	29.60	OMQ
	3 P.M.	N.	7	29.57	OMQ
	6 P.M.	N.	8	29.57	OMQ
	9 P.M.	N.	8-9	29.57	OMQ
9th	Midt.	N.	9	29.56	OMQ
	3 A.M.	N.	9	29.49	OMQ
	6 A.M.	N.N.W.	9	29.46	OMQ
	9 A.M.	N.N.E.	9	29.47	CMQ
	Noon	N.	9-10	29.43	CMQ
	3 P.M.	N.N.E.	10	29.33	CMQ
	6 P.M.	N.N.E.	10	29.35	OMQ
	9 P.M.	N.N.E.	10	29.36	OMQPD
10th	Midt.	N.N.E.	10-11	29.27	OMQPD
	3 A.M.	N.N.E.	11	29.15	OMQPD
	6 A.M.	N.	11-12	29.04	OMQ
	9 A.M.	N.	11	29.08	OMQ
	Noon	N.	11	29.02	OMQ
	3 P.M.	N.N.E.	11	28.93	OMQ
	6 P.M.	N.N.E.	12	29.03	OMQ
	9 P.M.	N.N.E.	11-12	29.11	OMQD
11th	Midt.	N.N.E.	10-11	29.18	OMQR
	3 A.M.	N.N.W.	10	29.33	OMQR
	6 A.M.	N.W.	9	29.47	OMQR
	9 A.M.	W.	6	29.51	OMD
	Noon	W.N.W.	7	29.53	OMP
	3 P.M.	W.N.W.	7-8	29.59	OMQR
	6 P.M.	N.W.	7-8	29.68	OMQ
	9 P.M.	N.W.	7	29.69	OMP

Digitized by Google

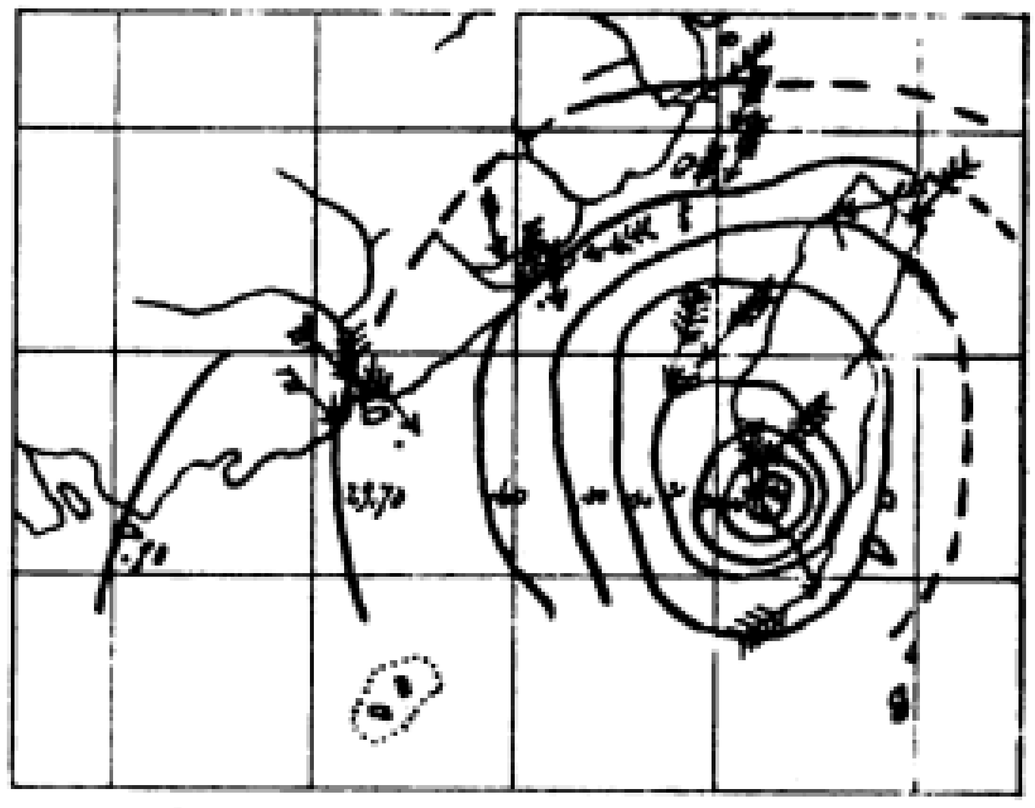
Original from UNIVERSITY OF CALIFORNIA

The Bokhara-Typhoon.

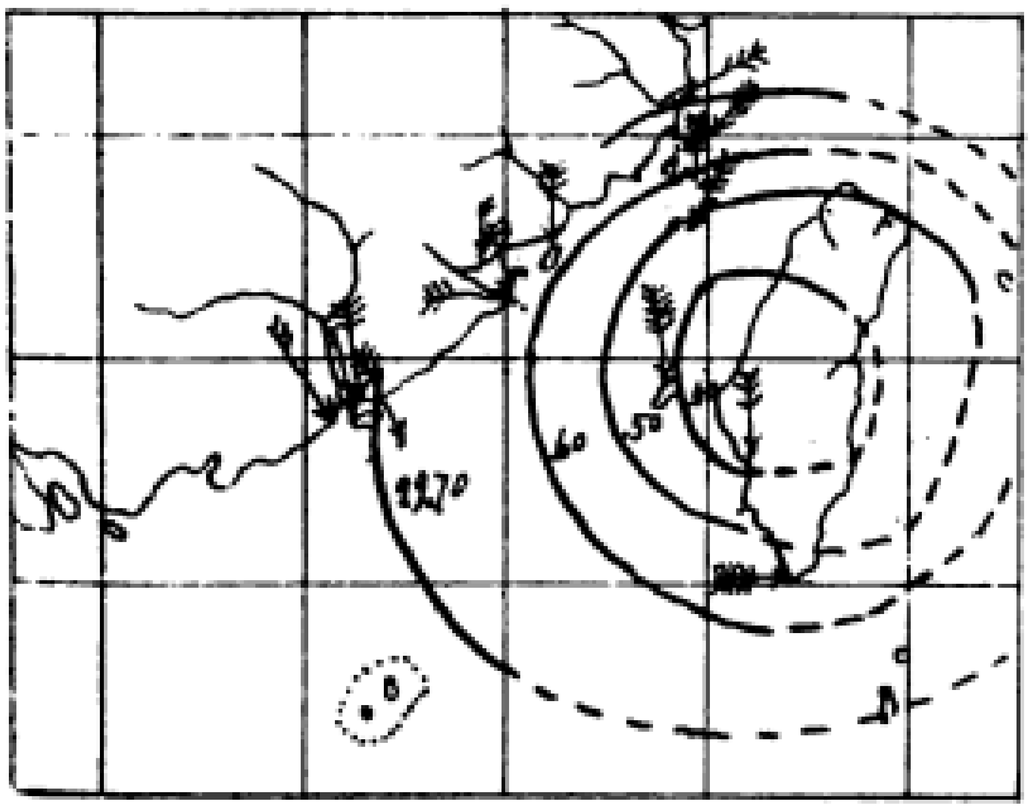
IV



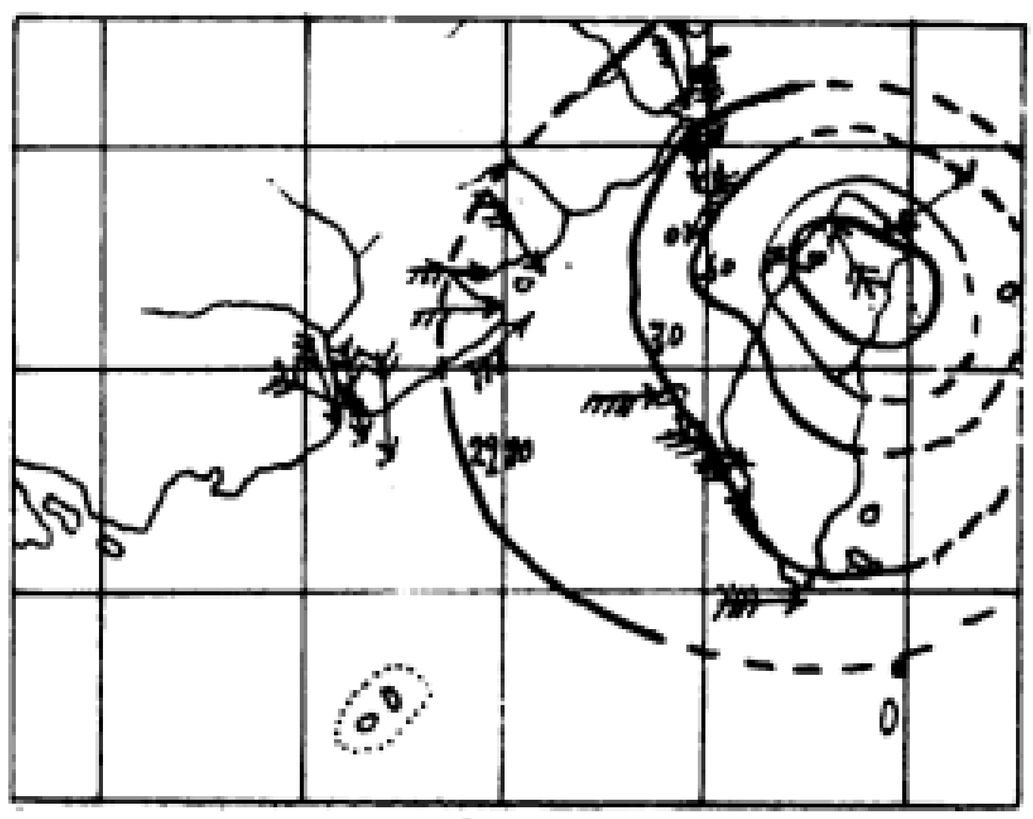
16th October 1892. 3.P.M.



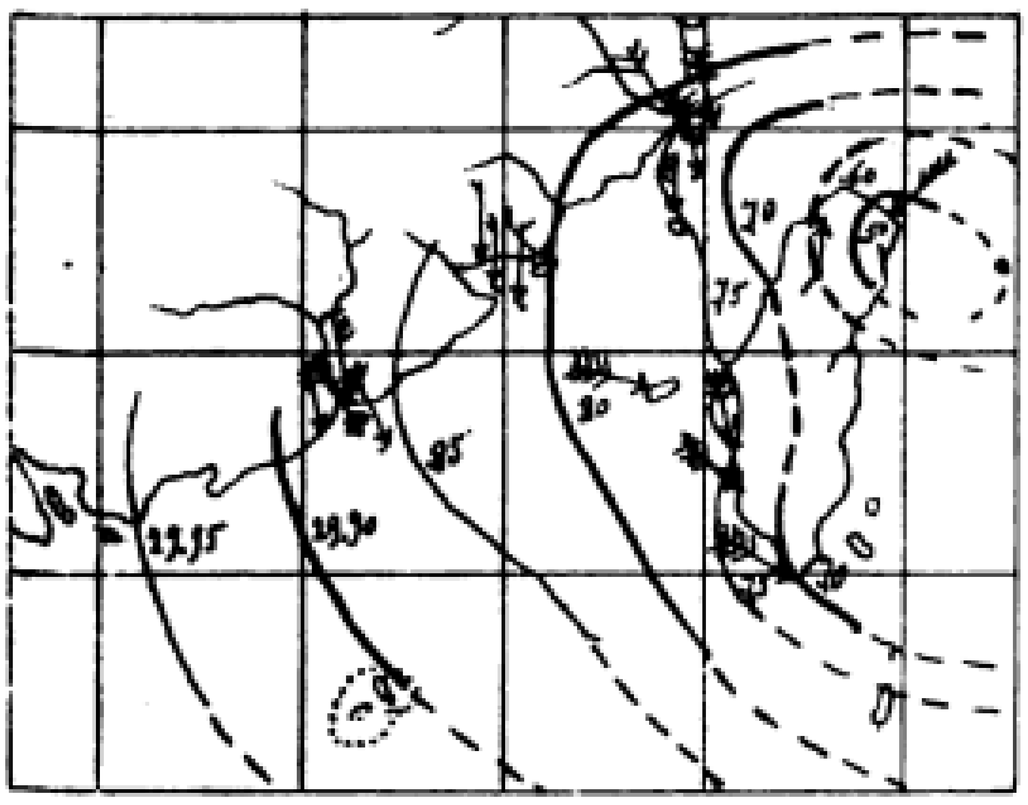
10th October 1892. 9.P.M.



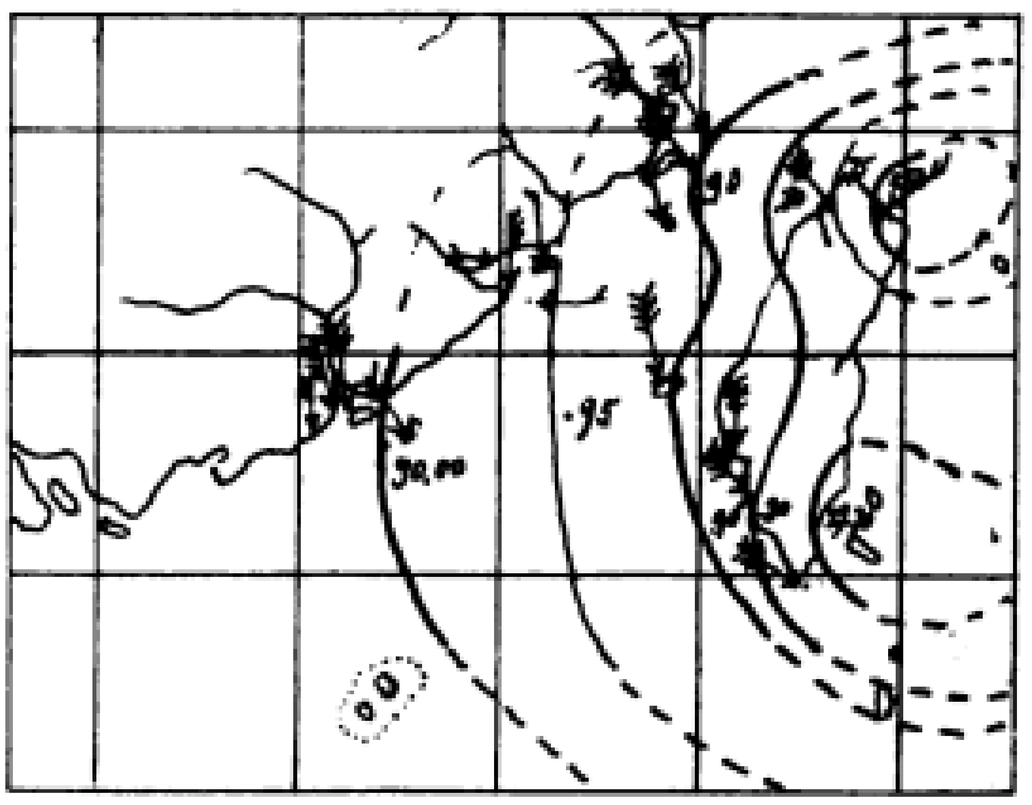
11th October 1892. 3.A.M.



