Distribution and Abundance of Finfish Eggs from Muthupetttai, South East Coast of India

J Selvam1*, D Varadharajan, A Babu and T Balasubramanian
Faculty of Marine Sciences, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, Tamil Nadu, India

Abstract

The occurrence and distribution of finfish eggs and larvae is an integral part of a fishery research programme. Finfish eggs abundance data is an important for patterns of distribution, an areas providing information for nursery ground and a range of adult and spawning trends. The density of fin fish eggs at all stations showed a seasonal variation. The maximum number of eggs were recorded during post-monsoon followed by pre-monsoon, summer and monsoon seasons. The seasonal occurrence of finfish eggs did not follow a similar pattern during the two-year period of study. This might be due to the fluctuation in the environmental parameters. Environmental parameters such as rainfall, atmospheric temperature, water temperature, salinity, pH and dissolved oxygen were recorded and correlated with the distribution of fish eggs. It is evident from the present study that the water temperature and salinity appear to play a significant role in determining the distribution of fin fish eggs in the study area.

Keywords: Fin fish eggs; Distribution; Abundance; Physico-chemical

Introduction

Estimation of abundance of fish eggs and larvae helps to evaluate marine fishery resources. Most of the marine fishes spawn in the open sea and produce pelagic eggs and larvae [1,2]. By regular collection of plankton, it is possible to map the marine area with respect to the breeding of fish and the relative abundance of ichthyoplankton of commercial fish stock, and use the information as an index of fish abundance or for the prediction of year class strength. Generally fishes spawn during a definite time of the day and this has been found to be true in marine fishes of Porto-Novo region [3,4]. Investigation on the occurrence and distribution of finfish eggs and larvae is an integral part of a fishery research programme. Most of the eggs and almost the larvae are pelagic and it is easy to sample several species over a wide area with simple plankton nets. Regular sampling of ichthyoplankton is essential for locating shoals of adult fishes and their spawning grounds. Ichthyoplankton studies are extensively useful in fishery investigation. Information on fish eggs and larvae of a particular region is useful in understanding the spawning season of fishes of commercial importance. Studies on the early developmental stages of fish allow us to comprehend the biology of the species besides determining their spawning seasons and to estimate spawning stock abundance. Such a study is also an essential prerequisite in undertaking the spawning biomass of target species monitoring, changes in exploitable stocks and yields, forecasting trends of production etc. [3-5]. Distribution of the early developmental stages, in space and time is known with considerable precision so that sampling effort can be efficiently concentrated in areas and time periods when they will be most effective [6]. Generally, fishes spawn during a definite time, hence, studies on the seasonal occurrence of fish eggs and larvae are useful in locating shoals of fish and their breeding grounds. Till recently studies on the quantitative aspects of fish eggs and larvae in Indian seas were limited to studies on their taxonomy, seasonal abundance based on material from the inshore plankton and post larval fish collections from restricted localities.

Materials and Methods

The study was conducted at Muthupetttai coast during between January 2011 to December 2012. Finfish eggs were collected every month in the early hours of the day during high tide, with the help of plankton net of diameter 0.5 m made of bolting silk (No: 10 mesh size, 158 μm). Volume of water filtered was quantified with the help of a calibrated flow meter (General Oceanics, INC model) attached to it. The net was towed horizontally along the surface water at a constant speed of 1.0 km/hr for about 15-20 minutes in each station by adopting the method of Venkataramujam, Ramamoorthi and Bensam [7,8]. Samples from all the stations were preserved onboard in 5% buffered formalin-seawater and sorted in the laboratory [9]. Fin fish eggs were sorted out from this sample and their abundance was expressed as number of eggs/100 m³.

Description of the Study Area

Station I (Sethukuda)

This station is situated at 10º20’49.68” N Lat. and 79º32’13.23” E Long. The average depth of the station is about 1 metre. Avicennia sp. is dominant in this station (Plate 1).

Station II (Lagoon)

This station is situated between 10º20’19.71” N Lat. and 79º31’52.64” E Long. The Lagoon is shallow with an average of 1 m depth. Avicennia sp. borders the Lagoon (Plate 1).

Station III (Chellimunai)

This station is situated at 10º19’42.56” N Lat. and 79º33’35.10” E Long. This station is shallow with an average depth of 1.5 m. The station is dominated by Avicennia sp (Plate 1).

*Corresponding author: J Selvam, Faculty of Marine Sciences, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, Tamil Nadu, India. Tel: 04144-243223; Fax: 04144-243553; E-mail: jagaselvam@yahoo.com

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Station IV (River Mouth)

This station is situated at 10º18'2076" N Lat. and 79º31'08.02" E Long (Plate 1).

Results and Discussion

Seasonal abundance and species/genus wise density of finfish eggs in the Muthupettai waters

Family: Ophichthidae

Ophichthys sp.: Ophichthys sp. single egg was observed during April-2011 at station II and maximum (29 eggs/100 m³) observed during January-2011 at station IV. During second year also a single egg was noticed in the station II during July-2012 and Maximum 36 eggs/100 m³ observed during January -2012 at station IV (Figure 1).

Considerable numbers of Ophichthys sp. eggs were observed during pre-monsoon, early month of monsoon and late month of post monsoon seasons. Present observation gives the picture about lengthened spawning period of these fishes. However, Ganapathi and Raju [10] observed only in post-monsoon season along Waltair coast. Manickasundaram [11] observed in early month of monsoon and pre-monsoon season at Coleroon estuary complex along the south east coast of India.

Family: Engraulidae

Setipinna taty: Minimum density (3 eggs/100 m³) was observed in May 2011 at station II and maximum (30 eggs/100 m³) in February 2011 at station III. In 2012 only single egg observed in the station III during December-2012 and maximum (32 eggs/100 m³) at station III during the month of January (Figure 2).

Thangaraja [12] observed the occurrence of this species eggs during post-monsoon season in the Parangipettai coastal waters. The present observation in the Muthupettai waters confirms that the spawning activity of these fishes is during the post-monsoon season.

Stolephorus tri: Stolephorus tri 3 eggs/100 m³ of were collected during May 2011 at station II and (54 eggs/100 m³) in November at station IV. In 2012, the minimum density of 2 eggs/100 m³ were observed in January-2012 at station I and maximum of 60 eggs/100 m³ in October -2012 at station III (Figure 3).

Occurrences of the eggs of Stolephorus tri was observed almost throughout the year in Muthupettai waters. Bensam [8] recorded the eggs of this species during summer months from Parangipettai waters, Nair [13] observed December to January in the Madras coastal waters. Siraimeetan and Marichamy [14] observed biannual spawning season of this species along the Tuticorin coast, Ramaiyan et al. [15]
collected these eggs throughout the year from Parangipettai coast, these observations are in support of the present findings.

**Stolephorus punctifer**: Minimum number (1 egg/100 m³) was observed in July 2011 at station I and maximum (35 eggs/100 m³) in August 2011 at station III. During the second year 2012, the minimum density (1 egg/100m³) was observed during May -2012 at station III and maximum density (31 eggs/100 m³) in July at station III (Figure 4).

