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CONTENTS

DEEP SEA: THE DARK WORLD

Kumar Rajendran[1], Kannapiran Ethiraj[1*], Kannan Karuppiah[2]
[1]Department of Fisheries Science, Alagappa University, Karaikudi – 630003, Tamil Nadu, India
[2]Department of Zoology, Kongunadu Arts and Science College, Coimbatore – 641029, Tamil Nadu, India

Deep sea - Environmental characteristics

Deep sea is the dark world which accounts for more than 95% of earth's living space. Mariana Trenchnear Guamis the deepest location of the ocean (10,911 m). The sunlight hasn't reach the bottom of the ocean in a billion years. Sun lights fades at a depth of around 200 m. The temperature ranges from freezing point (2 to 4 °C) to as high as 400 °C near hydrothermal vents. The pressure in the ocean increases by about 1 atmosphere for every 10 meters of depth. Salinity is about 35 parts per thousand. Hydrothermal vents exist in volcanically active areas. It harbours complex communities of life. Deep sea organisms have diverse adaptations in their anatomical structures, proteins and metabolic systems to survive in the extreme conditions.

Microorganisms

Here, photosynthetic organisms such as plants and phytoplanktons are absent due to lack of sun light required for their survival. Studies have found that methanogens are abundant in the hydrothermal vents which release hot fluids containing inorganic elements into the cold sea water. These chemicals serves as nutrient source for the chemosynthetic bacteria, the producers of the deep sea ecosystem. Marine bacteriophages are extremely abundant in sediments around the world which helps in cycling nutrients in deep sea sediments.

Fauna

Organisms living in the deep sea have a variety of adaptations to survive in these extreme conditions. Since the plants are absent in the deep sea, the organisms adopt different feeding methods such as predation, filtration, scavenging and feeding on marine snow, the sinking organic material consisting of algal particulates, detritus, and other forms of biological waste fallen from upper waters. Squat lobsters, red prawns, and sea cucumbers are found in the abyssal zone (between 3,000 and 6,000 meters below the sea surface). Deep sea animals are devoid of air sacs. Since the food availability is low in the deep sea, the animals in this region have slow metabolism. They often have slender body, extendable, hinged jaws with large teeth. Many organisms are hermaphroditic. Fishes haveupward field of vision with larger tubular eyes with only rod cells.Some deep sea organisms produce their own light (bioluminescence) foroffensive and defensive strategies to snag a meal or find a mate. It has been reported that 75 percent of deep-sea animals from

tiny microscopic single-celled algae to the giant Humboldt squidmake their own light.Some animals, like the angler fish rely on symbiotic algae (housed inside their body) to produce their light for them. Tactile organs are highly developed. Long feelers and slender attenuations of the fins act as a tactile organ. Some of the bizarre deep sea animals include Giant Isopod, Octopus, Sharks, Pacific Blackdragon, Squid, Japanese Spider Crab, Stonefish etc. Deep-sea corals may exist as individual coral polyps, as diversely-shaped colonies and as reefs with many colonies made up of one or more species. They also serve as a habitat for deep sea creatures like sea stars and sharks. Deep-sea corals obtain the energy and nutrients by trapping tiny organisms in their polyps from passing currents. Scientists described a snailfish (*Pseudoliparis swirei*), the deepest living fish at 27,000 feet below sea level in 2018. The snailfish lacks scales and has large teeth. Tube worms, clams, mussels, shrimp, and gigantic worms thrive in hydrothermal vent habitat. Riftia tubeworms depend on on microorganisms that produce energy using the hydrogen sulfide discharging from the hydrothermal vent.

Potential of Deep Sea

It has been suggested that we know more about the Moon than the deep sea. The deep sea is considered the least explored environment. The deep ocean is not only incredible but it's a vast reservoir of biodiversity. Deep sea ecosystem is essential to keep our planet healthy and keeping us alive by sequestering carbon and forming the basis of food chains. Deep sea mining is carried for extraction of various minerals from the sea bed. Indian scientists are planning for Samudrayaan Mission which is aimed to develop a self-propelled manned submersible to carry 3 human beings to a water depth of 6000 meters in the ocean for deep ocean exploration. This Deep Ocean Mission will support the 'Blue Economy' by sustainable utilisation of ocean resources for economic growth of the country, improve livelihoods and jobs, and preserve ocean ecosystem health.

