

Adults and Copepodite Stages of *Temora turbinata* (Copepoda: Calanoida) from the Indian Ocean

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Abstract. – This study is based on the sorted specimens from the aliquot samples of the zooplankton. The International ships during the International Indian Ocean Expedition collected them on the selected stations. It has been noted that *Temora turbinata* is a warm water neritic, planktonic species commonly found more frequently and in more abundance in the Northern Hemisphere as compared to the Southern Hemisphere. The adult and copepodite stages of females and males of this species have been carefully identified with the help of the reference literature and previous experience of the region.

Keywords: *Temora turbinata*, copepodite stages, Indian Ocean Expedition.

INTRODUCTION

This study deals with the epi-pelagic, warm water, calanoid copepod *Temora turbinata*, which belongs to the family Temoridae. *Temora turbinata* has been previously reported by some famous copepodologists from other parts of the world namely:

Calanus turbinatus Dana 1849, p.12; 1853, p.1057; 1855, p.72, fig.8.

Temora turbinata Giesbrecht 1892, p.329, pl.17, figs.14, 17, 18, 21, pl.38, fig.27; Scott A. 1909, p.118; Pesta 1912, p.48, fig.8; Sewell 1912, p.365, 1914, p.227; Fruchtl 1924, p.54; Sars 1925, p.193; Farran 1929, p.258; Wilson 1932, p.246; Mori 1937, p.64, pl.32, figs.3-8; Sewell 1947, p.165; Wilson 1950, p.343; Tanaka 1963, p.13; Gonzales and Bowman 1965, p.249, 250, figs. 5a-c.

The Indian Ocean Biological Centre (IOBC) Cochin, Kerala State, India, gave the present assignment. They sent us the unidentified specimens of Family Temoridae collected by various countries during the International Indian Ocean Expedition (IIOE) and deposited at the IOBC, for sorting and dispatching it world wide to the concerned experts/workers. We have identified the species *Temora turbinata* and also listed the counts of adult

females and males and copepodite stages. Its distribution reported here is totally based on the specimen received to us (aliquot samples). The counts of aliquot samples have been calculated to total sample (100% sample).

MATERIAL AND METHODS

The unidentified sorted specimens have kindly been provided to us by the IOBC. The countries listed in Table I (AB, Anton Brunn, USA; Co, Conch, India; Dm, Diamantina, Australia; Di, Discovery, U.K; Ki, Ins Kistna, India; Me, Meteor, Germany; Oshoro Maru, Japan; Va, Varuna, India; Zu, Zulfiquar) collected the samples. Whereas the summarized other data including the positions of samples and counts of the identified stages of both sexes are also tabulated. Most of the specimens came from the Northern Hemisphere, whereas few are from the Southern Hemisphere *i.e.* two stations of Diamantina, some occupancies of Meteor and 03 stations of Oshoro Maru. All samples of Southern Hemisphere were taken during northern winter, while the other samples of the Northern Hemisphere were collected during early and late winter NE-monsoon time.

The International Indian Ocean Standard Net (Currie, 1963) was employed for sampling mostly from the depth of 200-0 m as given in Table I. The specimens sent to us by the IOBC belonged to 37 stations collected in different months and years on various International ships.

Table I.- Occurrence, absolute numbers and relevant information of *Temora turbinata* obtained during the IIOE.

