



ISSN: 0976-3376

Available Online at <http://www.journalajst.com>

ASIAN JOURNAL OF  
SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology  
Vol. 15, Issue, 12, pp. 13233-13242, December, 2024

## RESEARCH ARTICLE

# QUANTITATIVE ANALYSIS OF DIFFERENT STAGES OF EMBRYOS PER BROOD POUCH OF MESOPODOPSIS ORIENTALIS FROM COASTAL, ESTUARINE AND SALTPAN WATERS

\*Sushilkumar B. Chaudhari and Dilip V. Nakhwa

Department of Zoology, The Institute of Science, Mumbai

### ARTICLE INFO

#### Article History:

Received 14<sup>th</sup> September 2024

Received in revised form

28<sup>th</sup> October, 2024

Accepted 17<sup>th</sup> November, 2024

Published online 09<sup>th</sup> December, 2024

#### Keywords:

Opossum shrimps, macro-zooplankton, Ecosystem, fluctuating season wise occurrence, Breeding period, Brood ratio.

### ABSTRACT

Mysids or opossum shrimps are grouped under macro-zooplankton which are used for human consumption. Mysids are harvested using hand trawl made of mosquito netting during low tide period at surface water. The study was carried out on monthly basis from one site from Coastal area, three sites from Mangrove estuarine area and three sites from Saltpan twice a month during May 2016 to December 2017. They show significant variation in their availability in different seasons. All the embryos within a single brood pouch were found at the same stage of development. The development of embryos within the brood pouch divided into three distinct stages as “eggs like embryos”, “eyeless embryos” and “eyed embryos”. Mysids from Coastal waters found more fecund than mysids from other Estuarine waters and Salt pan waters. Brood ratio of “Egg like embryos”, “Eyeless embryos” and “Eyed embryos” also indicates that coastal waters are more productive followed by estuarine waters and salt pan waters.

**Citation:** Sushilkumar B. Chaudhari and Dilip V. Nakhwa. 2024. “Quantitative analysis of different stages of embryos per brood pouch of mesopodopsis orientalis from coastal, Estuarine and Saltpan Waters”, *Asian Journal of Science and Technology*, 15, (12), 13233-13242.

Copyright©2024, Sushilkumar B. Chaudhari and Dilip V. Nakhwa. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## INTRODUCTION

Members of the order Mysidacea are shrimp like crustaceans, commonly called “opossum shrimp”, which refers to the presence of a brood pouch or marsupium in mature female. Fertilization is external. The male sheds the sperm directly into the brood pouch or near to its proximity and is carried to the marsupium by currents. The eggs are shed into the brood pouch where fertilization takes place. The larval development takes place entirely within the marsupium. The development within the marsupium can be divided into three stages as eggs, eyeless larvae and eyed larvae (Mauchline 1971). All the larvae within a single marsupium are at the same stage of development. They are regularly oriented, their heads pointing posteriorly and closely packed together. The duration of marsupial development is related to ambient temperature and salinity and varies with species and ranges from 96 hrs at 25° C -29° C (Nair 1939) to 150 - 270 days at 0.2°C -10°C (Berril 1971; Lasenby and Langford 1972). In general, in colder temperature the length of incubation period is greater than under warmer conditions. Mauchline (1980) has observed that eggs do not occur in the brood pouch since they are fertilized immediately, they are extruded from the oviducts. The early embryos are, therefore, spherical or sub-spherical and their size is closely similar to that of ripe eggs within the oviducts. The number of eggs contained in the brood pouch of a female depends upon her body size, the size of the individual eggs as well as latitudes and the season of the year. A relationship between the increasing body size of the female and increasing number of embryos in the brood pouch has been shown to exist in *Mesopodopsis slaberi* by Macquart-Moulin (1965), in *Metamesopodopsis elongate* by Clutter and Theilacker(1971), in *Mysopodopsis almyra* Price and Vodopich (1979) and

Mauchline(1971, 1973). Mysids species have a short reproductive cycle, which means they can quickly reproduce in vast numbers, and are a potentially useful food source for both wild and cultured organisms (Biju *et al.* 2009). In all species in the order Mysida, the females carry their embryos in the brood pouch or marsupium, a sub thoracic chamber formed by pairs of overlapping oostegites, where juveniles develop until they attain the adult form (Price 2004). Some species breed throughout the year, some produce three or more generations per year, some produce two and some only one generation per year. The present study undertaken to find out quantity of different stages of embryos which will enable to help culturing of mysids which can be used as live feed for aquaculture.

## MATERIALS AND METHODS

### Description of study area:

1. One site from Coastal area, the Back Bay, a shallow bay opposite to Wilson College also called as Girgaon Choupati.
2. Three sites from Mangrove estuarine area (Juchandra, Thane and “Kandalvan” at Mauze – Mulund/Bhandup). This study area is a vast expanse of mangrove habitat and
3. Three sites from Saltpan (Airoli, Vasai and Naigaon) from different parts viz., reservoirs, condensers and crystallizers.

Sampling procedure and data analysis: A plankton collection net was used for the collection of samples during low tide period at surface water in every month manually during May 2016 to December 2017. The study was carried out monthly basis, once in Waxing period (New Moon to Full Moon) and once in Waning period (Full Moon to

New Moon) at Coastal, estuarine and Saltpan waters during May 2016 to December 2017. Samples preserved in 5% buffered formalin. Mysids counted under a stereomicroscope in the laboratory.

**Laboratory work:** Mysids classified into different groups based on the degree of development of secondary sexual characteristics. Sexes can be distinguished by the presence of an extended fourth pleopod in males and the brood pouch in females (Mauchline 1980). The average number of specimens examined fortnightly for the study of breeding and fecundity for embryonic development. A dilute menthol solution was applied to slowly numb sample bodies, and after 10-15 minutes they were fixed with a solution of 4% formaldehyde for 5-10 minutes. The marsupial fecundity was determined by opening with a dissecting needle the pouch of each ovigerous female whose pouch showed no signs of damage.

## RESULTS

The females were divided into three groups, Females carrying 1 "Eggs like embryos". 2 "Eyeless embryos". And 3 "Eyed embryos" in their brood pouches. Nunez-Lecuanda (2013), identified marsupial stages of development. The terminology of Wortham-Neal and Price (2002) in *Americamysis bahia* (Molenock 1969) was used for the description of embryonic stages. (Armando *et al.* 2018).

which was 1-21 no (Table: 1). Among which, maximum "Egg-like embryos" 21 (43.6% of Grand total (ALL waters) maximum "Egg like embryos" 48.16 obtained in all waters) found in the month of October 2017 (Winter) whereas, minimum "Egg like embryos" found 1 (10.34% of Grand total minimum "Egg like embryos" 9.67 obtained in all waters) in the month of July 2016 and June August 2016 (Juchandra) and March, November 2017 (Thane creek) and not a single "Egg like embryos" found in March, April, May, June, August, November and December 2017. (Table: 10). "Eyeless embryo": Eyeless embryos have developing eyes and antennae. The average number of Eyeless embryos found 10.84 (7.47% of total "Egg like embryos" 145.02) with the range of which was 1.07-28.30 no. (Table: 1). Among which, maximum "Eyeless embryo" 28.30 (46.93% of Grand total maximum 60.3 found in the month of November 2016 (Winter) whereas, minimum "Egg like embryos" 1.07 (14.46% of 7.40 Grand total minimum "Egg like embryos" found in the month of April 2017 (Summer). (Table: 10). "Eyed embryo": "Eyed embryo" have fully developed stalked eyes and developing thoracic appendages. The average number of "Eyed embryo" found 11.94 (7.69% of total "Eyed embryo" 155.21) with the range of which was 18.06-17.56 no. (Table: 1). Among which, maximum "Eyed embryo" 17.56 (35.7% of 49.19 Grand total maximum "Eyed embryo" s found in the month of October 2017 (Winter) whereas, minimum "Eyed embryo" 8.06 (66.83% of 12.06 Grand total "Eyed embryo") found in the month of October 2016 (Winter) (Table 10).