The Estimation of Different Fish Feeding Methods on Growth Performance and Fish Yield in Composite Fish Culture System of Alagappa University Fisheries Ponds

S. Selvakumar, K. Kalaiselvan, E. Kannapiran

Fisheries Science department, Alagappa University, Karaikudi, Tamil Nadu – 630002

Abstract

Fish and Fisheries play an important role in the social and economic life of Bangladesh in terms of income, nutrition, employment and foreign exchange earnings. In the present study, the differences in growth of fish Labeo rohita could be attributed to the quality of feed, ingestion and digestion. The experiment diet contain live feed organism Daphnia (10%) resulted in better growth than control diet. In this study regularly monitoring water parameter such as temperature, pH, DO, BOD, COD and find out little or no plankton inside the cage to support catla catla and Labeo rohita in this experiment.

Introduction

The Carp is the most extensively cultured fresh water fish species in the world (Zhou et al, 2004). Common carp (Cyprinus carpio) occupy third place as aquaculture species among the family Cyprinidae after silver carp and grass carp. Common carp is distributed throughout tropical, sub-tropical and temperate regions. Its early maturation and prolific breeding habit retard growth through competition for food and space (Basavaraja et al, 1997). Water quality is an important part of environmental monitoring which is essential part of keeping the planet healthy and sustainable (Dinesh Kumaret al, 2017). Fish flesh contains all the essential amino acid and minerals viz., iodine, phosphorus, potassium, iron, copper and vitamin A and D in desirable concentrations (Sandhu, 2005). It serves as valuable source of protein to a healthy diet because of its low carbohydrate and unsaturated fat, especially Omega 3 contents (Razvi, 2006). So the inclusion of fish in our diet can make a valuable contribution to any diet that contain mainly cereals, starchy roots and sugar for the growth (Razvi, 2006; Salim, 2006; Yildrim et al., 2008).

Materials and Methods

Study area

This investigation was carried out to evaluate the status of the Alagappa university fisheries water pond in Karaikudi, Sivagangai district. It is situated between 10.0661to 10° 3' 58N North Latitude and 78.7679’ to 78° 46' 4E East Longitude. The water of this pond is used for Rainwater harvest, fisheries and partially domestic activities. The present study was conducted to the estimation of different fish feeding methods on growth performance and fish yield in composite fish culture system of Alagappa

university fisheries ponds properties of water in the period of five month from Decembers 2019 to April 2020.

Samples Collection of Fish seed

Due to low temperature the catch by the fishers was generally low as such a total of 120 fish samples belonging to two species Totally *catla catla* 60Nos fish seed and *Labeo rohita* 60Nos were collected randomly from the sampling sites between 9:00am-11:00am in December, 2019 The fish seed samples were collected from vayalur area , Kudanthai village, Thanjavur district.. The closed plastic bags were dipped into the water and then the cap is opened and water is allowed to fill up the O_2 absolutely. The cap is then closed and the plastic bags is brought out of the water. The method adopted for different physico-chemical parameters were followed according to the fish sample was collected to the study area of Alagappa University of fisheries ponds.

Experimental Design

The experimental was conducted in eight glass aquaria each having 50 L of filtrate pond water with 15 fish (*Cypriruns carpio* fry, mean weight 1.5. ±0.2gm, n=15) per aquarium. The fry were procured from a local fish farm and acclimatized to the laboratory conditions for 48 hours prior to the commencement of the experiment. Fifteen fishes were used for analysis of initial whole body proximate composition. The fry were randomly distributed at the rate of 15 fish per aquaria with three replications for each diets treatment. Aeration was continuously provided from air compressors through air stones daily and about 50% water from each aquarium was replaced with clean stored pond water. The aquaria were maintained indoor and natural photoperiod conditions. The experimental fish were fed twice daily at morning and evening at a fixed feeding rate of 5% of the total biomass for a period of 120 days and during this period certain physio-chemical parameters were recorded.

Table 1: Water quality parameters of experimental aquaria (±SE)

Month	Temp. (0C))	pH	DO(mg/l)	Alkalinity(mg/l)
Decembe	26.4±0.24	7.3±0.26	5.6±0.16	29±2.36
January	27.3±0.25	7.2±0.21	5.5±0.15	140.72±2.35
Februar	28.8±0.30	7.4±0.26	5.5±0.21	139.26±3.21
March	30.3±0.35	7.3±0.28	5.2±0.22	138.9±3.56

Table 2: composition of different feed ingredients used in preparing fish meal in different treatment A, B and control

Ingredients	A	B	Control
Fish meal (%)	**20**	**25**	**0**
Soybean meal (%)	**20**	**0**	**0**
Groundnut cake (%)	**23**	**36**	**0**

Rice bran (%)	**20**	**25**	**0**
Wheat flour (%)	**17**	**14**	**0**
Commercial fish feed (%)	**0**	**0**	**100**
Mixed vitamin (%)	**01**	**01**	**0**
Mineral (%)	**01**	**01**	**0**

Statistical analysis

The data collected were subjected to Analysis of Variance (ANOVA) using Microsoft software statistical followed by Duncan's multiple range tests to compare the result.

