INDIA WEATHER REVIEW, 1963

ANNUAL SUMMARY

PART C

S T O R M S A N D D E P R E S S I O N S

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INDIA WEATHER REVIEW, 1963

ANNUAL SUMMARY

PART-C

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STORMS & DEPRESSIONS

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I. DEPRESSIONS AND CYCLONIC STORMS

During the year, three cyclonic storms and ten depressions formed in the Bay of Bengal and three cyclonic storms and one depression in the Arabian Sea. Of these four were severe storms. For the first time over the Indian Seas, instrumented aircraft probed into the Arabian Sea Storm in May. The tracks of the storms and depressions are given in Plate 1 and 2. The dates of activity of the storms and the greatest barometric depths observed (or estimated) near their centres are summarised in the following table:

TABLE I

Location	Month	Date	Central Pressure (mb)	Corresponding depth (mb).
Arabian Sea	May	20 - 29	947.0	-62
Bay of Bengal	May	25 - 29	919.9	-85
Arabian Sea	October	14 - 17	998.0	-13
Bay of Bengal	October	19 - 24	984.2	-27
Bay of Bengal	October	26 - 28	995.0	-17
Arabian Sea	December	30 Nov- 7 Dec		

The monthly distribution of the storms and depressions for the year 1963 is given in the Table II at the end.

The detailed descriptions of these storms and depressions are given below:

1 Depression in the Bay of Bengal—
—3rd to 5th January—

A low pressure wave was moving westwards across Andaman Sea and adjoining southeast Bay of Bengal on 1st January, causing an increased precipitation over south Bay Islands on the 1st and 2nd. Car Nicobar recorded 5 cm of rain on 1st morning and Port Blair 3 cm; Kondul recorded 4 cm of rain on 2nd morning. Moving in a westerly direction, to the southwest Bay, it concentrated on 3rd morning into a depression centred at 0830 hrs IST near Lat. 5.5°N and Long. 85°E. At 1130 IST ship S.S.City of Wellington (Lat. 5.7°N, Long. 83.3°E) reported north-

westerly winds of 25 kt and shower in past hour. On 5th, there were no ships' observations sufficiently near to locate the centre uniquely. However, the centre could be estimated to be near Lat. 5.5°N, Long. 84°E at 0830 hrs IST of 5th. Subsequently the depression weakened into a low pressure area and shifted southwestwards.

2 Severe Cyclonic Storm in the Arabian Sea—
—18th to 29th May—

A low pressure area was lying over southeast Arabian Sea west of Maldive area on 16th. It became well marked on 17th. It slowly shifted north and concentrated into a depression by the morning of 18th near Lat. 8.0°N, Long. 68.5°E, as indicated by the following ships' observations.

Call Sign	Position		Time IST.	Wind	
	Lat. N.	Long E.		Dir.	Speed (Knot)
GYQB	9.7	67.1	0530	NNE	13
JKNP	9.9	65.4	0530	NNE	18

By 1730 hrs IST of 18th, the depression shifted north and was centred near Lat. 9.5°N, Long. 68.5°E. At this stage, an area of about 5° diameter was under the influence of the depression. The depression remained practically stationary and by 20th morning had intensified into a deep depression with its centre near Lat. 10.0°N, Long. 68.5°E, as indicated by the following ships' observations.

Date	Time IST.	Call Sign	Position		Wind		Weather Remark
			Lat. N.	Long E.	Dir.	Speed Knots	
20th	1130	VWPR	9.4	67.5	NW	20	Overcast
	1130	JHEM	8.6	68.0	WNW	30	Moderate continuous rain

There was a significant increase of rainfall over Arabian Sea Islands - on 20th morning, Minicoy recorded 3 cm of rain. Without any appreciable movement, the deep depression concentrated into a cyclonic storm by the morning of 21st and was centred at 0830 hrs IST near Lat. 10.5°N, Long. 68.0°E. The following observations of 21st May are of interest in this connection:

Name of the ship	Time of Obsn. IST	Position		Wind		Weather	Pressure (mb)	Wave height metres
		Lat. N.	Long E.	Dir.	Speed Knots			
King Arthur	0530	10.1	67.9	WNW	37	Heavy continuous rain	1001.9	5
[illegible]	1130	9.9	68.7	W	24		1006.7	2
Express	1130	10.3	69.1	S	16	Cloudy	1011.2	2

There was also a strengthening of the low level upper winds over Minicoy to 20/25 knots.

At 1730 hrs IST of 21st, the cyclonic storm was centred near Lat.10.5°N Long.67.5°E.

During the next 18 - 24 hours, the cyclonic storm intensified further into a severe cyclonic storm and was centred at 0830 hrs IST of 22nd near Lat. 11.0°N, Long.66.5°E. The U.S. Weather Bureau Research Flight Facility aircraft which flew a mission into the storm area reported the centre of the cyclone to be near Lat.11.3°N, Long.66.1°E at 1200 hrs IST with a circular but poorly defined eye and had a very small core of near hurricane winds. The aircraft reported maximum winds of 60 knots in the east quadrant and a central pressure of 984 mb. Another aircraft reported winds of 60 knots in the south quadrant at 1330 hrs IST At this stage the cyclonic storm was one of small extent. Tiros IV in orbit 3587 R/O 3586 GMT reported a vortex in the vicinity of Lat. 12°N, Long. 65°E, with centre out of picture limit.

During the next 48 hours, there were practically no observations within 3 to 4 degrees of the storm centre. The peripheral observations, although they indicated the circulation, could hardly give any indication of the intensity of the storm at the centre. During this period, the storm was apparently moving in northwesterly direction, and was centred successively at 0830 hrs IST of 23rd and 24th, within a degree of Lat. 12.5°N, Long. 64°E and Lat. 14°N, Long. 61°E respectively.

The U.S. Weather Bureau RFF aircraft again flew a mission into this storm on 24th and located the centre of the severe cyclonic storm at 0813 GMT - 1343 IST at Lat. 14.8°N, Long. 60.1°E, with a central pressure of 947 mb and maximum winds of 104 knot in the western wall. Tiros VI (Orbit 3616 R/O 3615 - 0513 GMT) reported a vortex at 14°N, 60.6°E. Important ships' observations available fairly close to the centre are reproduced below:

The hourly observations from M.V.Jaladhruv which crossed the path of the severe cyclonic storm are given below:

Time	Position Lat. N.	Position Long E.	Wind Dir.	Wind Speed B.F.	Corrected Barometer (mb).	Temp °C Dry.	Temp °C Wet.	Weather and Sea condition
24th May								
0000	15°42'	58°00'	NW/W	3	1003.5	30.5	29.0	Cloudy:Slight Sea and swell
0300	15°54'	58°42'	NE/E	5	1003.4	27.0	26.0	Overcast;drizzle rough sea. Ely swell
0400			NE	6	1001.8	27.0	26.0	Overcast,Drizzle;rough sea; Ely swell
0500			NE/E	10	1000.5	26.0	25.0	Overcast;rain squalls;rough sea;Ely swell
0600	16°00'	59°30'	N/E	11	999.8	26.7	25.9	Overcast,rain squalls and rough seas; Heavy Ely swell
0700			NE/E	10	996.9	26.7	26.0	Heavy rain squalls;very rough seas;heavy Ely swell

Time	Position Lat. N.	Position Long E.	Wind Dir.	Wind Speed B.F.	Corrected Barometer (mb).	Temp. °C Dry	Temp. °C Wet	Weather and Sea condition
0800	16°10'	59°42'	NE/E	10	997.1	27.5	26.2	
0900	16°12'	60°00'	NE/E	10	996.3	29.0	28.0	
1000			E/N	10	995.3	30.0	28.0	Overcast;heavy rain;squalls, very rough seas
1100			E/N	10	994.9	30.0	28.0	Heavy E/S Swell
1200	16°18'	60°36'	E/S	10	996.0	29.5	28.0	Overcast;heavy rain squalls, very rough seas; Heavy ESEly swell
1300			ESE	10	998.0	29.5	28.0	
1400			ESE	8/9	999.0	29.5	28.0	

It was estimated on board that "JALADHRUV" crossed the path of the storm at about 1100 GMT and was about 100 miles from the core when closest to it at about 1200 GMT.

Observations from S.S.Saudi

Time GMT.	Position Lat. N.	Position Long E.	Wind Dir. Deg.	Wind Speed Knots	Weather	Pressure (mb)	Waves Feet.
24th May							
0000	15.9	59.0	020	13	Cloudy	1002.8	3
0300	16.0	59.4	360	37	Rain	1001.9	Confused Seas 15
0600	15.3	59.3	360	37	Rain	997.8	15
0900	14.9	59.1	320	68	Rain	989.7	15
1200	14.4	59.6	260	68	Rain	998.3	15
1500	14.3	59.8	250	62	Drizzle	1007.5	14

At this stage an area of near 12 to 15 degrees diameter was in the grip of the circulation.

