Uttar Pradesh Journal of Zoology

Volume 44, Issue 21, Page 158-170, 2023; Article no.UPJOZ.2866
ISSN: 0256-971X (P)

Mugilidae and Chanidae Fish Seed Resources of the Kalingapatnam Estuary of Andhra Pradesh, East Coast of the India

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Authors' contributions

This work was carried out in collaboration between both authors. Authors KRR and VH designed the protocol, collected the samples, and performed the topographical anatomy studies of the wild fish seed. Both authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2023/v44i213683

Editor(s):
(1) Prob. Telat Yanik, Atatürk University, Turkey.
Reviewers:
(1) Aditi Chaudhary, Christ University, India.
(2) Bhukya Bhaskar, Rgca, India.

Original Research Article

Received: 02/09/2023
Accepted: 27/09/2023
Published: 05/10/2023

ABSTRACT

The samples of wild fish seeds collected from the Kalingapatnam estuary throughout the study period from February 2022 to August 2023. In the present study the samples collected various seasons and measured the average minimum length ranged from 1.4±0.14 cm to 1.9±0.25 cm, the maximum length range was 2.4±0.14 cm to 3.5±0.27 cm and the mean value is 2.1-2.9 cms for *Mugil spp*. The average minimum length ranged from 1.2±0.09 cm to 1.6±0.12 cm, the maximum length range was 1.8±0.07 cms to 3.0±0.117 cms and the mean value is 1.5-2.8 cms for *Liza spp*.

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The average minimum length ranged from 1.4±0.14 cm to 1.9±0.25 cm, the maximum length range was 2.4±0.14 cm to 3.6±0.27 cm and the mean value is 2.0-2.8 cms for *Chanos spp*. The present results clearly indicated that during the peak season lasting from April to July and the post monsoon ranging from October to March, the *Mugil spp*. contributed to 12.05%, *Liza spp*, contributed to 10.7%, *Chanos spp*. contributed to 07.85% and miscellaneous 69.6% was reported monthly and seasonally in the estuary. The present finding of one-way ANOVA, the p-value (0.189312) > α, H0, is accepted. The larger the p-value, the stronger it supports H_0. The test statistic F equals 1.7198, which is in the 95% region accepted. The comparison of water quality parameters with mullet and milkfish seed and the average body length determine the difference between the averages, which reflects a real difference between the groups in the present study. The Pearson Correlation The coefficient of **r**elationship between the variables for salinity and R value comparison with temperature, pH, transparency, and ammonia exhibited a positive correlation, and p values are significant at 0.05 levels, as discussed in this report.

Keywords: Wild fish seed; estuary; salinity; pH; dissolved oxygen; one-way ANOVA; pearson correlation.

1. INTRODUCTION

Mugil is one of the most significant brackish water fish, which is only found on the east coast of Southeast Asia and Africa. The fish reproduces once or twice a year in coastal marine waters at 25 m in depth. Mullet fish species female are spawned 1.5 to 1.7 million eggs, and sometimes up to 5 million. Because they are euryhaline, fish can withstand sudden changes in salinity effectively [1]. The larvae drift to the coastal waters near the estuaries with a temperature of about 23 °C, and the eggs take about 24 hours to hatch. Salinity is not too important (10 to 32 ppt), and the fish are captured where phytoplankton is abundant. When the fry have reached 1.3 cm in length, the yolk sac is completely absorbed, and they begin looking for food. Andhra Pradesh and Odisha are becoming more interested in marine finfish production utilising locally accessible wild seed. The main species accessible in adequate quantities in the wild include Asian seabass, milkfish, and several mullet species. Understanding the availability of wild seeds in the backwaters of Krishna and West Godavari districts, aquaculture of those fish has been created throughout the majority of Andhra Pradesh's coastal districts. Part-time seed-gathering activities are carried out by fishermen in a number of fishing settlements in these areas. Tidal patterns are used in traditional fish seed harvesting procedures [2,3]. It is necessary to research the biology of the fish species in order to decide when and where the fish should be caught.