**Table 1. Number of broods and Month wise maximum and minimum number of broods in Coastal waters of Girgaon Chowpati**

| Number of Embryos per brood pouch               |                    |                  |                    |                               |                 |               |               |
|---|--------------------|------------------|--------------------|-------------------------------|-----------------|---------------|---------------|
|   | "Eggs"             | Range            | "Eyeless"          | Range                         | "Eyed"          | Range         | Total Broods  |
| Total   | 121.38<br>(28.79%) | 4 - 21           | 145.02<br>(34.40%) | 1.07-<br>28.30                | 155.21 (36.81%) | 8.06-17.56    | 421.51        |
| Average   | 10.11(8.32%)       | 1 - 22           | 10.84(7.47%)       | 2 - 28                        | 11.94(7.69%)    | 1 - 23        |               |
| Brood Ratio                                     | 1                  | :                | 1.20               | :                             | 1.28            |               |               |
| Month wise maximum and minimum number of broods |                    |                  |                    |                               |                 |               |               |
|   | Maximum            |                  |                    |                               | Minimum         |               |               |
| Month   | Eggs               | Eyeless          | Eyed               | Month                         | Eggs            | Eyeless       | Eyed          |
| October 2017                                    | 21 (43.6%)         |                  |                    | July 2017                     | 4 (41.37%)      |               |               |
| November 2016                                   |                    | 28.3<br>(46.93%) |                    | April 2017                    |                 | 1.07 (14.46%) |               |
| October 2017                                    |                    |                  | 17.56 (35.7%)      | October 2016                  |                 |               | 8.06 (66.83%) |
| Grand Total of Maximum broods                   | 48.16              | 60.3             | 49.19              | Grand Total of Minimum broods | 9.67            | 7.40          | 12.06         |
| Maximum broods ratio                            | 1                  | 0.82             | 1.02               | Minimum broods ratio          | 1               | 1.63          | 1.25          |

**Table 2. Number of broods and Month wise maximum and minimum number of broods in Estuarine waters of Juchandra**

| Number of Embryos per brood pouch               |                |                  |                         |                               |                          |               |                    |
|---|----------------|------------------|-------------------------|-------------------------------|--------------------------|---------------|--------------------|
|   | "Eggs"         | Range            | "Eyeless"               | Range                         | "Eyed"                   | Range         | Total Broods Range |
| Total   | 81<br>(50.02%) | 1 - 15           | 41.86<br>(25.85%)       | 4.84 -<br>7.17                | 39.09<br>(24.14%)        | 4.50-7.0      | 161.95             |
| Average   | 8.10<br>(10%)  | 2 - 12           | 5.98(8.15%)<br>(14.29%) | 1 - 18                        | 5.58(14.27%)<br>(14.27%) | 1 - 10        |                    |
| Brood Ratio                                     | 1              | :                | 0.52                    | :                             | 0.48                     |               |                    |
| Month wise maximum and minimum number of broods |                |                  |                         |                               |                          |               |                    |
|   | Maximum        |                  |                         |                               | Minimum                  |               |                    |
| Month   | Eggs           | Eyeless          | Eyed                    | Month                         | Eggs                     | Eyeless       | Eyed               |
| March 2017                                      | 15 (50%)       |                  |                         | July 2016                     | 1 (18.18%)               |               |                    |
| May 2016 and February 2017                      |                | 7.17<br>(19.03%) |                         | March 2017                    |                          | 4.84 (33.24%) |                    |
| April 2017                                      |                |                  | 7 (20.19%)              | June 2016                     |                          |               | 4.5 (30.67%)       |
| Grand Total of Maximum broods                   | 48.16          | 60.3             | 49.19                   | Grand Total of Minimum broods | 9.67                     | 7.40          | 12.06              |

### **Number, Month & Season wise Maximum and Minimum Different Embryos per brood pouch**

**Coastal waters:** Frequency of developmental stages which determines the marsupial fecundity (number of embryos). Such as "Eggs like embryos": Eggs do not occur in the brood pouch since they are fertilized immediately, they are extruded from the oviducts (Nair 1939). The early embryos, however, are spherical or sub-spherical. In coastal waters, the average number of "Egg-like embryos" found 10.11(8.33% of total "Egg like embryos" 121.38) with the range of

**Estuarine waters :** In all estuarine waters of Juchandra, Thane creek and Mulund, out of total "Egg like embryos" 164.89 (24.80% of total broods 665.01), the average number of "Egg like embryos" found to be 5.92(3.59%) with the range of which was 1-16 no.; out of total "Eyeless embryos" 309.02(46.47%) the average number of "Eyeless embryos" found 8.25 (2.66%) with the range 1-28 no. and out of total "Eyed embryos" 191.10 (28.74%), the average number of "Eyed embryos" found 6.96 (3.64%) with the range 1-14 no. (Table 5). Among which, maximum "Egg like embryos" 15 (48.16% of Grand total maximum 48.16 "Egg like embryos" obtained in all waters)

found in the month of March 2017(Juchandra) (Winter) whereas, minimum “Egg like embryos” found 1(18.18% of Grand total minimum “Egg like embryos” 14.56obtained in all waters) in the month of June, July & August 2016 (Juchandra) and March, November 2017(Thane creek)and not a single egg like embryo found in March, April, May, June, August, November and December 2017. (Table 10). “Eyeless embryo”: Eyeless embryos have developing eyes and antennae. The average number of Eyeless embryos found 309.02 (46.46% of total eyeless embryos 665.01) with the range of which was 1-28no.(Table: 5). Among which, maximum “Eyeless embryo”20 (33.17% of Grand total maximum60.30 “Eyeless embryo”) found in the month of May 2016 and August 2017 (Thane creek) whereas, minimum “Eyeless embryo”4 (54.05% of 7.40 Grand total minimum Eyeless embryos found in the month of March 2017 (Thane creek). (Table: 10). “Eyed embryo”: Eyed embryos have fully developed stalked eyes and developing thoracic appendages. The average number of Eyed embryos found 6.96 (3.64% of total “Eyed embryos”191.10) with the range of which was 1-14.(Table: 5). Among which, maximum “Eyed embryos”18 (36.59 % of 34.67Grand total maximum “Eyed embryos” found in the month of January 2017 (Thane creek) (Winter) whereas, minimum “Eyed embryos”3 (24.87% of 12.06 Grand total “Eyed embryo”) found in the month of May 2016 and September 2017 (Thane creek) (Table: 10).

“Eyeless embryo”: Eyeless embryos have developing eyes and antennae. The average number of “Eyeless embryos” found 5.98 (14.28% of total “Eyeless embryos”41.86) with the range of which was 1-18 no. Among which, “Eyeless embryos”7.17(19.03% of Grand total maximum “Eyeless embryos” 60.3) found in the month of May 2016(Summer) and February2017(Winter) whereas, minimum “Eyeless embryos”4.84(65.40% of Grand total minimum “Eyeless embryos” 7.40) found in the month of March 2017(Monsoon) (Table: 2). “Eyed embryo”: Eyed embryos have fully developed stalked eyes and developing thoracic appendages. The average number of “Eyed embryos” found 5.58 (14.27% of total “Eyed embryos”39.09) with the range of which was 1-10no. Among which, maximum “Eyed embryos” 7(14.23% of Grand total maximum “Eyed embryos” 49.19) found in the month of April 2017 (Summer) whereas, minimum “Eyed embryos”1 (10.34 % of Grand total minimum “Eyed embryos” 12.06) found in the month of July 2016 (Monsoon) (Table: 2) In *Estuarine waters* of Thane, the average number of “egg-like embryos” found 2 (13.33% of total egg like embryos 15) with the range of which was 1-5 no. Among which, maximum embryos 4 (8.30% of Grand total maximum48.16) found in the month of September 2017 (Monsoon) whereas, minimum egg like embryos found 1(18.18% of Grand total minimum “Egg-like embryos”9.67) found in the month of June and August 2016 and March and

**Table 3. Number of broods and Month wise maximum and minimum number of broods in Estuarine waters of Thane creek**

| Number of Embryos per brood pouch               |            |             |   |                               |                |            |              |
|---|------------|-------------|---|-------------------------------|----------------|------------|--------------|
|   | "Eggs"     | Range       | "Eyeless"                                   | Range                         | "Eyed"         | Range      | Total Broods |
| Total   | 15 (5.24%) | 1 – 4       | 192.62 (67.27%)                             | 4 – 20                        | 78.72 (27.49%) | 3 – 18     | 286.34       |
| Average   | 2(13%)     | 1 – 5       | 11.33(5.88%)                                | 1 – 25                        | 7.16(9.09%)    | 1 – 14     |              |
| Brood Ratio                                     | 1          | :           | 12.84                                       | :                             | 5.25           |            |              |
| Month wise maximum and minimum number of broods |            |             |   |                               |                |            |              |
|   | Maximum    |             |   | Minimum                       |                |            |              |
| Month   | Eggs       | Eyeless     | Eyed  | Month                         | Eggs           | Eyeless    | Eyed         |
| September 2017                                  | 4 (13.33%) |             | June and August 2016 And March and Nov 2017 | 1 (18.18%)                    |                |            |              |
| May 2016 and August, 2017                       |            | 20 (53.09%) | March 2017                                  |                               | 4 (27.47%)     |            |              |
| January 2017                                    |            |             | 18 (51.92%)                                 | May 2016 and September 2017   |                | 3 (20.45%) |              |
| Grand Total of Maximum broods                   | 48.16      | 60.3        | 49.19                                       | Grand Total of Minimum broods | 9.67           | 7.40       | 12.06        |