Result and Discussion

The growth rate increases with increasing water temperature, but when the temperature becomes super optimal, it has negative instead of a stimulatory influence. Common carp are omnivorous fish and they eat any food, which can be digested. However, their habitat is to dig and burrow into the soil in search of organic matter such as larvae of insects, worms, mollusks and decayed matters containing bottom dwelling organisms, pieces of plants the young shoots of aquatic weeds. In case of aquarium culture, common carp fish can't get their natural protein food. Therefore, the fish might not grow satisfactorily. Artificial feed has two main functions in aquaculture especially in semi-intensive systems first it is directly eaten by fish and second it supplies nutrients to the ambient environment enhancing primary productivity and natural food availability. The major portion of artificial feed is lost as uneaten feed and feces. Benthivorous fishes enhance oxygen availability in the sediment and cause re-suspension of bottom particles by digging and sieving of sediments which has a large impact on the abiotic and biotic properties of the overlying water column of the pond (Hussain *et al.,* 2011) It also indicates that the fish growth would be better when fed with higher protein containing animal protein. The fish growth was better when fed with cattle fed containing animal protein than the fish fed with higher protein containing feed with necessary animal protein. When compared to the ingredient feed and commercial feed the ingredient feed has the higher growth rate than commercial feed. Further present study in ingredient feed on the Alagappa University fish pond highly growth on totally four month in *Catla catla* and *Labeo rohita*. The growth rate increases with increasing water temperature, but when the temperature becomes super optimal, it has negative instead of a stimulatory influence.

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Effect of dietary supplementation of carrot (*Daucus carota*), a carotenoid source, on growth, survival and pigmentation of freshwater ornamental fish, orange molly (*Poecilia sphenops*, Valenciennes, 1846)

Tanmoy Jana, Rajendran Srinivasan* and Ethiraj Kannapiran
Department of Fisheries Science, School of Marine Science, Alagappa University, Karaikudi 630003, Tamilnadu, India

Abstract

Daucus carota (Carrot) peel, a protein-carotenoids complex, can provide antioxidants and carotenoids to ornamental fish diets. Fading ornamental fish are uninteresting to buyers. In this 45-day feeding trial, the effect of carrot peel extract on growth, coloration, antioxidant enzymes and immune response in Orange Molly (*Poecilia sphenops*) was examined. Five diets were created: one control (C), one commercial feed without carotenoid sources, and three experimental pelleted diets with 1% Treatment (T1), 3% Treatment (T2) and 5% Treatment (T3) powdered carrot meal. After the experiment, the fish's skin and muscle carotenoid content and Specific Growth Rate (SGR) were measured. Skin and muscle carotene (μg/g wet weight basis) increased significantly. Digital photo analysis shows T3 has the most colour intensity, followed by T2, T1, and C. T3 had the highest Body Weight Gain (BWG)%, SGR%, and Food Conversion Ratio (FCR) growth (252.80, 2.952, 0.854), while C had the lowest (110.28 percent and 1.802). Carrot peels powder at 1%, 3% and 5% ensured 100% fish survival, while C and T4 at 90% and 80%, respectively. Carrot peel powder at 5gm/100gm fish feed had the highest pigment concentration in fresh fish muscles and a higher SGR. T3 fish had higher respiratory burst activity, indicating higher immunity. This study showed that ornamental fish farmers should use carrot peel-incorporated feed to improve growth, coloration, antioxidant activity and profit.

Keywords

Antioxidant, Carrot peel, Feed supplement, Ornamental fish, Orange Molly

INTRODUCTION

The hobby of keeping aquariums is gaining popularity in India, which ranks among the emerging nations. The brilliant hues, flamboyant patterns, and overall stunning appearance of ornamental fishes have garnered them a lot of attention over the years (Pandey and Mandal et al., 2017). The rate of success of the ornamental fish trade will be very high if the color of the fish is more vibrant (Sudirman et al., 2020). Therefore, there is a causal relationship between the consumption of carotenoids and the coloration of fish (Halten et al., 1997). Carotenoids are

the pigments that give ornamental fish their distinctive colours, both on the surface of their bodies and in their muscles. In addition, to its function as a pigment in the body, it also serves as a precursor for transcription regulators, as an antioxidant, and as a factor that contributes to the body's immune system. These additional functions are very important for the visual effects that it produces (Bendich and Olson et.al., 1989). Additionally, it has been discovered that fish with a high carotenoid content have a greater resistance to diseases caused by bacteria and fungi (Wagde et al., 2018).