11th October 1892. 9.A.M.



11th October 1892. 9.P.M.



17th October 1892. 9.P.M.

Zi-ka-wei — Catholic mission Lith.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

The various directions of the wind registered between 9 a.m. and 9 p.m. on the 10th are especially to be noticed as perfectly showing the recurving of the centre of the typhoon.

Allow me to read them.

	3 a.m.	6 a.m.	9 a,m.	Noon.	3 p.m.
Fisher Island...	N.N.E. 11	N. 11-12	N. 11	N. 11	N.N.E. 11
Amping	N.E. 7	...	N. by E. 9	...	N.N.E. 10
Takow	...	...	N. 10	...	N.N.E. 10

	6 p.m.	9 p.m.	Midnight.	3 a.m.	9 a.m.
Fisher Island...	N.N.E.12	N.N.E. 11-12	N.N.E.10-11	...	W. 6
Amping	...	N.E. 10	...	...	W.N.W. 7
Takow	...	N. 10	...	...	N.W. 7

From this we may take as an ascertained conclusion that the centre of the typhoon after passing a very few miles to the South-West of South Cape assumed a Northern direction and then moved towards the North-East, so that it must have entered the island somewhere between Anping and South Cape, and must have crossed it during the night.

The barometric observations of those three meteorological stations want to be carefully studied, but as this day is the very day which proved to be fatal to the *Bokhara* we must stop here in the account of the typhoon and record briefly the history of the lamentable wreck.

I should first notice *in extenso* the narrative of the departure of the *Bokhara* from Shanghai and of its voyage towards Hongkong. We have it well summed up in Captain Burr's report on the search for the *Bokhara*.

THE WRECK OF STEAMER *BOKHARA*.

"The steamer *Bokhara* left Shanghai at noon on Saturday, the 8th October, 1892, experiencing a fresh N.E. monsoon, with following moderate sea, which continued steady until Sunday morning, 9th. The *Bokhara* passed H.M.S. *Peacock* or *Pigmy* heading about N.W. and an Austrian corvette going the same way.

"During Sunday afternoon the wind began to increase, the barometer to fall and weather was getting thick; the position by observation was obtained at noon; no land to be seen.

"At 8 p.m. (Sunday, 9th) the barometer shewed 29.88 and still falling, the approximate position being about 8 miles east of Tungying Island, and the ship's course was then altered to make Turnabout Island.

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

"At 10 p m. (Sunday, 9th) the commander conferred with his officers as to the advisability of laying the ship to, as the glass had fallen to 29.77 and there was every probability of a typhoon to the southward of the vessel. The sea at that time was very heavy and breaking over her. The "hands" were then turned up and everything was secured for heavy weather.

"At midnight the glass was 29.70, and the commander had the sails furled, (reefed foresail, and whole foretopsail). The chief officer went on the bridge at 0.45 a.m. (Monday, 10th) and reported everything was ready for laying to. The ship was brought to the wind, going slow, on the port tack, heading from between N. 80 E. to N. 50 E. and behaving exceedingly well although a mountainous sea was running. During this time the wind had been steadily increasing with furious squalls, the weather being so thick that only about $\frac{1}{3}$ mile could be seen all round.

"At 4 a.m. Monday, 10th, the barometer registered 29.60 and was still falling.

"At 6 a.m. the barometer was at 29.55 and, daylight appearing, it was noticed that the water was very much discoloured, after which green water was seen, the lead giving 30 fathoms (mud and sand.)

"Under these circumstances the ship had reached far enough to the Eastward to put her on the other tack and work down the Formosa Channel until sea and wind should moderate, the glass shewing by this time (8 a.m.) 29.50 and the sea and wind being terrific. The ship was put at full speed ahead, and the helm put "hard a starboard;" but she would only come up to three points from the wind and then fall off again, though repeated efforts were made to get her round with tarpaulins and sails in the rigging to assist; the other sails on being loosed were blown to ribbons.

"Attempt was then made to wear, but all to no purpose, the sea and wind being too heavy, so nothing was left but to wait for the weather to moderate.

"At 10 a.m. it was blowing a full hurricane, the rolls of the ship being so great that the starboard life-boat was unhooked and rendered useless and had to be cut away for fear of damage to ship's side. The smoking room was stove in by a sea sweeping the quarter deck, hurling the jolly-boat inboard at the same time and carrying away lee gangway, etc.

"At noon (Monday, 10th) the glass showed 29.27, ship drifting in a south-westerly direction, her head being S. 50 E. and beam on to the sea, the commander putting her slow astern as opportunity offered. At this time a heavy roll to starboard took place shipping a sea at the same time carrying away all the remaining starboard boats and davits, and breaking in the engine room sky-

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

light which was battened down and which was re-secured again. Oil was then put into the weather latrines, aft and forward, which decidedly assisted in keeping the heavy breaking tops from coming inboard.

"At 2 p.m. (Monday, 10th) a roll to windward lifted the port lifeboat out of the davits which was stove in, and carried clear of the ship, and the 2nd cutter at the same time became unhooked but was re-secured, though practically useless: the only boat being left in the davits was the after port cutter.

"At 4 p.m. (Monday, 10th) the barometer shewed 29.15, but although the wind was blowing with terrific force, still very little water came inboard.

"At 5 p.m. and 6 p.m. the weather remained the same throughout without any material change in the barometer.

"At 8 p.m. the glass was steady at 29.15.

"At 10 p.m. three heavy seas broke over ship breaking in after skylights, commander's cabin and engine room skylights and stokehold doors and wheelhouse, putting out all the fires below, the heat and steam being so great that it was impossible for the engineers to get into the engine room or stokehold. The ship was now unmanageable with no steam and the chief engineer reported that it would be some time before he could possibly be ready; the lead was kept going, 25 fathoms being the average soundings.

"At 11.35 p.m. (Monday, 10th) the 3rd officer called the attention of the commander to a dark object on the lee beam; the land loomed up large through the drift. The chief officer came on the bridge and the reef was then plainly visible about 20 yards off. Nothing could be done.

"Then the commander said "Good-bye" to the chief officer and 3rd officer on the bridge and left them to warn the passengers; his words on bidding "farewell" to his officers were: "Good-bye, we have done our best to save the ship and there is nothing more that can be done;" at the same time shaking hands with them all. The chief officer and 3rd officer remained on the bridge with the look-out men and helmsmen.

"A minute afterward she struck, grinding her broadside on to a reef extending the whole length of the ship, and heeled over to port; she again struck the reef with fearful force and, as she began to settle down, it must have driven the whole of the starboard side in. The seas in the meantime breaking clean over all and washed the whole of those who came on the bridge on to the reef, which extended 250 yards from the high land; those that were saved were also thrown in this manner on to the reef being on the upper deck; of these there were 23,—7 Europeans, viz., Chief Officer, G. Prickett; 3rd Officer, T. Jones Parry; 4th Officer,

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

W. H. Sweeney; Quarter-masters Lewis and Ward; Passengers, Dr. Lowson and Lieutenant Markham, Shropshire Regiment; and 16 natives.

"All the survivors are most enthusiastic in their praises of the commander, who behaved during the whole of this anxious time in the coolest and most seamanlike manner, and nothing could have exceeded the skilfulness and steps that he took for the safety of his ship and the lives of those entrusted to his care. I may add that the remaining passengers express the same opinion of every officer belonging to this unfortunate vessel.

"The survivors remained at Sand Island all that night and until Wednesday at noon, when it was then five small junks came and took them all to Pehoe, where they remained until Thursday morning (13th October), the Chinese priest looking after them and giving them food, etc. Thence they were taken to Makung where they were well received by the Mandarin and were entertained in the most kindly way.

"The steamer *Thales*, that had instructions to seek for the missing ship, left Amoy on Friday, 14th, and went to the Northern part of the Pescadores, but finding nothing there, proceeded to Makung and then brought in the survivors to Anping.

"The number of those that went down in the ship was roughly 125 all told.

"J. Leslie Burr,
"*Commander.*

"18th October, 1892."

I will only extract from the report meteorological data contained in it from 8 p.m. on the 9th October till the wreck.

9th, 8 p.m., Bar. 29.88, wind N.E. 6-7, 8 miles East of Tungying had ship's course altered to make Turnabout.
10 p.m., Bar. 29.77, N.E., very heavy sea breaking over the ship.
Midnight, Bar. 29.70.
1.45 a.m., ship at 31.5 miles S.S.W. of Turnabout (Court of Inquiry) ship heave to on port tack.
4 a.m., Bar. 29.60 and falling, wind N.E. full gale.
6 a.m., Bar. 29.55.
8 a.m., Bar. 29.50, sea and wind terrific, attempts are made to bring the ship on the other tack and failed.
Noon, Bar. 29.27.
4 p.m., Bar. 29.15, wind blowing with terrific force.
8 p.m., Bar. steady at 29.15

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

The falling of the barometer, as shown by those data, are more rapid than at Anping or at the Pescadores when during the same time from 8 p.m. 9th October, to 4 p.m. on the 10th, the barometer fell respectively by 0.42 and 0.45, while on board the *Bokhara* it fell 0.73. But during this time the ship had advanced toward the typhoon for about 100 miles.

It has been much remarked that the Austrian corvette *Fasana*, which left Shanghai on the same day as the *Bokhara*, had a successfull voyage to Hongkong passing through the gale without considerable damage, by running on along the Coast of China. It is therefore to be supposed that in case the *Bokhara*, a more powerful steamer, had run instead of heaving to, she would have had a safe course to Hongkong. According, however, to the Court of Inquiry "the ship was not run too long and the precaution of laying to was taken in good time." Was it really a more prudent manœuvre to run along the coast, than to heave to, as did the *Bokhara*, and especially than to heave to on port tack, which has been censured before me by some marine officers. Before discussing that point as well as her heaving to on the port tack, let us consider the voyage made by the corvette *Fasana*. The following is a short abstract from the meteorological log kept by Lieutenant Fiedeler :—

"The *Fasana* ran 99.0 miles under steam alone, 84.9 miles under steam and canvas, and 662.4 under sail alone, in 4 days and 6 hours, 8.3 miles per hour. There was no serious damage done on board; except the loss of the two boats and some trifling damage to the rigging, when the sails were secured during the height of the hurricane. The force of wind is reckoned by Admiral Beaufort's scale, from 0 to 12; 0 being equal to calm, and 12 to hurricane force.

"The *Fasana* left Woosung at 5.52 a.m. on the 8th October, with light north-easterly wind, and fine weather, under easy steam, passing Kiutoan light.vessel at 8 a.m., and set square sails at 10 a.m. At noon in lat. 31° 2′ N., and 122° 18′, the barometer showed 30.02 mm., the thermometer 70°.7 with light N.E. wind, and cirro-stratus clouds, 4. Went on under sail alone. At 4 p.m. passed between the Saddle and Parker Group of Islands, and 7.35 p.m. through the Steep Island Pass, overtaken by a coaster. Up to 12 o'clock the wind had veered to N.N.E., increasing to force 6, with clear sky.

"On the 9th inst., at 5.45 a.m., sighted the Hieshans; passed a British gunboat, steering N.W., and were overtaken by the British mail steamer *Bokhara*, with fore-top-sail set, exchanging salutes with her, by dipping the ensigns. At 8 o'clock the wind veered to

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

the N., force 6 to 7, clouds cirro-stratus, 3. A steamer of mean capacity, probably the *Prostos*, overtook us. At noon found the position of the ship, by cross bearings of Pe-shan, San-shi and Chih-kok to be 29° 59'.9 N., and 121° 50' E.; barometer 29.95 mm., thermometer 70°.5; wind northerly, force 8 to 9, clouds 7. At 4 p.m. the wind shifted to N.E., force 8 to 9, and was N.N.E., at 8 o'clock, same force. At midnight same force of wind from N.E. by N., clouds strato-nimbus. Ship rolling 35°. Bar. 29.70 mm., ther. 71°.6.

"Monday, the 10th October, a few minutes after 5 a.m. sighted Turnabout for a short time, 6 points on the starboard bow. Afterwards could hardly see a ship's length, owing to the clouds sweeping so low, the labouring of the ship, and the spray of the sea; there was a strong sea following, and, owing to the vessel rolling about 40°, many seas were shipped. The wind was increasing from N.N.E., force 11, at 8 o'clock, N. by E, shifting to N. at 9 o'clock. At 10 a.m. wind and weather the same; a large sea broke over her stern, and smashed the commandant's gig on the quarter deck; the same sea smashed the largest barge on board, secured amidship. Ordered all fires to be lit. Lat. at noon 24°18.'9 N., long. 118°58.9'. Bar. 29.40 mm, ther. 71°.1., Wind N., 11; clouds nimbus, 10. Current in 24 hours 34 miles to S.W. $\frac{3}{4}$ W. At 11.45 the engine went full speed ahead. At 1 p.m. took in all square sail, storm fore-sail only set, it blowing a hurricane at the time.