**Table 4. Number of broods and Month wise maximum and minimum number of broods in Estuarine waters of Mulund**

| Number of Embryos per brood pouch               |                       |                |                   |                               |                |               |               |
|---|-----------------------|----------------|-------------------|-------------------------------|----------------|---------------|---------------|
|   | "Eggs"                | Range          | "Eyeless"         | Range                         | "Eyed"         | Range         | Total Broods  |
| Total   | 68.89 (31.79%)        | 3.50-11        | 74.54 (34.39%)    | 5.72-10.50                    | 73.29 (33.82%) | 7.17 -9.67    | 216.72        |
| Average   | 7.65(11.10%) (11.11%) | 4 – 16         | 7.45(99.9%) (10%) | 1 – 28                        | 8.14 (11.10%)  | 1 – 14        |               |
| Brood Ratio                                     | 1                     | :              | 1.08              | :                             | 1.06           |               |               |
| Month wise maximum and minimum number of broods |                       |                |                   |                               |                |               |               |
|   | Maximum               |                |                   | Minimum                       |                |               |               |
| Month   | Eggs                  | Eyeless        | Eyed              | Month                         | Eggs           | Eyeless       | Eyed          |
| February 2017                                   | 11(22.84%)            |                |                   | July 16 and March 17          | 3.50 (5.08%)   |               |               |
| November 2016                                   |                       | 10.50 (17.41%) |                   | March 2017                    |                | 5.72 (77.29%) |               |
| November 2016                                   |                       |                | 9.67 (27.89)      | July 2017                     |                |               | 7.17 (48.88%) |
| Total of Maximum brood                          | 30 (100%)             | 37.67 (100%)   | 34.67 (100%)      | Total of Minimum brood        | 5.5 (100%)     | 14.56 (100%)  | 14.67 (100%)  |
| Maximum broods Ratio                            | 1                     | 1.26           | 1.16              | Minimum broods ratio          | 1              | 2.65          | 2.67          |
| Grand Total of Maximum broods                   | 48.16                 | 60.3           | 49.19             | Grand Total of Minimum broods | 9.67           | 7.40          | 12.06         |
| Maximum broods ratio                            | 1                     | 0.82           | 1.02              | Minimum broods ratio          | 1              | 1.63          | 1.25          |

In *Estuarine waters* of Juchandra, the average number of “Egg-like embryos” found 8.10 (10%) of total “Eyed embryos” 81 with the range of which was 2-12 no. Among which, maximum “Eyed embryos”15(31.14% of Grand total maximum “Egg like embryos”) found in the month of March 2017 (Winter) whereas, minimum “Eyed embryos” found 1(10.34% of Grand total minimum “Egg like embryos”) obtained in the month of July 2016 (Monsoon). (Table:2).

November 2017(Monsoon).(Table:3).“Eyeless embryo”: “Eyeless embryos” have developing eyes and antennae. The average number of “Eyeless embryos” found 11.33 (5.88% of total “Eyeless embryos”192.62) with the range of which was 1-25no. Among which, maximum “Eyeless embryos” 20(33.16% of Grand total maximum “Eyeless embryo” 60.3) found in the month of May 2016(Summer)

and August, 2017(Winter) whereas, minimum “Eyeless embryos” found 4(54.05% of Grand total minimum “Eyeless embryos” 7.40) in the month of March 2017(Monsoon) (Table: 3). “Eyed embryo”: Eyed embryos have fully developed stalked eyes and developing thoracic appendages. The average number of “Eyed embryos” found 7.16 (9.09% of total “Eyed embryos”78.72) with the range of which was 1-14. Among which, maximum “Eyed embryos”18(36.59 of Grand total maximum “Eyed embryo” 49.19) found in the month of January 2017(Winter) whereas, minimum “Eyed embryos”3(24.87% of Grand total minimum “Eyed embryos” 12.06) found in the month of May 2016 and September 2017(Monsoon). (Table: 3) In *Estuarine waters* of Mulund, the average number of “Egg-like embryos” found 7.65 (11.10%) of total “Egg-like embryos”68.89) with the range of which was 4-16 no. Among which, maximum “Egg-like embryos”11(22.84% of Grand total maximum “Egg like embryo”48.16) found in the month of February 2017 (Winter) whereas, minimum “Egg-like embryos” found 3.50(9.67% of Grand total minimum “Egg like embryos”) obtained in the month of July 2016 (Monsoon) and March2017 (Summer). (Table: 4).

embryos”9.67(19.65% of Grand total maximum “Eyed embryo” 49.19) found in the month of November 2016 (Winter) whereas, minimum “Eyed embryos”3(24.87% of Grand total minimum “Eyed embryos”7.17) found in the month of July 2017(Monsoon). (Table: 4). In all Estuarine waters, the average number of “Egg like embryo” 5.92 (3.59% of total “Egg like embryos”164.89 (24.80% of total broods 665.01) nos. with the range was found 1-16 nos. found. The average number of “Eyeless embryo” 8.25(2.67 of total “Eyeless embryos”309.02(46.47% of total broods 665.01) nos. with the range was found 1 – 28nos. The average number of “Eyed embryo” 6.96 (3.64 of total “Eyed embryos”191.10 (28.74% of total broods 665.01) nos. with the range was found 1 – 14nos. (Table: 5).

**Saltpan waters:** In all Saltpan waters of Aairoli, Vasai and Naygaon out of total “Egg like embryos”204.77 (34.31% of total broods 596.79), the average number of “Egg like embryos” found to be 6.23 (3.04% of 6.23 total “Egg like embryos”) with the range of which was 2 –18.70 no.; out of total Eyeless embryos 227.02 (38.04%) the average number of “Eyeless embryos” found to be 6.41(2.82% of

**Table 5. Number of broods and Month wise maximum and minimum number of broods in All Estuarine waters of Juchandra, Thane creek and Mulund**

| Number of Embryos per brood pouch in All Estuarine waters of Juchandra, Thane creek and Mulund               |                    |                |                    |   |                    |            |              |
|--|--------------------|----------------|--------------------|---|--------------------|------------|--------------|
|  | "Eggs"             | Range          | "Eyeless"          | Range   | "Eyed"             | Range      | Total Broods |
| Total  | 164.89<br>(24.80%) | 1 – 15         | 309.02<br>(46.47%) | 4 – 20  | 191.10<br>(28.74%) | 3 – 18     | 665.01       |
| Average  | 5.92<br>(3.59%)    | 1 – 16         | 8.25<br>(2.67%)    | 1 – 28  | 6.96<br>(3.64%)    | 1 – 14     |              |
| Brood Ratio  | 1                  | :              | 1.87               | :   | 1.16               |            |              |
| Month wise maximum and minimum number of broods of all estuarine waters of Juchandra, Thane creek and Mulund |                    |                |                    |   |                    |            |              |
| March 2017<br>(Juchandra)  | 15<br>(31.15%)     |                |                    | July 16 and June, August<br>16 (Juchandra)and<br>March Nov17<br>(Thane creek) | 1<br>(10.34%)      |            |              |
| May 2016 and August 2017 (Thane creek)   |                    | 20<br>(33.17%) |                    |   |                    |            |              |
| January 2017 (Thane creek)   |                    |                | 18 (36.59%)        | March 2017 (Thane creek)  |                    | 4 (54.05%) |              |
|  |                    |                |                    | May2016 and September2017(Thane creek)  |                    | 3 (24.88%) |              |
| Grand Total of Maximum broods  | 48.16              | 60.3           | 49.19              | Grand Total of Minimum broods   | 9.67               | 7.40       | 12.06        |

**Table 6. Number of broods and Month wise maximum and minimum number of broods in Saltpan waters of Airoli**

| Number of Embryos per brood pouch   |                |               |             |                               |               |                  |              |
|---|----------------|---------------|-------------|-------------------------------|---------------|------------------|--------------|
|   | "Eggs"         | Range         | "Eyeless"   | Range                         | "Eyed"        | Range            | Total Broods |
| Total   | 50.72 (37.77%) | 3.93-7.50     | 54 (40.22%) | 5.09-6.87                     | 29.54 (22%)   | 1 - 5            | 134.26       |
| Average   | 5.64(11.12%)   | 3 – 10        | 6(11.11%)   | 1 – 16                        | 3.69(12.50%)  | 1 - 12           |              |
| Brood Ratio   | 1              | :             | 1.06        | :                             | 0.58          |                  |              |
| Month wise Maximum and Minimum number of broods Salt pan water area of Airoli |                |               |             |                               |               |                  |              |
|   | Maximum        |               |             | Minimum                       |               |                  |              |
| Month   | Eggs           | Eyeless       | Eyed        | Month                         | Eggs          | Eyeless          | Eyed         |
| June 2017   | 7.50 (15.57%)  |               |             | May and July 2016             | 3.93 (40.60%) |                  |              |
| July 2017   |                | 6.87 (11.39%) |             | June 2016 and May 2107        |               | 5.09<br>(68.78%) |              |
| July 2016, February and June 2017   |                |               | 5(20.3%)    | May 2016 and March 2017       |               |                  | 1 (11.59%)   |
| Grand Total of Maximum broods   | 48.16          | 60.3          | 49.19       | Grand Total of Minimum broods | 9.67          | 7.40             | 12.06        |
| Maximum broods ratio  | 1              | 0.82          | 1.02        | Minimum broods ratio          | 1             | 1.63             | 1.25         |

“Eyeless embryo”: Eyeless embryos” have developing eyes and antennae. The average number of “Eyeless embryos” found 7.45 (99.9% of total “Eyeless embryos”74.54) with the range of which was 1-28no. Among which, maximum “Eyeless embryos”10.50 (17.41% of Grand total maximum “Eyeless embryo” 60.3) found in the month of November 2016 (Winter) whereas, minimum “Eyeless embryos” found 5.72 (77.29% of Grand total minimum “Eyeless embryos” 7.40) in the month of March 2017(Monsoon) (Table: 4). “Eyed embryo”: Eyed embryos have fully developed stalked eyes and developing thoracic appendages. The average number of “Eyed embryos” found 8.14 (11.10% of total “Eyed embryos”73.29) with the range of which was 1-14. Among which, maximum “Eyed

total Eyeless embryos with the range 1-25 no. and out of total Eyed embryos 165(27.65%), the average number of “Eyed embryos” found 5.32 (3.32% of total “Eyeless embryos”) with the range 3.69-8.34 no. (Table: 9). Among which, maximum “Egg like embryos”12.16 (25.25% of Grand total maximum “Egg like embryos”48.16) found in the month of May and Oct 2016 and July 2017(Vasai) whereas, minimum “Egg like embryos” found 3.67(37.95%) in the month June, August2016 and July 2017 (Vasai); maximum “Eyeless embryos” embryos 12 (19.90% of maximum Grand total “Eyeless embryos” 60.3) found in the month of May 2016 and June 2017 (Naigaon) whereas, minimum “Eyeless embryos” found 2.33 (31.49% of Grand total 7.40) in the month of April 2017 (Naigaon).