Eggs of *Stolephorus punctifer* were collected during the early month of pre-monsoon (July-September), post-monsoon (January-March) and summer (October-December) during the present investigation. Observation made during post-monsoon and summer from Madras and along Coleroon estuary and observed this eggs in Porto Novo waters during both pre and post-monsoon and also in summer are in support of the present investigation [11,13,15].

**Stolephorus heterolobus**: Minimum number (1 egg/100 m³) was observed in April at station IV and maximum (60 eggs/100 m³) in January at station III. In the second year these eggs were observed minimum density in the station IV (1 egg/100 m³) during May 2012 and maximum (55 eggs/100 m³) in station III during March 2012 (Figure 5).

In the present investigation, *Stolephorus heterolobus* eggs were observed only during post monsoon and summer seasons and is suggesting that the breeding of this species may be takes place only in these seasons. This observation corroboram works are made in the Coleroon estuarine complex and along the Parangipettai coastal waters [11,15].

**Stolephorus macrops**: Figure 6 shows the monthly variation of eggs of *Stolephorus macrops* along Muthupettai coastal waters. Minimum density (2 eggs/100 m³) was observed in September at station II and maximum (24 eggs/100 m³) in February at station II during the year 2011. In 2012, a single egg was observed in October at station IV and maximum density (20 eggs/100 m³) was observed during February at station I.

*Stolephorus macrops* eggs were found to occur during postmonsoon and premonsoon, in the present investigation. In Parangipettai coastal waters, Thangaraja [12] found these eggs during February to March and Manickasundaram [11] observed during January to March with peak abundance in March along Coleroon estuary. Ramaiyan et al. [15] observed these eggs during post monsoon and summer season in Parangipettai waters.

**Thryssa dussumieri**: Figure 7 shows the distribution of the eggs of *Thryssa dussumieri* along Muthupettai waters. During the study period, the minimum density (1 egg/100 m³) was observed during September at station III and maximum (38 eggs/100 m³) in March at station IV.
In 2012, the minimum density (1 egg/100 m³) was observed in April at station II and maximum (35 eggs/100 m³) in August at station III. 

*Thryssa dussumieri* eggs were found in pre monsoon, post monsoon and summer seasons during the present investigation. The present observations are in agreement with the earlier ones made by [7,8,12,15] along Parangipettai coastal waters.

*Thryssa mystax*: Figure 8 shows the monthly variation of eggs of *Thryssa mystax* along Muthupettai waters. In the year 2011, minimum density was observed during August (1 egg/100 m³) at station I and the maximum (21 eggs/100 m³) during January at station IV. In year 2012, the minimum density of these eggs (2 eggs/100 m³) was noticed in August at station I and maximum (23 eggs/100 m³) in February at station III.

*Thryssa mystax* eggs were found in this investigation during post monsoon, early months of summer and premonsoon seasons in Muthupettai waters. Similar observations were made from Coleroon estuarine, Parangipettai coastal waters and in Madras the coast [7,11,15,16].

*Thryssa hamiltoni*: Monthly variation in the distribution of *Thryssa hamiltoni* eggs along Muthupettai coastal waters is shown in Figure 9. The minimum density of these eggs (1 egg/100 m³) were observed in April at station IV and the maximum density of (22 eggs/100 m³) were observed in January at station II. In the year 2012, 3 eggs/100 m³ were observed in July at station II and (22 eggs/100 m³) in February 2012 at station I.

Eggs of *Thryssa hamiltoni* were found to be abundant during the post monsoon and summer months. The eggs of *Thryssa hamiltoni* were also observed [7,8,15].

**Family: Pristigasteridae**

*Opisthopterus tardoore*: During the first year, the minimum density (1 egg/100 m³) was observed in December at station I and maximum (42 eggs/100 m³) in October at station IV. During the second year, the minimum density (2 eggs/100 m³) was observed in October at station II and maximum (49 eggs/100 m³) in March at station III (Figure 10).

*Opisthopterus tardoore* eggs were found to be abundant in the Muthupettai waters. These eggs were reported during post monsoon and summer in the Vellar estuary in the Coleroon estuarine [7,11,15,17].

**Family: Chirocentridae**

*Chirocentrus dorab*: The distribution of the eggs of *Chirocentrus dorab* is depicted in the Figure 11. During the first year of the study (2011), one was observed in September at station IV and 27 eggs/100 m³ in September at station III. In the year 2012, the minimum density of 1 egg/100 m³ was observed in December at station III and a maximum 23 eggs/100 m³ in November at station III.

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**Figure 8:** Distribution of *Thryssa mystax* eggs along Muthupettai waters (January-2011 to December-2012).

**Figure 9:** Distribution of *Thryssa hamiltoni* eggs along Muthupettai coastal waters (January-2011 to December-2012).

**Figure 10:** Distribution of *Opisthopterus tardoore* eggs along Muthupettai coastal waters (January-2011 to December-2012).

**Figure 11:** Distribution of *Chirocentrus dorab* eggs along Muthupettai waters (January-2011 to December-2012).
Chirocentrus dorab eggs were collected during premonsoon, monsoon and postmonsoon seasons from Muthupettai waters. Similar observations were made in the Coleroon estuarine system as well [11].

Family: Clupeidae

**Esculosa thoracata**: A single egg observed in December at station IV and maximum (25 eggs/100 m$^3$) in February at station IV. In the second year, the minimum density was in April (1 egg/100 m$^3$) at station II and maximum (55 eggs/100 m$^3$) in October at station II (Figure 12).

The abundance of *Esculosa thoracata* eggs was found during March, May to August from Mandapam and during March to October from Chilka Lake [18,19]. Their distribution during March to October from Parangipettai was reported [17]. These fishes appear to spawn over an extended period in Muthupettai waters in the Vellar estuary and in the Coleroon estuary [7,11].

**Sardinella fimbriata**: During the first year of the study, the minimum density was in September (3 eggs/100 m$^3$) at station I and maximum (54 eggs/100 m$^3$) in February at station III. During the second year of the study, the minimum density (1 egg/100 m$^3$) was collected during April at station I and maximum in January (45 eggs/100 m$^3$) at station IV (Figure 13). *Sardinella fimbriata* eggs were collected during premonsoon, post monsoon and summer seasons. Similar observations were made along Coleroon estuary, Parangipettai coastal waters and along Madras coast [7,8,11,17,20].

**Sardinella gibbosa**: Figure 14 shows the monthly variation of *Sardinella gibbosa* eggs along Muthupettai coastal waters. During the first year of the study period the minimum density (8 eggs/100 m$^3$) were observed in October at station III and maximum (49 eggs/100 m$^3$) in January at station III. But during the second year, the minimum density of these eggs (3 eggs/100 m$^3$) was encountered during September at station I and maximum (45 eggs/100 m$^3$) in January in the same station.