Because of this, pigmentation is a significant criterion for fishes because it has an impact on their acceptability in the commercial sector. There are many different kinds of synthetic sources as well as natural sources, such as plants and animals, which are present for the supply of carotenoids. However, synthetic carotenoids are currently on the market and while they are available to buy, their prices are very high and their application in the aqua feed industry is restricted due to species specificity (Torrissen and Naevdal, 1984). Carrot has excellent antioxidant property The present study was designed to assess the dietary efficacy of carrot (*D. carota*) meal on survival, growth and pigmentation, antioxidant and immune response of Orange molly *P. sphenops*, (Valenciennes, 1846) as Molly fish can able to adjust to any adverse climatic condition, easy to cultivate and breed in captive condition. Due to the unique properties of carrot, the present study was designed to assess the dietary efficacy of carrot (*D. carota*).

MATERIALS AND METHODS

Experimental site

The experiment was carried out in the Department of Fisheries Science, School of Marine Sciences, Alagappa University, Science Campus, Karaikudi, Tamil Nadu, India.

Collection and acclimatization of fishes

A total 100 experimental fishes including males and females of orange molly *P. sphenops*, of more or less uniform size (3.5 ± 0.01 cm in length and 0.8 ± 0.02 gm in weight) group was purchased from commercial ornamental fish. Initial disinfection of fishes followed by salt treatment (5%) and bath treatment with KMnO4 solution @ 1 ppm for 3 to 5 minutes (Bakshi et al., 2018). During acclimation, fish were fed with control food diet @ 2% of the body weight which is readily available in market (Behera et. al., 2018).

Experimental design and setup

After proper acclimatization of one-week, healthy fishes were stocked into the experimental tanks for feeding experiment. Prior to the experiment start day, fishes were starved for 24 hrs. and the total length andplus weight were measured. A total 10 set of cleaned, disinfected glass aquarium tank of 50 L capacity (39 × 37 × 35 cm) were used for 5 experiment groups (G-I:C, G-II: T1, G-III: T2, G-IV: T3, G-V: T4) with replicate. In each tank 10 numbers of juveniles were reared and

the total experiment was conducted for 45 days. Fishes were fed twice a day during morning 10:00 hrs. to afternoon 16:00 hrs. Equivalent to 2.0 % of their body weight. The physico-chemical characteristics of water sampled from all the tanks throughout the experimental period were assessed by the standard methods of APHA (2012) on daily basis and weekly basis (Table 1).

Experimental feed preparation

The experimental feed was prepared with basic ingredients such as Corn flour, Rice flour, Egg yolk, Fish meal and Vitamin mixture and Wheat flour was used as feed additive. In all experiments the same feed was used except for the incorporation of carotene. All ingredients were split into 5 equal parts. Then it was oven dried at 45℃ for 48 hours and then the contents were powdered with the help of a grinder and sieved in particle size of 0.1 to 0.2 mm, afterward stored in the refrigerator at 4°C. The dried powdered carrot meal was incorporated to the diets just before palletization at the rate of 0, 1. 3, 5 g/ 100 g of feed (Feed type C, T1, T2, T3 respectively) for the experiment and no carrot powder is added to the T4 feed because it is fully commercial feed **(**Table 2**)**. The feeds were prepared after every fortnight to avoid fungal infection and pigment loss due to storage and amount of feed was adjusted at every sampling (fortnightly interval) according to increase in fish weight.

Feeding Experimental diet

The control fish group were fed with customized formulated diet C (without addition of the powder of *D. carota*), experiment G-I fed with diet T1 (T1 = C+1g/100g powder Denote - [RF – Rice Flour, CF – Corn Flour, WF – Wheat Flour, FM – Fish Meal, MP – Milk Powder, GP – *Allium sativum* (Garlic) Powder & TP – *Curcuma zedoaria* (Turmeric Powder), MV – Multi Vitamin] of *D. carota*), experimental G-II fed with diet T2 (T2 = C+3g/100g powder of *D. carota*), experimental G-III with diet T3 (T3 = C+5g/100g powder of *D. carota*) and experimental group IV were fed with diet T4 (T4 = commercial diet (CD) - Optimum micro pellet, Made in Thailand). All fishes were fed at the rate of 2% percent of their body weight twice a day with experimental diets. Daily rations were adjusted every two weeks according to fish body weight in each of the tanks. Optimal daily feeding rates for *P. sphenops* may vary due to protein requirements and varies with the rearing environment as well as their genetic composition and feeding rates (% BWG/day) which was determined based on the recommendations of different researchers.

Proximate composition analysis- AOAC (2004).

Proximate analysis of feed, and tissue are performed as per the prescribed method of AOAC (2004). Crude protein, carbohydrate, lipid, ash content and moisture were estimated.