**Table 7. Number of broods and Month wise maximum and minimum number of broods in Saltpan waters of Vasai**

| Number of Embryos per brood pouch  |                     |               |                     |                                  |                     |               |               |
|--|---------------------|---------------|---------------------|----------------------------------|---------------------|---------------|---------------|
|  | "Eggs"              | Range         | "Eyeless"           | Range                            | "Eyed"              | Range         | Total Broods  |
| Total  | 102.34 (31.40%)     | 3.67-12.16    | 123.37 (37.86%)     | 5.75-10.61                       | 100.12 (30.73%)     | 6.63-13.63    | 325.83        |
| Average  | 7.31(7.14%) (7.14%) | 2 – 19        | 7.71(6.25%) (6.25%) | 1 – 25                           | 8.34(8.33%) (8.33%) | 1 – 15        |               |
| Brood Ratio  | 1                   | :             | 1.21                | :                                | 0.98                |               |               |
| Month wise Maximum and Minimum number of broods Salt pan water area of Vasai |                     |               |                     |                                  |                     |               |               |
|  | Maximum             |               |                     |                                  | Minimum             |               |               |
| Month  | Eggs                | Eyeless       | Eyed                | Month                            | Eggs                | Eyeless       | Eyed          |
| May & October 2016 And February 2017   | 12.16 (41.96%)      |               |                     | June, August 2016 and July, 2017 | 3.67 (37.95%)       |               |               |
| February 2017  |                     | 10.61 (35.7%) |                     |                                  |                     |               |               |
| June 2016 and February 17  |                     |               | 13.63 (55.34%)      | June 2016 and March 2017         |                     | 5.75 (43.66%) |               |
|  |                     |               |                     | March 2017                       |                     |               | 6.63 (76.83%) |
| Grand Total of Maximum broods  | 48.16               | 60.3          | 49.19               | Grand Total of Minimum broods    | 9.67                | 7.40          | 12.06         |
| Maximum broods ratio   | 1                   | 0.82          | 1.02                | Minimum broods ratio             | 1                   | 1.63          | 1.25          |

**Table 8. Number of broods and Month wise maximum and minimum number of broods in Saltpan waters of Naigaon**

| Number of Embryos per brood pouch  |                |             |                |                               |                |         |               |
|--|----------------|-------------|----------------|-------------------------------|----------------|---------|---------------|
|  | "Eggs"         | Range       | "Eyeless"      | Range                         | "Eyed"         | Range   | Total Broods  |
| Total  | 51.71 (37.83%) | 4.24-9.67   | 49.65 (36.32%) | 2.33-12.00                    | 35.34 (25.85%) | 1 - 6   | 136.7         |
| Average  | 5.75 (11.11)   | 8.20-18.70  | 5.52 (11.12%)  | 4.69-24.17                    | 3.93 (11.12%)  | 1 – 10  |               |
| Brood Ratio  | 1              |             | 0.96           |                               | 0.68           |         |               |
| Month wise Maximum and Minimum number of broods Salt pan water area of Naigaon |                |             |                |                               |                |         |               |
|  | Maximum        |             |                |                               | Minimum        |         |               |
| Month  | Eggs           | Eyeless     | Eyed           | Month                         | Eggs           | Eyeless | Eyed          |
| June 2016 and March 2017   | 9.67 (20.07%)  |             |                | May 2016                      | 4.24 (8.61%)   |         |               |
| May 2016 and June 2017   |                | 12 (19.90%) |                | April 2017                    |                |         | 2.33 (31.48%) |
| May and August, 2016   |                |             | 6 (12.19%)     | June 2016 and July 2017       |                |         | 1 (8.29%)     |
| Total of Maximum broods  | 29.33          | 29.72       | 24.63          | Total of Minimum broods       |                |         | 11.84         |
| Grand Total of Maximum broods  | 48.16          | 60.3        | 49.19          | Grand Total of Minimum broods | 9.67           | 7.40    | 12.06         |

**Table 9. Number of broods and Month wise maximum and minimum number of broods in All Salt pan waters of Aioli, Vasai and Naigaon**

| Number of Embryos per brood pouch in All Salt pan waters of Aioli, Vasai and Naigaon               |                 |             |                 |  |               |           | Total Broods |
|--|-----------------|-------------|-----------------|--|---------------|-----------|--------------|
| Total  | 204.77 (34.31%) | 3.67-12.16  | 227.02 (38.04%) | 2.33- 12.00  | 165 (27.65%)  | 1 – 13.63 | 596.79       |
| Average  | 6.23 (3.04%)    | 2 - 18.70   | 6.41 (2.82%)    | 1 - 25   | 5.32 (3.22%)  | 3.69-8.34 |              |
| Brood Ratio  | 1               | :           | 1.11            | :  | 0.81          |           |              |
| Month wise maximum and minimum number of broods in All Salt pan waters of Aioli, Vasai and Naigaon |                 |             |                 |  |               |           |              |
| May & October 2016 and July 2017(Vasai)  | 12.16 (25.25%)  |             |                 | June, August 2016 and July 2017(Vasai)                               | 3.67 (37.95%) |           |              |
| May 2016 and June 2017 (Naigaon)   |                 | 12 (19.90%) |                 | April 2017 (Naigaon)   |               |           | 2.33 31.49%) |
| June 2016 and February 2017(Vasai)   |                 |             | 13.63 (27.71%)  | May 2016 and March 2017 (Aioli) and June 2016 and June 2017(Naigaon) |               |           | 1 (8.29%)    |
| Grand Total of Maximum broods  | 48.16           | 60.3        | 49.19           | Grand Total of Minimum broods  | 9.67          | 7.40      | 12.06        |

As regards, “Eyed embryos” maximum 13.63 (27.91% of maximum Grand total “Eyed embryos 49.19) found in the month of June 2016 and February 2017 (Vasai) whereas, minimum “Eyed embryos” found 1(8.29% of minimum Grand total “Eyed embryos” 12.06) in the month of May 2016 and March 2017 (Aioli) and June 2016 and June 2017 (Naigaon). (Table: 9) In *Saltpan waters* of Aioli the average number of “Egg like embryos” found 5.64 (11.11%) of total “Egg like embryos” 50.72 (37.77% of total broods 134.26) with the range of which was 3-10 no. Among which, maximum “Egg like embryos” 7.50(15.57% of Grand total maximum “Egg like embryos” 48.16) found in the month of June 2017 (Monsoon) whereas, minimum “Egg like embryos” found 3.93(40.60%% of Ground total minimum “Egg like embryos”9.67) in the month of May (Summer)and July 2016 (Monsoon). (Table: 6).

“Eyeless embryos”: In *Saltpan waters* of Aioli the average number of “Eyeless embryos” found 6 (11.11%) of total “Eyeless embryos” 54(40.22% of total broods 134.26) with the range of 1-16. Among which, maximum “Eyeless embryos” found 6.87 (11.39% of Grand total maximum “Eyeless embryos” 60.3) with the range 1-16 found in the month of July 2017(Monsoon) whereas, minimum “Eyeless embryos” 5.09 (68.78% of Grand total minimum “Eyeless embryos” 7.40) found in the month of June 2016 (Monsoon) and May 2107 (Summer). (Table:6). “Eyed embryo”: Eyed embryos have fully developed stalked eyes and developing thoracic appendages. The average number of “Eyed embryos” found 3.69(12.50% of total “Eyed embryos”29.54) with the range of which was 1-12. Among which, maximum “Eyed embryos”9.67(68.78% of Grand total maximum “Eyed embryo”60.3) found in the month of July

2107(Monsoon) whereas, minimum Eyed embryos 1(11.59% of Grand total minimum "Eyed embryos"12.06) found in the month of May 2016 and March 2017(Summer).(Table:6) In *Saltpan waters* of Vasai, the average number of "Egg like embryos" found 7.31(7.14% of total "Egg like embryos" 102.34) with the range of which was 2-19 no. Among which, maximum "Egg like embryos"12.16(41.93% of Grand total maximum "Egg like embryos" 48.16) found in the month of May (Summer) & October 2016 (Winter) and February 2017(Summer) whereas, minimum "Egg like embryos found 3.67(37.95% of Grand total minimum "Egg like embryos"9.67) in the month June (Monsoon), August 2016 (Monsoon).And July 2017 (Monsoon) (Table:7). "Eyeless embryo": Eyeless embryos have developing eyes and antennae. The average number of Eyeless embryos found 7.71(6.25% of total Eyeless embryos 123.37) with the range of which was 1-25no. Among which, maximum "Eyeless embryos"10.61 (35.7% of Grand total maximum "Eyeless embryo" 60.3) found in the month of February, 2017 (Summer) whereas, minimum Eyeless embryos found 5.75(43.66% of Grand total minimum "Eyeless embryos" 7.40)obtained in the month of June 2016 and March 2017 (Table: 7). "Eyed embryo": "Eyed embryos" have fully developed stalked eyes and developing thoracic appendages. The average number of "Eyed embryos" found 8.34(8.33% of total "Eyed embryos"100.12(30.73% of total broods 325.83) with the range of which was 1-15. Among which, maximum "Eyed embryos"13.63(55.34%% of Grand total maximum "Eyed embryo" 49.19) found in the month of June 2016 and February 17, February (Summer) whereas, minimum "Eyed embryos"6.63(76.83% of Grand total minimum "Eyed embryos" 12.06) found in the month of March 2017(Summer). (Table 7).