The severe cyclonic storm was centred at 1730 hrs IST of 24th near Lat. 15.0°N, Long. 59.5°E. M.V.Jaladhruv (16°18'N; 60°36'E) reporting an easterly wind of 50 kts at 1730 IST, estimated the centre of the storm about 100 miles away at 1730 IST. Assuming that the central pressure of the storm was unchanged since the aircraft penetration at 1343 IST, the average pressure gradient in the storm area works out to be nearly (996 - 947 or 50 mb) 50 mb in 100 miles i.e. 1 mb per two miles. Ship VWPS (15.8°N; 59.6°E) at 1730 IST reported westerly wind of 70 kts and a pressure of 988.3 mb. The severe cyclonic storm moved in a westnorthwesterly direction and was centred near Lat. 15.5°N and Long. 57.5°E at 0830 hrs IST of 25th

At 1130 hrs IST S.S.Universe Defiance (15.2°N, 57.5°E) reported a wind 200 degrees 60 knots and pressure 991 mb, when the severe cyclonic storm was within half-a-degree of Lat. 15.5°N, Long. 57°E. The following sequence of observations from the above ship are of interest:

Time of Obsn. (GMT)	Position Lat. °N	Position Long °E	Wind Dir. Deg.	Wind Speed Knots	Weather	Pressure (mb)	Remarks
0000	14.0	56.5	270	48	Heavy continuous rain	995.2	Tropical cyclone with winds of hurricane force at times
0600	15.2	57.5	200	60	Drizzle	991.0	
1200	16.2	58.1	160	40	Drizzle	999.5	

On this day, the areal extent of the strong winds around the severe cyclonic storm increased and winds of speed 30 to 40 kt were reported even at distance of 4 to 5 degrees away from the centre.

After the mid-day of 25th, the severe cyclonic storm slowed down considerably. It was centred at 1730 hrs IST of 25th near Lat. 16.0°N; Long. 56.0°E.

By 26th the areal extent of the storm decreased. Winds of speed upto 50 kts were still reported from the southern quadrant. At 0830 hrs IST, the severe cyclonic storm was centred near Lat. 16.0°N, Long. 55.5°E. Tiros VI (Orbit 3646 R/0 3644 Time 0448 GMT) reported the centre at 16°N, 55°E. At 1730 hrs IST, the severe cyclonic storm was centred near Lat. 16.5°N, Long. 55°E, as in inferre from the following 1200 GMT observations.

Ship or Station	Position Lat. °N	Position Long °E	Wind Dir. Deg.	Wind Speed Knots	Weather	Pressure (mb)
GWCY	17.0	56.4	150	36	Heavy rain	996.6
Jala-Durga	13.4	56.0	SW	50		998.8
Salalah			360	37	Severe duststorm	991.7

The pressure fall at Salalah during the past 24 hours was 4.7 mb.

Thereafter, the severe cyclonic storm took a westsouthwesterly course, more or less parallel to the coast line. It was centred on 27th morning at 0830 hrs IST near Lat. 16.0°N, Long. 53.5°E. Ship GWCY (position near 16.2°N, 54.6°E) reported at 0300 hrs GMT southsoutheasterly winds of 35 knots and pressure 994.6 mb. Salalah reported at 0600 GMT wind 080/23 knots, heavy continuous rain and pressure 997.7 mb. S.S.Mohammadi (Position 13.6°N, 56.3°E) reported 230/50 knots and a pressure 999.0 mb.

Moving rather slowly westsouthwestwards, the system weakened into a depression by 29th and further weakened into a low over Gulf of Aden on 30th. Due to lack of observations, it is difficult to locate the centre beyond 27th evening On 29th morning it was centred near about Lat. 15.5°N, Long. 52.0°E, close to Arabia coast, as a depression.

Under the influence of the cyclonic storm, the southwest monsoon advanced, temporarily, upto Lat. 10°N along the west coast of the Peninsula by the third week of May. Mangalore recorded 8 cm of rain on 19th and Calicut 7 cm on 21st.

3 Severe Cyclonic Storm in the Bay of Bengal——
——25th to 29th May——

A low pressure area formed in the southeast Bay of Bengal and south Andaman Sea on 23rd morning and became well marked by the same evening. A number of ships and island stations in the area reported rain. By 24th morning, heavy to very heavy rain was reported by south Bay Island stations - Kondul reported 14 cm and Car Nicobar and Nancowrie 7 cm each. The well marked low pressure area shifted north and intensfied into a deep depression by 25th morning and was centred at 0830 hrs IST near Lat. 12°N, Long. 90.5°E. The following ships' observations are of interest in this connection.

Ship/ station	Position		Time IST.	Wind		Weather
	Lat. °N	Long °E		Dir.	Speed Knots	
Enchmay	12.5	90.6	0530	E	25	Showers
ZCKL	12.9	91.5	1130	SE	20	Rain in sight
Port Blair			0830	S	15	

A number of ships to the south, between Lat. 5°N and 10°N reported westerly winds of speed 20/25 knots, showers and squall.

By this time, the upper winds over Port Blair veered to southerly and also strengthened considerably. They were generally S/SW 35/45 knots upto 5.4 km. The pressure departure at Port Blair was -3.9 mb. Widespread rainfall continued over the Bay Islands - Maya Bandar recording 10 cm and Nancowrie 7 cm at 0830 hrs IST on 25th.

Between the morning and evening of 25th, the deep depression moved rather rapidly northwest, intensified into a cyclonic storm and was centred at 1730 hrs IST near Lat. 13.5°N, Long. 89.5°E as may be seen from the following ships' observations at 1730 hrs IST.

Ship/ station	Position		Wind		Pressure (mb)	Weather
	Lat. °N	Long °E	Dir.	Speed Knots		
PHBH	13.7	86.2	N	20	1001.5	Cloudy
Ajanta	13.3	87.0	NW	20	1000.2	Rain in last hr.

During the subsequent 15 hours, the cyclonic storm slowed down considerably, characteristic of recurvature, and was moving northnortheastwards, It was centred at 0830 hrs IST on 26th within half a degree of Lat. 14.5°N, Long. 89.5°E as suggested by the following observations.

Ship	Position		Time IST.	Wind		Pressure (mb)	Weather
	Lat. °N	Long °E		Dir.	Speed Knots		
Ajanta	13.5	87.9	1130	NW	25	998.9	Shower in last hr.
VWPW	13.0	88.5	1130	W	25	1000.4	-do-

Continuing to move northnortheast, the cyclonic storm was centred at 0830 hrs IST of 27th near Lat. 16.5°N, Long. 90.5°E. Observations from S.S. Bangalen (Complete observations reproduced below) at 0530 hrs IST (Position 18.8°N, 91.0°E) reported easterly 37 knots, pressure 994.8 mb and heavy showers. By 1730 hrs IST the same ship (Position Lat. 17.5°N, Long. 91.7°E) reported a wind of 150°/55 knots present weather squall and a pressure of 971.3 mb suggesting that the storm had become severe and was centred near Lat. 17.0°N and Long. 91.0°E. Subsequent observations from the ship at 0530 hrs of 28th indicated winds had reached hurricane force. Between 27th morning and 28th morning the movement of the severe cyclonic storm was rather slow. It was within half a degree of Lat. 18°N, Long. 91.5°E at 0830 hrs IST on 28th.

Observations from S.S.Bengalen

Date	Time IST.	Position		Wind		Weather	Pressure (mb)	Wave height metres	Remarks
		Lat. °N	Long. °E	Dir. Deg.	Speed Knots				
26th	1800	19.9	90.4	120	33	Showers	1000.5	3	
27th	0000	18.8	91.0	090	37	Heavy showers	994.8	3-4	
	0600	17.8	91.6	090	44	Squalls,rain	985.5	5	
	1200	17.5	91.7	150	55	Squalls	971.3	6	From 1400-2400 GMT - Moderate and heavy rain showers from time to time.
28th	0000	17.1	91.8	200	64	Heavy showers	984.1	9½	From 0000-0800 GMT - Moderate and heavy rain showers from time to time.
	0600	17.0	91.0	240	60	Heavy showers	994.5	9½	
	1200	16.5	90.6	210	30	Showers in last hour	997.5	6	
	1800	15.4	90.5	220	26	Cloudy	1001.3	5	

Subsequently the severe cyclonic storm moved rapidly in a more or less northerly direction and crossed the East Pakistan coast over Chittagong during the night of 28th.

The following observations from M.V. Wartenfels which left Chittagong at 1400 hrs on 28th and ran into the storm, clearly indicate that the severe cyclonic storm was a fully mature one with an eye and a ring of hurricane winds. The calm condition was reported by the ship for 20 minutes. The lowest pressure recorded by the ship was 919.9 mb (nearly 82 mb below normal). The pressure fell by 33mb in one hour and by 19 mb during the next 15 minutes till the eye moved across the ship.

Observations from M.V. Wartenfels

Date	Time IST.	Wind		Pressure (mbs)	Sea
		Dir.	Speed Knots		
28/5	1700	ENE	25	986.5	Rough
	1800	ENE	35	980.8	Rough

Date	Time IST.	Wind Dir.	Wind Speed Knots	Pressure (mbs)	Sea
	1900	E	50	976.6	Very rough
	2000	E	70	971.9	Very rough
	2100	E	70	938.5	Enormous
	2115	Var	2-5	919.9	Enormous
	(This lasted for about 20 minutes)				
	2200	W	70	946.5	Enormous
	2300	W	60	971.9	Enormous
29/5	0000	W	50	981.2	Very rough
	0100	SW	45	989.2	Very rough
	0400	SW	20	993.2	Very rough
	0500	SW	25	994.5	High swell

Unfortunately positions of the ship at various times are not available. Even assuming a relative speed of 20 knots between the ship and the storm, a fall of 19 mb in 15 minutes indicate a gradient of 4 mbs per mile close to the eye and 1.5 mb per mile a little further away.