Depending on the area, there are two basic techniques for seed collection. During low tide, scoop nets are used to capture fish seeds from mangrove water pools [4,5]. In the backwaters and along the coast, fish seeds are also harvested using a drag net or a seine net. During high tide, nets with poles are set around the estuary's border. During low tide, the fish seeds are collected in a net, and as the water recedes more, the fishermen collect them. Seed collection is mostly done from March to May for Asian seabass, March to July for milkfish, and all year for mullet. For Asian sea bass and milkfish, large-scale seed harvesting is being pursued. The seeds are gathered and put in tiny ponds near the seed gathering locations. These seeds are typically smaller than 2 cm in size and are separately stocked in Hapas or discharged directly into a pond of 1-2 acres in size. The seed-raising ponds are designed with two depths: a deeper section on the outside and a modest depth in the centre. Milk fish are fed rice bran, whereas sea bass are fed Tilapia juveniles [6]. Interestingly, little branches of a plant known as 'babul' (*Acacia nilotica*) are put at various locations around the pond. This serves as an aggregation mechanism for fish seeds. Furthermore, the epiphytic algae and zooplankton that collect in it serve as food for milkfish and seabass. The supplied fish are grown for 1-2 months before being sold to fish farmers for culture. Milkfish are typically marketed at 3-5 cm in length; however, seabass are raised to a much larger size. The branches are gently removed when harvesting fish from the pond, and the cast net is operated in the same area so that more fish are trapped in the net [7,8].

Mullet is grown all over the world and has a wide distribution. Mullets are classified as *Mugil* spp. or *Liza spp.* Although artificial reproduction is conceivable, there are still numerous cases

where significant volumes of fry are obtained from the wild. Mullets spawn in the sea, flourish in estuaries, and occasionally move to freshwater. The eggs are pelagic, and they hatch in two days. The larvae begin to swim along the coast after hatching and generally arrive in large numbers around 2 months later. They have grown to a size of 25 mm at this stage. They establish tiny schools along the shore and begin to travel into the estuaries. Using seine or dip nets, they are mainly caught when they enter the estuary at low or increasing tide. In Odissa, West Bengal, and Bangladesh, grey mullet wild seed was supplied and grown in polyculture with other suitable species. Under extensive brackish water pond culture conditions, with a grow-out duration of 8–9 months [9]. Due to a lack of hatchery seed, intensive cultivation is prohibited. This is the first investigation into natural fish seed resources in the Kalingapatnam area in terms of availability and illegal capture.

Estuaries exhibit a dynamic environment in terms of salt water, pH, temperature, oxygen, and contaminants. Fish and other local species may have evolved to withstand or escape the severe estuary conditions [10,11]. Estuaries also serve as areas for commercial and recreational activity, but many of them have lost some of their biotic integrity due to wastewater discharges that may be low in oxygen and high in pesticides, herbicides, heavy metals, and ammonia [12]. There is no fish seed data available in this estuary, and most of the local fishermen, including those from other states, catch Mullet *spp. and Chanos spp.* seasonally.

2. MATERIALS AND METHODS

Wild fish seed and water samples were collected from two sites, Kalingapatnam (18.343635N), 84.120134E, and Rajarampuram (18.351188N), 84.137954E, from February 2022 to August 2023 (Fig 1). Fish seed is collected with scoop nets or simple seine nets when phytoplankton is abundant; it reaches the estuary at low or high tide. The nylon mosquito screen dragnet, measuring 3 x 0.75 m with a mesh size of between 0.2 cm and 1.5cm, was dragged in shallow water for about 1–1.5 m. *Mullet spp.* and *Chanos spp*. seed in tiny schools along the shore and begin to travel into the estuaries. The larvae begin to swim near the coast, where they normally congregate in large numbers. The collected fish seed is brought to the laboratory and maintained in separate experimental tank of 2×4 mts glass aquaria for 7–10 days in clean brackish water. The identification of fish seed based on the morphometric and merstic characteristics like dorsal fins, mouth position and stripes on the body [13]. Weak, injured, and diseased fish are then removed. The collected fish seed was segregated genus-wise for the counting of population percentages at both sampling stations. Water quality parameters such as salinity, pH, dissolved oxygen, transparency, nitrite, and ammonia concentration were estimated following standard methodology [14]. The fish seed average length in comparison with other water quality parameters was calculated using correlation and a one-way ANOVA using Tukey HSD (Honestly Significant Difference) software.