Estimation of moisture (Uzma Shabir 2018)

In general samples were taken and heat for 105 ℃ for 16 hr. or 125 ℃ for 4 hrs. or 135 ℃ for 3 hrs. in hot air oven. Remove the Petri dish from the oven and keep it in desiccator for 1 hr.

Estimation of Crude Ash (CA) AOAC (2004).

About 1.5 to 2g sample to be taken in the silica crucible and keep it in muffle furnace and keep it in muffle furnace and incinerate at 550 – 600 ℃ for 3 h. Collect the crucibles from furnace and keep it in desiccators until completely cooled. Weight the ash content accurately.

Estimation of Total Lipid (TL) AOAC (2004).

Ten gram of the minced sample was taken for both fish and feed.

Estimation of Protein and Carbohydrate

Protein content of feed (Khanizadeh et al., 1995) and fish tissue was measured by Lowry's Method (Lowry et al, 1951) and Carbohydrate content of fish muscle and feed was measured by Anthrone Method (Loewus, 1952)

Feeding behavior analysis

The feeding behavior was categorized according to the responses recorded by Lee and Mayer's (1997) with modification.

Growth study

Growth performance and nutrient utilization of experimental fishes were evaluated by following equation:

1

$$\text{BWG (\%)} = \frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{Initial weight (g)}} \times 100$$

2

$$\text{LG (\%)} = \frac{\text{Final body length (cm)} - \text{Initial body length (cm)}}{\text{Initial body length (cm)}} \times 100$$

3

$$\text{Survival rate \%} = \frac{\text{Initial fish number} - \text{Final fish number}}{\text{Initial fish number}} \times 100$$

4

$$\text{CF} = \frac{\text{Wet weight of the body (g)}}{[\text{Standard body length (cm)}]^3} \times 100$$

5

$$\text{SGR (\%)} = \frac{\ln \text{Final body weight} - \ln \text{initial body weight}}{\text{Number of culturing days}} \times 100$$

6

$$FCR = \frac{\text{Total amount of feed given (g)}}{\text{Total weight gain (g)}}$$

Estimation of carotenoid content in different tissues of fish and in experimental diet

The carotenoid content was measured by the method of Bendich and Olson (1979). The optical density was read at 380nm, 450nm, 475nm and 500nm in a double beam microprocessor UV-VIS spectrophotometer (Model – LI-2802R). The wavelength, at maximum absorption, was used for the calculation.

Water quality analysis

The different types of physicochemical parameters of water were analyzed by standard method (APHA, 1995)

Statistical analysis

The data were statistically analysed by one way ANOVA and Regression Test by using the software statistical package IBM SPSS version 26 and Microsoft Excel 2016 and data were subjected to one way analysis of variance and Duncan's multiple range tests were used to determine the significant differences if any, between the means. Comparisons were made at the 5% probability level.

RESULT & DISSCUSSION

Poecilia sphenops prefer hard water with a pH range of 7.5–8.2 and the ideal temperature range for them is 18°C to 28°C Tamaru et.al. Vali et. al. 2002 initially maintain the water temperature, pH and ammonia i.e. 27 ± 1 °C, 7 – 7.8 and < 0.02 mg/L respectively and as well as maintain the water hardness around 200 mg $CaCO_3$ before the initiation of the toxicity experiment on adult common molly (*P.sphenops*). Wagde et. al. Reported that temperature fluctuate between 22.94°C to 23.60°C, pH belongs to 7.6 – 8.2, Oxygen range from 5.4 – 7.1 mg/L with the alkalinity range of 300 – 340 mg/L was ideal for the growth and coloration study on swordtail (*Xiphophorus hellerii*).The water quality results in the current study show that the water in the experimental tanks is hard, with a temperature and pH in the ideal range. During the experimental trial the temperature and pH was maintained between 27 °C to 32 °C and 7.9 to 8.7 respectively. Average DO value (5.7 – 6.5 mg/L) was maintain during the experimental period and other parameters like Total Hardness (TH),Ca^{2+}, Mg^{2+},ammonia, alkalinitywere respectively maintained in favourable condition which were suitable for the growth of the fish and are shown in the (Table 1).

The proximate composition of feed showed that all the experimental feeds were as per the nutritive profile of their respective feed formula (Table 3). The proximate composition of experimental feed showed higher carbohydrate content than commercial feed and moisture and ash content were relatively less than commercial feed. It

is observed that the commercial feed slightly induces the biochemical parameters of the experimental fishes than the commercial fish feed (Table 4).