"The minimum of the barometer was 744 mm. (29.292 inches) at 2.15 p.m., thermometer 72.°5; wind N., force 12, with cross seas from N. and N.W. At 3 p.m. wind N. by W., force 11, clouds nimbo-cumulus, 10; weather clearing somewhat to the north-westward. At 5.15 p.m. fixed the ship's position by bearings off the Amoy coast, course S.W. by W. The wind shifted to N.W., force 10. The sun set normally, light rain after six o'clock, but clear horizon; set sail. At 7 it became very dark, experienced strong lightning. At 9.5 sighted the Lamocks; at 10.30 stopped the engine. At 8 p.m. the wind changed to W.N.W., force 8 to 7, clouds cirro-stratus, 10. At midnight the Lamocks light was on the starboard beam, wind N.W. 5, clouds stratus 10, weather rainy. Barometer 29.61 thermometer 76°.3.

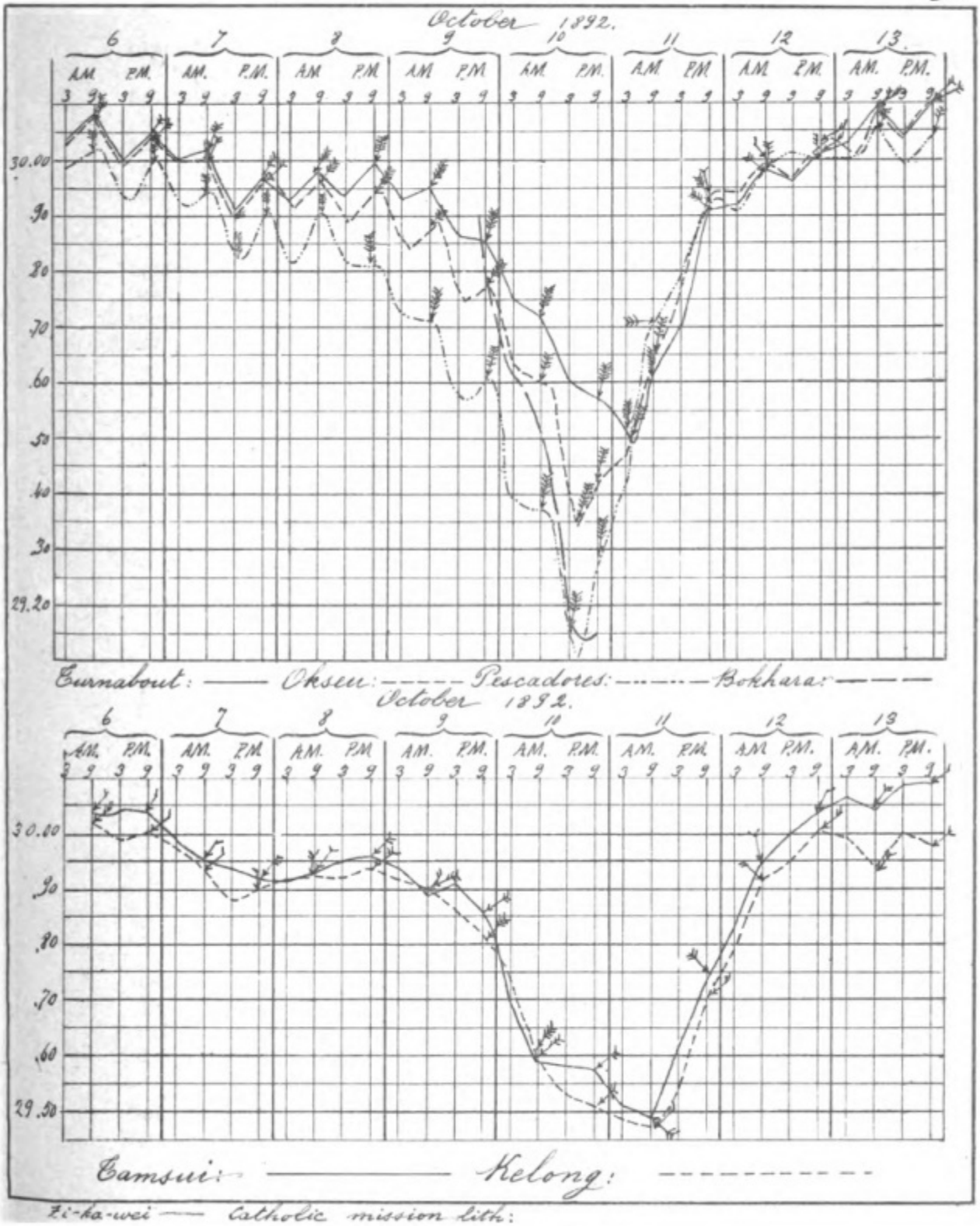
"Tuesday, the 11th October.—After midnight the weather changed remarkably for the better, the wind decreasing, north-westerly. At noon were by astronomical observations in Lat. 22° 22.'5 N., and 116° 34.' 3 E. Wind N.N.W. 4, clouds stratus 9. Barometer 29.756 mm., thermometer 81°.0.

"Wednesday, the 12th October, at 6 a.m. lit the fires, and furled the sails at 8 a.m., anchoring in Hongkong harbour, at

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

The Bokhara Typhoon.

V.



Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

11.47 a.m. Barometer at noon 29.934, thermometer 83°.7, wind N.E., force 1, and clear sky."

. It is evident, from the report that the *Fasana* running along the coast had also experienced a terrible gale, but on account of the recurving of the typhoon she got out of it on the 10th before night, while the *Bokhara* by running so far to the East had got nearer the centre.

When Captain Sam resolved to bring the ship to the wind, the barometer was still rather high 29.70; the centre of the typhoon was still distant 200 miles to the South; neither its bearing nor its direction were ascertained even with any degree of probability, However, according to meteorological laws, neither the precaution of heaving to at that moment instead of running, nor the heaving to on port tack, even in case the ship had had sea-room to the starboard, can be found fault with. Of course neither the bearing of the typhoon nor its trajectory were ascertained before heaving to; but to bring the ship to the wind is precisely a fair way of ascertaining both, those important points; and therefore it is a measure that may very well be taken, as soon as there is an appearance of a typhoon. Besides we must consider that, apart from the consideration of the peculiar meteorological circumstances, the most probable course of the typhoon, according to general laws, was to West-North-West or North-West, without any recurving, and in that case, the fact of heaving to on port tack, would have proved a fortunate manœuvre. Second to this, was the probability of its recurving as it did, to the South of Formosa, or to the South-East of it, to pass over Formosa or East of Formosa, travelling North-Eastward. In that case the heaving to on port tack was bringing the ship nearer the centre of the typhoon. But as the centre was still far off, the barometer shewing 29.70, and falling only by 0.03 from 10 p.m. to midnight (including the diurnal movement), there was plenty of time to bring the ship on the other tack, after having ascertained the trajectory. The probability of its running through the Formosa Channel, (in which case to run for shelter would have been the best resolution), was small, and there was time to run for shelter after having ascertained the trajectory of the typhoon. Therefore the decision of heaving to at that moment under the circumstances of wind, barometric fall, and general course of typhoons in that season, cannot be blamed in any way. The loss of the *Bokhara* was due to security arising from error in the reckoned position of the ship. The fall of the barometer reported by the chief officer, Mr. W. Prickett, as drawn here with those of Turnabout and Okseu,* and

* See plate V.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

especially (as we shall see further on) its steadiness at 29.15 from 3 p.m. to 8 p.m. make it certain, that he carefully watched his instrument. This fall with the persistance of the wind in blowing from North-East, should have indicated, especially in the afternoon of the 10th, that the typhoon was not travelling to Westward, but rather recurving as it did, and was coming nearer the ship. The ship being at that time unmanegeable there was perhaps nothing to do. However, it does not appear, that there was on board any anxiety to ascertain either the position of the typhoon, or its trajectory. It looks as if the heave to had been decided on, not to ascertain the trajectory of the typhoon, but only according to an old rule, strongly objected to, by Reed and Piddington: "You shall always heave to in a hurricane." The true rule must be; when signs of a typhoon appear, heave to, to ascertain the bearing of the typhoon, and its trajectory; these ascertained as accurately as possible, endeavour to get as far as possible from the centre, either by running or laying to on proper tack, according to circumstances of sea-room you have, of your position relatively to the centre, and its trajectory. But to determine either the position or the direction of the typhoon, it is necessary to know the angle between the direction of the wind and the radius vector (or straight line to the centre of the typhoon.) We will therefore treat here of that important question.

Our first assertion will be, that undoubtedly, outside the quite innermost layer of revolving air, the direction of the wind is not parallel to isobars, or at a right angle with the radius vector. The rule made out by Reid, Redfield, Piddington, and as Buys-Ballot law generally known: Face the wind, you have the centre of the cyclone directly on your right hand, in northern hemisphere, is the old rule. A great French astronomer, Mr. Faye, strenuously defends the accuracy of this rule, which is quite consistent with his own theory on cyclones. When objected that the synoptic weather maps, show, all around *a low*, an inrush of the wind towards the centre, he answers that such objection rests on a misapprehension of facts. In his recent work published in the American Meteorological Journal (Tom VI., p. 496, 498) "*Theories of Storm, based on Redfield's law*," he writes as follows:

"*Interpretation on synoptic charts*:—Eminent meteorologists without consenting to examine the preceding theory, have limited themselves to saying that a glance at the synoptic charts proves that around a depression—*a low*,—the arrows of the wind are more or less inclined toward the isobars, and indicate thus a centripetal component. In order that the air should move thus, more or less directly toward a central region, it must take an ascending direction in that region, incompatible with my ideas. This objection is

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

based upon a mistake, which is very compromising for the science of meteorology . . . .

"The argument drawn from the synoptic charts is explained thus: That in the ordinary depressions, the wind arrows are directed more or less towards the centre, may be seen effectively on the synoptic charts, and as they are much more frequent than the storms with which they are confounded (although everything separates them except the arrangement of the isobars), it is affirmed that a glance over the chart suffices to justify an assertion at which one could not but be astonished. It is very desirable, in order to avoid this mistake in future, that two different modes of tracing charts be adopted, to distinguish between cyclones and purely statical depressions. It is also necessary to determine the real limits of each storm, that is, the circle A, B, C, D, of the figure 3, p. 411,* for it is there only that one can study the existing relations between isobars and arrows of the wind."

In order to avoid imputation of error let us act upon the advice of Mr. Faye, which I acknowledge, very willingly, to be quite correct. The first advice is to separate cyclones from purely "*statical depressions.*" Not only I willingly grant that they ought to be separated from *statical depressions*, but also from Northern depressions which travel with a greater velocity, but originate in higher latitudes over Central Asia, instead of originating in tropical latitudes. But I think that the depression under consideration is neither statical, nor *a low* originated in high latitudes; it is a perfectly determined tropical cyclone, or typhoon. The second advice of Mr. Faye induces us to determine the real limits of each storm from the outside. To follow more closely this advice we must endeavour to take from the author, how to determine such limits.

I do not find in the author's works any passage more appropriate to the purpose that the description, given by him, in the same work *Theory of Storms* already related to, of the *Structure of a Cyclone*, of which I will quote what seems to be the more directly referring to the subject.

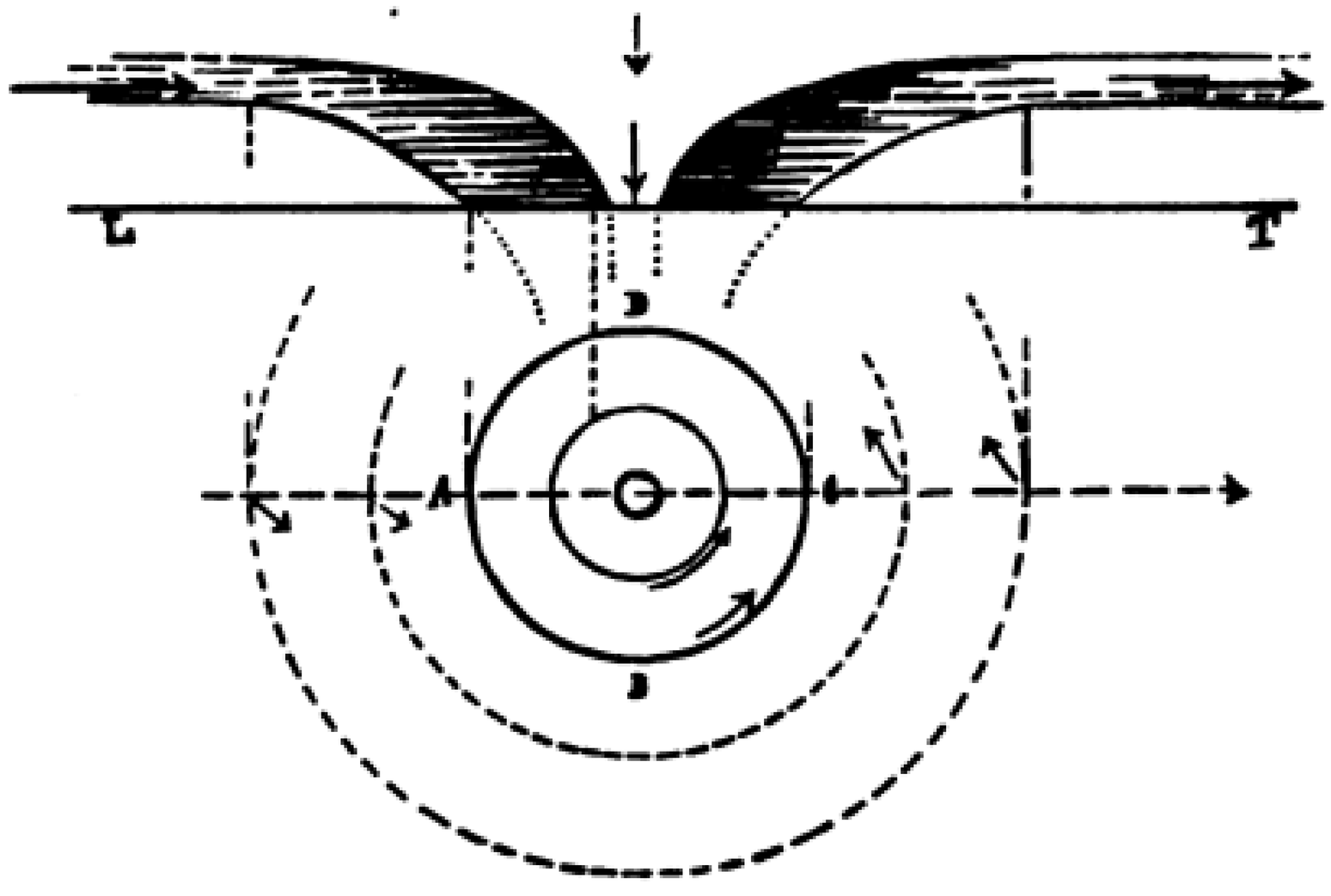
"*Structure of a Cyclone.*—The height of a cyclone is the depth of the aerial river which carries the Cirrus where the cyclone originates. Near the equator this altitude is from twelve to fifteen thousand metres. The horizontal diameter at the level of the surface is at least from 1° to 2°, that is, ten of fifteen time greater . . . . . I have sought to represent this ensemble in the following figure:

---

* See further on, page 26.