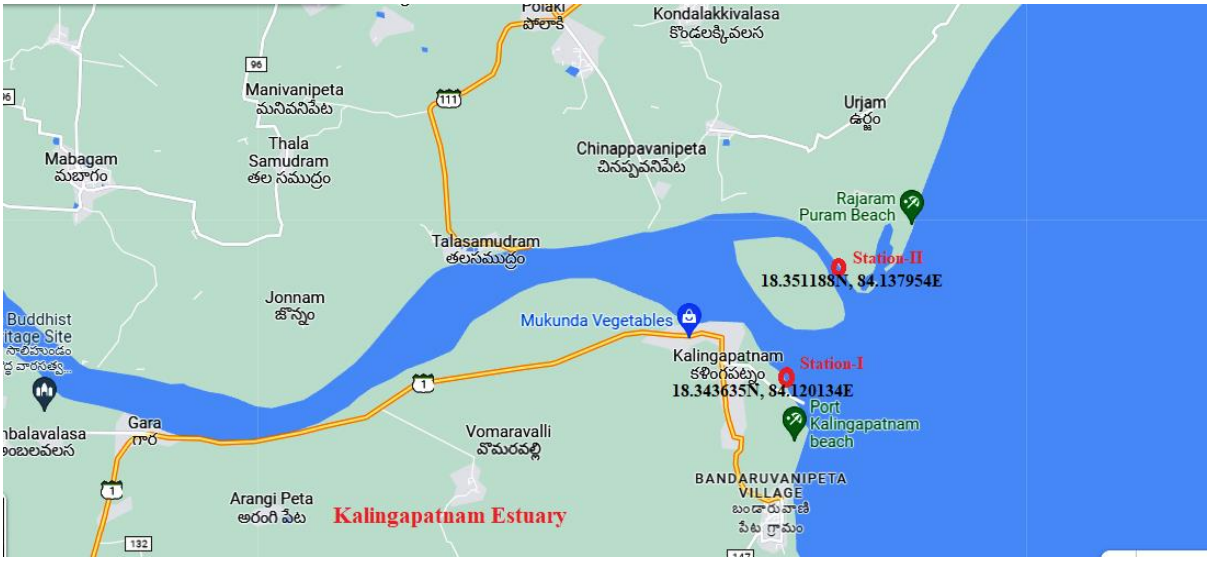

Image 1. Fish seed collection from Kalingapatnam estuary at station I and II

3. RESULTS AND DISCUSSION

The samples of wild fish seeds collected from the Kalingapatnam and Rajarampuram brackish water throughout the study period from February 2022 to August 2023 (Table 1). During the present study period concentrated on *mugil spp*. and *chanos spp*. abundance in these brackish waters. The number of juveniles caught in nylon screen dragnet, the samples measured various seasons for average minimum length ranged from 1.4±0.14 cm to 1.9±0.25 cm, the maximum length range was 2.4±0.14 to 3.5±0.27, the mean value is 2.1-2.9 cms in *Mugil spp*,. The average minimum length ranged from 1.2±0.09 cm to 1.6±0.12 cm, the maximum length range was 1.8±0.07 to 3.0±0.117, the mean value is 1.5-2.8 cms in *Liza spp*,. The average minimum length ranged from 1.4±0.14 cm to 1.9±0.25 cm, the maximum length range was 2.4±0.14 to 3.6±0.27, and the mean value is 2.0-2.8 cms in *Chanos spp*. (Table 1; Figs. 3 and 4). The data was collected from two sampling stations in the present study, the fish seed is available throughout the year except August and September because heavy flood water in this creek (Fig 6). The average mean values calculated for three species of one way ANOVA was, the p-value (0.189312) > α, H_0 is accepted. The larger the p-value the stronger it supports H_0. The test statistic F equals 1.7198, which is in the 95% region of accepted (-∞: 3.1788). The η^2 equals to 0.063, it means that the group explains 6.3% of the variance from the average (similar to R^2 in the linear regression). There is no significant difference between the means of any pair (Table 1, Fig. 7). The present results clearly indicated to the peak season lasting from April to July and the post monsoon ranging from October to March, the *Mugil spp*. Contributed to 12.05%, *Liza spp*, contributed to 10.7%, *Chanos spp*. contributed to 07.85% and miscellaneous 69.6% was reported monthly and seasonally in the creeks (Table 2, Fig. 1). The average population length was estimated at randomly, the results exhibits highest with *Mugil spp*, (14.75%), Liza Spp. (11.5%) *Chanos spp*. (9.0%) in Post-monsoon period, lowest indicated to *Mugil spp*, (8.5-10.5%), *Liza Spp*. (10.5%) *Chanos spp*. (8.0%) in the monsoon period (Table 2, Fig. 2). According to reports, the similar results were observed in many locations of their availability and relative abundance in different months and seasons. The occurrence and collecting of milk fish seed varies from site to site around India's east and west coasts, with the peak season lasting from April to July in most locations and the secondary season ranging from October to December. *Mugil cephalus* seed is plentiful among grey mullet seed, while other grey mullets are sparse [15]. The similar results were recorded by Purushottama et al. [16] estimated the finfish seeds, *Mugil spp.* and *E. suratensis* dominated and contributed to 56.4% and 25.6% respectively in the month of June. However, these two species were available in small quantities during rest of the study period in Shambhavi Estuary, Karnataka. According to Santhosh et al. [9] reported the fish seeds collection usually present in close coastal locations. Shore seine operations frequently bring in enormous quantities of fish seeds such as carangids, snappers, seabreams, mullets, barracudas, and tunas. It is difficult to gather the seeds without becoming injured throughout this process. Careful net operations can generate a