M.V.Innesmoor which was berthed at Chittagong (Observations reproduced below) reported an estimated maximum wind of 90 knots. Winds at Chittagong were estimated at 130 knots. From the observations of this ship, it is seen that the centre of storm passed over Chittagong port between 2000 to 2100 GMT.

Observations from M.V.Innesmoor berthed at Chittagong Port.
(Reproduced from the Marine Observer - 1964 pp 57-59)

28th May

0900 GMT : Wind increasing. Now southeast, force 7. Torrential rain for 15-20 minutes. Then sky cleared. From this time onwards, all work in the port ceased.

1200 GMT : Wind freshening again with increasing cloud.

1500 GMT : Wind southeast, force 6, showers of rain in past hour.

1800 GMT : Wind now northeast, force 9, accompanied by torrential rain. Barograph falling rapidly. Tide was high at this time and spray began to blow the deck. A number of small boats were adrift in the river and tugs steaming into wind.

1900 GMT : Wind east by north, force 12, torrential rain.

2000 GMT : Wind southeasterly in excess of force 12. Torrential rain reducing visibility to about 220 yds.

2100 GMT : Wind south by west, estimated at about 90 kts. Torrential rain. Visibility only about 50 yds. Heavy seas covering decks, and spray rising to 30-50 ft. Extensive damage to building. Whole port in darkness due to power failure. Vessel straining to all available moorings; damage to quay extensive. Slight rise in barograph now noted.

2200 GMT : Wind southwest by west, estimated at 85 knots. Torrential rain with 220 yds visibility.

2300 GMT : Wind southwest by west, force 12. Rain moderate continuous visibility improving to 2200 yds.

29th May.

0000 GMT : Wind southwest by west, force 9, very squally continuous heavy rain. Visibility now $2\frac{1}{2}$ miles. Barometer began to rise quickly.

0300 GMT : Wind westsouthwest, force 6, Slight drizzle. Visibility over 5 miles.

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After crossing the coast, the severe cyclonic storm weakened rapidly into a deep depression and lay over south Assam and adjoining East Pakistan with centre at 0830 hrs of 29th near Agartala. At Agartala, the surface wind attained a peak of 35 kts gusting to 40 knots. The lowest pressure recorded at Agartala was 986.4 mb at 0600 hrs. By the same evening, it weakened further into a well marked low pressure area and lay over Assam abd broke up against Assam-Himalayas by the next day.

Extracts from the press report of an eye witness account of Chittagong, as appeared in the "Hindustan Standard" of 1/6/1963 are given below:

> "At about 10 PM we heard a howling sound coming from the direction of Bay. An hour later the cyclone struck with blinding rage. Roofs flew like paper sheets and people groping in darkness wind in horror. Electric and water supply broke down. The worst time when it seemed that death was wrecking in destruction was between 1.30 AM and 4.30 AM"

A staff correspondent of an English daily in Dacca who toured Cox's Bazar reported as follows:

> "Cyclone came at 10 PM with booming sound from the sea. Angry winds reached in howling like thousand cannons. Hands went up in prayers. It seemed dooms-day was here. The cyclone battered the coastal town for nearly eight hours at 120 mph. An eye witness said that the worst fury was between 1.30 AM and 4.30 AM".

According to press reports, Akyab was flooded and hundreds made homeless by tidal wave caused by the severe cyclone. Patanga Air Port of Chittagong was submerged under five feet of water and four ocean-going ships in Chittagong harbour broke their moorings and were grounded. Severe loss of life and property were caused in the coastal districts and off-shore islands of East Pakistan. According to press reports, there was a death toll of 10,000 with three lakhs of people rendered homelss in East Pakistan. The cyclone also caused heavy damage in Tripura state.

Following heavy to very heavy rainfall caused by the waakening cyclonic storm, the Brahmaputra with all its tributaries was in spate and an all weather bridge over Dikrong river was washed away by flood waters.

4 Deep depression in the Bay of Bengal——
——6th to 8th June——

On the evening of 4th June, a well marked cyclonic circulation developed over central and north Bay between 1.5 and 5.0 km. On 5th morning the circulation extended from the surface to 6 km a.s.l. and at 700 mb level the circulation was quite marked. During this period the westerlies in the lower troposphere south of Lat. 15°N from southeast Arabian Sea to Andaman Sea began to strengthen and on 5th (morning and evening) they were on an average 30 to 40 knots, with a few stations in the south Peninsula reporting as high as 50 knots.

By 6th morning, the well marked circulation developed into a depression with its centre at 0830 hrs near Lat. 19.5°N, Long. 88.5°E. The observations from S.S.Jag Tara on this day are relevant in this connection:

Time IST.	Position		Wind		Pressure (mb)	Weather	Cloud
	Lat. °N	Long °E	Dir. Deg.	Speed Knots			
1130	19.6	87.7	350	13	997.8	Overcast, rain	6/8 Cb
1730	19.1	87.4	280	5	997.0	Past weather shower	
2330	18.5	87.1	240	18	1000.0	Cloudy	2/8 Cb

Under the influence of the depression the monsoon current strengthened in east central Bay and started to advance into northeast Bay, with the result tha the winds of speed 30/35 knots and high waves were reported from the area and the pressure gradient was also about 2.5 mb per 100 km in the northeast and central Bay. Observations from S.S.State of Travancore-Cochin in the east central Bay are of interest and are reproduced below:

Date	Time IST.	Position		Wind		Weather	Wave		
		Lat. °N	Long °E	Direction Degrees	Speed Knots		Dirn. Deg.	Period Second	Height metres
5/6	1730	18.2	92.0	160	37	Drizzle, Overcast	180	12	4
6/6	0530	16.6	93.2	180	30	Overcast skies	200	12	4

Moving in a northnortheasterly direction at an average speed of about 20 kmph, the depression was centred near Lat. 21°N, Long. 89°E at 1730 hrs of 6th. At this time the upper winds over Calcutta below 4.0 km were 25/30 kt. Sandheads which was closest to the centre reported a pressure of 992.7 mb which was 5.5 mb below normal. At this time the 24 hours pressure changes over coastal Bengal were about 3 mb.

During the course of the night, the depression deepened while approachin the coast and crossed the Sunderbans coast near Long. 89°E during the early hours of 7th June.

At 0830 hrs IST of 7th, the deep depression was centred near Satkhira in East Pakistan.

Continuing to move in a northerly direction, the deep depression was centred just east of Bogra at 1730 hrs, when Bogra reported a surface pressure of 990.6 mb (8 mb below normal), northerly winds of 20 knots and moderate continuous rain. 7 cm of rain had already fallen at Bogra.

During the subsequent 15 hours, the depression while continuing to move in a northerly direction was considerably retarded and it also weakened. At 0830 hrs of 8th, it was centred between Rangpur and Tura. Subsequently it moved in a northeasterly direction and rapidly weakened into a trough over west Assam by the same evening.

The depression helped the southwest monsoon to advance into the north Bay of Bengal and practically the whole of northeast India. Very heavy rainfall

was reported from Sub-Himalayan West Bengal and Assam, between 7th and 10th. Som significant amounts of rainfall in cm are : Tura 22 on 8th and Cherrapunji 40 on 9th and 51 on 10th.

5 Depression in the Bay of Bengal—
—24th to 26th June—

A trough of low pressure was lying over lower Burma and Gulf of Martaba on 22nd and a low pressure area formed over the Gulf of Martaban and adjoining no Andaman Sea on 23rd morning. The winds reported by ships in the south Bay of Ben gal also strengthened to 25 to 35 knots by 23rd morning. Under the influence of the above development, fairly widespread rain or thundershowers with some heavy to very heavy falls were reported along coastal Burma on 22nd and over north Bay Islands on 23rd morning. Port Blair recorded 15.7 cm of rain and Long Island 14.3 cm on 23rd morning.

The low pressure area ooncentrated into a depression on 24th morning an was centred at 0830 hrs IST near Lat. 15.0°N, Long. 95.0°E. The upper air circulation extended from surface to about 7 km. The surface pressure gradients and lower tropospheric winds were considerably stronger in the southern side of the depression than in the north. The depression moved in a westnorthwesterly direction and was centred near Lat. 15.5°N, Long. 93.5°E by 24th evening.

During the next 15 hours, the depression moved in a northwesterly direction. It was centred near Lat. 17°N, Long. 92?E at 0830 hrs of 25th and near Lat. 17.5°N, Long. 90.5°E at 1730 hrs. The following observations from ship JXKD on this day are relevant:

Time IST.	Position		Wind		Pressure (mb)	Cloud
	Lat. °N	Long °E	Direction	Speed Knots		
1130	18.6	92.0	E	25	999.0	3/8 Cb
1730	17.5	92.5	SE	20	1001.5	

For the next twelve hours, the depression moved quite rapidly towards Orissa coast with an average speed of about 30 km per hour and was centred at 083(hrs IST of 26th near Lat. 19.0°N, Long. 86.0°E off the south Orissa coast. The following observations from S.S.Indian Resource (Call sig: VWDK) close to the centre of the depression are useful to uniquely determine the centre of the depression:

Time IST.	Position		Wind		Weather	Pressure (mb)
	Lat. °N	Long °E	Direction Degrees	Speed Knots		
26th June						
0530	19.0	86.3	290	18	Overcast	1000.4
0700	19.1	86.4	050	24	Partly cloudy	1000.0
0800	19.5	86.8	140	17	Partly cloudy	1001.8

Even with the depression so near the coast 24 hours pressure changes along Orissa coast on 26th morning was generally rising except at Gopalpur and

Puri where the fall was 0.2 and 0.9 mb respectively. Similarly the pressure departures were generally positive along Orissa-West Bengal coast.