During introduction of feed into the different fish tanks the behavioral changes of experimental fishes was observed. At the very early stage from the first day upto the 7^{th} day of experiment the fishes take 5 to 11 mins to fully complete the food. As the day increases the acceptance of the food also increases and the feeding time also decreases. After 7^{th} day the rejection limit also very low. So it implies that due to new environmental condition fishes take time to finish their feed but after acclimatizing with the new environment it takes only 1 to 2 min. to finish the experimental feed. During the initial period of the experiment the feed acceptance (Figure 1) time was long but at the time increasing the acceptability of the feed increasing and the rejection percentage also decreasing. The feed was considered rejected only if the feed was uneaten by fish after 30 min to 1 hrs. At the beginning of the experiment the rejection percentage was maximum 5% but day by day it was gradually decrease.

Growth study was done by calculating the initial and final growth parameters during the experiments by measuring the SGR (Specific Growth Rate), FCR (Food Conversion Ratio), and % BWG (Body Weight Gain), % LG (Length Gain) (Table 5, 6, 7). Fish growth efficiency was shown to be higher when the FCR value was lower. The FCR levels in this recent study differed from species to species. *P.sphenops* FCR levels range from 1.0 to 1.1 when carrot powder is added to the meal. According to Fry et.al. 2018, the FCR value of fish is between 1.0 and 2.4. The values of the Feed Conversion Ratio showed a reduction for fish fed with Diet T3, but fish fed with diet T1, T2, and T4 showed higher values, when compared to those fed with Diet T3. Devi et al. 2019 reported that black molly attain better growth but FCR value was low when they fed formulated feed incorporated with spirulina, carrot powder and beetroot powder and this formulated can replace the cost effective commercial feed. Maiti et al. 2017 conclude that in common carp the percentage of growth was high in the group that fed formulated feed incorporated with carrot peel powder other than tomato peel powder. A correlation test between the growth parameters (log of body weight and log of body length) resulted as illustrated in (Figure 2). Logarithmic value of the body weight was positively related with logarithmic value of the body length of *P. sphenops* showing a slope of $Y = 1.745x - 0.8912$ and $R2 = 0.7346$. Zutshi and Madiyappa 2020 found that body weight of the *P.sphenops* correlated positively with body length, with a slope of $R^2 = 0.8727$ when fed with *Lantana. camara* flower petal incorporated in formulated diet. Zutshi and Madiyappa (2020) showed better growth ability ($P < 0.05$) in *X. helleri*ifed with the formulated diet with carotenoid pigment present in *L. camara*. Tiewsoh et al. (2019) reported that in goldfish diet with 6%

carrot is more effective for growth and colouration. CF values in experimental groups, when compared to the control groups, were insignificantly different, but fish fed with diet T3 showed higher values, when compared to those fed with T1, T2, T4 and control group. In this study the regression result shows that at the 95% confidence level $P<0.05$. So, the growth is allometric growth as b value is $\neq 3$.

Carotene level in fish skin observed visually (Figure 7) and at four different wavelengths. At 380 nm, the total variance in skin carotenoid levels was determined. The overall variation in carotenoid level of skin was observed at 500nm was ranged from 0.68 to 2.6µg/g. A maximum amount of carotenoid was recorded in 5g/100g followed by 3g/100g carrot powder incorporating diet fed fish and minimum level of carotenoids was seen in 1g/100g carrot and control diet fed fish.

At the end of experiment, it was evaluated that carrot powder incorporated diet T3 significantly showed highest carotenoid concentration ($P <0.05$) in the skin of *P.sphenops* at 475nm wavelength whereas absence of carrot powder in diet (control) caused a significant reduction of carotenoid concentration(Figure 3-6). But the commercial feed has also the significant role for colour enhancement. According to the result it is observed that more than 1g carrot powder can enhance the fish body coloration significantly. Few studies have shown and demonstrated the effect of natural carotenoids on the survivability, growth, colour development and antioxidational responses in ornamental fishes but some drawbacks also there. While plant meal contains certain imbalanced amino acids, it slows down the growth of the fish. Baron et.al. (2008) tried beet root juice on *Colisalalia*, but it didn't improve the fish's skin colour or growth. In this investigation, it was also discovered that if the carrot augmented feed did not store adequately, the carotene level of the feed decreased. Among natural vegetables, carrot (family Apiaceae) is a root vegetable which is one of the important pigment source that rich in bioactive compounds. In the carrot root the total carotenoid content present in the edible portion ranging from 6-55 mg/100g Simon and Wolff, (1987) with β-carotene (44-79 % of total carotenoids, 5.3 – 10 mg/100 g) as major component and the most important thing is that it is the single major source of β-carotene providing 17% of total vitamin A.