The present findings revealed that the eggs of *Sardinella gibbosa* were noticed during monsoon, post monsoon and summer seasons with a peak spawning activity in January to May along Muthupettai waters. Similar observations were reported from Parangipettai coastal waters and along Coleroon estuary that agreed with the present observation [7,11,17].

**Sardinella longiceps**: Figure 15 shows the monthly variation of *Sardinella longiceps* eggs along Muthupettai coastal waters. During the first year of the study, a single egg observed in May at station II and maximum (22 eggs/100 m$^3$) in March and April at station I. During the second year, single egg observed at station I during September and maximum (23 eggs/100 m$^3$) in station III during February.

*Sardinella longiceps* eggs were present during post monsoon, summer and early month of premonsoon seasons along Muthupettai waters. The present result confirms that the discontinuous spawning habit of these fishes. Findings of John and Devanesan [20,21] have
noticed these eggs in the plankton sample during post monsoon seasons; Lazarus [22] collected these eggs during premonsoon and monsoon seasons in Madras coast. Venkataramanujam [17] observed these eggs during monsoon, post monsoon and summer seasons along Parangipet coastal waters. Ganapathi and Raju [10] observed during the premonsoon, post monsoon and summer seasons with peak abundance during February along Coleroon estuary were agreed with the present findings.

Sardinella clupeoides: Figure 16 shows the monthly variation of Sardinella clupeoides eggs along Muthupettai coastal waters. During the first year of the study, the minimum numbers of eggs (2 eggs/100 m³) were observed in May at station I and maximum (33 eggs/100 m³) in February at station IV. In the second year, single egg was in May at station II and III and maximum (40 eggs/100 m³) in the same month at station VI.

Eggs of Sardinella clupeoides were collected during post monsoon, summer, early month of premonsoon and monsoon seasons with a peak in February along Muthupettai waters. Similar findings were made and these eggs were observed during monsoon, post monsoon and summer seasons, these eggs appeared in post monsoon and summer seasons from Vellar estuary and were observed during monsoon, post monsoon and summer seasons with a peak during February which supports the present investigation [8,11,17].

Anadontostoma chacunda: Figure 17 shows the monthly variation of Anadontostoma chacunda eggs along Muthupettai waters. In the first year of the in investigation no egg were observed, but in the second year, single egg was observed in January at station II and maximum (11 eggs/100 m³) in April at station III.

Eggs of Anadontostoma chacunda were observed only in the second year of the study period in the post monsoon and the early months of summer. Annual spawning of these fish agrees with the previous works on the east coast where similar observation from Parangipettai coastal waters were reported [7,12,17,18,20], Manickasundaram M [11] observed these eggs during February to May along Coleroon estuary.

Nematolosa nasus: Figure 18 shows the monthly variation of Nematolosa nasus eggs along Muthupettai waters. During the first year of the study (2 eggs/100 m³) observed in the month of January in the station I and maximum (8 eggs/100 m³) were observed in February at Station I. During the second year of the study a single egg of this species observed during March at station I and Maximum (16 eggs/100 m³) in the station IV in the month of December.

Eggs of Nematolosa nasus were collected during late months of monsoon and post monsoon seasons during the present study. This present observation supported by the previous work noticed these eggs during the post monsoon season from Vellar estuary and this eggs were observed in the monsoon and post monsoon season in parangipet coastal waters [8,15].

Family: Synodontidae

Saurida gracilis: Figure 19 shows the seasonal distribution of Saurida gracilis eggs along Muthupettai coastal waters. During the first year of the study, a single egg observed in the month of June in the station I and maximum (15 eggs/100 m³) in February at station IV. In second year, the minimum number of egg (1 egg/100 m³) was observed in January and February at station I and maximum (18 eggs/100 m³) in January at station IV.

Saurida gracilis eggs were collected during post monsoon, summer, late months of premonsoon and late month of monsoon seasons gives the picture about the prolonged spawning of these fishes. It was noticed during post monsoon and summer along Parangipettai coastal waters, during post monsoon along Coleroon estuary and these eggs

Figure 16: Distribution of Sardinella clupeoides eggs along Muthupettai coastal waters during the study period (January-2011 to December-2012).

Figure 17: Distribution of Anadontostoma chacunda eggs along Muthupettai coastal waters during the study period (January-2011 to December-2012).

Figure 18: Distribution of Nematolosa nasus eggs along Muthupettai coastal waters during the study period (January-2011 to December-2012).
were observed in post monsoon and summer, seasons in Parangipettai waters in the support of the present investigation [7,11,15,17,23].

**Saurida tumbil:** Figure 20 shows the monthly variation of *Saurida tumbil* eggs along Muthupettai coastal waters. During the first year of the study, the minimum density of these eggs (1 egg/100 m$^3$) was observed in April at station II and maximum (9 eggs/100 m$^3$) in May at station the same station. During the second year of study, a single egg was obtained in June at station IV and the maximum (6 eggs/100 m$^3$) in May at the same station.

*Saurida tumbil* eggs were collected during post monsoon, summer, premonsoon and late month of monsoon seasons along Muthupettai coastal waters. However, Venkataramanujam and Ramamoorthi [7] noticed during post monsoon and summer along Parangipettai coastal waters, Venkataramanujam [17] observed during post monsoon, summer and premonsoon seasons, Vijayaraghavan [24] observed during monsoon season along Madras coast.

**Saurida sp.**: Eggs of *Saurida* sp. (5 eggs/100 m$^3$) observed collected in April at station IV and a single egg was in the same month at station II, in the second year of study period (9 eggs/100 m$^3$) eggs were obtained in the month of April at the station II and (3 eggs/100 m$^3$) collected in the same month at the III and IVth stations along Muthupettai coastal waters (Figure 21). Ramaiyan et al. [15] observed this egg during early months of summer along the Parangipettai coast is the similar to the present findings.

**Saurus sp.**

A single egg of *Saurus* sp. was collected during April from station II and 5 eggs/100 m$^3$ eggs were obtained in the same month in the station IV. In the second year of the investigation minimum (3 eggs/100 m$^3$) were observed in the month of April in the station IV and maximum (6 eggs/100 m$^3$) were observed in the same month at the station II (Figure 22). Bapat [18] observed during summer season along Mandapam coast and Manickasundaram [11] noticed only during April along Coleroon estuarine are similar to the present findings.

**Synodontid Eggs:** Only few of *Synodontid* eggs observed in the first year of the investigation. Minimum (3 eggs/100 m$^3$) observed in April at Station II and maximum (5 eggs/100 m$^3$) in the same month of the station IV (Figure 23). Ramaiyan et al. [15] observed the eggs in the month monsoon and pre monsoon in the Parangipettai waters is the support of the present findings.

**Family: Mugilidae**

**Liza dussumieri:** The seasonal distribution of eggs of *Liza dussumieri* is depicted in Figure 24. The minimum density (2 eggs/100 m$^3$) was observed in April at station II and maximum (17 eggs/100 m$^3$) in January at station I. During the second year, the minimum number eggs (4
eggs/100 m$^3$) were observed in December and May at station I and II respectively, maximum (20 eggs/100 m$^3$) in December at station I.