By 1730 hrs of 26th June, the depression was crossing coast between Gopalpur and Calingapatam. Thereafter it weakened into a low pressure area while moving in a westnorthwesterly direction.

6 Depression in the Bay of Bengal—
—4th to 6th July—

On the morning of 3rd July, a low pressure area formed over head Bay of Bengal, which intensified into a depression by the next morning (4th) and was centred at 0830 hrs IST near Lat. 22.0°N, Long. 89.5°E. At this time, the upper wind over Chittagong were southeasterly 20/25 knots upto 1.0 km and the pressure departure near the centre of the depression was about 7.0 mb. The depression moved in an almost westerly direction and was just south of Calcutta by the evening and at 0830 hrs IST of 5th near Contai. Moving westwards, the depression was centred nea Lat. 22.5°N, Long. 86.0°E, south of Jamshedpur on 5th evening. Thereafter, it moved in westnorthwesterly direction and was weakening. It was centred 50 km to the west of Ambikapur at 0830 hrs IST of 6th. During the subsequent 24 hours, it weakened into a low pressure area and merged into the seasonal trough over extreme northwest Madhya Pradesh.

The depression caused well distributed rainfall in Gangetic West Bengal, Orissa, Bihar Plateau and Madhya Pradesh between 4th and 8th July.

7 Depression from the Bay of Bengal—
—9th to 14th August—

On 7th August, the seasonal monsoon trough was extending into northeast Bay of Bengal and on 8th morning a well marked low pressure area developed over north Bay with associated cyclonic circulation extending to 4.0 km a.s.l.

By 9th morning, the well marked low pressure area intensified into a depression and was centred at 0830 hrs IST near Lat. 20°N, Long. 89°E. Upper winds over Chittagong were SE/S 25/30 knots upto 2.1 km a.s.l. In association with the formation of the depression monsoon strengthened over central and adjoining north Bay of Bengal, where ships reported winds of speed 25 to 35 knots. The negative pressure departure at the centre of the depression was about 7 to 8 mb. The depression was centred at 1730 hrs IST of 9th close to coast near Balasore.

Moving in a northwesterly direction and crossing the coast during the night between Balasore and Contai, the depression was centred near Chakulia on 10th morning. Fairly widespread rainfall occurred in West Bengal, Orissa and Madhya Pradesh with a few heavy to very heavy falls in north Orissa, Cuttack repor ing 25 cm at 0830 hrs IST of 10th. On this day, the circulation extended upto 7.0 km. The monsoon continued to be strong to vigorous in north Bay.

Moving in a westnorthwesterly direction, the depression was successively centred about 70 km east of Ambikapur on 11th morning and between Jhansi and Nowgong on 12th morning. Fairly extensive rainfall occurred to the south of the track on these days with heavy to very heavy falls in north Madhya Pradesh. The following are some of the noteworthy amounts of rainfall in cm - Champa 26.0 and Mandla 11.0 on 11th and Ratlam 13.1, Bhilwara 12.0 and Pachmarhi 10.1 on 12th. A number of state raingauge stations also recorded rainfall exceeding 10 cm.

On these two days in the lower level, below 2.0 km a.s.l., both easterlies and westerlies away from the depression centre were equally strong, reaching 40 - 50 knots.

Subsequently the depression took a northwesterly course and was centred east of Alwar on 13th morning and about 100 km west of Delhi on 14th morning. Thi change in course was accompanied by a shift of rainfall area to the right of the depression track and fairly widespread moderate to heavy rain occurred in west Uttar Pradesh, Himachal Pradesh and adjoining Punjab (I) and Rajasthan - Hissar reported 7.2 cm of rain on 13th morning and 7.7 cm on 14th morning.

During the next 24 hours the depression weakened into a low pressure area over south Punjab and adjoining Rajasthan.

The estimated lowest pressure and the corresponding negative departure from normal during the life period of the depression was 991 mb and about 7-8 mb respectively on 9th at 1730 hrs.

Under the influence of the depression, the monsoon was active over the whole country. It was particularly strong in Orissa on 9th and 10th and in Uttar Pradesh and Madhya Pradesh from 11th to 14th. According to newspaper reports, mo of the rivers in Orissa and Uttar Pradesh were in spate and low lying areas were inundated following heavy rains.

8 Deep depression in the Bay of Bengal—
—8th to 15th September—

A well marked low pressure area moved into Gulf of Martaban and adjoining lower Burma on 8th morning, and concentrated into a depression with centre near Lat. 15.5°N, Long. 97.0°E at 0830 hrs IST on 8th. The circulation associate with the low pressure area extended upto 5.0 km a.s.l. The negative pressure departures over the area was about 7-8 mb and widespread moderate to heavy rainfall was reported from coastal Burma and Bay Islands - Maya Bandar reported 12 cm and Long Island 9 cm at 0830 hrs of 8th. The same evening upper winds over Bay Islan (Cocoa Island and Port Blair) were 25/35 knots from west to northwest upto 2.0 km a.s.l.

Moving in a northwesterly direction the depression was lying off Arakan coast on 9th morning at 0830 hrs IST with its centre near Lat. 18.5°N, Long. 93°E Widespread moderate to heavy rains continued over coastal Burma and Bay Islands. Ships off Arakan coast also repoted continuous rain with heavily clouded skies. On 10th morning it was centred near Lat. 19°N, Long. 91.5°E. 24 hours pressure changes of 2 to 2.5 mb fall over Sunderbans and 2 to 2.5 mb rise over north Bay Islands and coastal Burma suggested continued northwesterly movement of the depression. There was hardly any ship observation in northeast and adjoining east central Bay on this day, for locating the centre with sufficient accuracy.

Continuing to move in a northwesterly direction, the depression became deep and was centred near Lat. 20.5°N, Long. 89°E on 11th morning when four closed isobars at 2 mb interval could be drawn around the centre. The followihg observations are of interest, in this connection:

Time IST.	Ship/ Station	Position		Wind		Pressure (mb)	Weather
		Lat. °N	Long °E	Dir.	Speed Knots		
0530	S.S.Mussilloyd (PGBU)	18.2	90.4	SW	25	997.1	Drizzle during last hour
0830	Akyab			SE	15	1003.5	Drizzle
0830	Cox's Bazar			ESE	15	1000.9	Cloudy
	Sandheads			NNE	15	996.3	Rain during last hour
1130	VWKS	17.6	86.6	270	13	1001.8	Overcast -Cu and Ac

During the 24 hours ending at 0830 hrs of 11th, widespread moderate to heavy rainfall occurred in Gangetic West Bengal and east Orissa, Puri reporting 12 cm of rain.

At 1130 hrs, Tiros VII (Orbit 1240/ R/O 1239) also reported a well defined vortex at Lat. 21°N, Long. 89°E. During the course of the day, the depression moved and was centred near Lat. 20.5°N, Long. 88°E at 1730 hrs. Sandheads winds changed from northnortheasterly 15 knots at 0830 hrs to southeasterly 25 knots at 1730 hrs when it reported moderate continuous rain with a pressure of 991.6 mb which was 11.4 mb below normal.

The deep depression crossed coast between Balasore and Chandbali during the early hours of 12th and was over north Orissa on 12th morning centred slightly to the north of Keonjhargarh. Heavy to very heavy rainfall occurred in north Orissa and adjoining southeast Madhya Pradesh, Sambalpur reporting 16 cm and Phulbani 12 cm at 0830 hrs of 12th.

During the subsequent 48 hours, the deep depression moved in a westnorth westerly direction and was centred near Champa on 13th morning and a little to the southeast of Jabalpur on 14th morning. The negative pressure departure at the centre even on 14th was about 10 mb. Heavy to very heavy rainfall occurred to the south of the depression track, in south Madhya Pradesh, and Vidarbha. Some noteworthy amounts reported were : On 13th Raipur 12.7, Sambalpur 11.7 cm, Raigarh 10.0 cm and Gondia 9.6 cm and on 14th Betul and Seoni 15 cm each and Chhindwara and Narsinghpur 11 cm each.

Subsequently, the deep depression recurved to the right and moved in a northnorthwesterly direction with its centre about 120 km southsoutheast of Mainpuri at 0830 hrs IST on 15th morning. Heavy to very heavy rains extended over west Uttar Pradesh and northwest Madhya Pradesh, a number of stations reporting between 10 and 21 cm on 15th morning, with Mawana (Meerut District) reporting 36.5 cm. Thereafter moving in a northerly direction, the deep depression weakened during the course of the day. By 16th, it broke up over the hills of west Uttar Pradesh and rainfall ranging from 12 to 22 cm were recorded by many stations in north west Uttar Pradesh on 16th morning. The break up of the depression was immediatel followed by the withdrawal of the monsoon from Punjab (I) and west Rajasthan.

A well marked low in the middle latitude westerlies moving across Russia Turkistan and adjoining areas developed a large amplitude trough in the upper troposphere on 13th. On 14th evening, the trough axis was running along Long. 78°N to Gujarat region. The recurvature of the deep depression apparently took place under the influence of this middle latitude trough.

The estimated lowest pressure and the corresponding negative departure from normal during the life period of the depression was 990 mb and about 13 mb respectively at 1730 hrs IST of 11th.