Cruise / Sta.	Lat/ Long.	Depth, m	Date	D/N	Adult F	C5	C4	C3	Total F	Adult M	C5	C4	Total M	G. Total
ANTON BRUNN AB CR.1														
St.43	15°08'N; 94°04'E	50	01 04	D	38				38	6			6	44
St.91	17°14'N; 83°47'E	200	28 04	N						6			6	6
St.96	13°43'N; 85°47'E	200	30 04	D							2	2	2	
AB Cr.IV														
St.183	23°43'N; 66°21'E	200-0	28 10	N							3		3	3
St 196	20°44'N; 61°15'E	200-0	04 11	N	120				120	50			50	170
CONCH CO 196														
St.52	10°10'N; 75°46'E	200-0	18 10	D	60	20			80	105	15		120	200
CO 198														
St 55	10°19'N; 75°37'E	200-0	28 10	D	100				100	92	12		104	204
St 58	10°29'N; 75°31'E	200-0	28 10	N	68	84			152	56	92		148	300
St 62	10°39'N; 75°22'E	200-0	29 10	N	50	3			53	17	7		24	77
DIAMANTINA DM II														
St 61	24°30'S; 110°00'E	220-25	10 05	N	1				1	7			7	8
DM III														
St 129	09°33'S; 110°00'E	200-00	13 05	D	3	7			10	3			3	13
DISCOVERY Di III														
St 5539	03°57'S; 51°03'E	200-00	11 08	N	10				10					10
INS KISTNA KI XX														
St 526	03°00'S; 110°45'E	50-07	03 09	D	85	4	4		93	88	5	3	96	189
St 527	04°00'S; 99°49'E	50-05	03 09	N	2				2	4			4	6
METEOR ME I														
St 102	11°33'N; 52°54'E	200-20	20 12	N	46	7			53	13			13	66
St 103	11°27'N; 53°04'E	200-00	20 12	D						15				

Continued

Cruise / Sta.	Lat/ Long.	Depth, m	Date	D/N	Adult F	C5	C 4	C3	Total F	Adult M	C5	C4	Total M	G. Total
ME I			1965											
St 132	01°56'N; 49°03'E	200-00	01 01	D	4				4					4
St 144	11°27'N; 53°04'E	200-00	07 01	D	16	8			24	8			8	32
St 145	00°48'N; 45°23'E	200-20	07 01	N	400	340			740	500	20		520	1260
St 148	00°00'; 46°03'E	200-00	09 01	N	10				10					10
St 149	00°12'S; 46°15'E	200-25	09 01	D	4				4	4			4	8
St 151	02°36'S; 44°14'E	200-05	11 01	D	195	166			360	109	55		245	605
St 153	02°01'S; 43°22'E	230-30	12 01	N	733	13			746	495			495	1241
St 154	01°42'S; 43°01'E	232-30	13 01	D	20	4		4	28	16			16	44
St 157	01°12'S; 42°13'E	282-45	14 01	D	15	10			25	30	5		35	60
St 158	01°18'S; 41°46'E	200-00	14 01	N	386	92			478	304	13		317	795
St 167	05°00'S; 42°08'E	200-00	24 01	D	24	2			26	8	2		10	36
St 168	04°17'S; 48°01'E	200-05	26 01	D						3			3	3
St 198	14°14'S; 72°19'E	200-60	17 02	D	4				4	4			4	4
OSHO RO MARU														
OS VII			1963											
St 07	09°46'S; 109°56'E	213-20	19 12	N	30				30	52	2		54	84
St 08	10°12'S; 109°50'E	231-30	20 12	N	4				4	24			24	28
St 13	13°00'S; 111°25'E	204-12	25 12	N	1				1	1			1	2
VARUNA														
VA104			1963											
St 2007	09°00'S; 75°26'E	200-	04 11	D	5				5	5	3		8	13
St 2042	15°00'S; 73°40'E	80-	10 12	D							2		2	2
St 2044	14°48'S; 74°02'E	40-	10 12	-	60	4	4		68	72	20		92	160
ZULFIQUAR														
ZU			1964											
St 4	24°38'S; 65°49'E	198-	10 11	N	22				22	11			11	33
St 5	23°58'S; 66°09'E	150-	10 11	D	212	16			228	112	16		128	35
Total					2728	779	8	4	3519	2301	27 4	3	2578	6097

Lat./Long., Geographical positions of stations, F, females; M, males; C5, C4, C3, copepodite stages V, IV, III; Depth (m), depth of haul; D/N, day/night haul.

Table II. Average numbers of adult females, males and the copepodite stages of *T. turbinata* per haul collected during the IIOE.

S. No.	Name of Cruise/ No. of Stations	Females (Copepodites)					Males (Copepodites)					Grand Total
		Adults	V	IV	III	Sub-total	Adults	V	IV	III	Sub-total	
1.	Anton Brunn /05	31.6	0	0	0	31.6	12.4	1	0	0	13.4	45
2.	Conch / 04	69.5	27	0	0	96.25	67.5	32	0	0	99	195.25
3.	Diamantina / 02	2	3.5	0	0	5.5	5	0	0	0	5	10.5
4.	Discovery / 01	10	0	0	0	10	0	0	0	0	0	10
5.	Ins Kistna / 02	43.5	2	2	0	47.5	46	2.5	1.5	0	50	97.5
6.	Meteor / 15	123.8	43	0	0	166.8	106	6.3	0	0	112.3	279.13
7.	Oshoro Maru/03	11.6	0	0	0	11.6	25.6	0.6	0	0	26.3	37.99
8.	Varuna / 03	21.6	1.3	1.3	0	24.33	25.6	8.3	0	0	34	58.33
9.	Zulfiquar / 02	117	8	0	0	125	61.5	8	0	0	69.5	194.5

(Approximate volume of water strained was 400-500 m³/haul. 0=no specimen).

RESULTS

The occurrences of *T. turbinata* (°Lat. and °Long.), absolute numbers and some related physical information, both its adult sexes and also their copepodite stages III to V (C3-C5) based on random samples of various ships collected during International Indian Ocean Expedition (IIOE), is tabulated in Table I. The numbers of specimens given for each station equals the number of specimens per haul mostly (200-0m, oblique hauls). The year of collection date, time, day and night (D/N) haul with the exact depth (m) is also shown in the said table. A total of 6097 specimens were taken on 37 stations (samples) covered by nine international ships (Table I).

To make the results comparable, due to the variable number of random samples (hauls) of different ships, the average numbers of adults and copepodite stages were calculated and summarized in Table II. It appears at a glance that the higher numbers per haul were taken near the coast off Somalia upto Kenya along the east African coast. Similarly at Trivandrum near the Cape Comorin at 10° NW, (Indian coast) and at South East of Pakistan coast near the Indus Delta, being the highest per haul at the East African Coast on Meteor cruise. It seems that this warm water epi-planktonic species dominates in the coastal areas (Meteor, Conch and Zulfiquar cruises) as compared to other regions and cruises (Anton Brunn, Diamantina, Discovery, Ins Kistna, Oshoro Maru and Varuna). Interestingly the Discovery collection shows total

absence of males and presence of only 10 adult females. The copepodite stages were totally absent. The absence of any males could be accidental. Again the absence of copepodite stages, especially of stage III (C3) does not mean their total absence from that area at all. They might have been filtered out through the meshes of the net. In general female and male ratio seems to be more or less 1:1. It is further noted that the moderate numbers of specimens were taken on either the occupancy of relatively colder waters or oceanic oligotrophic areas known as deserts of the sea or it might be due to different season or time of the year (Table I). More numbers of adult females per haul were counted on Anton Brunn, Meteor and Zulfiquar cruises as compared to adult males. The 4th rank in higher average numbers (97.5/haul) was noted for Ins Kistna cruise (only two stations). These were restricted to 03°00'N, 110°45'E; and 04°00'N, 99°49' E in September.

DISCUSSION

The above mentioned results allow us to conclude the following:

That *Temora turbinata* is a warm water epi-pelagic, neritic species (as also previously noted by Ahmad *et al.*, 1972) which was found in dominating numbers during winter and in upwelling areas of summer (E. Africa) or in the low salinity waters of Indus Delta of Pakistan. Ali-Khan and Ali-Khan (2002) discussed the possible reasons of dominating of the other species, *T. discaudata* and attributed it

to nutrient rich waters in the regions of summer upwelling. It is further noted that both the species of *Temora* i.e. *T. discaudata* and *T. turbinata* show the co-occurrence and also the dominating abundance in more or less the same regions or similar climatic conditions. It is also noted that the numbers of specimens were more frequently taken on the stations of Northern Hemisphere and more in numbers as compared to the Southern Hemisphere where the waters were relatively colder.

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