However it was observed during premonsoon season and also during post monsoon, summer, and early months of monsoon in the support of the present findings [8,15].

**Liza tade:** Figure 25 shows the seasonal variation of *Liza tade* eggs along Muthupettai coastal waters. During the first year, the minimum density was observed in April (2 eggs/100 m$^3$) at station II and maximum (20 eggs/100 m$^3$) in February and December at station IV during the study period of first year. In the second year single egg was obtained in March at the station II and maximum (20 eggs/100 m$^3$) in February at station III.

The present observation agrees with the previous findings during January to April and July to October along Coleroon estuary, during August from Vellar estuary, the eggs were recorded during premonsoon and post monsoon seasons and these eggs were noticed during July to August from Chilka lake [11,12,17,19].

**Family: Hemiramphidae**

**Hemiramphus sp.:** A single egg of *Hemiramphus* sp. was observed in February at station II during the second year of study. Single egg observed in station III during May, and (2 eggs/100 m$^3$) observed in the same month at the station III. During the second year of the investigation single egg was observed in the month of June at the station III (Figure 27).

Another type of Hemiramphid eggs was reported during the summer season and this egg was observed during February along Parangipettai coastal waters [11,15].

**Family: Atherinidae**

**Pranesus pinguis:** Figure 28 gives the details of the distribution of
Pranesus pinguis eggs along Muthupettai coastal waters. During the first year, single egg was observed in the month of February at station I and maximum (12 eggs/100 m³) in June at station III. However, during the second year, the minimum density of single egg observed in September at station I and maximum (20 eggs/100 m³) in February at station II.

Present observation supported by the previous works made by Thangaraja[12]. But it was recorded during March, May to September and October from Vellar estuary and reported during March to June and September to November along Coleroon estuary[11].

Family: Carangidae

Carangoides malabaricus: The distribution of Carangoides malabaricus eggs is given in Figure 29. During the first year, the minimum density of single egg observed in May at the station III and IV and maximum (18 eggs/100 m³) in December at station I. The minimum density (2 eggs/100 m³) of these eggs was collected during April at station I and maximum (10 eggs/100 m³) during September at the same station I in the second year.

Eggs of Perciformes were numerically abundant and collected almost throughout the year in the present investigation. Same observation was made along the Vellar estuary[17]. During the post monsoon, summer and premonsoon seasons the carangid eggs were more in number and they were collected in all the stations, as already reported during May to June from Coleroon estuary[11]. But only during January it was reported along Madras coast[16]. Venkataramanujam[17] from Vellar, Bapat[18] from Mandapam and George[26] along Cochin backwaters also. Eggs of Carangoides malabaricus were observed during premonsoon, monsoon and summer in the present study. Krishnamurthy and Prince Jeyaseelan[27] recorded only in summer from Pichavaram mangrove systems.

Caranx sp. 1: Figure 30 shows the seasonal distribution of Caranx sp. 1 egg along Muthupettai coastal waters. During the first year, the minimum density (2 eggs/100 m³) was recorded in July at station III and maximum (100 eggs/100 m³) in January at station IV. During second year of the investigation single egg was observed in December at station I and maximum (99 eggs/100 m³) in February at the same station I.

Caranx sp. 1 eggs were available throughout the year in the present study revealed some clear trends. This result obtained in the present study confirms that these fishes are continuous spawners. Similar observation made along Vellar estuary, Coleroon estuary, Mandapam region and from Chilka Lake[7,11,19].

Caranx sp. 2: Figure 31 shows the seasonal distribution of the eggs of Caranx sp. 2 along Muthupettai coastal waters. During the first year...
of the study period, the minimum density (2 eggs/100 m³) were in July at station II and maximum (55 eggs/100 m³) in August at station I. In the second year of the study a single egg observed in the month of February and March in the station I and maximum (21 eggs/100 m³) in April at station IV.

Manickasundaram [11] observed throughout the year along Coleroon estuary was agreed and Venkataramanujam [17] observed during January to July and September to November along Parangipettai coastal waters with the present investigation.

*Decapterus russelli*: Figure 32 shows the seasonal distribution of the eggs of *Decapterus russelli* along Muthupettai coastal waters. During the first year, the minimum density (2 eggs/100 m³) was observed in December at station II and maximum (23 eggs/100 m³) in May at station IV. During the second year, a single egg was observed in March at station I and maximum density (23 eggs/100 m³) in January at station I.

*Decapterus russelli* eggs were observed during post monsoon, and monsoon seasons in the present study. However, Manickasundaram [11] noticed during post monsoon and summer, Thangaraja [12] observed only during monsoon along Vellar estuary. Krishnamurthy and Prince Jeyaseelan [25] observed in monsoon, post monsoon and summer seasons along Pitchavaram mangrove systems support the present study.

*Secutor ruconius*: Figure 34 gives the details of the distribution of *Secutor ruconius* eggs along Muthupettai coastal waters. During the first year, the minimum density (2 eggs/100 m³) was observed in February at station I and maximum (25 eggs/100 m³) in January and February at station I and II respectively in second year of investigation.


*Family: Leiognathidae*

*Scomberoides tol*: The distribution of the eggs of *Gerrus* was collected in September at station IV and maximum (23 eggs/100 m³) in April at station III. During the second year, the minimum density (4 eggs/100 m³) was in January at station II and maximum (22 eggs/100 m³) in August at station III.

*Scomberoides tol* eggs were collected in this investigation during premonsoon, and post monsoon season. Similar observation made by Manickasundaram [11] along Coleroon estuary and Ramaiyan et al. [15] along Parangipettai waters.

*Family: Gerreidae*

*Gerrus oblongus*: The distribution of the eggs of *Gerrus oblongus*...
is detailed below (Figure 35). During the first year, the minimum number of eggs (2 eggs/100 m³) was collected in December at station IV and maximum (21 eggs/100 m³) in October at station IV. During the second year, the minimum density (2 eggs/100 m³) was in December at station I and maximum (12 eggs/100 m³) in November and December at station II.

**Gerrus oblongus** eggs were observed monsoon season only in the study period. It is with the agreement of Bensam [8] along the Parangipettai waters. But Ramaiyan et al. [15] noticed this egg during monsoon and post monsoon season.

**Family: Terapontidae**

**Terapon jarbua**: Figure 36 gives the details of the distribution of eggs of *Terapon jarbua* along Muthupettai coastal waters. The minimum number of eggs (2 eggs/100 m³) was observed in March at station I and maximum (100 eggs/100 m³) in October at the same station. In the second year minimum density (2 eggs/100 m³) was observed in May at station I and maximum (42 eggs/100 m³) in December at station II.