Table 1. Availability of prioritized natural seed recourses along the Kalingapatnam estuary

Seasons		*Mugil spp.* total length					*Liza spp. total length*					*Chanos spp.* total length				
	Month	Min. (cm)	S.D	Max. (cm)	S.D	Mean. (cm)	Min. (cm)	S.D	Max. (cm)	S.D	Mean. (cm)	Min. (cm)	S.D	Max. (cm)	S.D	Mean. (cm)
Pre-monsoon	Feb-22	1.8	±0.14	2.4	±0.14	2.2	1.5	±0.08	2.0	±0.08	1.7	1.8	±0.14	2.4	±0.14	2.2
	Mar	1.6	±0.17	2.7	±0.16	2.4	1.3	±0.07	1.8	±0.07	1.5	1.6	±0.17	2.7	±0.16	2.4
	Apr	1.5	±0.13	3.2	±0.21	2.8	1.4	±0.06	2.2	±0.12	1.8	1.5	±0.13	3.2	±0.21	2.8
	May	1.7	±0.16	3.5	±0.24	2.4	1.4	±0.11	2.5	±0.14	2.1	1.7	±0.16	3.5	±0.24	2.4
Monsoon	June	1.6	±0.15	2.8	±0.18	2.5	1.3	±0.08	2.1	±0.11	1.7	1.6	±0.15	2.8	±0.18	2.5
	July	1.9	±0.25	2.7	±0.24	2. 1	1.6	±0.12	2.2	±0.17	1.8	1.9	±0.25	2.7	±0.24	2.1
	*Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	*Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Post-monsoon	Oct	1.6	±0.22	2.6	±0.16	2.1	1.5	±0.14	2.1	±0.07	1.7	1.6	±0.22	2.6	±0.16	2.0
	Nov	1.4	±0.14	2.6	±0.18	2.3	1.3	±0.08	2.2	±0.11	1.8	1.4	±0.14	2.6	±0.18	2.3
	Dec	1.5	±0.13	2.8	±0.22	2.4	1.2	±0.11	2.4	±0.14	2.1	1.5	±0.13	2.8	±0.22	2.4
	Jan-23	1.8	±0.17	3.2	±0.25	2.4	1.4	±0.12	2.8	±0.14	2.2	1.8	±0.17	3.2	±0.25	2.4
Pre-monsoon	Feb	1.8	±0.15	3.5	±0.27	2.6	1.5	±0.09	3.0	±0.11	2.8	1.8	±0.15	3.6	±0.27	2.6
	Mar	1.6	±0.13	3.1	±0.22	2.5	1.2	±0.08	2.7	±0.13	2.2	1.6	±0.13	3.1	±0.22	2.5
	Apr	1.8	±0.15	3.5	±0.24	2.9	1.3	±0.06	2.4	±0.18	2.1	1.8	±0.15	3.5	±0.24	2.8
	May	1.6	±0.12	3.3	±0.21	2.6	1.2	±0.11	2.8	±0.12	2.2	1.6	±0.12	3.3	±0.21	2.6
Monsoon	Jun	1.6	±0.13	3.2	±0.22	2.5	1.2	±0.09	2.5	±0.12	1.9	1.6	±0.13	3.1	±0.22	2.5
	Jul	1.8	±0.15	3.4	±0.24	2.8	1.5	±0.12	2.8	±0.09	2.2	1.8	±0.15	3.5	±0.24	2.8
	*Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*(*Heavy floods in the month of August and September)*

large number of fish seeds at Vizhinjam [17]. Asok Biswas, [18] investigated on riverine collection of spawn and fry in Punjab was initiated for the first time in 1963, and riverine collection is already generating the highest number of fish seed to the tune of 32.89 lakhs of spawn and 23.04 lakhs of fry in 1964-65, out of all the other ways. Fry collecting nets, which are fine-meshed drag nets, are used to gather the fry and fingerlings. Cast nets, traps made of fine muslin cloth, are also used to catch fingerlings when they jump over irrigation barriers. Basket traps are employed in the rivers Godavari, Krishna, and Cauvery to catch fry and fingerlings.