In association with the formation and movement of the deep depression, heavy rain was reported from the Bay Islands between 5th and 9th and the monsoon activity increased over Gangetic West Bengal and Orissa on 11th and 12th over Madhya Pradesh from 12th to 14th, Uttar Pradesh on 15th and 16th and in Punjab (I) on 16th. These heavy rains in the catchment areas led to the flooding in the major rivers of Orissa, west Uttar Pradesh and Punjab (I) with consequent damage to standing crops and public property and loss of life. The floods were serious in western parts of Uttar Pradesh, where over 200 people were reported to have lost their lives. More than 50 lakh of people in nearly 16,000 villages were affected and over 6 lakh of houses were damaged or destroyed.

9 Deep depression in the Bay of Bengal—
—25th to 28th September—

A well marked low pressure area moved from the east into north Andaman Sea and Gulf of Martaban on the evening of 24th. The circulation was well marked between 1.5 and 4.5 km a.s.l. Moving in a northwesterly direction, it developed into a depression on 25th morning and was centred at 0830 hrs IST near Lat. 17°N, Long. 92.5°E. Tiros VII (Orbit 1444 R/O 1443) also reported a vortex near Lat. 17°N, Long. 91.5°E on 25th -0118 GMT. During the 24 hours period ending at 0830 hrs IST of 25th, rainfall increased in the Bay Islands, Car Nicobar reporting 7 c Ships in the south Bay of Bengal and south Andaman Sea reported westerlies of spe 20/25 knots with rain and thundershowers. By 25th evening upper winds over Port Blair strengthened to 25/30 knots upto 1.0 km a.s.l. Moving in a northwesterly direction, the depression was centred near Lat. 19.5°N, Long. 89°E on 26th mornin at 0830 hrs IST. The followibg observations are relevant in this connection:

Time of Obsn IST	Ship/ Station	Position Lat. °N	Position Long °E	Wind Dir.	Wind Speed Knots	Pressure (mb)	Weather	Wave Height metres
26th Sept.								
0530	Barpeta-GWLD	21.2	90.3	100	27	1003.2	Rain	3
0530	Ocean Envoy - AQBT	18.4	88.0	270	13	1001.0	Thunderstorm	
0530	Rustom	19.6	90.2	SSE	10	994.0		
0830	Sandheads			NNE	10	1006.0	Rain	
1130	AQEV	18.6	89.6	200	13		Drizzle	

By the evening, the depression became deep and was centred about 70 km southwest of Sandheads which reported eastsoutheasterly winds of speed 30 knots and a pressure of 998.7 mb which was 7.3 mb below normal. The pressure fell at the station by over 5.0 mb during the preceding 24 hours.

The deep depression crossed north Orissa coast to the south of Balasore during the early hours of 27th and lay over north Orissa and neighbourhood with i centre about 100 km west of Balasore at 0830 hrs IST of 27th. Heavy to very heav rain had fallen along coastal Orissa, Chandbali reporting 19 cm.

Subsequently the deep depression moved in a more or less northerly dire tion and weakened into a depression. By 28th morning (0830 hrs IST), it was lyin over south Bihar centred about 50 km east of Ranchi. While moving across Bihar Plateau, the depression weakened further and on 29th morning it lay as a low pres sure area over Bihar Plains. Subsequently, it weakened further and became unim portant.

During its movement across Bihar, the depression caused widespread rain fall in Bihar and West Bengal for two days with some very heavy falls in Bihar and north Bengal. Hazaribagh and Ranchi recorded 17 cm each on 28th morning and Dar jeeling and Siliguri 15 cm each on 29th morning.

The estimated lowest pressure and the corresponding negative departure from normal during the life period of the depression was 996 mb and about 10 mb respectively at 1730 hrs IST of 26th September. At least 15 persons were reported to have lost their lives and serious damage was caused to standing crops and pub lic property in Orissa due to the heavy rains caused by the deep depression.

10 Depression in the Bay of Bengal—
—5th to 7th October—

A well marked low pressure area moving from the east emerged into the Gulf of Martaban and north Andaman Sea on the morning of 4th October. Moving northwestwards into the east central Bay of Bengal off Arakan coast it concentrated into a depression with centre near Lat. 18°N, Long. 92°E at 0830 hrs IST of 5th. It continued to move in a northwesterly direction and was centred within half-a-degree of Lat. 21°N, Long. 90°E, at 0830 hrs IST of 6th.

During the course of the day, the depression remained practically stationary. Chittagong upper winds on the evening were southeasterly 35/40 knots upto 2 km. Thereafter the depression recurved and on 7th morning at 0830 hrs it was close to East Pakistan coast near Lat. 22.5°N, Long. 91°E. Chittagong reported a surface wind of southeasterly - 30 knots at this time. Widespread heavy to very heavy rains had fallen along East Pakistan coast, Barisal reporting 19 cm 7th morning.

Moving in a northeasterly direction, the depression crossed East Pakistan coast in the course of the day and was centred at 1730 hrs IST near Agartala. Thereafter, the depression weakened rapidly and broke up against the hills of south Assam by 8th morning, after causing heavy to very heavy falls of rain in south Assam. The noteworthy amounts on 8th were : Silchar 16 cm, Agartala 15 cm, Haflong 10 cm and Imphal 9 cm.

The lowest estimated central pressure in this disturbance was 995 mb at 1430 hrs IST of 7th.

The following account of weather at Agartala on 7th October 1963 (reproduced from notes and news portion of Indian Journal of Meteorology and Geophysics, Jan. 1964) is of interest:

> ".....the sky conditions at Agartala gradually deteriorated and there was continuous rain from the evening of 6th which became heavy from 7th morning. High winds and rain-squalls raged from 1100 IST reducing surface visibility to less than 1000 m. Wind speed gradually increased and attained its peak value of 45 to 55 knots in gusts at 1330 hrs IST (from northnortheast).
>
> Total rainfall recorded at Agartala Airport in association with the depression was 167 mm. The barometric pressure fell by about 9 mb between 0900 to 1400 hrs IST of 7th, the lowest value being 995 mb at 1430 hrs IST....."

According to press reports, the depression accompanied by heavy rains lashed several sub-divisions of Tripura State and caused inundation of low lying areas and disruption of telecommunication and air services. Low lying areas in Agartala town and in Kailashar were under waist deep water for a day or two due to incessant rains and floods. Widespread damage and some loss of life were also reported from coastal districts of East Pakistan.

11 Cyclonic Storm in the Arabian Sea—
—13th to 17th October—

With the weakening of the previous depression over Assam and East Pakistan on 8th October, the seasonal trough shifted southwards and on 10th morning it extended from east central Arabian Sea to central Bay of Bengal. The trough was well marked and it was noticeable in the upper air upto 6 km a.s.l. An upper air low embedded in the trough moved westwards from central Bay to west Mysore, Kanara and adjoining south Konkan coast across north Madras State between 10th and 12th and caused an increase of rainfall over the Peninsula.

Apparently under the influence of the upper air low, the surface trough became well marked off Kanara coast on 12th morning; and a well marked low pressure area formed off south Konkan coast by the evening when a number of ships and coastal stations in the area reported continuous rain at 1730 hrs. During the next 24 hours, the low pressure area moved northwest and concentrated into a depression by the evening of 13th, when it was centred near Lat. 17.5°N, Long. 70.5° S.S.Saudi on voyage from Aden to Bombay reported at 0900 GMT of 13th northerly winds of 13 knots at Lat. 18.1°N, Long. 69.6°E. Subsequent observations from the ship showed a veering of the wind to southeasterly 18 knots by 1800 GMT when the ship's position was at Lat. 18.6°N, Long. 71.5°E. The ship enabled to fix the centre of the depression on 13th evening fairly acuurately. From the available ship's observations, the maximum wind in the circulation was noticed to be about 20/25 knots. The sea surface temperature readings over this area were 28-29°C ar slightly higher than air temperatures - conditions favourable for storm formation

The depression became deep and was centred near Lat. 17.5°N, Long. 69.C at 0830 hrs IST of 14th. It further intensified into a storm by about mid-day as inferred from the following observations from S.S.Indian Resource which was close to the centre on this morning.

Observations from S.S.Indian Resource

Time of Obsn. IST	Position Lat. °N	Position Long °E	Wind Dir. Deg.	Wind Speed Knots	Pressure (mb)	Weather
14th October						
0530	17.9	68.5	100	9	1005.6	Past Weather - Showers
0830	18.1	69.6	130	30	1008.4	Cloudy
1130	18.2	69.9	140	37	1009.9	Cloudy

For the next two days, the cyclonic storm moved more or less in a northerly direction and was successively centred near Lat. 19.5°N, Long. 68.5°E and Lat. 22.0°N, Long. 68.5°E on the morning (0830 hrs IST) of 15th and 16th respectively. Between 0900 and 1200 GMT of 15th, S.S.Safina-e-Arab (AQVA) which was within one degree of the centre of the storm reported winds of speed 30/35 knots. As the cyclonic storm moved north, surface winds at Veraval gradually veered and strengthened from 110°-19 knots at 0830 hrs IST of 15th to 150°-30 knots by the mid-night of the same day. On the 16th, at 0830 hrs with the centre of the storm about one degree to the southwest, Dwarka reported southeasterly winds of 25 knot and a pressure of 1008.4 mb which was 4.0 mb below normal. However, surface wind at Karachi reached upto 40 knots from east during the afternoon of 16th.