Venkataramanujam [17] observed during post monsoon and summer season and annual spawning of these fish agrees with the previous works on the east coast by Bensam [8] observed during post monsoon, Manickasundaram [11] noticed almost throughout the year along Coleroon estuary, Thangaraja [12] noticed almost throughout the year along Vellar estuary and this present study agreed with the observation already made by Krishnamurthy and Prince Jeyaseelan[25] along Pitchavaram mangrove systems and Thangaraja and Ramamoorthi [28] observed during April to June, August to October [18,19,20].

**Family: Scombridae**

**Scomberomorus sp.** The distribution of the eggs of *Scomberomorus* sp. is given in Figure 37. During the first year, the minimum density (3 eggs/100 m³) was observed during November at station II and maximum (22 eggs/100 m³) were in August at station II. During the second year, the minimum density (3 eggs/100 m³) were observed in November at station III and maximum density (64 eggs/100 m³) in November at station I.

*Scomberomorus* sp. eggs were collected during premonsoon, and monsoon months from Muthupettai coastal waters. But, Venkataramanujam [17] noticed only during November along Vellar estuary, Ramaiyan et al. [15] noticed these eggs during premonsoon and summer along Parangipettai waters.

**Family: Bothidae**

**Pseudorhambus javanicus** eggs observed during the study period along Muthupettai coastal waters. During the first year, the minimum density (3 eggs/100 m³) was observed during February at station IV and maximum (32 eggs/100 m³) in March at station IV. In the second year of the
investigation minimum (10 eggs/100 m³) observed in the month of April at the station II and maximum (21 eggs/100 m³) observed May and November at the station IV and I, respectively.

*Pseudorhambus javanicus* eggs were collected only in the post monsoon and summer seasons from Muthupettai waters. Similar observations were made along Coleroon estuary and along Vellar estuary [7,11,17].

**Family: Pleuronectidae**: Distribution of *Pleuronectid* eggs in the study period (January-2011 to December-2012) along Muthupettai coastal waters is given below (Figure 39). *Pleuronectid* eggs were observed during April, minimum (1 egg/100 m³) at station I and maximum (19 eggs/100 m³) at station II. During the second year minimum (6 eggs/100 m³) were observed in the month of October at the station I and maximum (12 eggs/100 m³) collected in the month of September at station II.

Ramaiyan et al. [15] observed this egg during early month of summer is the support of the present investigation.

**Family: Soleidae**

*Solea ovata*: The details of the distribution of eggs of *Solea ovata* during the study period of two years along Muthupettai coastal waters are given in Figure 40. During the first year, single egg observed during October at station IV and maximum (10 eggs/100 m³) was in December at station III. During the second year, the minimum density (2 eggs/100 m³) was observed in November at station III and maximum (11 eggs/100 m³) in October station IV.

Few *Solea ovata* eggs were noticed during the in monsoon and last months of premonsoon season. Thangaraja [12] observed these eggs in summer season along Parangipettai waters. Ramaiyan et al. [15] observed these eggs in monsoon and premonsoon seasons along the Parangipettai waters.

**Family: Cynoglossidae**

*Cynoglossus arel*: The details of the distribution of eggs of *Cynoglossus arel* during the period of investigation (January-2011 to December-2012) along Muthupettai coastal waters are depicted in Figure 41. Single egg observed during the month of November at station IV and maximum (31 eggs/100 m³) in February at station III in the first year and the minimum eggs (2 eggs/100 m³) were observed in December at station I and maximum (29 eggs/100 m³) in November at station IV during the second year.

Manickasundaram [11] noticed these eggs abundant in summer months along Coleroon estuary. Nair [13] observed these eggs only during monsoon and post monsoon season. Bapat [18] observed irregular appearance of these eggs along Mandapam region. These previous works agreed with the present investigation.

*Cynoglossus puncticeps*: Figure 42 shows the monthly variation.
of the eggs of *Cynoglossus puncticeps* along Muthupettai coastal waters. During the first year of the study, these eggs were collected in January (4 eggs/100 m\(^3\)) at station II and maximum (30 eggs/100 m\(^3\)) eggs observed in month of February at station IV. During the second year, single egg observed in the month of February at station IV and maximum (29 eggs/100 m\(^3\)) in November at the same station IV.

*Cynoglossus puncticeps* eggs were collected post monsoon and late months of the monsoon season along Parangipettai coastal waters [12,15,17].

**Family: Tetraodontidae**

*Arothron hispidus*: The distribution of eggs of *Arothron hispidus* along Muthupettai coastal waters is displayed in Figure 43. Minimum density (2 eggs/100 m\(^3\)) was available in November at station III and maximum density during February (31 eggs/100 m\(^3\)) at station III. During the second year minimum density (2 eggs/100 m\(^3\)) were observed in January at station III and maximum (18 eggs/100 m\(^3\)) were in January at station I.

Eggs of *Arothron hispidus* were collected during Monsoon, post monsoon and summer season in the present investigation but Venkataramanujam and Ramamoorthi [7] noticed during post monsoon and summer seasons, Thangaraja [12] observed during monsoon season and Thangaraja [29] collected during monsoon and post monsoon seasons along Parangipettai coastal waters. The present result exposed that the protracted spawning habit of these fishes.

*Arothron sp.*: Figure 44 shows the seasonal distribution of *Arothron sp.* eggs along Muthupettai coastal waters. During the first year single egg observed at station I in July and maximum (31 eggs/100 m\(^3\)) at station III in the month of May, in the second year minimum (2 eggs/100 m\(^3\)) observed at station I in the month of April, and Maximum (34 eggs/100 m\(^3\)) collected at station III in the month of July.

Eggs of *Arothron sp.* were collected summer and premonsoon along Muthupettai coastal waters. The results of this present investigation were supported by the previous works made by Manickasundaram [11] from Coelocon estuary and Venkataramanujam [17] along Muthupettai coastal waters south east coast of India.

**Population density of finfish eggs**

The population density of fin fish eggs observed during the study period (January-2011 to December-2012) is given in Figure 45. During first year of observation, the minimum density of fish eggs observed during July (15 No/100 m\(^3\)) and maximum during January and October (100 No/100 m\(^3\)) at station I. However at station II, the minimum density was observed in June (99 No/100 m\(^3\)) and maximum during January (499 No/100 m\(^3\)). At station III, the minimum density was observed during December (152 No/100 m\(^3\)) and maximum during January (558/100 m\(^3\)).

At station IV, the minimum density was observed during August (96 No/100 m\(^3\)) and maximum during January (553 No/100 m\(^3\)). During the second year 2012, the population density of fish eggs ranged from 16 to 89 No/100 m\(^3\) at station I. Minimum density was recorded during April and maximum in December. Station II, the minimum density of 45 and maximum of 472 No/100 m\(^3\) were recorded during June and February, respectively. In station III, it varied from 23 to 472 No/100 m\(^3\), the minimum during June and maximum during January. Fish eggs density recorded at station IV ranged from 14 to 464 No/100 m\(^3\). Minimum density was observed during June and maximum in January.