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA



The circle A, B, C, D, which is marked with a strong black line upon the figure is the true limit of the cyclone; it is quite as characteristic as for trombes and tornadoes where it is marked at the intersection of their nebulous sheet with surface.

Beyond the horizontal track of the cyclone the atmosphere is in the state in which it was before the arrival of the storm. Only the dimunition of pressure due to the upper spirals which made the circle A, B, C, D, will be felt, and if the atmosphere is calm, the isobar relative to this region will also be circular, but with a very weak gradient. The air will have a feeble tendency towards the cyclone; the arrows of the wind will be no longer parrallel to the isobars, but perpendicular to these curves, except the little deviation due to the rotation of the earth. It is certain, at least, that in the region exterior to the cyclone there are only stray breezes; puffs of warm air without relation to the winds will not fail to blow with violence as soon as the storms declares itself.

"But if the lower strata of the atmosphere were submitted to a region of prevailing wind like the trade-winds or the monsoons, the cyclonic spirals would be represented as descending in the midst of the strata without changing their motion of translation; the effect produced would be a composition of the two velocities. It is scarcely perceptible in the interior of a cyclone because of the great preponderance of the velocity of gyration but it is upon the outskirts of the storm."

Many would think that there is no place for doubt after all what took place in the Formosa Channel, that the whole of it, from Foochow to Swatow on the China Coast, and the whole Formosa

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Island, being in the body of the typhoon, on the 10th October. There I have prepared two tables with synoptic maps showing all the meteorological observations taken simultaneously, or almost so, in the Channel at 9 a.m. and 3 p.m., which prove that the gale was blowing in the whole Channel on that day.*

FORMOSA CHANNEL, 9 A.M., 10th October, 1892.

Meteorological Stations.	Barometer,	Variation 24 h.	Wind. Direction,	Force.	Weather.
Pagoda	29.78	—0.16	N.E.	4	R
Middle Dog	29.74	—0.17	N.N.E.	7	OMP
Turnabout	29.73	—0.23	N.N.E.	11	GMP
Ockseu	29.61	—0.27	N.N.E.	9	OMD
Dodd Island	29.62	—0.23	N.E.	7	OM
Amoy	29.62	—0.24	N.N.E.	3	C
Pescadores	29.34	—0.39	N.	11	OMQ
Kelong	29.63	—0.28	N.E.	7	OR
Tamsui	29.60	—0.28	N.E.	5	R
Anping	29.29	—0.45	N. by E.	9	OHQ
Takow	29.19	—0.45	N.	10	R
South Cape	28.88	—0.77	E.N.E.	10	OGMQR
Lamocks	29.65	—0.22	N.N.W.	4	BC
Swatow	29.67	—0.17	N.N.W.	6	C
Cape of Good Hope ...	29.64	—0.24	N.N.W.	7	B
Breaker Point	29.62	—0.25	N.W.	4-5	BCM

3 P.M., 10th October, 1892.

Pagoda	29.68	—0.18	N.E.	5	R
Middle Dog	29.62	—0.24	N.N.E.	7	OMP
Turnabout	29.61	—0.26	N.	11	GMD
Ockseu	29.41	—0.37	N.N.E.	9-10	OM
Dodd Island	29.52	—0.26	N.E.	8	BCM
Amoy	29.50	—0.24	N.	5	C
Pescadores	29.18	—0.41	N.N.E.	11	OMQ
Kelong	29.50	—0.33	N.E.	5	OP
Tamsui	29.51	—0.33	N.E.	3	R
Anping	29.07	—0.49	N.N.E.	10	OGQ
Takow	28.96	—0.51	N.N.E.	10	G
South Cape	28.65	rising	S.	12	OGMQR
Lamocks	29.55	—0.18	N.W.	3	BC
Swatow	29.62	—0.10	N.N.W.	6	O
Cape of Good Hope ...	29.55	—0.23	N.N.W.	6	B
Breaker Point	29.51	—0.20	N.W.	6	BCM

Not to dwell too long on this point, let us look more closely at one only of these maps. At 3 p.m. the *Bokhara* was drifting in a South-West direction at the rate of about 4 or 5 knots; the glass registered 29.18 and corrected for instrumental error should have registered 29.26 or about so, the wind was blowing from N.E. with terrific violence.

* See plate IV., page 16.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Between the centre of the typhoon, which lay undoubtedly somewhere to West or North-West of South Cape and Anping, the gradient was about 0.70 inch, more than one hundredth of an inch for a mile. To the North from Anping to Ockseu the gradients were not so steep, but were still about 0.20 for 60 miles, though the winds are not reported to have been of less violence. It is quite true that in that part of the Channel the monsoon was acting directly, both to enforce the violence of the whirlwinds and to give them a North-East direction, inclined on the isobars, with inward tendency. But at Swatow, Lamocks, and in their neighbourhood, the monsoon would have rather impressed on the whirls of air an outward direction. You see however that, as well in that South part of the Channel, though in a less degree, the winds were inclined along the radius vector, and not at a right angle with it; and notwithstanding the contrary action of the monsoon they show an inward tendency. But to avoid useless discussion on the position of those stations outside or inside the body of the cyclone, let us grant that the body of the typhoon did not extend beyond Anping to the North. We shall have at least three stations, Anping, Takow and South Cape quite evidently placed in the circle of the cyclone. Now I ask where could be placed the centre of the typhoon in order that the direction of the wind at those three stations should be parallel to isobars or at a right angle with the radius vector. Place it perpendicularly to the southern direction of the wind at South Cape; then the direction of wind at the other stations will be very much inclined on the radius vector and have a *decided inward tendency*. Place it where you like, the same *decided inward tendency* at two stations at least will remain evident. Therefore it is useless to struggle against well ascertained facts. It is plain that save perhaps the quite inner spirals the winds all around the centre of a cyclone blow in a direction inclined to the isobars, with an inward tendency to the centre of the cyclone. *But "in order that the air should move thus more or less directly toward a central region, it must take an ascending direction in that region."* We have ascertained the fact in a true tropical cyclone, well distinguished from a *statical low*, even well distinguished from *a low* of higher latitudes; we have ascertained the fact for stations surely *inside the limits of the typhoon*. Hence the conclusion, which Mr. Faye cannot deny to be a rightful one, must be admitted. That, does not improve the theory that the generating principle of a typhoon lies in the upper regions; nor deny that the originating cause of its motion lies in the upper currents. But is it possible that notwithstandig an uprush of air on the outside of the inner spirals, there could be in those inner spirals a descending current? That looks at least difficult if not impossible.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

It remains to determine the value of the inclination of the wind to the radius vector. As that inclination is far from being constant, we must determine the limits of its variations and the circumstances according to which it varies rather than its mean value. The limits of its variations are so great even for the same position relatively to the centre, for instance, 100 miles ahead of it, as to include almost a full quarter of the circumference. Hence it appears useless to adopt in the determination of that, so small unity as the degree of the circumference, and a more appropriate unity will be the point of the compass. Speaking generally we may say that the bearing of the centre of the typhoon is 10 or 12 points from direction of the wind. But that inclination varies with the position relatively to the centre, and was stated by Rev. Father Dechevrens, to be somewhat greater in rear than in front. Mr. Doberck asserts that it is greater in higher latitudes. I am not prepared just now to consider and discuss those two statements without the observations on which their computations are based. But as to what Mr. Doberck says: "Once "the wind has reached to the force of a strong breeze the average "angle between the wind and the direction of the centre does not "appear to change at all; but the wind blowing in great gusts in a "typhoon may oscillate to both sides of the mean value. That "it does not appear to be any foundation at all for the belief that "the wind near the centre blows in circle round the centre." I venture to say that both these assertions are incorrect.

That the angle of the direction of the wind with the radius vector changes with the distance has been proved in many works by Rev. Father Dechevrens; it has been proved by myself particularly in the report on the typhoon experienced in October 1890 by the French mail str. *Natal*. But without going so far a glance at the maps will show that this angle is generally greater at the more distant stations in the same direction.

As to the inner spirals asserted by some meteorologists, and among them by Rev. F. Dechevrens, to be circular, and denied here by Mr. Doberck, I will state first that there is great difficulty in ascertaining whether the assertion is true or not. When a station is very near the centre of the typhoon a *small* variation in the position of the centre produces a *great* variation in the angle of the wind with the radius of the typhoon. Therefore this angle cannot be determined accurately for those stations, unless, *previously*,* the bearing of the centre is determined with perfect exactness. But this exact determination is seldom possible. I dare not say that any position of the *Bokhara* typhoon has been determined so

* This determination must be arrived at previously, and therefore independently from any supposed inclination of the wind on the isobars, and ought to be certain and accurate.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

exactly as to be used in resolving the present question. In the study of the typhoons of the year 1892 I found two typhoons the bearing of the centre of which was determined with perfect exactness very near a meteorological station, and they have both shown the inner spirals in a typhoon to be circular round the centre. The first was the typhoon which passed on the 17th of August between Turnabout and Middle Dog; the second the typhoon which passed over Tamsui during the night of the 6th September. I will shew that in a special study on the typhoons of the year 1892.

There is another circumstance which has a great influence on the direction of the wind, and to which great attention must be paid, in determining the bearing upon of the centre. That is the direction of the monsoon. You have a fair example of its influence on the weather map which we have just considered. In the neighbourhood of Swatow the winds have an inward tendency, which is far from being so great as at the Northern Stations of the Channel. We will close this discussion with the above enunciated and generally admitted rule. The centre of a typhoon bears generally 10 to 12 points from the direction of the wind; thence with back to wind you will have the centre on your left, 2 to 4 points ahead; but if the monsoon is blowing so as to narrow the angle with the radius vector, especially if you are still far from the centre, allow at least 5 points ahead, and still bear in mind that such estimate is only a rough approximation.

Up to the 3 p.m. on the 10th, all was regular in the movements of the typhoon, but then we enter upon the mysterious part of its history. Looking closely at the barometric observations at South Cape, on the curve shewn here,* you will observe that the rise of the barometer is far quicker than its fall. Three reasons may be alleged as accounting for this fact; 1st such a disposition of the isobars round the centre, that they should be more close to one another in rear than in front of the typhoon; 2nd an increasing velocity of the typhoon; 3rd a decrease in the central *low*. As to the second, not only it is *a priori* improbable, for the typhoon being at that time recurving, and therefore, according to general law, rather decreasing than increasing in velocity, but it is quite refuted by the bearing of the typhoon at 9 p.m.

As to the first cause, though the rapid fall of the wind in the rear of the typhoon makes against it, it is however brought into evidence by the synoptic map of 9 p.m.; which shows a much steeper gradient between South Cape and Takow than between Takow and Anping. But from the same map, and still more evidently from a close comparison between the observations made at South Cape, Takow and Anping, it appears that the main

* See plate III., page 14.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

cause of that quick rising of the barometer at South Cape was a thorough change in the central low pressure.

Indeed, from the above ascertained trajectory of the typhoon its centre must have passed either over Takow or very near that meteorological station. From the reported variation of the wind it is manifest that it passed rather South than North of the station; therefore it evidently must have passed between Takow and South Cape. Then, from the barometric observations at 6 p.m., time of lowest reading at Takow, it is evident that it was very near Takow or over that station.

At Anping 40 miles North of Takow the barometer indicated 29.00, wind N. or N.N.E. 10. "Takow 50 miles North-West of "South Cape had barometer 28.96*, wind N. or N.N.E. 10. South "Cape 50 miles South-East of Takow had barometer 29.17, wind "S.W. 10."

I have been anxious to establish that fact by all possible evidence; otherwise I should have been satisfied to show it in a mere rough comparison between the barometric curves of South Cape, Takow and Anping, which I beg now to submit.† Such a difference between the barometric variations at South Cape and that of the other stations is quite incousistent with the above ascertained trajectory, unless there was a thorough change in the central *low* of the typhoon. To determine an approximate measure of that change we must avail ourselves of the barometric height at 6 p.m. above reported, which recorded on a map will shew, by means of isobars, that the central *low* was about 28.75. Such barometric reading when compared with the lowest reading of South Cape 28.15 gives 0,60 as the amount of the change in the central low pressure.