The weakening of the low level upper winds at Bhuj during the course of 16th, and a rise of pressure over Kutch, Saurashtra and lower Sind on 17th was suggestive of a change in the track of the storm to the west after 16th morning and a probable weakening.

At 0630 hrs IST of 17th, S.S.Volsella (Lat. 20°57'N, Long. 68.0°E) reported southwesterly winds of speed 25 knots and a pressure of 999.5 mb. At 0830 hrs IST Dwarka reported southeasterly 15 kt while morning upper winds over Bhuj and Jamnagar were southeast/south 15/25 knots upto 3.0 km. The storm was centred within half-a-degree of Lat. 22°N, Long. 67.5°E at 0830 hrs on this day. By the same evening the storm had apparently weakened into a depression while moving in a westnorthwesterly direction. Ship GKDS (Lat. 22.2°N, Long. 65.3°E) reported at 1730 hrs IST a northerly wind of 20 knots and rain at a distance with a pressure of 999.0 mb (which was probably rather too low).

On 18th, there were practically no ships' observations from northwest Arabian Sea. Coastal observations suggested that the depression was weakening further while moving westnorthwestards. By 19th morning it became unimportant.

In association with the northward movement of the storm, thunderstorm activity extended northwards to north Maharashtra, Gujarat State, south Rajasthan and west Madhya Pradesh.

12 Severe Cyclonic Storm in the Bay of Bengal—
—19th to 24th October—

The seasonal trough was active extending from southwest Bay of Bengal to Phillipines Sea. A well marked low pressure area formed over Andaman Sea on 18th. Pressures were falling over Andaman Sea by 1.5 to 2.0 mb on the evening of 18th. It was also accompanied by an increase in rainfall over the Bay Islands. Ships over the south Bay of Bengal and south Andaman Sea reported westerly winds of speed 15/20 knots with overcast skies, rain and showers.

The low pressure area moved westwards and concentrated into a depression on 19th morning with centre at 0830 hrs IST within one degree of Lat. 10°N, Long. 90°E. Moving in an almost westerly direction, the depression became deep and was within half-a-degree of Lat. 10°N, Long. 84.5°E at 0830 hrs IST of 20th. By the afternoon of the same day winds in the field increased to over 30 knots. The deep depression intensified into a cyclonic storm and was centred at 1730 hrs IST within half-a-degree of Lat. 10.5°N, Long. 82.5°E. The following observations are of interst in this connection.

Time of Obsn. GMT	Position Lat. °N	Long °E	Wind Dir. Deg.	Speed Knots	Weather	Pressure Actual (mb)	fall (mb) during 3 hrs.	Wave Ht. ft.
20th October								
					State of Madras			
0600	9.5	83.9	280	30	Heavy continuous rain	1005.9	-	10
0900	9.7	83.1	270	30	Drizzle and heavy rain	1001.0	3.1 falling	8
1200	9.9	82.7	270	37	Moderate continuous rain	999.7	2.0 falling	14
					Indian Skipper			
1200	13.6	80.6	NE	35	Showers	1005.3	-	-
					S a f i n a			
1200	10.0	84.0	SW	25	-	-	-	-

During the next 6 hours, the cyclonic storm intensified further and became severe as inferred from the observations from State of Madras which reported winds of speed 45 knots at 2330 hrs on 20th October.

Time GMT.	Ship	Position Lat. °N	Long °E	Wind Dir. Deg.	Speed Knots	Pressure (mb)	Weather	Wave ht. ft.
1800	State of Madras	9.8	81.6	210	45	1003.4	Heavy rain	15
	City of Swansea	9.5	81.1	300	44	999.8	Rain	8

These observations would suggest that the severe cyclonic storm was nea Lat. 10.5°N, Long. 81°E at 2330 hrs IST of 20th. Subsequently it took a northwes terly course and was about 50 km southeast of Cuddalore at 0830 hrs IST of 21st. It crossed the coast between Pondicherry and Cuddalore near noon time.

City of Swansea which was coming to Madras from south had recorded hour or two hourly observations between 1430 GMT of 20th to 0830 GMT of 22nd. The max mum wind speed reported by the ship was B.F. 12 and minimum pressure 29.40" (995. mb). Observations from City of Swansea suggest that the severe storm had a core of hurricane winds. Observations from City of Swansea and State of Madras also show that the sea waters in the storm area was 2 to 4°C warmer than the air.

Shri.G. Natarajan, Assistant Meteorologist, who toured the coastal area has concluded from the various reports collected by him, that the storm had a cal "eye". The observatory at Cuddalore reported a lull between 1050 and 1140 hrs IS Cuddalore also recorded the lowest pressure of 984.2 mb at 1120 hrs. This was th lowest pressure recorded in the field of the storm. From a study of the damage done by the cyclone in Pondicherry and in the eastern parts of south Arcot Distri Shri.Natarajan has inferred that the maximum wind in the field of the storm at th time it crossed the coast was probably of the order of 80 knots, exceeding 100 kt in gusts.

After crossing coast, it lay as a cyclonic storm over Madras State with its centre about 50 km southeast of Vellore at 1730 hrs IST of 21st. By the next morning, it weakened into a deep depression over Mysore State with its Centre abo 100 km east of Chitaldurg at 0830 hrs and about 70 km north of Chitaldurg at 1730 hrs. On the 23rd morning it weakened further as a depression over north Mysore State and was centred about 100 km southwest of Raichur. Thereafter it moved in a northeasterly direction and was centred between Bidar and Hyderabad on 24th mor ing. The recurvature of the storm took place under the influence of a well marke trough in westerlies which moved across northern India between 22nd and 24th. By 25th morning, it weakened in to a well marked low pressure area over Telangana an adjoining areas.

In association with the movement of the storm, widespread rainfall with a few heavy falls commenced over Madras State and Andhra coast on 20th. Later by 22nd, it extended to whole of the Peninsula, The heaviest rainfall of 24 cm alon the Madras coast was recorded at Nagapattinam on 21st morning. Heavy to very hea falls were recorded by a number of stations in coastal Andhra Pradesh and coastal Orissa between 22nd and 24th although the area was not in the immediate field of circulation of the storm. Some of the noteworthy amounts are - 22nd October - Vishakhapatnam 13 cm; 23 October Gopalpur 16 cm, Puri 15 cm and Kakinada 13 cm an 24th October - Gopalpur 13 cm and Vishakhapatnam 11 cm. Heavy rainfall also exte ded to northeast India.

According to press reports, the strong winds and heavy rains associated with the severe cyclonic storm caused serious disruption of telecommunications, rail and air services in Madras State. S.S.Bharatbir ran aground near Thiruvotti yur (near Madras) on 21st evening. The heavy rain also led to serious floods and caused disruption of traffic and damage to standing crops in Andhra Pradesh and Orissa. In coastal Andhra Pradesh train services had to be suspended between Vis khapatnam and Vijayawada as the track was inundated at several points. Extensive damage to paddy crops and houses was reported from six coastal districts of Andhr Pradesh. Thousands of acres with paddy crop in low lying areas were submerged. In Krishna district some loss of life was reported. Eluru, Headquarters of West Godavari district, was under five feet of water and about fifty thousand persons were removed to safe places. Traffic to neighbouring areas was interrupted and ammonium sulphate worth seventy thousand rupees was washed away.

13 Depression in the Bay of Bengal—
—24th to 26th October—

A low pressure area from Malaysia moved in a westerly direction across the Malacca Straits into south Andaman Sea between 21st and 23rd. There was a general fall of pressure (24 hours pressure change) of about 1.5 to 2.0 mb over Bay Islands on 23rd evening as well as on 24th morning. There was also an increas in rainfall over the Bay Islands during the 24 hours period ending at 0830 hrs of 24th.

The low pressure area moved northwestwards across the chain of islands and apparently concentrated into a depression on 24th morning with its centre at 0830 hrs within half-a-degree of Lat. 10.5°N, Long. 91.5°E. Mid-day upper winds over Port Blair were ESE/SE speed about 30 knots upto 1.0 km. Tiros VII also reported a well defined cloud vortex near Lat. 11°N, Long. 91.5°E in its pass No. 1874 (0551 GMT).

During the next 24 hours Port Blair winds gradually veered and on 25th morning they were mainly westsouthwesterly speed ranging from 30 to 45 knots between 1.0 and 3.0 km. Pressure began to rise over Nicobars by 24th evening, the tendencies extending northwards on 25th morning. These suggested a northward movement of the depression. On 25th morning, the depression was centred within a degree of Lat. 15°N, Long. 91°E. Judged from the strength of low level upper wind over the Bay Islands, the depression was probably deep.

Later, the depression recurved to northeast. On 25th evening ship S.S.Jalamani (Position Lat. 15.5°N, Long. 92.0°E) reported westnorthwesterly winds of speed 20 knots. The depression was centred near Lat. 17.0°N, Long. 92.5°E. During the course of the night the depression crossed Arakan coast and by 26th morning weakened over deltaic Burma.

In association with the depression, Bay Islands experienced a spell of moderate rainfall.