**Species composition**

In total 43 species of fin fish eggs were collected and identified over a period of two years (January-2011 to December-2012) from the Muthupettai mangroves in the present investigation (Table 1). They
### Table 1: Checklist of finfish eggs species recorded from four stations.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Species</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td><strong>Family : Ophichthidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Ophichthys sp.</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Engraulidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Selipinia taty</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>Stolephorus tri</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td>S. punctifer</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td>S. heterolobus</td>
<td>+</td>
</tr>
<tr>
<td>6.</td>
<td>S. macrops</td>
<td>+</td>
</tr>
<tr>
<td>7.</td>
<td>Thryssa dussumieri</td>
<td>+</td>
</tr>
<tr>
<td>8.</td>
<td>T. mystax</td>
<td>+</td>
</tr>
<tr>
<td>9.</td>
<td>T. hamiltone</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Pristigasteridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Opisthopterus tardoore</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Chirocentridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Chirocentrus dorab</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family Clupeidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Esculosa thoracata</td>
<td>+</td>
</tr>
<tr>
<td>13.</td>
<td>Sardinella indica</td>
<td>+</td>
</tr>
<tr>
<td>14.</td>
<td>S. gibbosa</td>
<td>+</td>
</tr>
<tr>
<td>15.</td>
<td>S. longiceps</td>
<td>+</td>
</tr>
<tr>
<td>16.</td>
<td>S. clupeoides</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Tetraodontidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Terapon jarbua</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Scombridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>Carangoides malabaricus</td>
<td>+</td>
</tr>
<tr>
<td>29.</td>
<td>Caranx sp 1</td>
<td>+</td>
</tr>
<tr>
<td>30.</td>
<td>Caranx sp 2</td>
<td>+</td>
</tr>
<tr>
<td>31.</td>
<td>Decapterus russell</td>
<td>+</td>
</tr>
<tr>
<td>32.</td>
<td>Scomberoides tol</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Synodontidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33.</td>
<td>Anadontostoma chacunda</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Mugilidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>Liza dussumieri</td>
<td>+</td>
</tr>
<tr>
<td>35.</td>
<td>L. tade</td>
<td>+</td>
</tr>
<tr>
<td>36.</td>
<td>Mugil cephalus</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Hemiramphidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.</td>
<td>Hemiramphus sp</td>
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</tr>
<tr>
<td><strong>Family : Atherinidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38.</td>
<td>Pranesus pinguis</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Carangidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.</td>
<td>Gerris oblongus</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Teraponidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.</td>
<td>Terapon jarbua</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Scombridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.</td>
<td>Scombermorius sp</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Pleuronectidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42.</td>
<td>Pleuronectid egg</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Bothidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.</td>
<td>Solea ovata</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Cynoglossidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.</td>
<td>Cynoglossus are</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Tetradontidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45.</td>
<td>Tetrodon sp</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Scombridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46.</td>
<td>Decapterus sp</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Cynoglossidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47.</td>
<td>C. puncticeps</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Tetradontidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48.</td>
<td>Arothron hispidus</td>
<td>+</td>
</tr>
<tr>
<td><strong>Family : Scombridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49.</td>
<td>Arothron sp</td>
<td>+</td>
</tr>
</tbody>
</table>

(*) denotes presence, (--) denotes absence.

were found to be ubiquitously present in all the station, almost, station I and IV few species are absent.

### Percentage composition

#### Eggs from Station-I (2011): At station I, Clupeids formed the dominant group contributing 24.60% and Engraulis ranked next (17.84%) followed by Caranajs (14.22%), Tetrodonids (9.18%), Teraponids (7.14%), Mugilids (5.60%), Cynoglassids (4.54%), Pristigeridts (2.42%), Chirocentrids (2.29%), Scombrids (1.83%), Athenriods (1.59%), Ambassids (1.32%) and Ophichthids (1.29%) (Figure 46).

#### Eggs from Station-II (2011): At station II also Clupeids were the dominant group (29.36%) followed by Engraulids (19.64%), Caranajs (11.50%), Tetrodonids (7.73%), Mugilids (6.38%), Cynoglassids (4.02%), Scombrids (3.07 %), Teraponids (3.63%), Chirocentrids (2.92%), Pristigeridts (2.89%), Ambassids (1.67%), Pleurocnetinids (1.45%) and Gerrides (0.66%) (Figure 47).

#### Eggs from Station-III (2011): Station III, Engraulis ranked first (24.22) followed by Clupeids (24.07%), Caranajs (14.19%),

---

*Figure 46: The percentage composition of fin fish eggs observed during 2011.*

*Figure 47: The percentage composition of fin fish eggs observed during 2012.*
Tetraodontids (9.59%), Mugilids (6.77%), Cynoglossids (3.73%), Pristigastrids (2.94%), Scombrids (2.78%), Teraponids (2.59%), Gerreids (1.71%), Synodontids and Atherinids contributing 1.28% and 1.16% respectively. Ambassides (0.88%), chrocentrids (0.74%) and others are contributing very lesser (Figure 48).

**Eggs from Station-IV (2011):** In station IV, more number of Clupeids (31.04%) were collected followed by Engraulids (21.4%), Carangids (9.81%), Mugilids (9.08%), Pristigastrids (5.73%), Teraponids (4.20%), Cynoglossids (3.53%), Scombrids (2.47%), Chirocentroids (2.24%), Ophichthids (1.77%), Gerreids (1.61%), Synodontids (1.59%) and Ambassides (1.10%) (Figure 49).

**Eggs from Station-I (2012):** The details of the percentage composition of fin fish eggs observed during the second year of study period is shown in Figure 50. At station I, Clupeids ranked first contributing 31.97%, followed by Engraulids (18.75%), Carangids (11.59%), Pristigastrids (5.94%), Cynoglossids (5.00%), Tetrodontids (4.63%), Paralichthys (3.89%), Chirocentroids (2.86%), Scombrids (2.82%), Ophichthys (1.83%), Synodontids (1.38%), Ambassides (1.32%), Soleids (1.25%), Atherinids (1.10%) and Teraponids (0.91%).

**Eggs from Station-II (2012):** Similarly at station II, the Clupeids (10.48%) were the dominant group (25.07%) followed by Cynoglossids Carangids (18.28%), Engraulids (16.24%), Tetrodontids (6.36%), Mugilids (4.53%), Pleurocruroidis (3.94%), Pristigastrids and Paralichthys contributing 3.77% and 3.74% respectively. The eggs of Chirocentroids and Cynoglosides contributing 3.65% and 3.64% respectively followed by Ambassides (3.10%) (Figure 51).

**Eggs from Station-III (2012):** At station also III, Clupeids ranked first contributing 26.39%, followed by Engraulids (21.0%), Carangids (10.85%), Tetrodontids (8.51%), Mugilids (5.14%), Cynoglossids (3.80%), Paralichthys (3.73%), Chirocentroids (3.32%), Synodontids (2.04%), Ophichthys (1.93%), Ambassides (1.88%), Atherinids (1.55%), and Hemiramphids (1.08%) (Figure 52).