Thence we may account for the barometer of the *Bokhara* keeping steady at 29.15 from 4 p.m. to 8 p.m. and as I said above this observation proves that Mr. Prickett had carefully watched his instrument during the storm. This change in the central depression accounts also for the strange feature of the barometric variations registered at the stations of Northern Formosa, as they are shown by the accompanying curves.‡

At 3 p.m. the barometer at these stations, as on board the *Bokhara*, stood at a low reading, and kept almost steady until 3 p.m. of the next day. The fact of such change in the central depression of the typhoon is beyond any doubt; but such fact is easier to be ascertained than to be explained. We must however venture to propose some explanation.

---

* The barometric range between Takow and Amping must have been about 0.08; the barometric reading at Takow being probably too high by 0.04.

† See plate III., page 14. ‡ See plate V., page 22.

Digitized by Google Original from UNIVERSITY OF CALIFORNIA

It is generally granted by meteorologists that typhoons or cycloues, tornadoes and water spouts are phenomena of the same nature, different only in accidental particulars ; such as larger or smaller size and the like. Therefore, I must be allowed for an explanation of the present difficulty, to look at some well-known feature of tornadoes. I have not here to dwell upon the description of those recent terrible whirlwinds. Those funnel shaped clouds, which are seen as descending downward, with whirling motion, from dark masses of clouds, bringing devastation everywhere their conical point reaches the ground, are known to every one. It is a well ascertained fact, that tornadoes having once reached the ground, sweeping, crushing everything on their onward course, will often ascend for a while, and then descend or dip again to the ground. I will quote here a few words on that point from an *Essay on Tornadoes*, written by Mr. Finley, a high authority on the matter, and printed in the *American Meteorological Journal* as first prize essay (vol. VII., p. 170) : "It frequently "happens that the tornado cloud rises from the earth and forms "a gap of several miles in its path, descending again with its "usual violence, to remain perhaps, until it finally disappears.

"If an observer is located in the gap and witnesses the "tornado cloud passing overhead at a safe distance he should, "according to some critics, report no tornado, unless perchance "he examined the entire track of the storm, which he is not at all "likely to do, as one who voluntarily renders service for science. "If reports can be obtained from various points along the sup- "posed track of the storm, its identity may be established by "unmistakable evidence of its violence."

In another *Prize Essay*, printed by the same A. M. Journal ; Professor H. A. Hazen, writes among his enumeration of facts, (p. 211): "*Dipping and Rising of the Tornado.*—There is a "peculiar up and down motion in the tornado which has been "described by hundreds of witnesses and seems to prove that "most if not all the destruction is begun by a downward action. "This motion is entirely independent of the topography, and, "indeed, it has been well proven that the topography of the "country has nothing to do with tornado action. The dipping is "so well manifested, that, right in the centre of the track, there "are left spaces without destruction for several rods, beyond "which the destruction again begins."

Now if tornadoes and typhoons are phenomena of the same kind, it is obvious that such dipping and rising observed in tornadoes may well happen in typhoons. Granting, as I do, that such identity of nature is merely hypothetical, it remains, however, quite sure, that they are phenomena in many points similar. Therefore, if there is some peculiarity observed in a

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

typhoon which seems to be easily explained by refering to tornadoes, it is obvious to think that tornadoes and typhoons have in common that feature among others. Hence the probability of identity of nature between the two phenomena will be strengthened; the more so as there is no other simple and easy explanation of the fact. Such dipping and rising are very easily perceived in water-spouts and tornadoes, as well by observation at the moment they happen, as afterwards in the solution of continuity in the trajectory of the tornadoes traced by a vast amount of destruction, everywhere its tail reached the ground. But it cannot be so for a typhoon.

Indeed, tornadoes and typhoons are whirlwind storms; granting the identity of their nature, viz., granting that the cause originating and maintaining in both of them an extremely violent whirlwind, be the same, they still differ very much, not only in their absolute extent, but also in the proportion of their height to their breadth. The small size of the funnel-shaped cloud called tornadoe allows a spectator to catch at once a sight of the whole of it, and therefore to perceive its dipping and rising. The small breadth of the tornado, when compared with its height, allows the conical point to rise at a height which compared with the same breadth is still sufficiently great to admit of the lower part entirely rising without any whirlwind touching the ground. With a typhoon nothing of that kind appears. It is so broad that evidently no spectator can watch it in its entirety, and therefore its rising cannot be perceived like that of a tornado. Its breadth, so great in proportion with its height, will prevent it from rising so completely as not to be felt, upon the earth's surface. So that even in case there should be some rising up of a typhoon, as of a tornado, it could not be watched as is the rising of a tornado, nor evidence given by a total absence of devastation along a part of of its trajectory, it could be only assumed from some singular features.* Let us examine what particularities would probably in that case be presented by the typhoon.

1st—The first peculiarity would be undoubtedly a great change in the central depression. Whether the central low pressure be due either to a dinamic effect of the violent whirlwind which modifies the transmission of the pressure of the air, as supposed by Mr. Faye, or to a physical rarefaction of air in that centre; a great change must take place in it by the rising of the lower part of the typhoon.

2nd—A quick abating of the wind round the centre of the typhoon. According to the above sketch of a typhoon rising

* This difference in proportion of the breadth to the height as shown in the accompanying plate, leads very easily to understand how the rising up of a typhoon will differ from the rising up of a tornado.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

up to a narrow centre of low pressure with all around itself isobaric lines the more close to one another the more you get near the centre, a larger area will be substituted, with smaller gradients and consequently winds of a moderate force.

Of course, such area would be larger or smaller according to the dimensions of the typhoon and the height to which the lower part might rise.

3rd—A third consequence would be the existence of a ring of steeper gradients and consequently stronger winds round the large central area. That is shown also in the accompanying drawing, and is a consequence of the larger area of the typhoon which does not allow it to rise in its entirety.

4th—By such dipping and rising we may also account for the chief differences presented by the centres of various typhoons. The actual existence of a central calm is well-known. I find about it two opinions; Dr. Sprung, as reported by Mr. Faye, (*Amer. Meteor. Journal, Vol. VI, p.* 407) is inclined to think that it is a pure accident. Mr. Faye, on the contrary, that it is a constant fact and an "essential trait of the constitution of all cyclones, not yet deformed." The opinion of Mr. Faye on that point seems more likely the true one. It is certain, however, that the description of that calm, as experienced by some vessels, cannot be applied to every typhoon. "It might be called (said Mr. Faye) a long bell-shaped tube, opening upwards, a sort of hyperboloid of revolution piercing the thick clouds, through which a portion of the blue sky appears near the Zenith." It is so in many circumstances, but in many others, there is neither calm nor blue sky; the wind abating blows with force of a moderate or fresh breeze, the sky dark and ugly, looking very threatening. It is obvious that those differences will be easily explained on the above hypothesis. Indeed, the "blue magnificent sky in the zenith, with stars shining out in all their splendor obscured now and then by light mist which passes rapidly" will be observed only when the bell-shaped tube opening upwards has its lower part on the ground; the dark, ugly, threatening sky, with fresh variable breezes, will be the case of a typhoon having its tail risen above ground and hence the lower part of the tube closed.

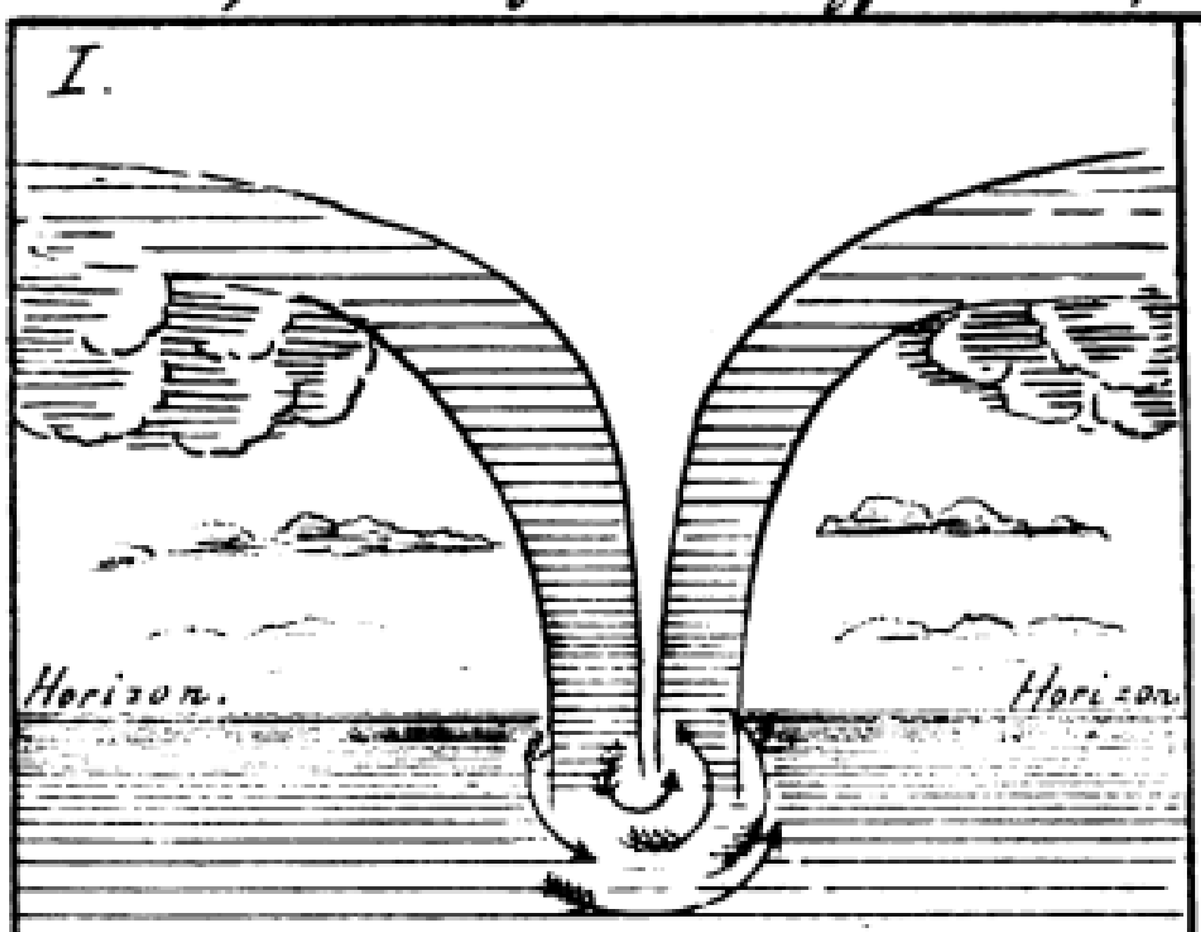
Let us now examine the question whether the particularities above specified, as consequences of the rising of a typhoon, were observed in the *Bokhara* typhoon. We left it at 9 p.m. on the 10th with its centre lying over the island of Formosa and travelling North-Eastward. During the following night took place the lamentable wrecks of the *Bokhara* and *Normand*. The frightful history is still impressed in all our memories; this is not the place for relating it. Let us only interrupt but for a while our meteorological report to express a feeling of deep regret

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Sketches of tornadoes and typhoons

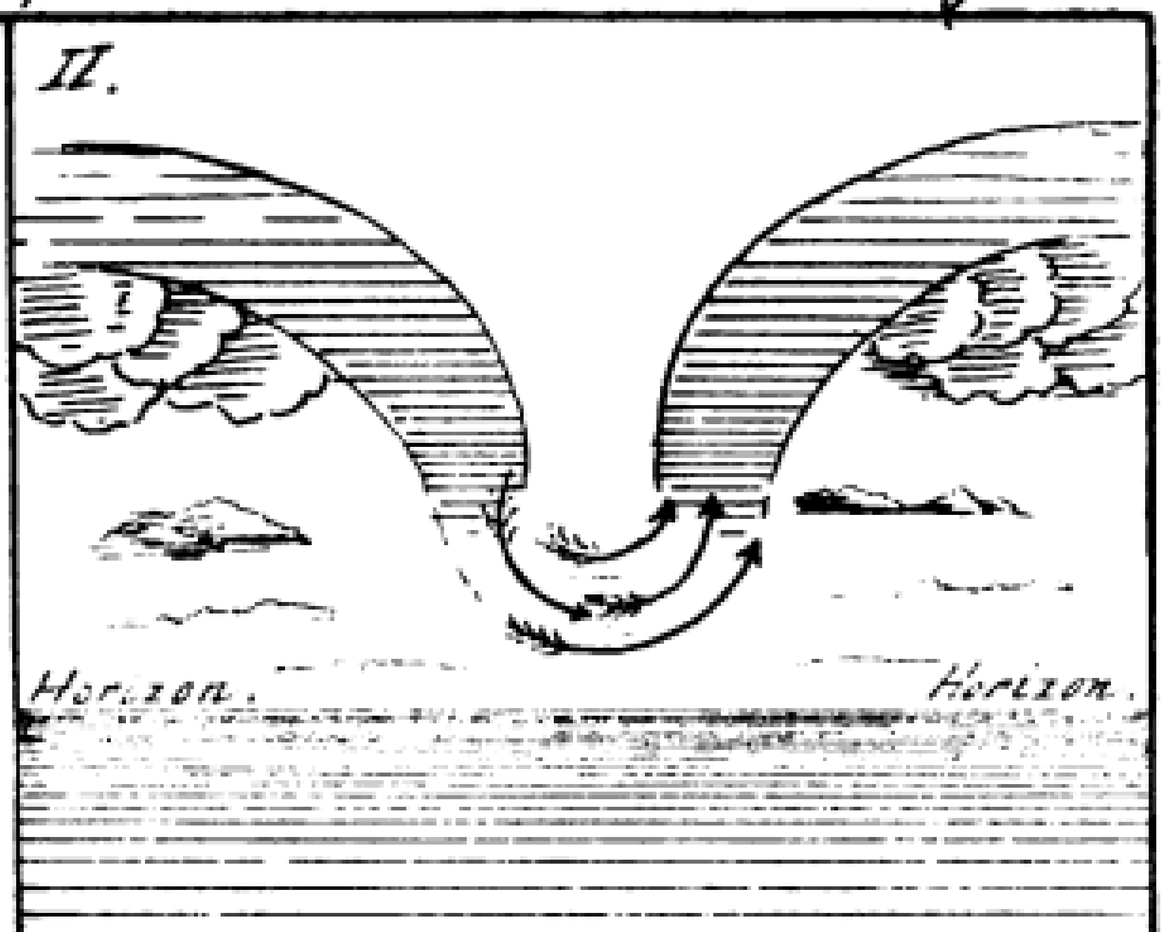
Intended to show their difference in dipping and rising in consequence of their different proportions in breadth and height.