CONCLUSION

As a result, the research discovered that using a vegetable carotenoid source (such as carrot) had a lot of favorable benefits on the colouring of mollies. However, while they are inexpensive and widely available, it appears that processing them into a raw material is useful (powdering after drying) before adding them to feeds is important to produce more good results. In conclusion, carrot powder can be used as a colour

enhancer and growth promoter in the orange molly diet at a rate of 5%.

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Integrative Taxonomy of Stone Fishes (Perciformes: Synanceiidae) from Southeast Coast of India

Soumyadip Roy, Marimuthu P*, K. Kannan, Kannapiran E

Department of Fisheries Science, Alagappa University, Karaikudi-630003, Tamilnadu

Abstract:

The taxonomy of the family Synanceiidae is not well studied from the Southeast Coast of India, hence an integrated approach was attempted in this study.So far, a total of 13 fish species from the Scorpaeniformes order, which are classified into 5 different genera, have been identified in Indian coast. This identification was achieved by a combination of morphological and molecular techniques.Using the mitochondrial CO1 gene, DNA barcoding successfully verified the presence of three distinct species from Scorpaeniformes fishes. The molecular data from this investigation were compared to sequences from GenBank. Expert taxonomists picked published sequences and matched them based on their maximal identity.

Keywords: Morphology, Molecular Taxonomy, Stone fishes,Gulf of Mannar.

Introduction:

The East coast of India is inhabited by roughly 1121 species of marine fish. This region provides a distinctive habitat setting, characterised by estuary-like conditions in the north and coral reefs in the Gulf of Mannar in the south(Mishra 2013).The marine fisheries sector is faced with significant challenges such as pollution, environmental degradation, overexploitation, and a major concern known as bycatch. The bycatch of no commercial value include coelenterates, echinoderms, various species of gastropods, and crustaceans such as small inedible crabs and mantis shrimp. Occasionally, smaller inedible species of fish and eels are also included.The family Synanceiidae is belongs to the orderPerciformes and is primarily found in the Indo-Pacific waters. The different species of this family are commonly referred to as stonefish, stingers, sting fish, and ghouls.These species possess the most powerful neurotoxins of all fish venoms. These poisons are produced by glands located near the base of their needle-shaped dorsal fin spines (David, 2014).The species is commonly referred to by its vernacular name due to its tendency to mimic the appearance of rocks as a form of camouflage(Lee*et al.* 2004).

Currently, there exist 37 confirmed species within the family Synanceiidae and 12 confirmed species within the subfamily Choridactylinae (Eschmeyeret al. 2010).Stone fish are distinguished by their rough skin and intimidating appearance.Stonefish have a limited number of predators, such as sharks, due to their ability to blend in with their surroundings through

camouflage(Prokofiev 2021).The taxonomy of Synanceiidae on the Indian coast has not been extensively studied. Therefore, this work aimed to use a combined method of traditional morphometrics and DNA barcoding, specifically targeting the mitochondrial cytochrome oxidase subunit 1 (COI) gene, to examine selected species.In this study, we provide a comprehensive taxonomic analysis of fish belonging to the Synanceiidae family that are by - caught in the main fishing ports of Gulf of Mannar. Additionally, we conduct DNA barcoding of specific stone fish species using the COI gene to verify their identification and gain insights into the evolutionary relationships among the identified species.

Materials and methods:

The specimens were obtained on a random basis from the bycatch of trawl, as well as from seine nets and gill nets, in the main fishing harbours of Tamilnadu such as Mandapam (Gulf of Mannar) and Karankadu (Southeast Coast of India) (Fig. 1). A field survey was carried out on a weekly basis from February to April 2022 at commercial fish landing centres. Samples werecollected and cleaned with water toeliminate detritus and other particulate matter from the soil.Subsequently, the samples were carefully stored with ice and promptly transferred to the laboratory for taxonomic analysis.The tissue samples fromfin clips were collected for molecular analysis and preserved in 95% ethanol. Species identification was done based on FAO identification sheets, catalogue of Fishes and Fish base.

Total DNA was extracted from the muscle sample following the procedure with minor modifications (Ward et al. 2005). The DNA that was obtained was subjected to 0.8% agarose gel electrophoresis to verify its quality. Additionally, the quantity and quality of the DNA were assessed using a UV spectrophotometer (Beckman, Brea, CA) by measuring the optical density (OD) at 260 nm and 280 nm.The partial sequence of COI gene was amplified using primers Fish F1 (5’ -TCA ACC AACCAC AAA GAC ATTGGC AC 3’) and Fish R1 (5’ -TAG ACT TCT GGG TGG CCA AAGAATCA 3’) (Ward et al., 2005). The amplifications were performed in 25 µL reactionscontaining- assay buffer (100 mM Tris, 500 mM KCl, 0.1% gelatin, pH 9.0) with 25 mMMgCl2 (Thermo Fischer Scientific, Mumbai, India), 10 pmoles of each primer, 200 mM of each dNTP (Thermo Fisher Scientific, Mumbai, India), 1.5U Taq DNA polymerase and 40 ng of template DNA. The thermocycler conditions included initial preheating at 95ºC for 5 min, denaturation at 94ºC for 30 s, annealing at 54ºC for 30 s, and extension at 72ºC for 45 s, repeated for 32 cycles, followed by a final extension for 5 min at 72ºC. About 3 µL PCR product along with marker (100 bp DNA ladder; Thermo Fischer Scientific, Mumbai, India) were electrophoresed in 1.5% agarose gel with ethidium bromide using TBE buffer for 30min at constant voltage (90 V). The gel was