**Eggs from Station-V (2012):** At station IV also, Clupeids (38.06%), eggs were relatively more followed by Engraulids (20.45%), Carangids (13.57%), Pristigastrids (4.58%), Tetrodonids (4.06%), Chirocentroids (2.96%), Ophichthys (2.33%), Ambassides (1.98%), Pleurocruroidis (1.48%) and Soleids (0.72%) (Figure 53).
General observations

As a result of the present observation over a period of two years, 43 forms of fin fish eggs were identified, of which, finfish eggs belonging to 38 species of fish were identified up to species level, 3 were identified up to the genus level and 2 were identified up to the family level.

Manickasundaram [11] documented the fish eggs belonging to 30 species from Coleroon estuary. Fish eggs belonging to 44 species from Parangipettai waters was also described [12,15]. Venkataramanujam [17] recorded 18 species fin fish eggs along Parangipettai waters. Similarly, Koteswarma [30] recorded fin fish eggs belonging to 12 species from Bapatla coast.

The present investigation confirms the relatively rich ichthyoplankton occurrence along Muthupettai waters, south east coast of India.

Results

Miniumum eggs were observed during Monsoon in all the stations along Muthupettai waters. Similar observations were made from Parangipettai coastal waters, Coleroon estuary, Indian Ocean, Baptla coast and from Cochin back waters [7,12,15,17,30,31,32].

Seasonal distribution of eggs was significant during post monsoon followed by premonsoon, summer and monsoon. Similar observations were made by earlier workers from Parangipettai coastal waters, Coleroon estuary, Vellar estuary and from Tuticorin coastal waters along south east coast of India, more number of fish eggs were also observed in premonsoon season along Cape Comarin area [7,11,12,14,17,33]. Common occurrence of fin fish eggs along Bombay coast during premonsoon has also been reported [34,35]. Abundant occurrence of eggs during post monsoon may be due to the peak spawning activities of these fishes along Parangipettai, Baptla coast and Coleroon estuary along the south east coast of India [17,30].

Two-way analysis of variance showed significant differences in fin fish egg population density between seasons and stations in both the years of study period (Tables 2 and 3).

Pattern of distribution and abundance of fish eggs and larvae is associated with environmental factors and the environment may act either as a favorable factor for successful spawning by fish and survival during eggs and larval stages. The suitability of developmental stages in a spatial feature is a main characteristic of the life cycle of fish. For pelagic species the stability is related to hydrographic features. Thus the pattern of distribution and seasonal occurrence of eggs is not similar in the present study period of two years. This may be due to the changes in environmental conditions due to variation in the environmental factors. Two environmental factors viz., temperature and salinity have profound influence on the development and hatching of marine teleosts.

Abundance of eggs and larval stages in relation to the hydrographic features is crucial for the comprehension of the mechanism determining recruitment. Special attention is paid to the stability of the spatial distribution and the interannual and seasonal variability of the abundance index of eggs and larval abundance in relation to environmental features and planktonic predators [36].

Further, the environment also influences biological activities such as spawning and growth. Temperature determines the annual stock at the spawning ground. Fish appears to report to their oceanographic ‘climate’ rather than to geographically fixed preference period during the spawning season [9].

Studies on eggs and larvae of marine fishes although essential for understanding the dynamics of fish population are hampered by several methodological problems, such as occurrence of eggs and planktonic stages of the different species of fishes showing their seasonal variation in space and time. This might also be related to their spawning period. The heavy rainfall during monsoon considerably reduces the salinity of the estuarine water, which again increases during the post monsoon season. Distribution and abundance of fish eggs and larvae are influenced by hydrographical parameters like temperature, salinity, pH and dissolved oxygen.

Spawning of most marine fishes in tropical waters especially in Indian coastal waters is protracted. Spawning usually begins at the onset of monsoon rains [8]. The previous works on occurrence of finfish eggs and larvae indicate the protracted spawning [37-40].
Present investigation is also indicating protracted spawning behavior of fishes.

Temperature is known to play an important role in determining the fluctuations of ichthyoplankton and their distribution. Bapat [18] has stated that low temperature in Mandapam waters, Hooghly, Maltah estuarine system in the east coast of India, are conducive to growth for many fish eggs and larvae. However in the present study, environmental surface water temperature did not seem to have any direct effect on the distribution of fish eggs although each species of fish prefers to have optimal temperature and time for spawning. Normally eggs are collected in large numbers in increasing temperature and salinity. Salinity of water affects the availability of fish eggs in an estuary [12]. Each species has a certain salinity range. More number of eggs was observed in post monsoon seasons. This corresponds to a decline in salinity from the high salinity of the previous season, stimulating spawning activity in some coastal fishes. Similar observations were made along coleroon estuary and at Parangipettai coastal waters [7,11,12,17].

During the low temperature and salinity conditions the abundance of eggs was low in number but in high temperature and salinity conditions abundance of eggs was more. Perhaps high salinity and temperature conditions may stimulate spawning activity in some coastal fishes as observed presently. This finding is also in agreement with the previous works [11,14,17,30,41].

Of the two years (January 2011 to December 2012) of the present investigation, during the second year the total annual rain fall was lower than the first year. Rainfall and abundance of fish eggs appear to show a reverse relationship as reported in the Maltah estuarine system and from Vellar estuary, east coast of India [17,42]. During the present study the heavy rainfall during monsoon period considerably reduces the salinity of the estuarine and coastal waters so that the abundance of fish eggs was in less number, which again increases during the post monsoon seasons. This corresponds to a decline in salinity from the high salinity of the previous season, stimulating spawning activity in some coastal fishes. Similar observations were made along coleroon estuary and at Parangipettai coastal waters [7,11,12,17]. Thus the variations observed in the seasonal distribution and abundance of fish eggs in all the stations in the present study may be due to several reasons. Further, the variation in seasonal distribution and abundance of eggs was not similar during the study period of two years (January-2011 to December-2012).

This might also due to the environmental factors such as drainage of water, delay in spawning, predation on eggs and larvae. In addition, it is not unusual that several organisms may show variations from year to year on the magnitude of their population and also in the time of occurrence of maximum and minimum which is slightly earlier or later [43].

The correlation coefficient values between finfish eggs density and environmental parameters for all the stations along Muthupettai waters not significantly correlated, which is in agreement with the past findings [11,44,45]. However, a significant correlation (P<0.05) with surface water temperature was observed in station I during the first year along Muthupettai waters and station IV (Tables 4-7) which is supported by the observation [11].