I.



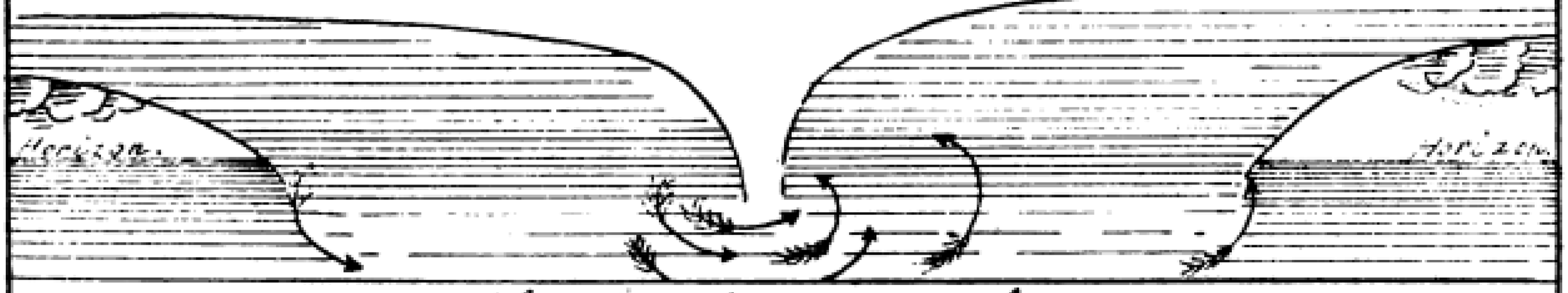
A Sketch of a tornado
the lower part of which is touching on the ground.

II.



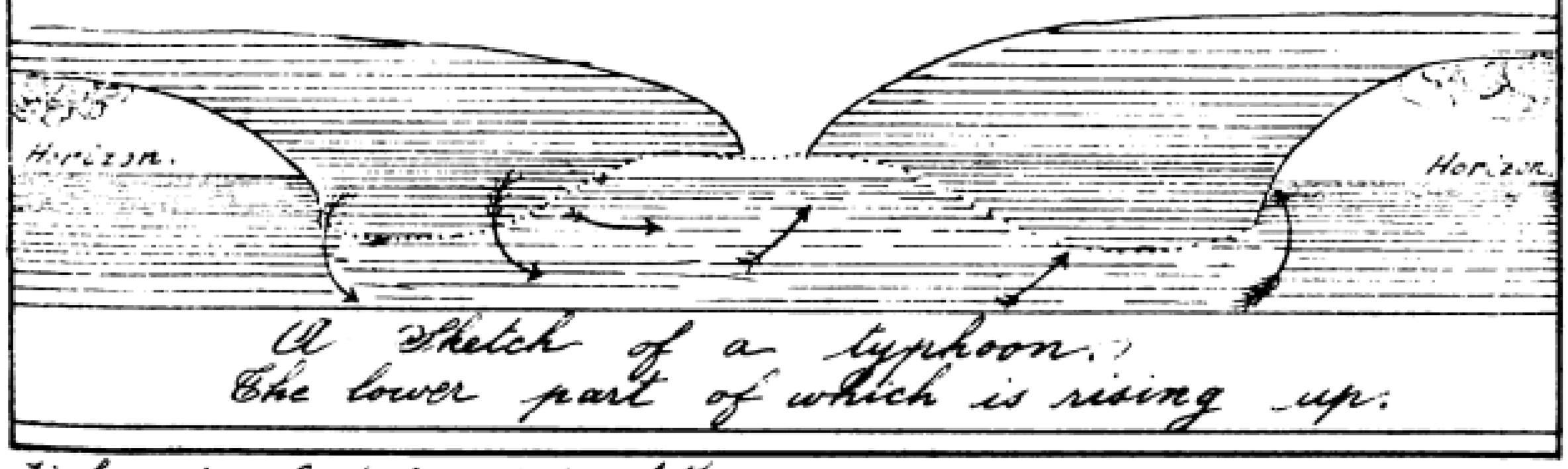
A Sketch of a tornado.
The lower part of which is rising up.

III.



A Sketch of a typhoon.
The lower part of which is resting on the ground.

IV.



A Sketch of a typhoon.
The lower part of which is rising up.

Zi-ka-wei — Catholic mission lith.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

at so awful a disaster with the hope that Our Merciful Lord will have mercifully received its victims.

When attentively looking at the documents relating to the typhoon after its reaching Formosa at 6 p.m. on the 10th, the striking fact which any one will notice, is, with the change in the central depression already pointed out, the disappearance of a well defined centre, and the setting up, instead of it, of a large area of low barometric presure with soft gradients and consequently moderate breezes. All around that large area there is evidence of a ring of steeper gradients with stronger breezes blowing still with the violence of a fresh gale. I have stated above, that the occurence of such phenomena would be the consequence of a rising of the lower part of a typhoon. Therefore, their appearance in our case, once well ascertained, would give strong evidence in support of the above theory. Consequently I wish to ascertain those facts with all possible clearness. The existence of a large area of low pressure with soft gradients and moderate breezes is proved especially by the observations registered at the meteorological stations of Northern Formosa, and those of the barque *Nanaimo*, Captain W. Otter. The existence of the ring of stronger breezes is ascertained by the observations of the Northern part of the Formosa Channel, those of Southern Formosa, already mentioned, and the report of *City of Peking Phra-Nang* and *Empress of Japan*. All those observations are carefully shewn on the accompanying table:—

Meteorological Reports, October 1892.*

Date.	Hour.	Middle Dog. Barometer.	Wind. Dir.	Force.	Weather.	Turnabout. Barometer.	Wind. Dir.	Force.	Weather.
10th	3 A.M.	29.72	N.N.E.	7	OMP	29.48	N.N.E.	10	OMP
	9 A.M.	29.68	N.N.E.	7	OMP	29.45	N.N.E.	11	GMP
	3 P.M.	29.55	N.N.E.	7	OMP	29.32	N.	11	GMD
	9 P.M.	29.54	N.N.E.	8-9	OMPQ	29.29	N.	12	GMD
11th	3 A.M.	29.47	N.N.E.	8-9	OMPQ	29.23	N.	12	OMD
	9 A.M.	29.54	N.N.W.	8-9	OMPQ	29.34	N.	10-11	GMD
	3 P.M.	29.60	N.N.W.	6-7	OMPQ	29.42	N.N.W.	9	OMD
	9 P.M.	29.76	N.W.	5	OMD	29.63	N.W.	7	GM

Date.	Hour.	Kelong. Barometer.	Wind. Dir.	Force.	Weather.	Tamsui. Barometer.	Wind. Dir.	Force.	Weather.
10th	9 A.M.	29.75	N.E.	6-8	OR	* 29.72	N.E.	4-6	R
	3 P.M.	29.63	N.E.	5	OP	29.63	N.E.	3	OR
	9 P.M.	29.63	N.E.	5	OP	29.67	E.N.E.	3	O
11th	9 A.M.	29.61	N.E.	2	OD	29.60	S.E.	4	O
	3 P.M.	29.64	N.E.	4	OR	29.65	S.	1	OD
	9 P.M.	29.80	N.E.	2	OR	29.83	N.W.	3-6	OD

In addition to these observations see the reports of Fisher Island, Anping, Takow and South Cape above printed.

* The barometric readings are not reduced to sea level.

Digitized by Google

Original from UNIVERSITY OF CALIFORNIA

The *City of Peking* reports:—"Sailed from Yokohama 6th October, 6.18 a.m.; had moderate to fresh N.E. to East winds to Kuro Island, where the weather became unsettled with rain and heavy squalls. 10th October, lat. 25° 37′ North, long. 120° 41′ East we encountered a very heavy gale from N.E., with hard squalls and heavy sea, ship hove to for 17 hours. 11th October, wind and sea moderate for above 6 hours, when it again increased to a violent gale from N.N.E., with squalls of hurricane force and very ugly, dangerous and heavy sea running Ship hove to for 15 hours—lowest barometer 29.40. Same day at 9.15 a.m. passed C. P. R. steamer standing to N.E., lat. 25° 51′ N. long 121° 03′ E. 12th October, 2 a.m., wind moderating resumed our course to Hongkong, with light N.E. winds and fine clear weather to port."

The Northern Pacific chartered steamer *Phra Nang*, on arriving at Hongkong from Tacoma, reported "having passed through the typhoon near Turnabout. On the voyage from Tacoma to Japan the *Phra Nang* encountered very rough weather in the Pacific and had to heave to for two nights. After leaving Kobe, she had fairly good weather till Monday morning, 10th. At four o'clock the barometer fell to 29.87, and at eight o'clock there was a light N.N.E. gale with sea coming from the same direction. Some sails were set to steady the steamer, and one heavy squall about this time split the foresail. By noon the barometer had fallen to 29.62. It was then blowing a strong gale from N.N.E. with a high following sea. The *Phra Nang*, however, had a well-balanced cargo, and as she was neither too light nor too heavy she ran easily and did not ship any water. An hour later the sea got worse, and at 1.30 p.m. she shipped a heavy cross sea which smashed one of the starboard lifeboats, started the beams of the boat deck and damaged two of the boats. At this time the gale was very strong and the sea mountainous, and the terrific squalls which struck the ship from time to time tried her sea-going qualities to the utmost. The fore-topsail was blown out of the bolt ropes and had to be cut away, The barometer continued to fall steadily, and the lowest point was reached at four o'olock, when it then recorded 29.26. Towards evening the wind was blowing with hurricane force, still from N.N.E., and as there was a terrible sea running Captain Watton deemed it expedient to heave his ship to with her head to the wind. At 6 p.m. the wind backed to the North, and the ship was hove to on the port tack the engines being worked as required. From this time the barometer began to rise, while the wind backed to N. by W. and afterwards to N.W. Between 10 p.m. 11th, and 2 a.m. on Tuesday, 12th, the typhoon was renewed with all its former fury, but the ship behaved splendidly and was never in any actual danger.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

By 6 a.m. the gale had moderated, but the sea remained as stormy almost all the way to port. During the worst weather the haze was so dense that those on board could not see further than a quarter of a mile away. No other vessels were sighted."

But let us illustrate the subject in way easier of comprehension and more appropriate to a public lecture. Three synoptic maps put before you showing the isobaric lines with the prevailing winds from the Southern part of the Formosa Channel, up to the North of Formosa, will perfectly answer the purpose.* The first is constructed to represent the meteorological state for 9 a.m. on 11th; the second for 3 p.m., and the third for 9 p.m. of the same day.

Let us look attentively to the map of 9 a.m. The lowest barometric pressure was observed at the meteorological station of Northern Formosa, where light breezes of variable directions prevailed. Neither those light breezes nor the steadiness of the barometer at Keelung and Tamsui, from 3 p.m. on the 10th to 3 p.m. on 11th, is consistent with any distribution of barometric pressure but a large area of gentle gradients. The same phenomena are registered by Captain W. Otter, master of the barque *Nanaimo*.

Abstract from Meteorological Log of the British barque *Nanaimo*,
Capt. W. Otter.

Date.	Hour.	Barometer.	Wind.	Force.	Position.	
8th,	3 P.M.	30.00	N.E. by N.	4 to 5	Agincourt Island N.E. 2 miles.	*(a)*
9th,	8 A.M.	29.76	N.E.	7	,, N.W. 11m.	*(b)*
	1 P.M.	29.76	N.E.	6	.....	
	5.40 to 8 P.M.	29.75	N.E.	var.	.....	*(c)*
10th,	8 A.M.	29.62	N.E.	8 & 9	East of Agincourt.	*(d)*
	Noon	29.55	N.E. by E.	9	do.	*(e)*
	8 P.M.	29.54	E. by N.	3	Drifting S. by E.	*(f)*
11th,	6 A.M. to 6 P.M.	29.54	E.S.E.	2 & 3	Agincourt S.W. Noon 26.44 N. 122.40 E.	*(g)*
	7 P.M.	29.54	S.S. by E. var. to E.	2	.....	
	8 P.M.	29.54	N.W., N.E. & E.	0 to 9	Since above position, vessel went N.E., about 7 miles.	*(h)*
12th,	3 A.M.	29.58	N.	8	.....	*(i)*
	6 A.M.	29.64	N.	8	.....	*(j)*
	8 A.M.	29.72	N.	7	.....	*(k)*
	Noon	29.76	N.	6	26.58N. 121.56E.	*(l)*

* See plate IV., page 16.

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Remarks :—

(a) Occasional rain showers, light squalls, bar. falling.
(b) O.Q.P., confused sea.
(c) R., very heavy rain showers, wind puffy, bar. falling.
(d) R.P., strong gale, squally with rain.
(e) R.P., heavy squalls with rain, heavy cross sea.
(f) O.Q.R., changeable.
(g) Irregular confused sea. Gloomy appearance towards evening.
(h) About 8 p.m. a heavy squall from N.W., 2 or 3 minutes calm, then N.E. calm again, and oft. repeated before canvas was taken in. A heavy one from E.N.E. took vessel aback, and blew continuously typhoon force, finally getting into N.N.E. at 10 p.m. Rain continuously.
(i) Rain finished, squalls yet heavy.
(j) Squalls more moderate.
(k) O., sky breaking into clouds.
(l) Finer, sun out, typhoon over. Steadily increasing fine weather, bar. rising. Readings bar. are taken from Aneroid (a very good one), shewing at noon 10th January, 1893. No. 1 Section, Shanghai Harbour, 30.37 and estimated as 2/10ths above mercury. The 2/10ths are deducted in all above readings so the actual readings were 2 10ths more.*

* The barometric reading at noon on the 10th was 130.21 at Zi-ka-wei, thence the correction applied should have been 0.16 instead of 0.20.