14 Severe Cyclonic Storm in the Bay of Bengal—
—26th to 27th October—

The remnants of the severe cyclonic storm which crossed Madras coast near Cuddalore on 21st and weakened, lay over Telangana as a well marked low pressure area on 25th morning. This low pressure area moved eastwards across north Andhra coast and emerged into northwest and adjoining west central Bay of Bengal on 26th morning. With a favourable superposition over the low, by a moving upper trough in westerlies, the low very rapidly intensified into a severe cyclonic stor with a core of hurricane winds and was centred at noon near Lat. 18.5°N, Long. 86° But for the following two observations from Canada Mail, it would not have been possible to judge the severity of the storm.

i 0430 GMT. Position 18.24°N, 85.50°E. Winds northwest 80 to 100 m.p.h. Barometer 995.0 mb dropping 16 mb per hour.

ii Northwest winds 80 to 100 m.p.h. from 0430 to 0630 hrs GMT. At 1030 hrs GMT winds northerly force 7 with gusts to force 10. Bar. 1000 mb and rising. Winds veering and abating (Position not reported at this hour).

The following other ships' reports are also relevant in this connection:

Date	Time GMT.	Ship	Position Lat. °N	Position Long °E	Wind Dir.	Wind Speed Knots	Weather	Pressure (mb)
26th	0600	Wikki (GODM)	17.3	86.5	SSW	30/35 mph	Heavy rain- squall	1003.0
	0600	Malaja (GDHQ)	17.4	86.6	W	40		

However, the most interesting report was from M.V.Jaladuhita which was quite close to Canada Mail reported the following observations:

Time GMT.	Position Lat. °N	Position Long °E	Wind Dir. Deg.	Wind Speed Knots	Weather	Pressure (mb)
0000	18.6	85.8	210	13	Cloudy	1002.9
0600	19.8	87.2	040	13	Rain and drizzle	1003.6

The observations from Canada Mail along with Jala Duhita would suggest that the winds of hurricane force were confined to a very narrow area and the sev ere cyclonic storm was one probably of mesoscale. Later also there was no eviden that the storm was one of severe intensity. It is also of interst to note that Tiros VII (Orbit 1911 R/0 1904 at 0637 GMT) reported only a possible circulation centre at 19°N, 85°E.

Being under the influence of strong upper westerlies the severe cycloni storm moved rapidly eastnortheastwards and was centred at 1730 hrs within half-a-degree of Lat. 19.5°N, Long. 90.0°E. At this time, the cyclonic circulation was noticed only upto 2.1 km; perhaps at this stage the severe storm had weakened int a storm.

Continuing to move in a easterly direction, the cyclonic storm was centred at 0830 hrs IST on 27th near Lat. 19.5°N, Long. 92.0°E. The following obser vations are relevant in this connection:

Ship/ Station	Position Lat. °N	Position Long °E	Time IST.	Wind Dir. Deg.	Wind Speed Knots	Weather
S.S.Rutherevett	19.4	92.2	0530	SE	30	Shower and rain
AQLY	17.5	89.1	0530	W	15	
Akyab			0830	E	30	Continuous rain
S.S.Rutherevert	19.0	92.0	1130	N	20	Overcast

The negative pressure departure along Arakan-Chittagong coast on this morning was 8-9 mb. The 24 hours change at Cox's Bazar and Akyab were about -5 m This suggested a further northward movement. By 1730 hrs IST, Akyab winds veered to southerly 20 knots and the storm had apparently weakened into a deep depressio

and was within half-a-degree of Lat. 20.5°N, Long. 92.5°E. It crossed coast during the night, north of Akyab and rapidly weakened into a low pressure area over central Burma on 28th morning. It caused widespread heavy rain over Burma.

The lowest central pressure of 995.0 mb during the life of the storm wa reported by Canada Mail at 1000 hrs IST on 26th and the corresponding negative pressure deficiency will be of the order of 17 mb.

15 Depression in the Arabian Sea—
—24th to 25th November—

Under the influence of an eastward moving upper westerly trough, a well marked low pressure area formed over northwest and adjoining northeast Arabian Se on the evening of 23rd. During the next 12 hours, it concentrated into a depression without any appreciable movement and was centred at 0830 hrs IST of 24th wi in half-a-degree of Lat. 22.5°N, Long. 63.5°E. It moved in an easterly direction and was centred near Lat. 22.5°N, Long. 65.5°E by the evening. At this time, shi in northwest Arabian Sea about 3 to 4 degrees dup west of depression centre repor ted northerly winds of speed 20/25 knots with skies partly covered with Cu and Sc On the 25th morning the depression was centred near Lat. 22.5°N, Long. 67.0°E. Fairly widespread moderate rain was reported on 25th morning from Saurashtra and Kutch and lower Sind. By this time the depression was probably weakening as the low level winds of Bhuj and Veraval were not affected by the circulation over nor east Arabian Sea.

By the evening, the upper westerly trough had overtaken the depression and moved to Sind-Gujarat. With the unfavourable superposition of the upper leve system, the depression rapidly weakened into a well marked low pressure area off Saurashtra coast. By 26th morning, it weakened into a trough without any further movement.

The depression was controlled by upper westerly trough. Probably, it was more akin to winter time intense western disturbance than a tropical system.

Under the influence of the depression, there was fairly well distribute rain over Gujarat State and adjoining areas of south Rajasthan, west Madhya Prade and north Maharashtra State between 25th and 26th, a number of stations recording 4 cm of rain.

During this period, a well marked low pressure area moved westwards across south Arabian Sea from Comorin area to extreme southwest Arabian Sea. Ships observations coupled with Tiros VII data on a few days suggest that it might have reached depression intensity at some stage. However, observations are inadequate to give more details.

16 Cyclonic Storm in the Arabian Sea—
—30th November to 7th December—

A low pressure area moving westwards across Ceylon and Comorin area lay over Laccadives and off Malabar coast on 29th morning. Minicoy recorded a rainfall of 6 cm on 29th morning. By the next morning, the low pressure area moved slightly westwards and became well marked. At this time, the pressure departure over Laccadives was about -4 mb. Between 29th evening and 30th morning, Minicoy upper winds below 3.0 km sharply changed from northwest/north to south/southwest. By noon of the same day, Minicoy upper winds strengthened to about 20 knots. By the evening, the well marked low pressure area concentrated into a depression cen tred near Lat. 9.5°N, Long. 72.0°E at 1730 hrs IST of 30th. At this time the negative pressure departure at Minicoy was 4.5 mb. It was centred near Lat. 9.5°N and Long. 70.0°E at 0830 hrs IST on 1st December.

Moving in a westnorthwesterly direction, the depression deepened by 1st December evening when it was centred within half-a-degree of Lat. 10°N, Long.68.5°E. The following observations are of interest:

Ship	Time GMT.	Position		Wind		Pressure (mb)	Weather
		Lat. °N	Long °E	Dir. Deg.	Speed Knots		
No name	1200	8.8	68.0	W	28	1002.0	Rain
PNRK	1200	8.5	67.1	NW	19	1004.8	Overcast
No name	1200	7.8	72.5	SW	20	1003.8	Heavy continuous rain
MASC	1800	8.8	69.3	WSW	20	1004.5	Rain
GVFT	1200	7.6	73.5	S	30	1005.5	Overcast

Ship 'AUSTRALIND' (Lat. 7.9°N, Long. 72.4°E) at 1730 hours IST reported very heavy rain squall. Continuing to move westnorthwestwards, the deep depression was centred at 0830 hrs IST of 2nd December within half-a-degree of Lat. 10°N, Long. 67.5°E. At about noon time (0544 GMT) Tiros VII located a tropical vortex at 10.5°N, Long. 65.5°E with central overcast four degrees in diameter and extensive banding to north. Apparently, the deep depression had intensified into a cyclonic storm, which was also confirmed by the following ships' observations for 1730 hrs IST.

Call Sign	Position		Wind		Pressure (mb)	Weather	Wave height metres
	Lat. °N	Long °E	Dir. Deg.	Speed Knots			
GBMZ	9.4	64.8	300	34	1002.9	Overcast	3.5
MASC	9.6	65.6	260	25	1002.8	Overcast	1.5

At 0830 hrs of 3rd, the cyclonic storm was centred within half-a-degree of Lat. 10.5°N, Long. 64.5°E.

Between 3rd and 4th, the cyclonic storm moved in a northwesterly direction. On 4th morning at 0830 hrs IST, it was within a degree of Lat. 12°N, Long. 62.0°E. The storm circulation covered nearly an area of ten to twelve degrees square on 3rd and 4th. In the absence of any observations within 250 km of the estimated centre, the intensity of the storm could not be judged, nor theposition critically fixed. There were no satellite cloud pictures also to help.

Continuing to move northwestwards, the cyclonic storm was centred at 1730 hours IST of 4th within half-a-degree of Lat. 12.5°N, Long. 61.0°E. The following observations for this day from S.S.Saudi on voyage from Aden to Bombay are of significance:

Date	Time IST.	Position		Wind		Weather	Pressure (mb)	Wave height feet
		Lat. °N	Long °E	Dir. Deg.	Speed Knots			
4th	0230	15.7	59.3	NE	24	Cloudy	1009.5	9
	0530	15.6	59.6	NE	18	Cloudy	1007.8	9

Date	Time IST.	Position Lat. °N	Position Long °E	Wind Dir. Deg.	Wind Speed Knots	Weather	Pressure (mb)	Wave height feet
	1130	15.9	60.6	ENE	25	Rain	1009.8	9
	1430	16.0	60.8	ENE	25	Showers	1006.2	10
	1730	16.0	60.8	ENE	25	Showers	1006.0	10
	2030	16.1	61.6	080	25	Cloudy	1007.5	10
	2330	16.3	61.9	080	25	Cloudy	1008.8	9
5th	0230	16.4	62.4	090	21	Cloudy	1008.7	8

At 0830 hrs IST of 5th, the cyclonic storm was centred within half-a-degree of Lat. 13.5°N, Long. 60°E.