The time and intensity of spawning of fishes may perhaps be controlled by the seasonal cycle of the environmental factors. The physic-chemical parameters recorded from various stations presently observed monthly seasonal and annual variations. Minimum eggs were observed during Monsoon in all the stations along Muthupettai waters. Seasonal distribution of eggs was significant during post monsoon followed by premonsoon, summer and monsoon. Abundant occurrence of eggs during post monsoon may be due to the peak spawning activities of these fishes coinciding the fishing holyday declared by the coastal state government with a view to enhance the breeding and spawning activities of these fishes. Regular sampling of ichthyoplankton is essential for locating shoals of adult fishes and their spawning grounds. Ichthyoplankton studies are extensively useful in fishery investigation. Information on fish eggs and larvae of a particular region is useful in understanding the spawning season of fishes of commercial importance. Studies on the early developmental stages of fish allow

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
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<td>3.84E-08</td>
<td>2.891564</td>
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<td>52411.857</td>
<td>10.60099</td>
<td>5.9E-08</td>
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<td>Error</td>
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<td>33</td>
<td>4944.036</td>
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<tr>
<td>Total</td>
<td>1075212.479</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Two-way ANOVA for differences in abundance of fin fish eggs between seasons and stations I to IV along Muthupettai waters for the study period (January-2011 to December-2012).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rows</td>
<td>222265.1667</td>
<td>3</td>
<td>74088.389</td>
<td>15.06155</td>
<td>2.4E-06</td>
<td>2.891564</td>
</tr>
<tr>
<td>Columns</td>
<td>511608.5</td>
<td>11</td>
<td>46509.864</td>
<td>9.455068</td>
<td>2.26E-07</td>
<td>2.093254</td>
</tr>
<tr>
<td>Error</td>
<td>162328.3333</td>
<td>33</td>
<td>4919.0404</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>896202</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Two-way ANOVA for differences in abundance of fin fish eggs between seasons and stations I to IV along Muthupettai waters for the study period (January-2011 to December-2012).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Rainfall (mm)</th>
<th>At. Temp. (°C)</th>
<th>Wat. Temp. (°C)</th>
<th>Salinity (%)</th>
<th>pH</th>
<th>DO (ml/l)</th>
<th>Fish eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.00</td>
<td>-0.65</td>
<td>-0.59</td>
<td>-0.53</td>
<td>-0.29</td>
<td>0.10</td>
<td>0.27</td>
</tr>
<tr>
<td>Rainfall (mm)</td>
<td>-0.65</td>
<td>1.00</td>
<td>0.55</td>
<td>0.65</td>
<td>0.44</td>
<td>-0.01</td>
<td>-0.51</td>
</tr>
<tr>
<td>At. Temp. (°C)</td>
<td>-0.65</td>
<td>1.00</td>
<td>0.55</td>
<td>0.65</td>
<td>0.44</td>
<td>-0.01</td>
<td>-0.51</td>
</tr>
<tr>
<td>Wat. Temp. (°C)</td>
<td>-0.65</td>
<td>1.00</td>
<td>0.55</td>
<td>0.65</td>
<td>0.44</td>
<td>-0.01</td>
<td>-0.51</td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>-0.53</td>
<td>1.00</td>
<td>0.55</td>
<td>0.65</td>
<td>0.44</td>
<td>-0.01</td>
<td>-0.51</td>
</tr>
<tr>
<td>pH</td>
<td>-0.29</td>
<td>0.44</td>
<td>0.48</td>
<td>0.09</td>
<td>0.09</td>
<td>0.10</td>
<td>0.23</td>
</tr>
<tr>
<td>DO (ml/l)</td>
<td>0.10</td>
<td>-0.01</td>
<td>0.38</td>
<td>-0.51</td>
<td>0.09</td>
<td>1.00</td>
<td>0.23</td>
</tr>
<tr>
<td>Fish eggs</td>
<td>0.27</td>
<td>-0.51</td>
<td>-0.18</td>
<td>-0.29</td>
<td>-0.29</td>
<td>0.02</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 4: Correlation coefficient (r) values between fin fish eggs abundance and physicochemical parameters, at stations I along Muthupettai waters during January-2011 to December-2012.
Table 5: Correlation coefficient (r) values between fin fish eggs abundance and physicochemical parameters, at stations II along Muthupettai waters during January-2011 to December-2012.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Rainfall (mm)</th>
<th>At. Temp. (°C)</th>
<th>Wat. Temp. (°C)</th>
<th>Salinity (%)</th>
<th>pH</th>
<th>DO (ml/l)</th>
<th>Fish eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (mm)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At. Temp. (°C)</td>
<td>-0.67</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wat. Temp. (°C)</td>
<td>0.25</td>
<td>-0.17</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>-0.75</td>
<td>0.83</td>
<td>-0.31</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>-0.13</td>
<td>0.10</td>
<td>-0.22</td>
<td>0.072</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DO (ml/l)</td>
<td>-0.36</td>
<td>0.41</td>
<td>-0.62</td>
<td>0.40</td>
<td>0.09</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fish eggs</td>
<td>-0.34</td>
<td>0.01</td>
<td>-0.15</td>
<td>0.058</td>
<td>-0.11</td>
<td>0.11</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6: Correlation coefficient (r) values between fin fish eggs abundance and physicochemical parameters, at stations III along Muthupettai waters during January-2011 to December-2012.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Rainfall (mm)</th>
<th>At. Temp. (°C)</th>
<th>Wat. Temp. (°C)</th>
<th>Salinity (%)</th>
<th>pH</th>
<th>DO (ml/l)</th>
<th>Fish eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (mm)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At. Temp. (°C)</td>
<td>-0.68</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wat. Temp. (°C)</td>
<td>-0.59</td>
<td>0.82</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>-0.83</td>
<td>0.80</td>
<td>0.70</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>-0.65</td>
<td>0.48</td>
<td>0.39</td>
<td>0.72</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DO (ml/l)</td>
<td>-0.37</td>
<td>0.46</td>
<td>0.30</td>
<td>0.32</td>
<td>0.14</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fish eggs</td>
<td>-0.26</td>
<td>0.057</td>
<td>0.13</td>
<td>0.026</td>
<td>-0.12</td>
<td>0.28</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 7: Correlation coefficient (r) values between fin fish eggs abundance and physicochemical parameters, at stations IV along Muthupettai waters during January-2011 to December-2012.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Rainfall (mm)</th>
<th>At. Temp. (°C)</th>
<th>Wat. Temp. (°C)</th>
<th>Salinity (%)</th>
<th>pH</th>
<th>DO (ml/l)</th>
<th>Fish eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (mm)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At. Temp. (°C)</td>
<td>-0.66</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wat. Temp. (°C)</td>
<td>-0.55</td>
<td>0.88</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>-0.74</td>
<td>0.96</td>
<td>0.87</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
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<td>0.65</td>
<td>0.54</td>
<td>0.70</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DO (ml/l)</td>
<td>0.06</td>
<td>0.41</td>
<td>0.39</td>
<td>0.40</td>
<td>0.23</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fish eggs</td>
<td>-0.31</td>
<td>0.08</td>
<td>0.26</td>
<td>0.07</td>
<td>0.00</td>
<td>-0.54</td>
<td>1</td>
</tr>
</tbody>
</table>

us to comprehend the biology of the species besides determining their spawning seasons and to estimate spawning stock abundance. Therefore, study is also an essential prerequisite in undertaking the spawning biomass of target species monitoring, changes in exploitable stocks and yields, forecasting trends of production.

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