The ring of steeper gradients and stronger breezes appears at the first glance at the map, on looking at the arrows traced at the Middle Dog, Turnabout, Ockseu, Pescadores, South Cape. We have no means of completing the ring all around the area of light breezes, but as we have it to the West and South, and the French gunboat *Vipère* which was at that moment travelling from Japan to Shanghai. We feel assured that it existed also to the North by 32° N. and 126° E., we can hold that it inclosed completely the area of low pressure. The lack of observations taken to the East of Formosa may fairly account for the difficulty of placing the centre of the typhoon on that day, but this difficulty is also partly due to the lack of a well defined centre.

The third map for 9 p.m. shows also that another phenomenon had taken place during the same day, viz., the division of the typhoon into two segments. The division appears to have been complete before night, and the two fractions were, at 9 p.m., travelling each in its direction. The Southern segment, well indicated by the observations of Southern Formosa, must have gone to the East or South-East, where for want of further observations we cannot follow it. The Northern segment, the position of which is sufficiently ascertained by the barque *Nanaimo*, the meteorological stations of the Northern part of the Channel, and of the island of Formosa, went on to the North-East.

We will now follow for a moment the trajectory of this Northern segment of the typhoon, the bearing of which at 9 p.m. on the 11th was near Agincourt Island. Except a report from the French gunboat *Vipère*. We have no meteorological observations

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

from any boat having experienced it in that part of its trajectory. The *Vipère*, in its voyage from Nagasaki to Shanghai, passed ahead of it, and its reports reads as follows :—

Abstract from the Meteorological Log of Gunboat *Vipère*.

Date.	Hour.	Position.	Direction.	Force.	Baro-meter.	Ther., dry.	Ther. wet.	Rain, hours.
10th,	4 A.M.	.....	N.E.	1	763	19	18	...*(a)*
	8 A.M.	Nagasaki.	N.E.	1	763	21	20	...
	Noon	.....	N.N.E.	2	763	23	21	...*(b)*
	4 P.M.	32° 28′ N. 128° 39′.5 E.	N.N.E.	3	763	22.5	21	...*(c)*
	8 P.M.	.....	N.	4	763.5	21	20.5	...*(d)*
	Mid.	.....	N.E.	5	763.5	20.5	19	2
11th,	4 A.M.	.....	N.E.	4	763	21	20	4
	8 A.M.	.....	E.N.E.	5	763.5	19	18.5	4
	Noon	31° 45′ N. 125° 21′.5 E.	N.E.	4	763	19	18	3.5*(e)*
	4 P.M.	.....	N.E.	5	763	19	18	3
	8 P.M.	.....	N.E.	6	763.5	19	18	4
	Mid.	.....	N.E.	6	763	18.5	17	4
12th,	4 A.M.	.....	N N.E.	7	762.5	18	17.5	4
	8 A.M.	.....	N.N.W.	6	760.5	19	18	3
	Noon	30° 45′ N. 122° 17′.5 E.	N.W.	5	760.5	20	18.5	0.5*(f)*
	4 P.M.	.....	N.	5	760	21.5	20	...
	8 P.M.	.....	N.W.	4	760	20	19.5	...
	Mid.	.....	N.W.	3	761	19	18.5	...
13th,	4 A.M.	.....	N.W.	3	761	18.5	18	...*(g)*
	8 A.M.	.....	W.N.W.	2	762.5	19	18	...
	Noon	31° 08′ N. 121° 59′ E.	N.W.	1	763	25	24	...
	4 P.M.	.....	N.W.	1	763	24	22	...
	8 P.M.	Shanghai.	N.W.	2	763	19	18	...
	Mid.	.....	N.W.	1	763.5	19	18	...

Remarks :—*(a)* Sky overcast, smooth sea. *(b)* Rough sea. *(c)* Very rough sea. *(d)* Squalls. *(e)* Sea very heavy—poured oil during 20 hours. *(f)* Sea manageable. *(g)* Fine weather.

This report shows pretty clearly that the typhoon, ahead of which the *Vipère* passed was travelling North-Eastward. When running this part of its trajectory it began to be experienced at Shanghai ; the fall of the barometer was not, however, very great, though it was exaggerated by another depression over the Northern Coast of China ; the winds rather light had backed from North-East to North-North-East and so continued steadly during the 12th of October ; weather very rainy on the 11th with North-East winds turned rather fine on the 12th. On that day under the Strato-Cumulus running with the wind from North-West very well defined Alto-Cumulus were seen to follow with great velocity in the same direction. This last point was carefully observed on account of its importance in the matter, and must be accepted as perfectly certain.

In the weather maps, published tri-daily by the Central Meteorological Observatory of Tokio, we should expect to find it. Of course to find the typhoon on those maps we must look at

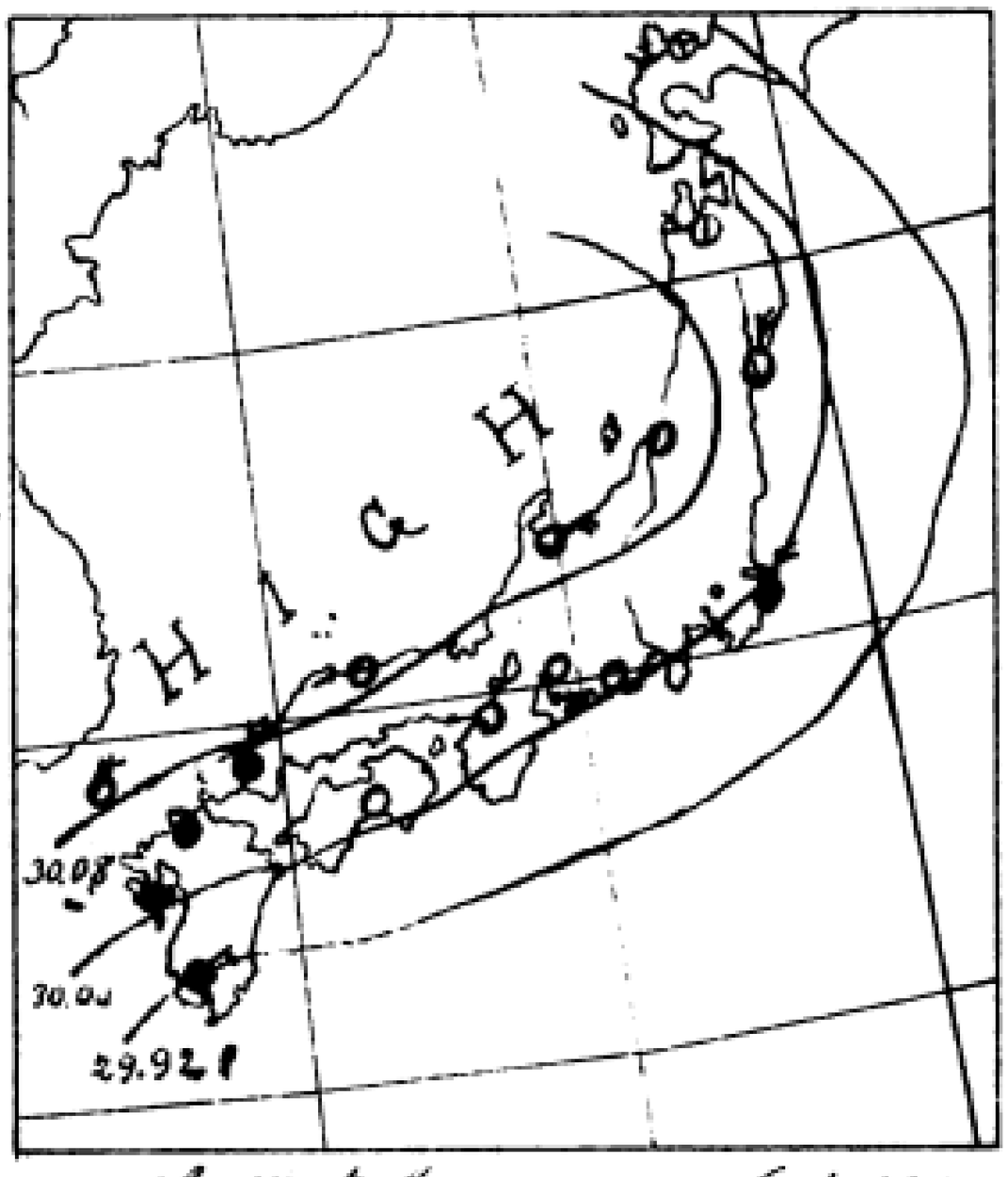
Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

those relating to the 12th of October. But let us take a look at the previous maps. On the 6th, 7th, 8th and 9th the weather maps show a low barometric pressure prevailing to the South-West of Japan, extending gradually to the South and South-East of those islands. That relatively low pressure has nothing to do with our typhoon. The weather maps of the 10th of October show a high barometric pressure prevailing over the sea of Japan and extending over the whole Empire with rather cloudy, but fine weather. Thus we seem to find here what we denied before, viz., an anticyclonic area prevailing within 600 to 1,000 miles from the centre of the typhoon, and affording an apparently fair prognostic of the typhoon. It looks so at a first glance. But it is a question whether the area indicated on that map as high, is somewhat, at least, above the mean pressure or not; and whether the centre of that area was really over the sea of Japan as it appears to be according to the map. Taking the weather map mostly favourable to the supposed existence of a centre of high pressure over the sea of Japan, viz., the map of 10 p.m. on the 10th. We see on that map the isobar 30.02 passing near Sakai and Kanikawa, but that barometric height does not exceed the normal height of the barometer at those stations. Therefore the area prevailing properly cannot be called high. There was, however, a centre of high barometric pressure, but it lay far to the North-West; and the subsequent weather maps show it coming, during the next 24 hours, nearer the centre of the typhoon, until it was thrust back by the segment of the typhoon travelling to the North-East. Thus this afford further proof in support of the statement made above against the existence of an anticyclonic area.

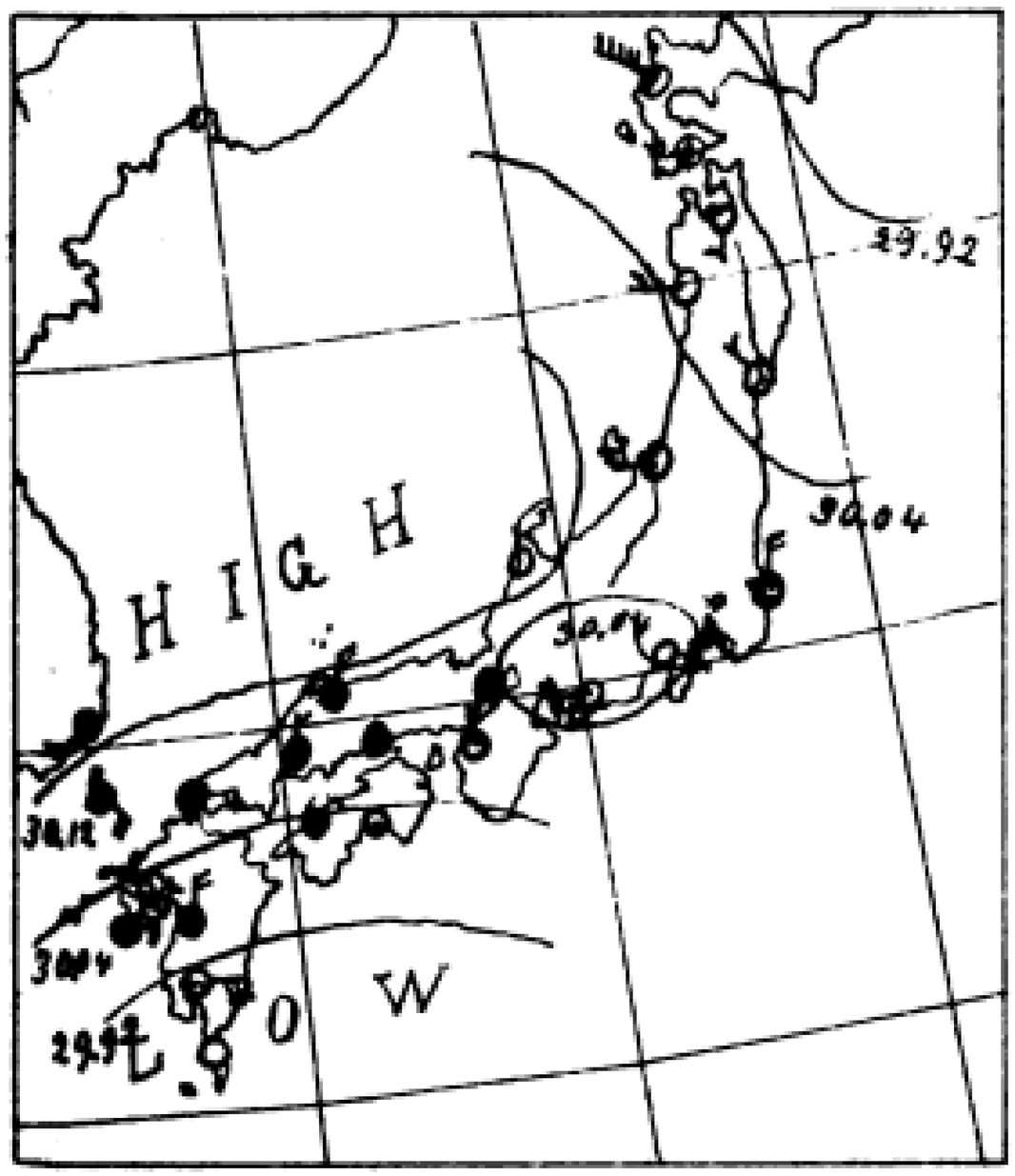
During the night of the 11th the blinding rain encountered at sea by the gunboat *Vipère* reached the South-West Coast of Japan thrusting back, as we said, the incoming area of high pressure. Observe here what we find on the weather map relating 2 p.m. on 11th. *Hongkong Observatory reports that a typhoon has appeared in the Bashee Channel proceeding North-Westward.* And in the map relating to the 12th, at 2 p.m., we see that the *typhoon of Bashee Channel has altered its course near Amoy and is now North-East of Formosa.* The same map shows indications of a depression in the Corea Channel, which is the actual centre of the typhoon of Bashee Channel. Evidently, Mr. Wada reported that depression according to the numerous telegrams he had received from Japanese stations; but he could not have thought that such depression was that same typhoon, which was telegraphed to have recurved near Amoy and to be then North-East of Formosa. It is evident that with the scanty information we can get by telegraph, it is very difficult to point out the