By the 6th morning, the storm began to affect Kuria-Muria coast. At 0830 hrs IST, Masirah reported northeasterly 15 knots and Salalah northerly 20 knots. The cyclonic storm was probably centred at this time within a degree of Lat. 15.0°N, Long. 58°E. During this time, the areal extent of the storm also considerably decreased and when it crossed the coast it was probably not more tha 2 to 3 degrees in diameter. At 0830 hrs IST of 7th, it was within a degree of Lat. 15.5°N, Long. 57.5°E. During the night of 7th, the cyclonic storm apparentl crossed Kuria-Muria coast near Lat. 18°N,and moved inland. The following ships' observations and sequence of observations from Salalah are of significance:

Date	Time IST.	Ship/ Station	Position Lat. °N	Position Long °E	Wind Dir.	Wind Speed Knots	Pressure (mb)	Weather
7th	1130	FOJZ	18.2	57.0	N	20	1018.5	Overcast
	1730	FOJZ	17.3	55.9	NW	30	1013.2	Overcast
		Observations from Salalah						
7th	0830	Salalah			N	20	1015.8	Cloudy
	1730				NNW	20	1011.6	Cloudy
8th	0830				WNW	20	1014.3	Cloudy
	1730				NNW	15	1012.6	Cloudy

Due to lack of observations, the intensity of the storm could not be determined. However, judged from the areal extent and the strength of winds in the outer storm area, it is quite possible that it was one of severe intensity near its centre on 4th. In the absence of observations sufficiently near the centre, no reliable estimate of the lowest pressure at the centre could be obtained. Similarly the estimation of the centres of 5th, 6th and 7th also suffered due to lack of sufficient number of ships' observations. It is quite possib that after 5th the disturbance had weakened into a deep depression.

17 Deep depression in the Bay of Bengal——
——1st to 4th December——

A low pressure area formed over the extreme south Andaman Sea and adjoining southeast Bay of Bengal between 28th and 29th November. By 30th morning, it became well marked when it moved into southeast Bay of Bengal. Widespread moderate rainfall was reported from south Bay Islands. Upper winds over Port Blair also strengthened upto 25/30 knots below 3.0 km a.s.l.

Moving in a westerly direction, the well marked low pressure area concentrated into a deep depression during the course of 1st December and was centred at 1730 hrs IST within half-a-degree of Lat. 6.5°N, Long. 86.5°E. The following ships' observations are relevant:

Ship	Position		Time IST.	Wind		Pressure (mb)	Weather
	Lat. °N	Long °E		Dir. Deg.	Speed Knots		
JFCF	6.0	83.9	1730	WNW	20		
JLEN	5.8	86.0	1730	280	28	1004.0	Cloudy
FNGI	5.9	88.0	1730	250	18	1005.5	Cloudy

The deep depression moved in a westerly direction and was centred at 0830 hrs IST of 2nd within half-a-degree of Lat. 6.5°N, Long. 85.5°E. At 0530 hrs IST of 2nd, Ship FNGI (Lat. 5.9°N, Long. 84.5°E) reported northwesterly winds of 18 knots and ship S.S.Perseus (Lat. 6.0°N, Long. 86.9°E) reported westerly 18 knots.

During the subsequent 24 hours, there were not enough observations from the depression field. At 0830 hrs IST of 3rd, the deep depression was centred near Lat. 7°N, Long. 83.5°E and by the same evening near Lat. 7.0°N, Long. 83.0°E Moving in a westnorthwesterly direction, the deep depression crossed the east coa of Ceylon south of Batticola during the night of 3-4 and weakened into a depression. It was centred at 0830 hrs IST of 4th about 40 km southwest of Batticola. It remained practically stationary till the evening of 4th and thereafter started recurving. Moving in a northeasterly direction, it emerged into the southwest Ba of Bengal near Trincomalee and was centred at 0830 hrs IST of 5th near Lat. 9.0°N Long. 82.0°E. The pressure of stations over north Ceylon which were falling duri the previous evening, started rising on the morning of 5th. By 5th evening, the depression was centred near Lat. 10.0°N, Long. 82.5°E and by the next morning nea Lat. 11.0°N, Long. 82.5°E,

The following ships' observations are significant in this connection:

Date	Time IST.	Call sign/ name of the ship/station	Position		Wind		Pressure (mb)	Weather
			Lat. °N	Long °E	Dir. Deg.	Speed Knots		
5th	1730	VWFN	9.3	81.4	W	15	1005.9	Distant rain
	1730	Indian Trust	11.3	81.7	Calm	-	1006.4	-
	1730	State of Maharashtra	11.5	83.5	SE	10	1008.3	-
	1730	Trincomalee			W	15	1005.8	Distant rain
	2330	Indian Trust	10.2	81.2	NE	5	1007.0	-
6th	0530	VWQF	12.3	81.9	NE	10	1008.2	-
	0530	Rajula	11.3	87.1	SE	15	1009.9	-
	0830	Trincomalee			W	10	1010.5	-

After the morning of 6th, the depression moved in a northerly direction and weakened into a low pressure area over the southwest Bay of Bengal.

Under the influence of this system, Ceylon experienced good rainfall activity from 2nd to 5th. Rainfall over Madras State also inreased with a few

heavy falls along the east coast. At 0830 hrs IST of 3rd, Nagapattinam reported 14 cm and Cuddalore 16 cm of rain.

The depression, while it was lying over Ceylon on 4th morning, induced a small low off Madras coast the same day. The surface winds at Cuddalore, Nagapattinam and Vedaranniyam were northerly 5 kt, 15 kt and NNE 2 kt respectively. at 1730 hrs IST of 3rd. The pressure at these stations was 1009.7 mb, 1008.4 mb and 1008.0 mb respectively at the same hour. There was a general rise of pressur during the past 24 hours all along the Madras coast and the rise was of the order of 0.5 to 1.0 mb. No upper winds were available except those of Madras, which were northeasterly 15 to 20 kt upto 900 m a.s.l. on the evening of 3rd. However, on the morning of 4th at 0830 hrs IST, Nagapattinam reported surface wind ENE/25 knots and Atirampattinam WNW/05 kt. Pamban reported surface wind NW/20 kt at the same time. Ship VWWV at position Lat. 9.2°N, Long. 82.4°E reported southerly win of 15 kt and pressure 1006.3 mb at 0530 hrs IST. The pressure all over the south Peninsula were falling and particularly large negative falls were confined to the extreme southeast Peninsula. Vellore reported -2.0 mb, Tiruchchirapalli -2.1 mb, Nagapattinam, -4.1 mb and Pamban -2.4 mb pressure change during the past 24 hours The pressure departure was -5.2 mb at Nagapattinam and -4.4 mb at Pamban, suggesti a vortex of very small extent was centred near Lat. 10.5°N, Long. 80.5°E. At 053 hrs IST on this day, Madras upper winds showed significant strengthening as compa red to the previous evening. They were northeasterly 25 kt upto 1.5 km a.s.l. Tiruchchirappalli reported NW/15 kt at 0.3 km, NNE/25 kt at 0.6 km and NNE/30 kt at 0.9 km. By 1730 hrs IST, the surface wind at Nagapattinam backed and became WNW/10 kt and Cuddalore NE/10 kt suggesting that the small vortex has moved north wards and was lying close to the coast near Lat. 11.5°N. A small closed low of 1006 mb value could be drawn around this vortex. The 24 hour pressure change at Madras and Cuddalore was -2.4 and -2.2 mb respectively and the highest negative pressure departure of 4.0 mb was at Cuddalore. By the same evening, the pressure all along Madras coast have started rising. The upper winds at Madras have backe to NE/15-25 kt upto 1.5 km a.s.l. No closed isobar could be drawn at this time o the Madras coast and it would appear that the vortex has weakened in situ.

Under the influence of this vortex, there was good rainfall activity al along Madras coast extending from Cuddalore upto Tuticorin on 4th morning. Pamba recorded 10 cm of rain, Atirampattinam 8 cm and Nagapattinam 6 cm on 4th. At 083(hrs IST of the next morning (5th), Cuddalore recorded 40 cm of rain and Atirampat tinam, according to available records is the highest ever recorded at that statio Of this amount, the major portion, viz. 336.8 mm fell during the 9 hours period between 1030 hrs and 1930 hrs IST of 4th December.

According to press reports, the gales and heavy rains caused severe dam to public property in the coastal areas of the Madras state, Tanjore district, be the worst affected with more than 37,000 acres of paddy field submerged in flood waters.

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Table II

Monthly distribution of Cyclonic Storms and Depressions in the Bay of Bengal and Arabian Sea 1963

Month	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Total	
Disturbance	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C
Bay of Bengal	1									1(1)	2		1		1		2		2	1(1) 1(1)			1		10	3(3)
Arabian Sea										1(1)										1	1	1			1	3(1)
Total	1									2(2)	2		1		1		2		2	3(2)	1	1	1		11	6(4)

D = Depression

C = Cyclonic Storm

Figures in brackets indicate severe cyclonic storms

TRACKS OF STORMS AND DEPRESSIONS

(IN THE INDIAN SEAS)

1963