"Egg like embryos": In *Saltpan waters* of Naigaon, the average number of "Egg-like embryos" found 5.75(11.11% of total "Egg like embryos"51.71(37.83% of total broods 136.7) with the range of which was 8.20-24.17 no. Among which, maximum "Egg like embryos"9.67(20.27% of Total Grand maximum "Egg like embryos" 48.16)found in the month June 2016 (Monsoon) and March 2017(Summer) whereas, minimum "Egg like embryos" found 4.24 (8.61% of Total Grand minimum "Egg like embryos" 9.67) found in the month May 2016 (Monsoon).(Table:8). "Eyeless embryo": Eyeless embryos have developing eyes and antennae. The average number of Eyeless embryos found 5.52 (11.12 of total "Eyeless embryos"49.65 (36.32% of total broods 136.7) with the range of which was 4.69-24.17no. Among which, maximum "Eyeless embryos"12(1.90% of Grand total maximum "Eyeless embryo" 60.3)found in the month of May 2016 (Summer) and June 2017 (Monsoon) whereas, minimum Eyeless embryos found 2.33(31.48% of Grand total minimum "Eyeless embryos" 7.40)in the month of April 2017(Summer) (Table: 8). "Eyed embryo": Eyed embryos have fully developed stalked eyes and developing thoracic appendages. The average number of "Eyed embryos" found 3.93 (11.12% of total "Eyed embryos"35.34(25.85% of total broods 136.7) with the range of which was 1-10no. Among which, maximum "Eyed embryos"6 (12.19% of Total Grand maximum "Eyed embryos"49.19) found in the month of May (Summer) and August 2016 (Monsoon), whereas, minimum "Eyed embryos"1 (8.29% of Total Grand minimum "Eyed embryos 12.06) found in the month of June 2016 and July 2017 (Monsoon) (Table: 8) In all Saltpan waters, the average number of "Egg like embryo" 6.23 (3.04% of total "Egg like embryos"204.77) nos. with the range was found 2-18.70nos. The average number of "Eyeless embryo" 6.41(2.82 of total Eyeless embryos 227.02 (38.04% of total broods 596.79) nos. with the range was found 1 – 25 nos. The average number of "Eyed embryo" 5.32 (3.22% of total eyeless embryos 165 (27.65 % of total broods 596.76) nos. with the range was found 3.69-8.34nos. (Table: 9).

**All waters of Coast, Estuaries and Salt pans:** Month and season wise average maximum & minimum number of total different broods in relation to total broods in All waters of Coast, Estuaries and Salt pans:

"Egg like embryos" In all waters, out of total "Egg like embryos"491.04 (29.17% of total broods 1683.41), the average

number of Egg-like embryos found to be 7.42 (1.51% of total "Egg like embryos" 491.04) with the range of which was 1–22 no.; Among which, maximum "Egg like embryos"21(43.6% of Grand Total maximum "Egg like embryos" 48.16)found in the month June & October 2017 (Winter) in Coast whereas, minimum "Egg like embryos" found 1(10.34% of Total Grand minimum "Egg like embryos" 9.67 found in the month June, July & August 2016 (Monsoon) in Juchandra) and March, November 2017 (Winter) in Thane Creek).(Table:10). "Eyeless embryos": In all waters, out of total "Eyeless embryos" 681.06 (40.45% of total broods 1683.41), the average number of Eyeless embryos found to be 8.25(1.21% of total Eyeless embryos 681.06) with the range 1-28 no. Among which, maximum "Eyeless embryo" 28.3(46.93% of Grand total maximum "Eyeless embryo" 60.3) found in the month of November 2016 (Winter) in Coast whereas, minimum "Eyeless embryos" found 1.07(14.46% of Grand total minimum "Eyeless embryos" 7.40)in the month of April 2017 (Summer) in Coast(Table: 10). "Eyed embryos": In all waters, out of total "Eyed embryos 511.31 (30.37% of total broods 1683.41), the average number of "Eyed embryos" found 8.07(1.57% of total "Eyed embryos" 511.31(30.37% of total broods 1683.41) with the range 1-23 no. Among which, maximum "Eyed embryos"18 (36.59% of Grand total maximum "Eyed embryo"49.19)found in the month of January 2017 (Winter) in Thane Creek-Estuary whereas, minimum Eyed embryos found 1(8.29%)of Grand total minimum "Eyed embryos" 12.06)found in the month of May 2016 and March 2017 (Summer) and June 2016 and June 2017(Monsoon) in Salt pans(Table: 10).

Sample stations wise average number of different embryos in all waters:

1)"Egg like embryos": In Coastal waters, the average number of "Egg like embryos" 8.1 (8.32% of total "Egg like embryos"121.38 (28.79% of total broods) found with the range of nos was found 1 – 22 nos. The average number of "Egg like embryos" 8.10 (10% of total Egg like embryos 81(50.01% of total broods) nos. with the range was found 2-12nos. in Estuarine waters of Juchandra. (Table: 2). In estuarine waters of Thane-Creek, the average number of "Egg like embryos" 2(13% of total "Egg like embryos"15 (5.24%) of total broods) nos. with the range found 1-5nos. (Table: 3).In estuarine waters of Mulund, the average number of "Egg like embryos" 7.65(11.10% of total Egg like embryos 68.89(31.79%) of 216.72 total broods) nos. with the range was found 4-6nos. (Table:4).The average number of "Eyeless embryo" 11.33 (5.88% of total "Eyeless embryos" 192.62) nos. with the range of nos was found 1 – 25 nos. in Estuarine waters of Thane creek. The average number of "Eyeless embryo" 7.45(10% of total eyeless embryos 74.54) nos. with the range was found 1 – 28 nos. in Estuarine waters of Mulund. (Table: 4). In all saltpan waters, the average number of "Egg like embryos"6.23(3.04% of total "Egg like embryos" 204.77(34.31% of total broods 596.79)found with the range was found 2-18.70. In Salt pan waters of Airoli, the average number of "Egg like embryos"5.64(11.12% of 50.72 (37.77%) of total broods 134.26) with the range of nos was found 3 – 10. In saltpan waters of Vasai, the average number of "Egg like embryos" found 7.31(7.14% total broods 102.34(31.40% of total broods) with the range 2-19 and in saltpan waters of Nagaon the average number of "Egg like embryos" found 5.75(11.11% of total embryos 51.71(37.83% of 51.71 total broods) with the range 8.20-18.70 found. "Eyeless embryos": In all saltpan waters, the average number of "Eyeless embryos"6.41(2.82% of total "Eyeless embryos" 227.02 (38.04% of total broods 596.79) found with the range 1-25. In saltpan waters of Airoli, the average number of "Eyeless embryos" found 6(11.11% of 54(40.22%) of 134.26 total broods) with the range 1-16. In saltpan waters of Vasai, the average number of "Eyeless embryos" found 7.71(6.25% of total "Eyeless embryos" of 134.26 total broods) with the range 1-25 and in saltpan waters of Nagaon the average number of "Eyeless embryos"5.52(11.12% of total "Eyeless embryos" 49.65 (36.32% of total broods 136.7 found with the range 4.69-24.17. "Eyed embryos": In all saltpan waters, the average number of "Eyed embryos"5.32(3.22% of total "Eyed embryos" 165 (27.65% of total

broods 596.79) found with the range 3.69-8.34. In saltpan waters of Airoli, the average number of "Eyed embryos" observed 3.69(12.50%) of 29.54(22%) of total "Eyed embryos"134.26 found with the range 1-12. In saltpan waters of Vasai, the average number of "Eyed embryos" found 8.34(8.33%) of total "Eyed embryos" 100.12(30.73% of total broods 325.83) with the range 1-15. In saltpan waters of Naigaon, the average number of "Eyed embryos" found 3.93(11.12%) of total "Eyed embryos" 35.34(25.85% of total broods 136.7) with the range 1-10.