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

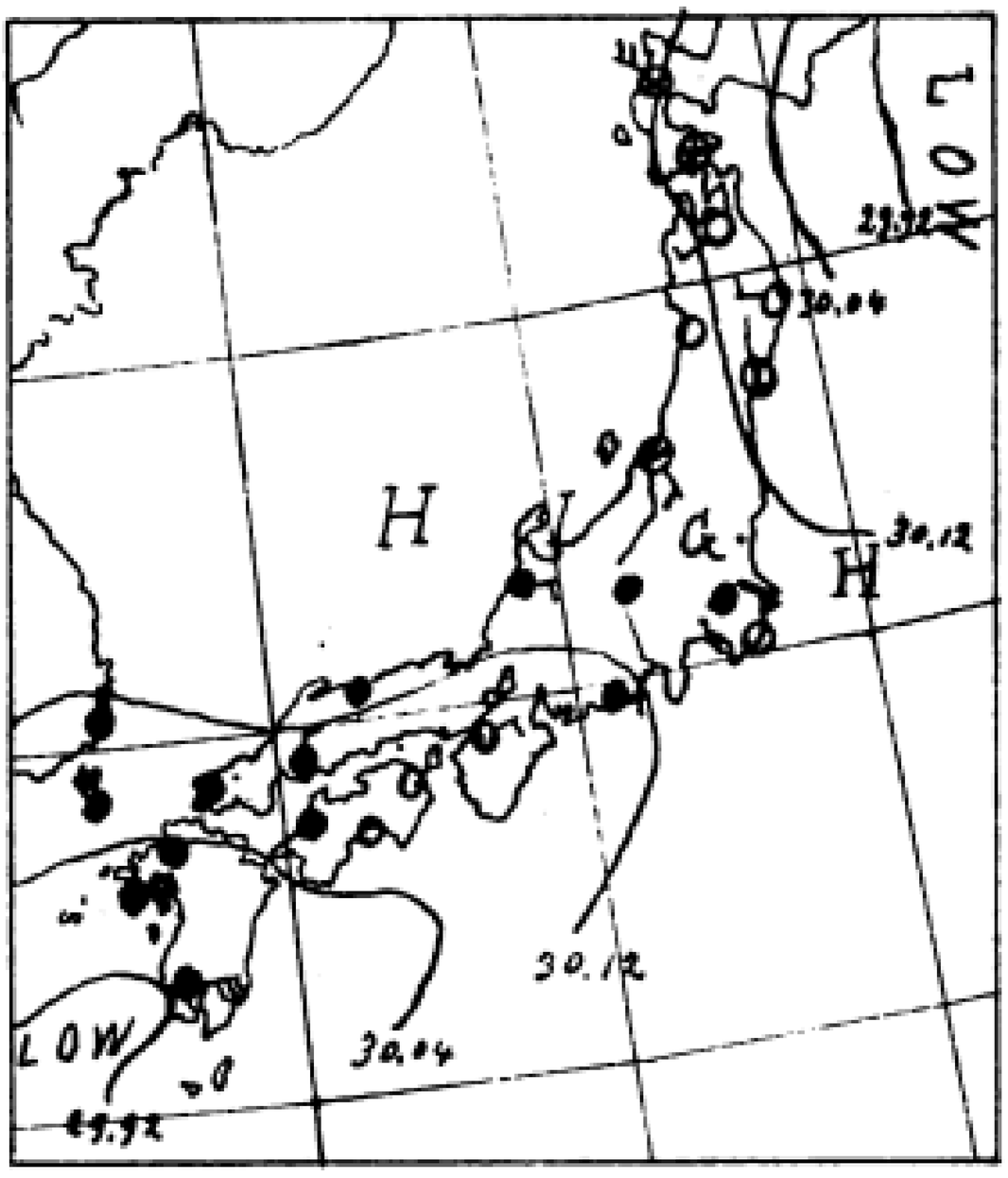
10th October, 1892. 10. P.M.



11th October, 1892. 6. A.M.



11th October, 1892. 2. P.M.



11th October, 1892. 10. P.M.

From the tri-daily weather map published by the Tokio central meteorological observatory.

Zi-ka wei. Catholic mission lith.

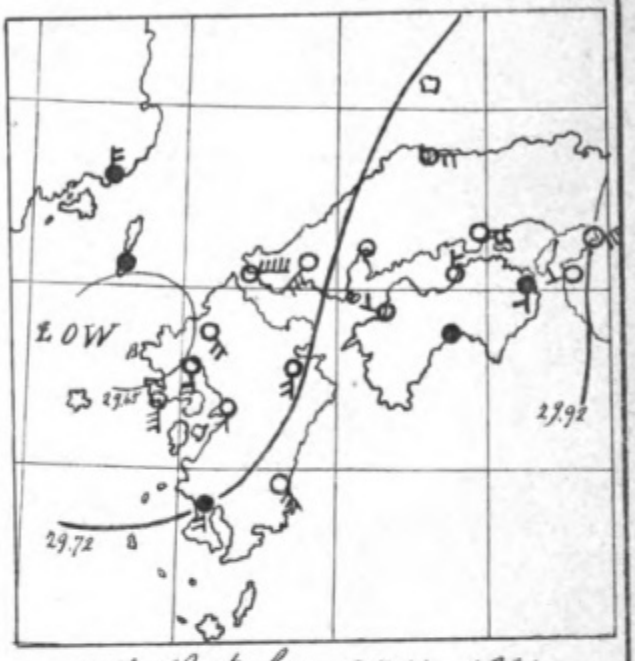
Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

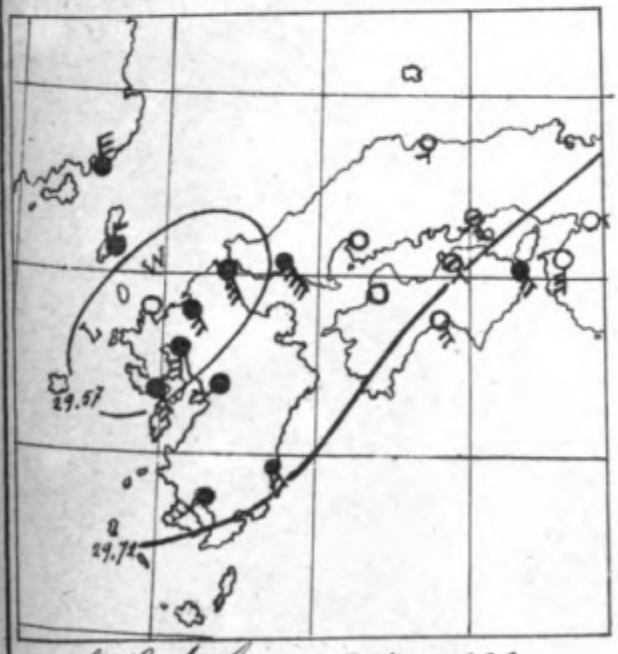
Original from
UNIVERSITY OF CALIFORNIA

The Bokhara Typhoon.

12th October, 6.A.M. 1892.



12th October, 2.P.M. 1892.



12th October, 10. P.M. 1892.

13th October, 6 A.M. 1892.

From the tridaily weather maps published by the Tokio, Met. Cent. Obs.

Zi-ka-wei — Catholic mission title:

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

true bearing of a typhoon. It appears also how injurious a long delay in transmission of meteorological information really is.

There is no doubt that the centre of low pressure shewn on the map of 10 p.m. of the 12th October, is the centre of the Northern segment of our typhoon. On the preceding map for 2 p.m. of the same day the same low pressure is indicated at the same place, whence the map for 10 p.m. would lead to the conclusion that it has remained steady. But the former indication was a mistake due to a lack of information taken at sea to the South of Japan. From the position of the typhoon on the 11th at night and this new position we may conclude that its means velocity during the preceding 24 hours was 20 miles an hour. Its velocity of translation had been therefore much altered, from 8 miles an hour, which it had before reaching South Cape, to 20 miles an hour between Formosa and Japan. But in this last part of its course it was no longer that formidable typhoon which with a central low pressure at 28.15 a gradient of 0.70 for 60 miles, disturbed with such a violence the whole Formosa Channel, and wrecked the *Bokhara*. The lowest barometric reading at 10 p.m. on the 12th was 29.53 with a very moderate gradient of 0.04 for 60 miles. Nevertheless there was a fresh gale blowing in the Corea Strait and over Kiu-siu Island.

Looking at the next weather map, we find two distinct central depressions. A small one with a central pressure at 29.135 lying over Okayama, seems quite obviously the remains of our typhoon. Another centre of low pressure deeper and wider, appears on the same map, as lying over the sea of Japan. Therefore, it looks at first sight as if a new division had taken place. But it is not really so. The second centre of low pressure was a regular winter-low pressure coming from the North. It had passed to the North of Tientsin, apparently not very far from that place, on the 12th of October at 11 p.m. The fall of the barometer was very great on the Northern Coast of China from the 11th of October until 12th, 11 p.m., or the 13th, 3 a.m. As the following map bears indication of only one centre of low pressure, this segment of the formidable *Bokhara Typhoon* was eventually absorbed by another centre of low barometric pressure originated in higher latitudes.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

CONCLUSIONS.

We have followed this terrible typhoon all along its trajectory from its first appearance to the East-North-East of Luzon till its cessation on the Western Coast of Japan. We will now summarize on a page or two all the couclusions we have been able to arrive at from the study.

From a theoretical standpoint we may sum up the results as follows:—

1st.—No area of high barometric pressure can be asserted to exist within 600 to 1,000 miles from the centre, either all around it, or ahead of it.

2nd.—Save the inner spirals, which appear to be circular or almost so, the whirlwinds have a decided tendency towards the centre of the typhoon. This tendency of the wind towards the centre of the typhoon is well ascertained not only outside the limits of the typhoon, but within these limits, in the very body of the cyclone. Therefore an uprush of air must exist, either in the inner or the outer spirals. Not to carry this conclusion beyond its logical limits, we have abstained from denying a descending current of air in the inner and circular spirals.

3rd.—Typhoons as well as tornadoes are subject to dipping and rising of their lower part, with the difference, however, that in tornadoes the lower part rises up entirely, while in typhoons only the inner spirals do so, the outer ones continuing to touch the ground.

From a practical standpoint: 1st. We have endeavoured to warn marine officers, that in lower latitudes careful attention must be paid to Cirrus and Cirro-Stratus as the best sign of a still distant typhoon. According to the remarks originally made by Rev. F. Saderra; the bearing of the centre of a typhoon and its direction are shown by the point on the horizon from which the Cirrus appear to be *radiating* and the motion of this point.

2nd. We seem to have established the fact notwithstanding various contradictions that the rule given many years ago by Rev. F. Dechevrens must be retained: The centre of the typhoon bears, generally speaking, 10 to 12 points from the direction of the wind. Therefore, under ordinary circumstances, with your back to windward you will have the centre on your left 2 or 4 points in front. But to prevent fatal errors which might ensue

Digitized by Google
Original from UNIVERSITY OF CALIFORNIA

from accepting too confidently this estimation as an invariable one, we have insisted on its roughness, and settled the circumstances according to which the angle between the direction of the wind and the radius vector is changed. These circumstances, according to our observations, are the distance to the centre, the position ahead or in rear of it, and mainly the direction of the monsoon relatively to the bearing in respect of the centre.

3rd. We have seen that after the monsoon is settled along the coast of China the presence of a typhoon in the South, will always bring on a full North-East gale in the whole Channel.

4th. From the ordinary trajectories of typhoons in October we have concluded that a ship which is bound to the South and on reaching the North of Formosa Channel finds signs of a typhoon in the South, will act prudently by hearing to and keeping as much as possible the North of the Channel.

5th. We have called to mind, and urged the true rule of heaving to, viz., where you have signs of a typhoon, heave to for the purpose of fixing the bearing and the trajectory of the typhoon, and of taking subsequently the best appropriate course for bringing the ship away from the centre. In the circumstances under consideration, it is evident that a tendency of the wind to veer from North-East to East would show that the typhoon is crossing the Channel travelling Westward; while a tendency to back would show that it has recurved near the South point of Formosa.

Should these conclusions be of service in obviating future disaster, I shall feel amply rewarded for the time and labour spent in the study of this typhoon.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ZI-KA-WEI OBSERVATORY

THE "BOKHARA" TYPHOON

OCTOBER 1892.

READ BEFORE THE SHANGHAI METEOROLOGICAL SOCIETY

BY

THE REV. S. CHEVALIER, S.J.,

DIRECTOR OF THE ZI-KA-WEI OBSERVATORY,

PRESIDENT OF THE SHANGHAI METEOROLOGICAL SOCIETY.

SHANGHAI:
PRINTED AT THE "NORTH-CHINA HERALD" OFFICE.

1893.

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA