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Lunar influence on water parameters in relation to population of mysids (*Mesopodopsis orientalis*)

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Abstract

Specimen samples of ***mysids (Mesopodopsis orientalis)*** collected during low tide twice a month viz., once in Waxing period (New Moon to Full Moon) and once in Waning period (Full Moon to New Moon). Simultaneously, surface water samples also collected using a clean polyethylene bucket for the estimation of relevant water quality parameters viz., pH, temperature and salinity during May 2016 to December 2017. The study area in the Coastal, Estuarine and Saltpan waters ecosystem does have a moderate potential for mysids. The observations indicate that there is a lunar influence on population of mysids as also on water parameters viz., temperature, pH and salinity.

Key words: Waxing and Waning period, Lunar influence, Ecosystem, Water parameters, mysids (Kolim).

INTRODUCTION

Mesopodopsis orientalis is the common mysid of Indian coastal waters. It is widely distributed throughout shallow coastal waters of India. It has been recorded in back waters, estuaries and even up to the inner reaches or rivers, where the water is almost fresh (Pannikar and Aiyar, 1937, Devasundaram and Roy 1954, Pillai, 1957, and George, 1958).

Opossum shrimps form the popular small scale mysid (kolim) fishery in all the waters of Maharashtra viz., ocean, estuary and saltpans. Mysid (Kolim) is the favourite sea food of fishing community and is consumed in fresh and dry form. This study reveals that the selected sites are found to be suitable for sustainable mysids collection.

Mysids are primarily benthic in habit moving about during daytime just above the bottom, feeding on detritus. Many species perform a dial vertical migration, rising to the surface layers during night and returning to the deeper layers at daylight. Mysids generally avoid bright illumination; therefore, light intensity appears to be the major factor controlling the vertical migration. Seasonal changes in the vertical migration have been found, to avoid seasonal extremes of temperature and salinity in littoral zone and brackish water environment.

Mysis spp. perform diel migrations at dusk and dawn from their daytime refuge in dark, deep water to the meta or epilimnion, where they feed on zooplankton and algae. These migrations can be over 100 m and are limited by temperatures above 12 to 16°C and light levels above 10–4 lux, i.e. light levels that limit fish visual feeding. Boscarino et al. (2009a, this Theme Section) show that the actual distributions, not just the mean depth, can be predicted from the response of mysids to these variables in the laboratory (Boscarino et al. 2007, 2009b).

Temperature is the most important environment factor with effect on plants and animals. Water has several unique thermal properties which combine to minimize temperature change. The Water temperature depends on the depth of the water column, climatic and topographic changes (Water Quality Assessment (WQA) 1992). It affects many chemical and biological parameters (Gupta 2004). Most of the Indian estuaries have a difference of 8 – 10^{o} C between the lowest and highest temperatures The difference of 18°C in the present investigation can be due to shallowness of the ecosystem. The lowest temperature was observed in January, whereas the highest in June. Temperature was predominantly affected by the seasonal changes in atmospheric temperature.] .(Mishra *et al.*, 1993).

pH, one of the most common analyses in soil and watertesting, is the standard measure of how acidic or alkaline asolution is. It is measured a scale from 0 -14. pH of 7 isneutral, pH is less than 7 is acidic and pH greater than 7 isbasic. Aquatic organisms need the pH of their water body to bea certain range optimal growth and survival. The presence ofacid rain can lower the pH in lakes making them more acidic (SS Sagar et.al.2015).

Salinity considered as most vital in all waters as it can tremendously influence the distribution of biological communities and their metabolic functions (Gauri Sahoo, 2010). Salinity is the saltiness or dissolved inorganic salt content of a body of water. Substances that are dissolved in water are usually called solutes. The typical seawater has a **salinity** of 35 ppt or 35‰ (Encyclopaedia, Google). Salinity is the predominant governing factor in the spatial distribution of mysids (Rappé et al., 2011).

The water parameters as also population of mysids were found fluctuating by seasonal impact in all the waters viz., ocean, and estuary as also saltpans. The size of individuals in the population found fluctuating by lunar influence as also by season (Nakhwa, 2023).

It was observed that mysids population fluctuate by lunar influence in waxing and waning period in all the types of waters viz., coastal, estuary and saltpans. It was observed that mysids population fluctuate by lunar influence in waxing period the types of waters viz., coastal, estuary and saltpans.

Bhattacharya (1982) has studied salinity tolerance in the laboratory and reveal that *M. orientalis* of Indian coastal waters could survive under an extremely wide range of salinity conditions, even though it tends towards a low salinity preference, particularly in the early life stages; this ability ensures its wide distribution from sea water to near fresh water conditions. The mysids are important in marine food chains since they occur in large numbers in inshore waters and estuaries. In terms of mysid population density, Bhayander (ave. 79 inds. /m3) was more productive than Thane (ave. 14 inds. /m3) (Mustafa et. al.1995).

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. It is necessary to know details about different physical chemical parameters such as temperature, pH and salinity used for testing of water quality.

MATERIALS AND METHODS

Specimen samples were collected during low tide twice a month viz., once in Waxing period (New Moon to Full Moon) and once in Waning period (Full Moon to New Moon). A plankton collection net was used for the collection of samples at surface water in every month manually during May 2016 to December 2017. Simultaneously, surface water samples also collected during low tide using a clean polyethylene bucket for the estimation of relevant water quality parameters viz., pH, temperature and salinity. The water temperature was recorded using alcohol cleaned thermometer. pH was recorded by pH meter and salinity by salinometer. The data is presented after consolidating it Fortnight wise by calculating average values.

The study area was one site from Coastal area (Girgaon Chaoupati), three sites from Mangrove estuarine area (Juchandra, Thane and "Kandalvan" at Mauze – Mulund/Bhandup). is a vast expanse of mangrove habitat and three sites from Saltpan (Airoli, Vasai and Naigaon) from different parts viz., reservoirs, condensers and crystallizers.

RESULTS

The water parameters as also population of mysids were found fluctuating by lunar influence in all the waters viz., ocean, estuary and saltpans.

In ocean water during Waning period at Girgaon chaupati total 24319 no. of mysids obtained during collection, which represents 48.56% of total quantity of mysid 50080 (Waning and Waxing) when average temperature 27.43^{0}C, pH 7.75 and salinity 34.8‰. Whereas during Waxing period in ocean water of Girgaon chaupati 25761 no. of mysids obtained during collection which represents 51.44% when average temperature 28.58 ^{0}C, pH 8.11 and salinity 34.77‰ was observed. Whereas throughout collection period total quantity of mysid obtained 50080 no.; when total average water parameters viz., temperature was 28.06 ^{0}C, pH was 7.96 and salinity was 34.71‰.

Estuaries form a transition zone between river environments and maritime environments. They are subject both to marine influences such as tides, waves, and the influx of saline water and to riverine influences such as flows of fresh water and sediment.

Estuaries are incredibly dynamic systems, where temperature, salinity, turbidity, depth and flow all change daily in response to the tides. Two of the main challenges of estuarine life are the variability in salinity and sedimentation. Many species of fish and invertebrates have various methods to control or conform to the shifts in salt concentrations and are termed osmoconformers and osmoregulators. (Goldin et.al, 2001).

In Estuarine waters during Waning period at Juchandra 1956 no. of mysids obtained during collection which represents 68.80% of total quantity of mysid 2843 (Waning and Waxing) found when average temperature 27.35^{0}C, pH 6.36 and salinity 14.52‰ found. During Waxing period in Estuarine waters of Juchandra 887 no. of mysids obtained during collection which represents 31.20% when average temperature 29.95 ^{0}C, pH 8.78 and salinity 17.03 was observed. Whereas throughout collection period total quantity of mysid was obtained 2843 no. When total average water parameters viz., temperature was 28.92, pH was 7.75 and salinity was 16.67‰.

In Estuarine waters of Thane creek 6530 no. of mysids obtained during collection which represents 22.42% of total quantity of mysid 29129 (Waning and Waxing) found when average temperature 28.05^{0}C, pH 6.59 and salinity 21.27‰ found during Waning period. During Waxing period in Estuarine_waters of Thane creek 22599 no. of mysids which represents 77.58% when average temperature 29.78^{0}C, pH 9.23 and salinity 30.39‰ was observed. Whereas throughout collection period total quantity of mysid was obtained 29129 no. When total average water parameters viz., temperature was 29.07 ^{0}C, pH was 7.20 and salinity was 24.78‰.

In Estuarine waters of Mulund creek 6797 no. of mysids obtained which represents 37.31% of total quantity of mysid 18217 (Waning and Waxing) found when average temperature 39.83^{0}C, pH 6.42 and salinity 20.13‰ found during Waning period. During Waxing in Estuarine waters of Mulund estuary 11420 no. of mysids obtained during collection which represents 52.79% when average temperature 30.48^{0}C, pH 9.28 and salinity 27.87‰ was observed. Whereas throughout collection period total quantity of mysid was obtained 18217no. When total average water parameters viz., temperature was 29.17 ^{0}C, pH was 7.92 and salinity was 23.79‰.

Salt pans

In Salt pans waters of Airoli 7502 no. of mysids obtained during collection which represents 51.81% of total quantity of mysid 14480 (Waning and Waxing) found when average temperature 28.34^{0}C, pH 6.32 and salinity 27.64‰ found during Waning period. During Waxing period in Salt pans of Airoli 6978 no. of mysids obtained during collection which represents 48.19% when average temperature 30.18^{0}C, pH 8.36 and salinity 31.98‰ was observed. Whereas throughout collection period total quantity of mysid was obtained 18217no. When total average water parameters viz., temperature was 29.30 ^{0}C, pH was 7.17 and salinity was 29.55‰.

In Salt pans waters of Vasai 4584 no. of mysids obtained during collection which represents 43.80% of total quantity of mysid 19600 (Waning and Waxing) found when average temperature 27.46^{0}C, pH 4.63 and salinity 22.73 ‰ found during Waning. During Waxing period in Salt pans of Vasai estuary 11076 no. of mysids obtained during collection which represents 56.51% when average temperature 29.67^{0}C, pH 7.14 and salinity 25.7‰ was observed. Whereas throughout collection period total quantity of mysid was obtained 19600no. When total average water parameters viz., temperature was 28.75 ^{0}C, pH was 6.11 and salinity was 24.36‰.

In Salt pans waters of Naigaon 5752 no. of mysids obtained during collection which represents 90.80% of total quantity of mysid 6335 (Waning and Waxing) found when average temperature 26.78^{0}C, pH 5.42 and salinity 32.50‰ found during Waning period. During Waxing period in Salt pans of Naigaon 583 no. of mysids which represents 9.20% when average temperature 29.99^{0}C, pH 8.61 with range of and salinity 35.90‰ was observed. Whereas throughout collection period total quantity of mysid was obtained 6335. When total average water parameters viz., temperature was 28.60^{0}C, pH was 7.08 and salinity was 34.88‰.

Water parameters of mysids collection centres in different fortnights(Waning and Waxing) from May,2016 to december,2017

	*	Waning Fortnight			+	Waxing Fortnight			Total	Average Water parameters		
	Quantity	Temp.	pH	Salinity	Quantity	Temp.	pH	Salinity	Quantity	Temp.	pH	Salinity
	Nos	^{0} C		(‰)	Nos	^{0} C		(‰)	Nos	^{0} C		‰
Girgaon Chaupati	24319	27.43	7.75	34.8	25761	28.58	8.11	34.77	50080	28.06	7.96	34.71
Juchandra Estuary	1956	27.35	6.36	14.52	887	29.95	8.78	17.03	2843	28.92	7.75	16.67
Thane Estuary	6530	28.05	6.59	21.27	22599	29.78	9.23	30.39	29129	29.07	7.7	24.78
Mulund Estuary	6797	39.83	6.42	20.13	11420	30.48	9.28	27.87	18217	29.17	7.92	23.79
Airoli Salt pans	7502	28.34	6.32	27.64	6978	30.18	8.36	31.95	14480	29.3	7.17	29.55
Vasai Salt pans	8584	27.46	4.63	22.73	11076.7	29.67	7.14	25.27	19600	28.75	6.11	24.36
Naigaon Salt pans	5752	26.78	5.42	32.5	583	29.99	8.61	35.9	6335	28.6	7.08	34.88

Average Water temperature during Waning period in the Coastal water area of Girgaon Chowpati was 27.43^{0}C, when 24319 no. of mysids obtained which was found 48.56% of.50080 no total quantity of mysids (Waning and Waxing). Whereas in the Estuarine water areas of Juchandra, Thane and Mulund, temperature was found varied from 27.35^{0}C, 28.05^{0}C and 39.83^{0}C respectively when 1956, 6530 and 6797 no. of mysids obtained which was found 68.80%, 22.42% and 37.21% of 2843, 29129 and 18217 no total quantity of mysids (Waning and Waxing) respectively and in the Saltpan water areas of Aairoli, Vasai and Naigaon, temperature was varied from 28.34^{0}C,27.46 ^{0}C and 26.78 ^{0}C when 7502, 8584 and 5752 no. of mysids obtained which was found 51.81%, 43.80% and 90.80% of 14480, 19600 and 6335 no total quantity of mysids respectively. Whereas average water temperature during Waxing period in the Coastal water area of Girgaon Chowpati was 28.58 ^{0}C, when 25761 no. of mysids obtained which was found 51.44% of 50080 no total quantity of mysids. Whereas in the Estuarine water areas of Juchandra, Thane and Mulund, temperature was found varied 29.95^{0}C, 29.78^{0}C and 30.48^{0}C respectively when 887, 22599 and 11420 no. of mysids obtained which was found 31.20%, 77.58% and 62.69% of 2843, 29129 and 18217 no total quantity of mysids respectively and in the Saltpan water areas of Aairoli, Vasai and Naigaon, temperature was varied from 30.18^{0}C, 29.67 ^{0}C and 29.99 ^{0}C when 6978, 11076 and 583 no. of mysids obtained which was found 48.19%, 56.51% and 9.20 % of 14480, 19600 and 6335 no total quantity of mysids respectively.

pH indicates the presence of acidic and alkaline nature of water. Fluctuation in pH values observed during both the fortnights i.e.Waning and Waxing periods. Average pH during Waning period in the Coastal water area of Girgaon Chowpati was 27.43 ^{0}C, when 24319 no. of mysids obtained which was found 48.56% of.50080 no total quantity of mysids (Waning and Waxing). Whereas in the Estuarine water areas of Juchandra, Thane and Mulund, temperature was found varied from 27.35^{0}C, 28.05^{0}C and 39.83^{0}C respectively when 1956, 6530 and 6797 no. of mysids obtained which was found 68.80%, 22.42% and 37.21% of 2843, 29129 and 18217 no total quantity of mysids respectively and in the Saltpan water areas of Aairoli, Vasai and Naigaon, temperature was varied from 28.34^{0}C,27.46 ^{0}C and 26.78 ^{0}C when 7502, 8584 and 5752 no. of mysids obtained which was found 51.81%, 43.80% and 90.80% of 14480, 19600 and 6335 no total quantity of mysids respectively. Whereas average pH during Waxing period in the Coastal water area of Girgaon Chowpati was 8.11, when 25761 no. of mysids obtained which was found 51.44% of 50080 no total quantity of mysids (Waning and Waxing). Whereas in the Estuarine water areas of Juchandra, Thane and Mulund, average pH was found varied 8.78,9.23 and 9.28 respectively when 887, 22599 and 11420 no. of mysids obtained which was found 31.20%, 77.58% and 62.69%of 2843, 29129 and 18217 no total quantity of

mysids respectively and in the Saltpan water areas of Airoli, Vasai and Naigaon, temperature was varied from 8.36.7.14 and 8.61 when 6978, 11076 and 583 no. of mysids obtained which was found 48.19%, 56.51% and 9.20% of 14480, 19600 and 6335 no total quantity of mysids respectively.

Salinity of the coastal waters was observed. Average salinity during Waning period in the coastal water area of Girgaon Chaupati was 34.80‰, when 24319 no. of mysids obtained which was found 48.56% of.50080 no total quantity of mysids (Waning and Waxing). Whereas in the Estuarine water areas of Juchandra, Thane and Mulund, salinity was found varied from 14.52, 21.27 and 20.13‰ respectively when 1956, 6530 and 6797 no. of mysids obtained which was found 68.80%, 22.42% and 37.21% of 2843, 29129 and 18217 no total quantity of mysids (Waning and Waxing) respectively and in the Saltpan water areas of Aairoli, Vasai and Naigaon, salinity was varied from 27.64,22.73 and 32.50‰ when 7502, 8584 and 5752 no. of mysids obtained which was found 51.81%, 43.80% and 90.80% of 14480, 19600 and 6335 no total quantity of mysids respectively. Whereas average salinity during Waxing period in the Coastal water area of Girgaon Chowpati was 34.77‰, when 25761 no. of mysids obtained which was found 51.44 % of 50080 no total quantity of mysids (Waning and Waxing). Whereas in the Estuarine water areas of Juchandra, Thane and Mulund, average salinity was found varied 17.03. 30.39 and 27.87‰ respectively when 887, 22599 and 11420 no. of mysids obtained which was found 31.20%, 77.58% and 62.69% of 2843, 29129 and 18217 no total quantity of mysids respectively and in the Saltpan water areas of Airoli, Vasai and Naigaon, salinity was varied from 31.92, 25.37 and 35.90‰ when 6978, 11076 and 583 no. of mysids obtained which was found 48.19%, 56.51% and 9.20% of 14480, 19600 and 6335 no total quantity of mysids respectively. During waxing and waning period total average parameters viz., temperature, pH and salinity was 28.06 ^{0}C, 7.96 and 34.71‰ respectively found in coastal waters of Girgaon chaupati Whereas in the Estuarine water areas of Juchandra total average temperature 28.92^{0}C, pH 7.75 and salinity was 16.67‰; in Thane total average temperature 19.07^{0}C, pH 7.70 and salinity was 24.78‰ and Mulund total average temperature 29.17^{0}C, pH 7.92 and salinity was 23.79‰. Whereas in the Saltpan water areas of Aairoli total average temperature 39.30^{0}C, pH 7.17 and salinity was 29.55‰ in Vasai total average temperature 28.75^{0}C, pH 6.11 and salinity was 24.36‰ and in Naigaon total average temperature 28.60^{0}C, pH 7.08 and salinity was 24.88‰.

Average Water parameters of coast, estuary & salt pan waters in relation with population of mysid collection from May, 2016 to December, 2017

	Waning Fortnight				Waxing Fortnight				Total	Average Water parameters		
Water Areas	Quantity	Temp.	pH	Salinity	Quantity	Temp.	pH	Salinity	Quantity	Temp.	pH	Salinity
Stations	No	0 C		ppt	Nos	^{0} C		(‰)	Nos	^{0} C		‰
Ocean-Girgaon	**24319.00**	**27.4**	**7.8**	**34.8**	**25761.00**	**28.58**	**8.11**	**34.77**	**50080.00**	**28.06**	**7.96**	**34.71**
Percentage	**48.56**				**51.44**							
Juchandra-Estuary	1956.00	27.35	6.36	14.52	887.00	29.95	8.78	17.03	2843.00	28.92	7.75	16.67
Percentage	**68.80**				**31.20**							
Thane-Esturary	6530.00	28.05	6.59	21.27	22599.00	29.78	9.23	30.39	29129.00	29.07	7.70	24.78
Percentage	**22.42**				**77.58**							
Mulund-Estuary	6797.00	39.83	6.42	20.13	11420.00	30.48	9.28	27.87	18217.00	29.17	7.92	23.79
Percentage	**37.31**				**62.69**							
Estuary-Average	**5094.33**	**31.74**	**6.46**	**18.64**	**11635.33**	**30.07**	**9.10**	**25.10**	**16729.66**	**29.05**	**7.79**	**21.75**
Percentage	**30.45**				**69.55**							
Airoli-Salt pans	7502.00	28.34	6.32	27.64	6978.00	30.18	8.36	31.95	14480.00	29.30	7.17	29.55
Percentage	**51.81**				**48.19**							
Vasai-Salt pans	8584.00	27.46	4.63	22.73	11076.70	29.67	7.14	25.27	19600.00	28.75	6.11	24.36
Percentage	**43.80**				**56.51**							
Naigaon-Salt pans	5752.00	26.78	5.42	32.50	583.00	29.99	8.61	35.90	6335.00	28.60	7.08	34.88
Percentage	**90.80**				**9.20**							
Salt pan-Average	**7279.33**	**27.53**	**5.46**	**27.62**	**6212.57**	**29.95**	**8.04**	**31.04**	**13491.90**	**28.88**	**6.79**	**29.60**
Percentage	**53.95**				**46.05**							
Grand Total	**36692.66**	**28.90**	**6.56**	**27.02**	**43608.90**	**29.53**	**8.42**	**30.30**	**80301.56**	**28.66**	**7.51**	**28.60**

Fortnight wise total average water temperature exhibited fluctuates between 28.06 – 29.05^{0}C. Where average water temperature of estuarine waters observed 29.05^{0}C followed by 28.88 ^{0}C in saltpan waters and 28.06 ^{0}C of coastal waters. The total average pH ranged from 6.79 to 7.96, where average pH 7.96 of coastal waters followed by pH 7.79 of estuarine waters and pH 6.79 of saltpan waters. The total average salinity was found ranged from 21.75 – 34.71‰ where average salinity 34.71‰ of coastal waters followed by 29.60‰ of saltpan waters and 21.75‰ of estuarine waters. Simultaneously we observed that total quantity of mysid was more 50080 no. i.e. 62.36% of total collection 80301.56 no. in coastal waters followed by 16729.66 no. i.e. 20.83% in estuarine waters and 13491.90 no. i.e. 16.80% in saltpan waters.

It was observed that total quantity of mysid found 43608.90 no. i.e.54.31% in waxing period and in waning period which found 36692.66 no. i.e.45.69% of total collection 80301.56. Total average temperature, pH and salinity found more i.e.29.53^{0}C, 8.42 and 30.30 ‰ respectively in waxing period than waning period in which it found total average temperature, pH and salinity was 28.90 ^{0}C, 6.56 and 27.02 ‰ respectively.

DISCUSSSION

In all waters, total mysids found more in Coastal waters of Girgaon Chowpati followed by Salt pan waters and then Estuarine waters. Whereas, average temperature observed more in Salt pan waters followed by Estuarine waters and then Coastal waters. Average pH found more in Estuarine waters followed by Coastal waters and then Salt pan waters. Salinity observed more in Estuarine waters followed by Salt pan waters and then in Coastal waters. These observations indicate that there is a lunar influence on population of mysids and also water parameters viz., temperature, pH and salinity. The present investigation found due to shallowness of the ecosystem. It therefore shows that there is direct correlation of water parameters with population of mysids during lunar period, hence, one can very well plan for collection of mysids. (Nakhwa, 2023).

Territorial water, or a territorial sea, as defined by the 1982 United Nations Convention on the Law of the Sea, is a belt of coastal waters extending at most 12 nautical miles from the baseline (usually the mean low-water mark) of a coastal state. Estuaries are incredibly dynamic systems, where temperature, salinity, turbidity, depth and flow all change daily in response to the tides. Salt pans are unique tide water impounded enclosed systems adjacent to creek environment. Further studies on the fauna of the salt pans have been done by Deshmukh (1989), Ratan and Ansari (1982), Madhupratap and Haridas (1992), Shirgur and Deshmukh (1994), Mustafa (1995) and Mustafa et al. (1999).

Mysids generally avoid bright illumination; therefore, light intensity appears to be the major factor controlling the vertical migration. These migrations can be over 100 m and are limited by temperatures above 12 to 16°C. Boscarino *et al*. 2007, 2009a 2009b show that the actual distributions, not just the mean depth, can be predicted from the response of mysids to these variables in the laboratory. The spatial distribution of mysids along the lagoon boundary was found to depend mainly on the estuarine boundary conditions. Mangrove vegetation along the estuarine boundary was found to be favourable for mysids while concrete boundaries and accumulation of garbage along boundaries were found to be unsuitable. (Punchihewa and Krishnarajah, 2019).

The number of individuals in the population was found fluctuating by lunar influence. 35.59% of Total mysids found in Oceanic waters followed by 35.67% in Estuarine waters and 28.72% in Saltpan waters. In Waxing period 56.32% collection was found whereas 43.67% found in Waning period. In Estuarine waters 69.55% specimen obtained in Waxing period followed by 51% in Oceanic waters and 45.96% in Saltwaters. Whereas in Waning period, 54.03% obtained from Saltpan waters followed by 49% mysids obtained in oceanic waters and 30.44% from Estuarine waters. It reveals that population in all the waters during Waxing period of mysids was found more than Waning period (Parab and Nakhwa 2019).

The relationship between zooplankton biomass and moon illumination has been studied north of the Canary Islands. Biomass was significantly greater during the second quarter of the moon's cycle, and decreased dramatically after the full moon in all the size classes of mesozooplankton. The pattern was similar to that described in lakes and confirms the existence of this phenomenon in the sea. This lunar cycle in zooplankton could account for a rather large percentage of the gravitational flux and may help to explain the periodicity in the sinking flux observed in sediment traps in subtropical waters (Santiago Hernandez-Leon et al. 2002).

There are variable effects of lunar cycle on zooplankton emergence. In the Phosphorescent Bay, all taxa had greater emergence mainly at full moon, with most invertebrate larvae showing no response for a lunar period. Other larval forms and transparent adult zooplankters (e.g., copepod and cirriped nauplii and larvaceans) emerged mainly during full and new moon. Emergence occurred predominately at night, and all taxa had a greater emergence to surface waters during full moon (Rios-Jara 2005). The diel vertical migration patterns of demersal zooplankton, those organisms which habit bottom substrates but periodically

emerge to swim freely in the water column, water determined throughout the lunar cycle. Large zooplankton migrated less frequently into the water column during moonlit periods than small forms. Demersal zooplankton emerged into artificially darkened emergence traps in significantly higher numbers during daylight and during full and quarter moons than into un darkened control traps, demonstrating that absence of light is a major cue stimulating migration (Alldredge, A. L., King, J. M. (1980).

There are variable effects of lunar cycle on zooplankton emergence (Ohlhorst 1982). The higher zooplankton densities at the surface during the night and at the bottom during the day, with the number of species following a similar pattern (Morgado et. al. 2006). Difference of abundance of many small invertebrates between surface and bottom waters at night shows that each species has a preferred layer in the water column for swimming or dispersing at night (Saigusa, M., and K. Oishi. 2000).

A seasonal variation exists in brood size in the *N. integer* population regardless of the body size, with a larger number of broods during winter and spring compared to the summer. In the other mysid populations, the brood sizes vary only with the length of the ovigerous females. (Rappé, K. et.al.2011).

Full moon had the lowest catch all throughout the duration of the study while new moon had the highest catch of commercially important fishes. Based on the results, the change in temperature and salinity is independent from the change of moon phase and does not directly affect the catch of stationary lift nets. However, the change in moon phase had a direct and indirect influence in the total number of catch and catch composition of the stationary lift nets in Miagao, Iloilo. (Christopher John C et.al.2017).

Observations made on new moon, full moon and during both quarters revealed variations in total catch as well as individual species catch in gillnetters and trawlers. Gillnet catches of sardines and mackerels showed a gradual increasing trend from new moon to full moon and then a decline towards the new moon whereas, barracuda and tuna catches exhibited an increasing trend from full moon to new moon. The catches of seerfish and sailfish were high during full moon to new moon quarter and were nominal during full moon. In trawl catches, during the first half of new moon and full moon days, Fenneropenaeus indicus and Penaeus semisulcatus were caught in large numbers and Fenneropenaeus merguiensis dominated the later half. Metapenaeus monoceros and Penaeus monodon were caught in lesser quantities. Maximum catch per unit effort (CPUE) for gillnetting and trawling were recorded during new moon (52.35 and 9.97 kg h-1) and minimum values during full moon quarter (2.5 and 1.63 kg h -1). Larger size groups were dominant during new moon for all species and the differences were significant ($p<0.01$). Significant variations in total catch during different lunar phases were noticed for fishes caught by gillnetting as well as the shrimps caught by trawling (Libini CL and Khan SA. 2012). Bigger fish were caught 4-2 days to full moon and at full moon in the surface fleet, but only 2–4 days after full moon in the shore fleet (Samuel Olu. Otubusin 1990).

The lunar cycle has a direct influence on gonadal maturity of green mussel, *Perna viridis*, in Malampaya Sound, Taytay, Palawan, Philippines. Gonadal changes in both male and female *P. viridis* were observed histologically and both exhibit the characteristic of lunar-synchronous pattern. It was observed that a high number of green mussels with spawning stages usually occur during the full moon and new moon. Furthermore, gonadal maturity was also affected by the tidal fluctuation. A higher number of *P. viridis* with spawning stages were recorded during spring tide, whereas the percentage of spent individuals were higher during neap tides. Furthermore, it was observed in the present study that salinity fluctuation could influence spawning of green mussel, wherein the number of spent individuals increased after the sudden drop in water salinity from 30 to 13 ppt after the heavy rainfall, an indication that spawning had occurred. The presence of individuals with spawning stages was also observed throughout of period of sampling which indicates that mussels were continuously breeding in the area. The highest percentage of individuals having spawning stages were recorded in October and November. The information on the factors that affect gonadal maturation and spawning schedule can help mussel growers predict the schedule of spat fall.(Adzel Adrian Guillen Baldevieso et.al.(2022).

Periods of rapid growth were correlated with lunar phases. New and full moons appear to be associated with periods of lower growth while more rapid growth appears to occur some time midway between new and full moons. The precise phase relationship between growth and lunar phenomenon is difficult to determine from these data, primarily because of the relatively long time between weighings (4

days) (Farbridge, K. J. and Leatherland, J. F. 1987). The lunar cycle is the most obvious environmental factor that might be serving as a *Zeitgeber* for the synchronization of the observed growth rhythm. A biological rhythm may be defined as having a lunar periodicity if the peaks and troughs of the rhythmical process appear once or twice in every lunar month at the same time, that is at the time of a certain lunar phase (Hauenschild, 1961). Bigger fish were caught 4-2 days to full moon and at full moon in the surface fleet, but only 2–4 days after full moon in the shore fleet (Samuel Olu. Otubusin 1990).

CONCLUSION

Total quantity of mysid found more 43608.90 no.i.e.54.31% in waxing period than waning period which found no. i.e. 36692.66 i.e.45.69% of total collection 80301.56. Total average temperature, pH as also salinity found more i.e. 29.53^{0}C, 8.42 and 30.30 ‰ respectively in waxing period than waning period in which it found total average temperature, pH as also salinity was 28.90 ^{0}C, 6.56 and 27.02‰ respectively. It also reveals that total quantity of mysid was more 50080 no. i.e. 62.36% of total collection 80301.56 no. in coastal waters followed by 16729.66 no. i.e. 20.83% in estuarine waters and 13491.90 no. i.e. 16.80% in saltpan waters. The present investigation found due to shallowness of the ecosystem. In Estuarine waters 69.55% specimen obtained in Waxing period followed by 51.44% in Oceanic waters and 46.05% in Saltpan waters. Whereas in Waning period, 53.95% obtained from Saltpan waters followed by 48.56% mysids obtained in oceanic waters and 30.45% from Estuarine waters. It reveals that in all the waters during Waxing period population of mysids was found more than Waning period. The study area in the Coastal, Estuarine and Saltpan waters ecosystem does have a moderate potential for mysids. These observations indicate that there is a lunar influence on population of mysids and also on water parameters eg. temperature, pH and salinity.

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