developmental stage of *M.orientalis* has been found to be 11.94 (7.69% of total "Eyed embryos" 155.21(36.81%) of total broods 421.51) with the range of which was 1-23no. in coastal waters (Table:1). In Estuarine waters of Juchandra, Thane and Mulund, 6.96(3.64% of total "Eyed embryos" was the average no among the range of 1-4 no of "Eyed embryos". (Table: 5). Whereas in Saltpan waters of Aairoli, Vasai and Naygaon, 3.93(11.12% of total "Eyed embryos" 35.34(25.85% of total broods 136.7) was the average no with the range of which was 1-10 nos. "Eyed" embryos"(Table: 8)

**Table 10. Number of broods and Month wise maximum and minimum number of broods in All waters of Coast, Estuaries and Salt pans**

| Number of Embryos per brood pouch from All waters of Coast, Estuaries and Salt pans |                    |                  |                    |  |                    |                  |              |
|---|--------------------|------------------|--------------------|--|--------------------|------------------|--------------|
|   | "Eggs"             | Range            | "Eyeless"          | Range  | "Eyed"             | Range            | Total Broods |
| Number of Embryos per brood pouch in All waters of Coast, Estuaries and Salt pans   |                    |                  |                    |  |                    |                  |              |
| Total   | 491.04<br>(29.17%) | 1 - 15           | 681.06<br>(57.12%) | 1.07-<br>28.30   | 511.31<br>(42.88%) | 3 - 18           | 1683.41      |
| Average   | 7.42(1.51%)        | 1 - 22           | 7.67(1.12%)        | 1 - 28   | 8.07(1.57%)        | 1 - 23           |              |
| Brood Ratio   | 1                  | :                | 1.39               | :  | 1.04               |                  |              |
| Month wise maximum and minimum number of broods in Coast, Estuaries and Salt pans   |                    |                  |                    |  |                    |                  |              |
| Maximum broods  |                    |                  |                    | Minimum broods   |                    |                  |              |
| Months  | Eggs               | Eyeless          | Eyed               | Months   | Eggs               | Eyeless          | Eyed         |
| October 2017<br>(Coast)   | 21<br>(43.6%)      |                  |                    | July 16 and June August16<br>(Juchandra)and<br>March, November 2017<br>(Thane creek) | 1<br>(10.34%)      |                  |              |
| November 2016 (Coast)   |                    | 28.3<br>(46.93%) |                    | April 2017(Coast)  |                    | 1.07<br>(14.46%) |              |
| January 2017 (Thane Creek-Estuary)  |                    |                  | 18<br>(36.59%)     | May 2016 and March 2017<br>and June 16 and June 2017(Salt pans)                      |                    |                  | 1<br>(8.29%) |
| Grand Total of Maximum<br>broods  | 48.16              | 60.3             | 49.19              | Grand Total of Minimum<br>broods   | 9.67               | 7.40             | 12.06        |
| Maximum broods ratio  | 1                  | 0.82             | 1.02               | Minimum broods ratio   | 1                  | 1.63             | 1.25         |

2) "Eyeless embryo": Eyeless embryos have developing eyes and antennae. In Coastal waters, the average number of "Eyeless embryo" 10.84(7.47% of total "Eyeless embryos"145.02(34.34% of total broods 21.51) with the range of nos was found 2 – 28 nos. (Table: 1) The average number of "Eyeless embryo" 5.98(14.28% of total "Eyeless embryos"41.86(25.85% of total broods 161.95) nos. with the range of nos was found 1 – 18 nos. in Estuarine waters of Juchandra. (Table: 2)The average number of "Eyeless embryo" 11.33(5.88% of total "Eyeless embryos" 192.62(67.27% of total broods 286.34) nos. with the range of nos was found 1 – 25 nos. in Estuarine waters of Thane creek. (Table: 3)The average number of "Eyeless embryo" 7.45(99.9 % of total eyeless embryos 74.54(34.39% of total broods 216.72) nos. with the range found 1 – 28 nos. in Estuarine waters of Mulund.(Table: 4). In Estuarine waters of Juchandra, Thane and Mulund, an average no. of "Eyeless embryo"was found 8.25 (2.67%of total "Eye less embryos" 309.02 (46.47%) of total broods 665.01) with the range of which was shown 1-28 nos. (Table: 5) Whereas in Saltpan waters of Aairoli, Vasai and Naigaon an average no was found 6.41(2.82% of total "Eye less embryos" 227.02 (38.04% of total broods 596.79) with the range of which was 1-25 nos. (Table: 9).

3) "Eyed embryo": Eyed embryos have fully developed stalked eyes and developing thoracic appendages. The average number of Eyed embryonic developmental stage of *M.orientalis* has been found 11.94 (7.69% of total "Eyed embryos" 155.21(36.81%) of total broods 421.51) with the range of which was 1-23no. in coastal waters.(Table:1). "Eyed embryos" as average no.5.58 (14.27% of total "Eyed embryos" 39.09(24.14% of total broods 161.95 with the range of 1–10 no. found in Estuarine waters of Juchandra (Table: 2). In Estuarine waters of Thane creek7.16nos.(9.09% of total "Eyed embryos" 78.72(27.79% of total broods 286.34) of "Eyed embryos" as average no with the range of 1–14 no. found (Table: 3).In Estuarine waters of Mululnd8.14 nos.(11.10 of total "Eyed embryos" 73.29(33.82% of total broods 216.72) as average no with the range of 1 – 14 no. found. (Table: 4). The average number of Eyed embryonic

Brood ratio of "Egg like embryos", "Eyeless embryos" and "Eyed embryos" also indicates that coastal waters are more productive followed by estuarine waters and salt pan waters.

Brood Ratio of "Egg like embryos", "Eyeless embryos" and "Eyed embryos"

| Waters               | "Egg like embryos" | "Eyeless embryos" | "Eyed embryos" | "Eyeless embryos" | "Eyed embryos" |
|----------------------|--------------------|-------------------|----------------|-------------------|----------------|
| Coast(Table:1)       | 1                  | 1.2               | 1.28           |                   |                |
| Estuaries(Table: 5)  | 1                  | 1.87              | 1.16           |                   |                |
| Salt pans (Table: 9) | 1                  | 1.11              | 0.81           |                   |                |

## DISCUSSION

Embryonic development: The embryonic development of mysids takes place entirely within the brood pouch, Nair (1939). All the embryos within a single brood pouch were found at the same stage of development. The development of embryos within the brood pouch is usually divided into three distinct stages as "eggs", "eyeless embryos" and "eyed embryos"(Nair 1939, Matsudaira *et al* 1952, Davis 1966, Mauchline 1973). *Mesopodopsis orientalis* breed throughout the year but there is a seasonal variation in the intensity of breeding. (Biju A and Panampunnal S.U.2011). *M. orientalis* shows variation in their seasonality in abundance with respect to different population. For example, in Cochin backwaters, abundance of this species associated with monsoon period (Biju *et al.*, 2009) while in Hooghly estuary, the periodicity in abundance of *M.orientalis* weakly correlated with the monsoon season (Sarkar and Choudhary1986). *Mesopodopsis orientalis* breed throughout the year but there is a seasonal variation in the intensity of breeding. The species produced more than one generation per year and the number of embryos carried by a single female ranged from 5 – 25. (Parab and Nakhwa, 2019). The size of mature males and females was at maximum during the post-monsoon period. The species produced more than one generation per year and the number of embryos carried by a single female ranged from 6–18, and was correlated with female body length (R2 = 0.69). Egg size

varied between 0.32 and 0.45 mm, with no correlation with length of females. (A. Biju and S.U. Panampunnayil, 2011). No correlation between the length of females and fecundity was found. (Armando ORTEGA Salaset. Al., 2018). Seasonal variation found in the distribution of *M.orientalis*. High abundance of mysids observed in pre-monsoon period in coastal waters. Whereas, summer season found favourable for mysids in estuarine waters as also in saltpan waters when maximum quantity of mysids observed. Winter season found most favourable and monsoon found least favourable for total mysids in all waters.

**Brood Ratio of “Egg like embryos”, “Eyeless embryos” and “Eyed embryos”:** In coastal waters brood ratio found 1: 1.2: 1.28. (Table: 1). Whereas in all estuarine waters broods ratio found 1: 1.87: 1.16 (Table: 5) of which Thane creek waters found more productive followed by Mulund and Juchandra respectively (Table: 3 & Table: 4) and in all salt pan waters broods ratio found 1: 1.11: 0.81 (Table: 9) of which Vasai salt pans waters found more productive followed by Naigaon and Airoli respectively. As regards all waters of coast, estuaries and salt pans broods ratio found 1: 1.39: 1.04 of which coastal waters found more productive followed by estuarine and salt pan waters respectively. Month and Season wise Maximum and Minimum broods: As regards month and season wise maximum and minimum broods, in the Coastal waters maximum “Egg like embryos” observed in the month of October 2017 (Winter). Maximum “Eyeless embryos” found in during November 2016 (Winter) and maximum “eyed embryos” found in October 2017 (Winter), whereas minimum “Egg like embryos”, “Eyeless embryos” and “Eyed embryos” per brood pouch found in July 2017 (Monsoon), April 2017 (Summer) and October 2016 (Winter) respectively. (Table: 1) In Estuarine waters of Juchandra, the maximum “Eyeless embryos” found during May 2016 (Summer) and February 2017 (Winter). Maximum “Eyed embryos” found in April 2017 (Winter), whereas Minimum “egg like embryos” observed in March 2017 (Summer), “Eyeless embryos” and “Eyed embryos” per brood pouch were noticed in July 2016 (Monsoon), March, 2017 (Summer) and June 2016 (Monsoon) respectively. (Table: 2)

In Estuarine waters of Thane creek, the maximum “Eyeless embryos” 20 (10.38% of total no 192.62) found in the brood pouch during May 2016 (Winter) and August 2017 (Monsoon). Maximum “Eyed embryos” found in January 2017 (Winter) and maximum “Eggs like embryos” found in the month of September 2017 (Monsoon). Whereas minimum “Egg like embryo”, “Eyeless embryos” and “Eyed embryos” found in June 2016 (Monsoon), August 2016 (Monsoon), March (Summer) and November 2017 (Winter), March, 2017 (Summer) and September 2017 (Monsoon) respectively. (Table: 3) In Estuarine waters of Mulund, the maximum “eyeless embryos” found in the brood pouch during November 2016 (Winter). Maximum “eyed embryos” found in November 2016 (Winter), and “eggs” were observed in the brood pouch in February 2017 (Winter). Whereas minimum “Eggs like embryos”, “Eyeless embryos” and “Eyed embryos” per brood found in July 2016 (Monsoon) and March 2017 (Summer), March 2017 (Summer) and July 2017 (Monsoon) respectively. (Table: 4) In all the estuarine water areas of Juchandra, Thane creek and Mulund sample areas wise total maximum and minimum broods per brood pouch viz., “Egg like embryos”, “Eyeless embryos” and “Eyed embryos”. (Table: 2 - 4). Maximum “Egg like embryos” found in Juchandra in the month of March, 2017 (Summer) followed by Mulund estuarine waters in the month of February 2017 (Winter) then Thane creek in the month of September 2017 (Late monsoon). Maximum “Eyeless embryos” found in Thane creek in the months of May 2016 (Summer) and August 2017 (Monsoon) followed by Mulund estuarine waters in the month of November 2016 (Winter) then Juchandra in the months of May 2016 (Summer) and February 2017 (Winter) and Maximum “Eyed embryos” found in Thane creek in the month of January 2017 (Winter) followed by Mulund in the month of November 2016 (Winter) then Juchandra in April 2017 (Summer). Minimum broods: Minimum “Egg like embryos” found in Juchandra as also Thane creek in the months of July 2016 (Monsoon) and June, August 2016 (Monsoon) and March (Summer), November 2017 (Winter) respectively followed by Mulund in the months of July

2016 (Monsoon) and March 2017 (Summer). Minimum “Eyeless embryos” found in Thane creek in the month of March 2017 (Summer) followed by Juchandra in the month of March 2017 (Summer) then Mulund in the month of March 2017 (Summer). Minimum “Eyed embryos” found in Thane in the month of May 2016 (Summer) and September 2017 (Monsoon) followed by Juchandra in the month of June 2016 (Monsoon) then Mulund in the month of July 2017 (Monsoon). (Tale: 2-4) In all these estuarine water areas Maximum “Egg like embryos” found in Juchandra in the month of March 2017 (Summer), Maximum “Eyeless embryos” found in Thane creek in the months of May 2016 (Summer) and August 2017 (Monsoon) and Maximum “Eyed embryos” found in Thane creek in the month of January 2017 (Winter) whereas Minimum “Egg like embryos” found in Juchandra and Thane creek in the months of June, August 2016 (Monsoon) and March (Summer), November 2017. The above observations clearly indicate that mysids from Thane creek found more fecund than mysids from other estuarine waters viz., Juchandra and Mulund. (Table: 2-4) In Salt pan waters of Airoli, maximum “Eyeless embryos” observed in the brood pouch found during July 2017 (Monsoon). Maximum number of “Eyed embryos” found in July 2016 (Monsoon), February (Winter) and June 2017 (Monsoon), whereas “Egg like embryos” found in June 2017 (Early summer) and minimum “egg like embryos”, “eyeless embryos” and “eyed embryos” per brood pouch found in May (Summer) and July (Monsoon) 2016 and May 2017 (Summer), June 2016 (Summer) and May 2017 (Summer) and May 2016 (Summer) and March 2017 (Summer) respectively. (Table: 6)

In Salt pan waters of Vasai, Maximum “Eyeless embryos” found in the brood pouch during February 2017 (Winter). Maximum number of “Eyed embryos” found in June 2016 (Monsoon) and February 2017 (Winter) and maximum “Egg like embryos” found in May (Summer) and October (Winter) 2016 and February 2017 (Summer), whereas minimum “Egg like embryos”, “Eyeless embryos”, and “Eyed embryos” per brood pouch found in June, August, 2016 (Monsoon) and July 2017 (Monsoon), June 2016 (Monsoon) and March 2017 (Summer) and March 2017 (Summer) respectively. (Table: 7) In Salt pan waters of Naigaon, Maximum “Eyeless embryos” found in the brood pouch during May 2016 (Summer) and June 2017 (Monsoon). Maximum “Eyed embryos” found in May (Summer) and August (Monsoon) 2016 and March (Summer) and August (Monsoon) and “Egg like embryos” found in June 2016 (Monsoon) and March 2017 (Summer). Whereas minimum “Egg like embryos”, “Eyeless embryos”, and “Eyed embryos” per brood pouch found in May 2016 (Summer), April 2017 (Summer), and June 2016 and July 2017 (Monsoon) respectively. (Table: 8) In all the salt pan waters of Airoli, Vasai and Naigaon sample area wise total maximum and minimum broods per brood pouch viz., “Egg like embryos”, “Eyeless embryos” and “Eyed embryos”. (Table: 6-8). Maximum “Egg like embryos” found in Vasai in the month of May (Summer) and October (Winter) 2016 and February 2017 (Winter) followed by Naigaon salt pan waters in the month of June 2016 and March 2017 and Airoli salt pans in the month of June 2017 (Monsoon). Maximum “Eyeless embryos” found in Naigaon in the months of May 2016 (Summer) and June 2017 (Monsoon) followed by Vasai salt pan waters in the month of February 2017 (Summer) and Airoli in the months of June 2017 (Monsoon) and Maximum “eyed embryos” found in Vasai in the month of June 2016 (Monsoon) and February 17 (Summer) followed by 6 (24.36%) Naigaon in the month of May and August 2016 and Airoli in the months of July 2016 (Monsoon), February (Early summer) and June 2017 (Monsoon). While Minimum broods, Minimum “Egg like embryos” found in Vasai in the months of June, August 2016 and July 2017 (Monsoon) followed by Airoli in the months of May (Summer) and July (Monsoon) 2016 and Naigaon in the month of May 2016 (Summer). Minimum “eyeless embryos” found in Naigaon in the month of April 2017 (Summer) followed by Airoli in the months of June 2016 (Monsoon) and May 2017 (Summer) and Vasai in the months of June 2016 (Monsoon) and March 2017 (Summer) and Minimum “eyed embryos” found in Naigaon in the months of June- July 2017 (Monsoon) and in Airoli in the months of May, 2016 (Summer) and March 2017 (Summer) and Vasai in the month of March 2017 (Summer). In all these salt pan water areas



Maximum “Egg like embryos” found in Vasai in the months of May (Summer) and October 2016 (Winter) and February 2017 (Summer), Maximum “Eyeless embryos” found in Naigaon in the months of May 2016 (Summer) and June 2017 (Monsoon) and Maximum “Eyed embryos” 13.63 (55.34%) found in Vasai in the months of June 2016 (Monsoon) and February 2017 (Summer) whereas Minimum “egg like embryos” found in Vasai in the months of June, August 2016 and July 2017 (Monsoon). Minimum “eyeless embryos” in Naigaon in the month of April 2017 (Summer) and Minimum “Eyed embryos” found in Naigaon in the months of June- July 2017 (Monsoon) as also found in Airoli in the months of May 2016 and March, 2017 (Summer). All these observations show that mysids from Vasai salt pans found more fecund than mysids from other salt pan waters viz., Naigaon.

Comparison of Maximum and Minimum broods of Mysids (*Mesopodopsis orientalis*) from all the waters of Coast, Estuaries and Salt pans: In Coastal Waters Maximum “Egg like embryos” found in the month of October 2017 (Winter) > Estuarine waters of Juchandra in the month of March 2017 (Summer) and Vasai salt pans in the month of May (Summer) and October (Winter) 2016 and February 2017 (Summer). Maximum “Eyeless embryos” found in Coastal waters in the months of November 2016 (Winter) found in Thane creek of Estuarine waters in the month of May 2016 (Summer) and August 2017 (Monsoon) and Naigaon salt pan waters in the months of May 2016 (Summer) and June 2017 (Monsoon) and Maximum “Eyed embryos” found in Thane creek Estuarine waters in the month of January 2017 (Winter) > Coastal waters in the month of October 2017 (Winter) and Vasai Salt pans waters in the months of June 2016 (Monsoon) and February 2017 (Summer). Minimum “egg like embryos” found in Juchandra and Thane creek of Estuarine waters in the months of June-August 2016 (Monsoon) and March (Summer) and November 2017 (Winter) > Vasai Salt pans waters in the months of June, August 2016 and July 2017 (Monsoon) and Naigaon Salt pans waters in the month of April 2017 (Summer). Minimum “eyeless embryos” found in Naigaon in the month of April 2017 (Summer) > Airoli in the months of June 2016 (Monsoon) and May 2017 (Summer) and Vasai in the months of June 2016 (Monsoon) and March 2017 (Summer) and minimum “Eyed embryos” found in Airoli Salt pans waters and also in Naigaon Salt pans waters in the months of May 2016 and March 2017 (Summer) and in June 2016 and July 2017 (Monsoon) respectively > Thane creek Estuarine waters in the month of May 2016 (Summer) and Sept 2017 (Monsoon) > Coastal waters in the month of October 2016 (Winter).

These observations show that in all these water areas of Coast, Estuaries and Salt pans, Maximum “Egg like embryos” found in Coastal waters in the months of October 2017 (Winter), Maximum “Eyeless embryos” also found in Coastal waters in the months of November 2016 (Winter) and Maximum “Eyed embryos” also found in Thane creek Estuarine waters in the month of January 2017 (Winter) whereas Minimum “Egg like embryos” found in Juchandra and Thane creek Estuarine waters in the months of July, June and August 2016 (Monsoon) and March (Summer) and November 2017 (Winter) respectively. (Tables: 1 to 5). Minimum “Eyeless embryos” in Coastal waters in the month of April 2017 (Summer) and Minimum “eyed embryos” found in Airoli Salt pans waters in the months of May 2016 and March 2017 (Summer) as also found in Naigaon Salt pans waters in the months of June, 2016 and July 2017 (Monsoon). (Table: 10) Hence above observations indicate, mysids from Coastal waters found more fecund than mysids from other Estuarine waters and Salt pan waters. In all these waters viz., coast, estuaries and salt pans mysid fecundity shows more in Winter season. Moreover, Brood ratio of “Egg like embryos”, “Eyeless embryos” and “Eyed embryos” indicates that coastal waters are more productive followed by estuarine waters and salt pan waters. It clearly indicates that the fecundity is subject to the seasonal variation being generally in the late winter (October, November and January) than early winter (October). A similar analysis of the average number of embryos per brood pouch of ovigerous female of *Praunus inermis* was made by Mauchline (1980) and he observed the largest broods were produced during the early summer months. In view of the Brood ratio of “Egg like embryos”, “Eyeless embryos” and “Eyed embryos”

indicates that coastal waters are more productive followed by estuarine waters and salt pan waters.

## CONCLUSION

1. In Estuarine waters mysids from Thane creek found more fecund than mysids from other estuarine waters viz., Juchandra and Mulund.
2. In Salt pan waters mysids from Vasai salt pans found more fecund than mysids from other salt pan waters viz., Naigaon.
3. In all waters mysids from Coastal waters found more fecund than mysids from other Estuarine waters and Salt pan waters.
4. In all waters of coast, estuaries and salt pans mysid fecundity shows more in Winter season.
5. Coastal waters are more productive followed by estuarine waters and salt pan waters.

## REFERENCES

- Armando A. Ortega-Salas, Judith Nuñez, Sergio Rendón and Arturo Nuñez (2018); “Fecundity of *Metamysidopsis elongata* (Crustacea: Mysidae) from Mazatlán Bay, Sinaloa, Mexico” *Hidrobiológica* 28 (1): 103-108.
- Baldó F., Taracido L. J., Arias A. M., Drake P. 2001. Distribution and life history of the mysid *Rhopalophthalmus mediterraneus* in the Guadalquivir estuary (SW Spain). *J. Crust. Biol.*, 21: 961-972.
- Berril M. (1971) The embryonic development of the avoidance reflex of *Neomysis Americana* and *Praunus flexuosus* (Crustacea-Mysidacea). *Animal Behavior* 19, 707-713.
- Biju A. and Panampunni S.U. (2011); Population structure and reproductive biology of *Mesopodopsis orientalis* (Crustacea: Mysida) in a tropical mangrove ecosystem in India. *Mar. Biodivers. Rec.*: 4(e43); 2011; 9 pp; doi:10.1017/S1755267211000273.
- Biju A., Gireesh R., Jayalakshmi KJ and Haridevi C.K. (2009); “Seasonal abundance, ecology, reproductive biology, and biochemical composition of *Mesopodopsis orientalis* W.M. Tattersall (Mysidacea) from a tropical estuary (Cochin Backwater) in India” *Crustaceana* 82(8).
- Clutter, R.I. and G.H. Theilacker (1971). Ecological efficiency of a pelagic mysid shrimp; estimates from growth, energy budget, and mortality studies. *Fishery Bulletin* 69 (1): 93-115.
- Davis, C. C. (1966): A study of the hatching process in aquatic invertebrates. 22. Multiple membrane shedding in *Mysidium columbae* (Zimmer) (Crustacea: Mysidacea). *Bulletin of Marine Science*. 16(1), 124-131.
- Hanamura et. al 2009, “Mysids (Crustacea) from the salt pans of Mumbai, India”, Article in *Marine Biology Research* 6(6).
- Lasenby and Langford, (1972); Growth, Life history, and respiration of *Mysis relicta* in an arctic and temperate lake. *J. Fish. Res. Bd. Canada* 29: 1701-1708.
- Macquart-Moulin, Cl. (1965). Les mysidacea benthico-planctoniques du Golfe de Marseille. *Rec. Trav. Stat. Mar. End., Bull.* 38, Fasc. 54, 129-253.
- Matsudaira, C., Kariya T., and Tsuda T. (1952): The study on the biology of a mysid *Gastrosaccus vulgaria* Nakazawa.—*Tohoku Journal of Agricultural Research* 3: 115-174.
- Mauchline J. (1980) The Biology of Mysids and Euphausiids. *Advances in Marine Biology*. J. Mar. Biol. Assoc. U.K. 50: 169-175.
- Mauchline, J. (1971). Rare species of Mysidacea (Crustacea) from the west coast of Scotland. - *J. mar. biol. Ass. U.K.*, 51: 799-808
- Mauchline, J. (1973) Inter moult growth of species of Mysidacea (Crustacea). *Journal of the Marine Biological Association of the United Kingdom* 53, 801-817.
- Molenock, J. (1969). *Mysidopsis bahia* (Molenock 1969) a new species of Mysid (Crustacea: Mysidacea) from Galveston Bay, Texas. *Tulane Stud. Zool. Bot.* 15 (3): 113-116.

- Nair B. (1939): The reproduction, oogenesis and development of *M. orientalis* Tatt. Proceedings of Indian Academy of Sciences; 9: 175-223
- Nath, C. N. (1973). Breeding and fecundity in a subterranean mysid, *Lepidomysis longipes* (Pillai and Mariamma). *International Journal of Speleology*. 5: 319-323.
- Núñez-Lecuanda, J. 2013. Evaluación de la fecundidad marsupial y posmarsupial de *Metamysidopsis elongata* (Holmes, 1900) (Crustacea: Mysidae) en condiciones silvestres y semicontroladas de la costa de la Bahía de Mazatlán, Sinaloa México [Estimate of marsupial and post-marsupial fecundity of *Metamysidopsis elongata* (Holmes, 1900) (Crustacea: Mysidae) from the shore of the Mazatlán Bay, Sinaloa, México, under wild and semi-controlled conditions]. In: postgraduate thesis. 67 p. + figs. (Universidad Nacional Autónoma de Mexico, Mazatlan). Abstract available at [http://132.248.246.25/tesigrado/consulta/detpaterno.cfm?al\\_cuenta=511014697](http://132.248.246.25/tesigrado/consulta/detpaterno.cfm?al_cuenta=511014697)
- Parab and Nakhwa, 2019: "Comparative Study of Population Dynamics and Seasonal Variation of Mysid *Mesopodopsis orientalis* (Crustacea: Mysida) in Coastal, Estuarine and Saltpan Waters of Mumbai Area.
- Price, W. W. (2004). An annotated checklist for the order Mysida (Crustacea: Malacostraca: Peracarida) from the Pacific coasts of the Americas (Alaska to Chile). In M. E. Hendrickx, (Ed.), *Contributions to the study of East Pacific Crustaceans*, 3: 53-77. Universidad Nacional Autónoma de México, México D. F.
- Price, W. W. and Vodopich, D. S. (1979). Occurrence of *Mysidopsis almyra* (Mysidacea, Mysidae) on the east coast of Florida, U.S.A. *Crustaceana* 36(2): 194–196.
- Toda H., Takahashi M., Ichimura S. 1982. Abundance and life history of *Neomysis intermedia* Czerniawsky in Lake Kasumigaura. *Hydrobiologia*, 93: 31-39.
- TODA, H., M. TAKAHASHI & S. ICHIMURA 1984. The effect of temperature on the post-embryonic growth of *Neomysis intermedia* Czerniawsky (Crustacea, Mysidacea) under laboratory conditions. *J. Plankton Res.*, 6: 647-662.
- Wittmann K.J. (1984) Ecophysiology of marsupial development and reproduction in Mysidacea (Crustacea). *Oceanography and Marine Biology: Annual Review* 22, 393 – 428.
- Wortham-Neal Jennifer L., Wayne Price W. (2002); "Marsupial Developmental Stages in *Americamysis Bahía* (Mysida: Mysidae)" *Journal of Crustacean Biology*, 22(1): 98–112.

\*\*\*\*\*