In the present study the water quality parameters was observed at Kalingapatnam estuary, the salinity was highest (33‰) was observed in the pre-monsoon period and lowest (4‰) in the monsoon season. During the study period, Water temperature ranged 22.5 to 30.6 ^{0C}, the pH range tested was 6.8 to 8.5, the dissolved oxygen observed range was 5.45 (mg/L) to 7.84 (mg/L), the transparency secchi disc vision was 10 – 68 cms, Nitrite concentration ranged from 1.25 -4.12 mg/L and the ammonia content was recorded 0.1 to 0.68 mg/L (Table 3, Fig 5). The similar observations were reported by Ashok Prabu et al. [19] observed the salinity (‰), pH and dissolved oxygen (ml l-1) ranges were 6.0- 38.0; 7.1-8.2 and 2.4 to 4.5 nitrites, 1.05-4.15 µM. Nutrient concentrations were higher during monsoon season and low during summer in Cuddalore , southeast coast of India. Higher summer values (38.0‰) may also be attributed to the low amount of rainfall, high degree of evaporation besides dominance of neritic water from the Vellar estuary [20]. Water temperature, pH, dissolved oxygen and salinity ranged between 28.8 (January) and 32.7°C (May); 7.24 (October) and -1 7.78 (May); 3.75 (May) and 5.24 mgl (February) (October) and 31.13ppt (May), respectively in composition of finfish and shellfish seeds in mangroves of Gangolli estuary [21]. On the other hand, during the monsoon season, the rainfall and the consequent freshwater inflow from the Vamsadhara in turn would have moderately reduced the salinity (4.0‰). The recorded high summer pH values might be due to the influence of seawater penetration and high biological activity and also due to the occurrence of high photosynthetic activity [22].

The higher values of dissolved oxygen were recorded during monsoon season which might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing [23,6,20]. The higher value of nitrite recorded during monsoon season (4.15 mg/L) could be due to variation in phytoplankton excretion, oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and bacterial decomposition of planktonic detritus [24] and also due to denitrification and air-sea interaction exchange of chemicals [20]. The recorded low value (1.05 mg/L) during summer and post-monsoon seasons could be related to less freshwater inflow and high salinity [24,25] and the similar results were recorded in the Kalingapatnam estuary.

The water quality parameters comparison with mullet and milk fish seed, the average body length determine the difference between the averages reflects a real difference between the group in the present study. The Pearson Correlation Coefficient of relationship between the variables for salinity R value compared with temperature, pH, transparency, and ammonia had exhibit a positive correlation, and p values is significant at 0.05 levels. The Dissolved oxygen and transparency negatively correlated and the values are not significant. The results of pH are significant with nitrite and ammonia and nitrite significant with ammonia in the Kalingapatnam estuary (Table 4). The similar studies were revealed that the temperature is assumed to be an important element determining animal dispersion [26], and hence in estuarine and backwater settings with high organic carbon content and rich [27,28]. In the Mulki Estuary, the seasonal distribution and behaviour of nutrients were examined in relation to the tidal cycle [29,30].

Table 2. Seasonal percentage of population length of genus wise random sample at both sites

Seasons	*Mugil spp.*	*Liza spp.*	*Chanos spp.*	Other spp.
Pre-monsoon	14	10.25	7	68.75
Monsoon	10.5	10.5	8	72
Post monsoon	14.75	11.5	9	64.75
Pre-monsoon	12.5	10.75	7.25	69.5
Monsoon	8.5	10.5	8	73
Average	12.05	10.7	7.85	69.6

Table 3. Water quality parameters in Kalingapatnam estuary

Seasons	Months	Salinity (ppt)	Temperature (0C)	pH	Dissolved oxygen (mg/L)	Transparency (cm)	Nitrite (mg/L)	Ammonia (mg/L)
Pre-	Feb-22	32	26.2	7.8	6.21	42	2.52	0.42
monsoon	Mar	32	28.4	7.8	5.45	48	1.82	0.58
	Apr	33	28.7	7.9	5.83	62	1.64	0.64
	May	33	30.6	8.2	6.52	65	1.25	0.68
Monsoon	June	24	28.5	7.7	6.84	54	3.15	0.26
	July	15	27.8	6.8	7.41	18	3.72	0.22
	Aug	5	25.2	7	7.82	10 Tur.	4.12	0.15
	Sep	5	25.5	7.5	7.34	36	3.92	0.01
Post.	Oct	15	24.5	7.5	7.01	45	3.64	0.2
monsoon	Nov	25	24.8	7.8	6.55	62	3.43	0.48
	Dec	25	23	7.8	6.78	54	3.12	0.52
	Jan-23	27	22.5	7.9	7.12	52	3.15	0.43
Pre-	Feb	30	27.2	7.9	7.34	46	2.89	0.52
monsoon	Mar	33	28.8	8.1	6.85	52	2.75	0.64
	Apr	33	29.4	8.3	7.84	62	2.55	0.62
	May	33	30.1	8.5	7.42	68	2.21	0.58
Monsoon	Jun	23	28.8	7.8	6.85	35	2.98	0.25
	Jul	4	28.2	7.9	7.84	12 Tur.	3.12	0.13
	Aug	5	26.3	7.6	7.82	10 Tur.	3.78	0.15

(Tur: Turbidity, Flooded time more turbidity was observed)

Table 4. Pearson Correlation Coefficient of relationship between the variables for R value and p-value

Parameters	Salinity	Temperature	pH	D. O.	Transparency	Nitrite	Ammonia
Salinity	0	0.3605	0.6626	-0.5936	0.8459	-0.789	0.9212
		0.12946	0.00199	0.0073	0.0001	0.00005	<0.00001
Temperature		0	0.420	-0.0897	0.2063	-0.6183	0.3572
			0.7341	0.7149	0.3967	0.00478	0.1332
pH			0	-0.17	0.4204	-0.6932	0.6877
				0.4865	0.7310	0.00099	0.0011
D. O.				0	-0.0897	-0.6183	-0.5044
					0.7149	0.0048	0.0276
Transparency					0	-0.366	0.3572
						0.1232	0.1332
Nitrite						0	-0.8128
							0.00002
Ammonia							0

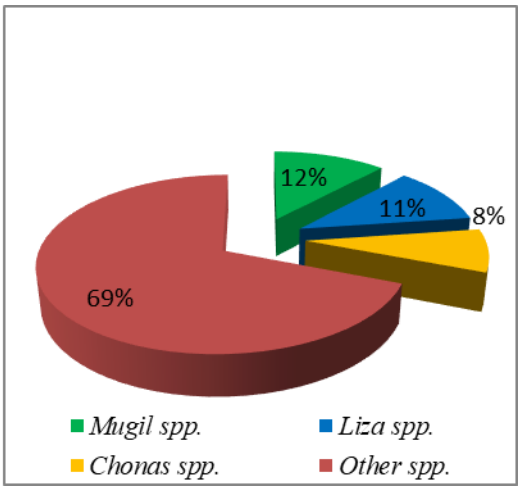

Fig. 1. Monthly percentage of Population Length

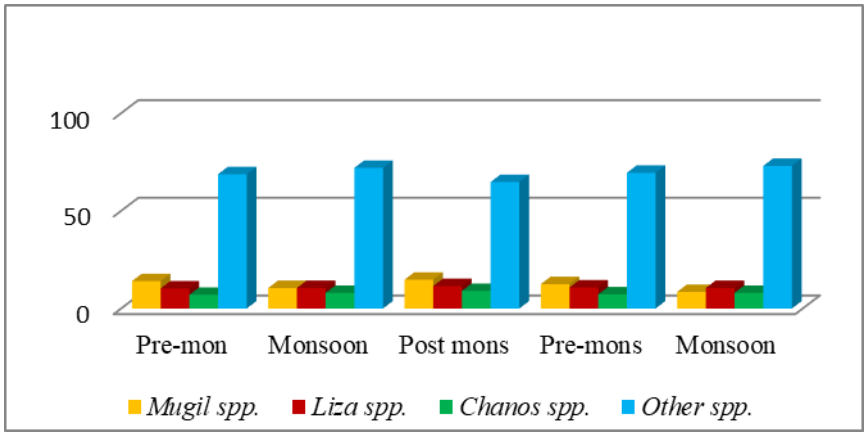

Fig. 2. Seasonal percentage of Population Length

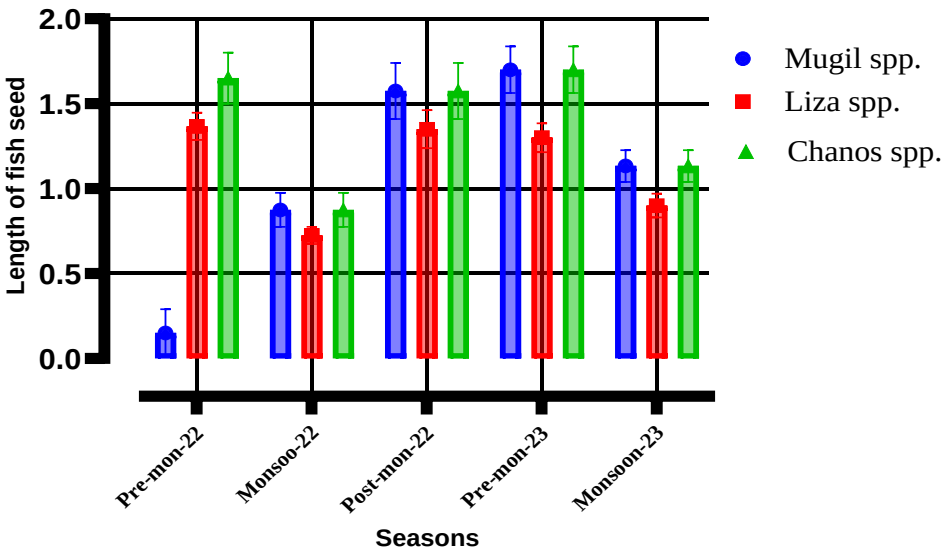

Fig. 3. An average minimum length of fish seed

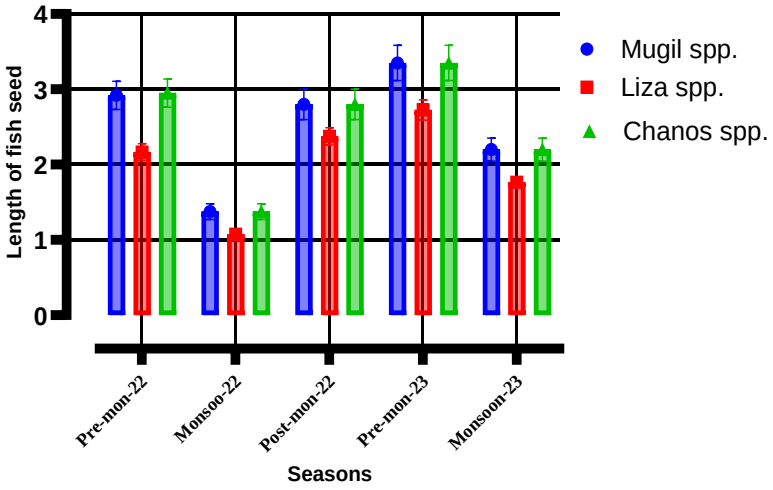

Fig. 4. An average maximum length of fish seed

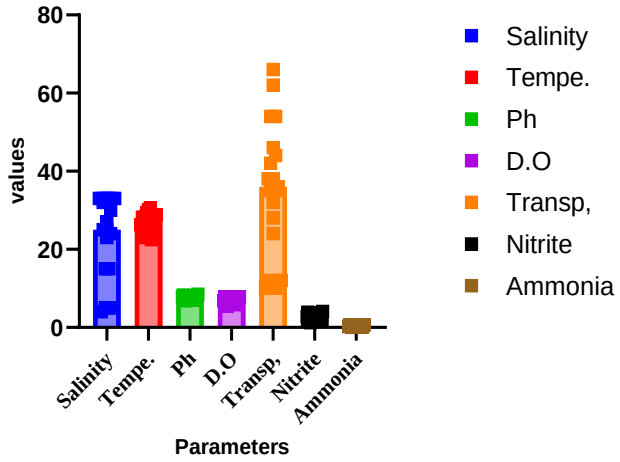

Fig. 5. Physico-chemical parameters

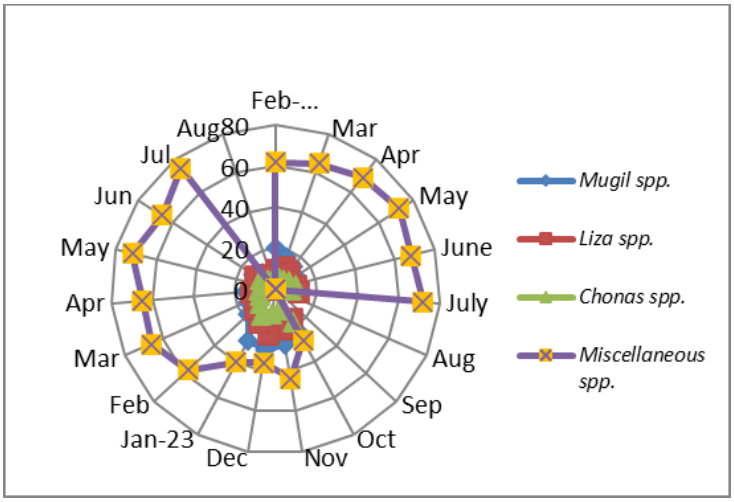

Fig. 6. Radar chart of Monthly percentage of Population Length

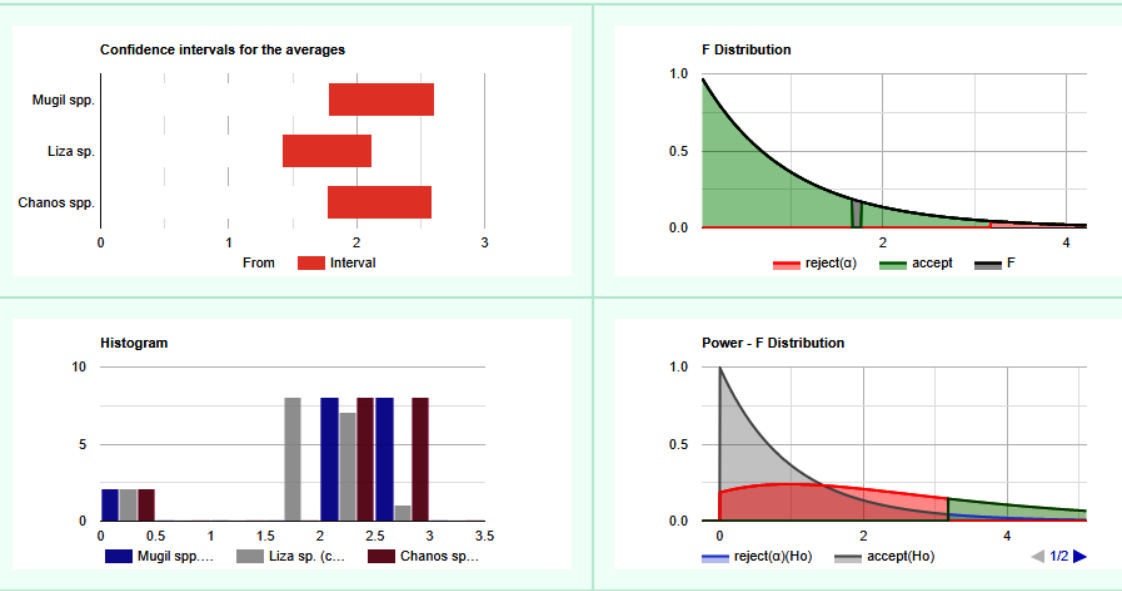

Fig. 7. The mean values of ANOVA for three fish seed genus in various months

4. CONCLUSION

According to the current results, it is clearly indicated that the peak season lasts from April to July and the post-monsoon ranges from October to March. The *Mugil spp*. contributed to 12.05%, *Liza spp*, contributed to 10.7%, *Chanos spp*. contributed to 07.85% and miscellaneous 69.6% was reported monthly and seasonally in the creeks recorded throughout the investigation period. During the research period, two abundance peaks were observed in the pre monsoon and early post-monsoon. The water quality characteristics were compared to the average body length of M*ullet spp*., when one-way ANOVA test identify to significance between the groups. The lower the F statistic is difference between certain groups' averages is large enough to be statistically significant. The water quality parameters were suitable for growth and abundance of wild seed in the Kalingapatnam estuary.

DATA AVAILABILITY STATEMENT

The authors confirm that the data used to support the findings of this study are available within the article.

ETHICAL APPROVAL

This study was conducted according to international ethical standards set by the Institutional Animal Care and Use Committee

ACKNOWLEDGEMENTS

The author would like to thank Vice-Chancellor Andhra University, Director AU TDR HUB, the Commissioner, Commissionerate of Collegiate Education, Andhra Pradesh and Dr. I. Vijaya Babu, Principal, Dr. V. S. Krishna Government Degree & PG College (A), Visakhapatnam, for providing necessary facilities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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