visualized and documented using BIORAD Gel Doc TM XR + with Image Lab Software (Bio-Rad Laboratories, Inc., Berkeley, CA). The remaining PCR product was purified using Gene J ET PCR Purification Kit (Thermo Fisher Scientific, Mumbai, India) following the instructions given by the manufacturer. Products were labelled using the Big Dye Terminator V.3.1 Cycle sequencing Kit (Applied Biosystems Inc., Foster City, CA) and sequenced bidirectionally using ABI 3730 capillary sequencer, following the instructions of the manufacturer.

Results and Discussions:

Systematics:

***Minous monodactylus* (Bloch & Schneider, 1801)Grey stingfish**

Description: *Minous monodactylus* has between 10 spines and 10 and 11 soft rays in the dorsal fin (Table 1). The anal fin has 2 spines and between 9 soft rays. It reaches a maximum total length of 15 cm (5.9 in).The pectoral fins have 10+1 rays with the lowest ray being clearly detached from the rest, is slightly larger and has fleshy "cap". The pelvic fin has a single spine and 5 soft rays. All fin rays are simple, i.e. unbranched. There are no scales on the head and body except for those that make up the lateral line. There are teeth in the jaws and there are vomerine teeth but no teeth on the palatine. There are dermal cirrhi on the upper eyeball and lower jaw but the rest of the skin is smooth (Plate 1).

***Choridactylus multibarbus*(Richardson, 1848)Orangebanded stingfish**

Description: *Choridactylus multibarbus* have XIII spines and 9 soft rays in the dorsal fin with II spines and 10 soft rays in the anal fin (Table 1). The pectoral fins have 9 fin rays with the 3 lower rays being separated. The caudal fin is truncated (triangular) tail adapted for turning quickly. They have small blunt heads with bulging eyes with an occipital depression.The mouth is small and slightly oblique with villiform teeth on the jaws with no vomerine teeth or palatine teeth. The body has small tentacles or skin flaps on the lower jaw, eye, spiny dorsal fin and spiny anal fin. There are tufts on the lateral line and upper body. These fishes vary in size from a total length of 14 cm in *C. multibarbus* (Plate 2).

***Inimicus sinensis*(Vaienciennes, 1833)**

Description: The meristic characters dorsal fins have XVII spines and 9 soft rays in the dorsal fin (Table 1). The anal fin has II spines and between 12 soft rays. The body color is red or sandy yellow with light blotches, and very similar to that of the surrounding sandy or coral seabed in which they are found (Plate 3). This coloration acts as a camouflage which renders them extremely difficult to detect in their natural habitat. The skin is without scales except along the lateral line, and is covered with venomous spines and wartlike glands which give it a knobby appearance. The head is flattened, depressed andconcave. The eyes, mouth and nostrils project upwards and outwards from the dorsal aspect of the head. *I. sinensis* had rounded caudal fin adapted

for slow swimming. The Body depth, head depth and other meristic characters were collected and depicted in the Table 2.

Cytochrome Oxidase subunit I (COI) and DNA barcoding

In this work, we investigate the stone fishes in the Gulf of Mannar region. We examine a total of 11 specimens, which belong to 3 confirmed species. The confirmation is based on the analysis of COI genes. The phylogenetic analysis conforms that our sample matched with *I.sinensis*, the phylogenetic tree consist of three major clades, from that the first clade has two divisions from that first division the group A. it was occupied by *I. sinensis* followed by *I. didsctylus* species and within *I. sinensis* species showed haplotype variation (position 96,195 and 358) was observed (Supplementary data). The maximum parsimony and neighbour joining using the Kimura two parameter model yielded trees were generated using MEGA 6.0. Both the trees exhibited identical topology with high bootstrap support values. In both the algorithm, the three species showed clear cut separate clusters indicating the robustness of species specific molecular signatures generated in this study. Trees generated using both NJ and MP algorithm depicted the species of the different genera (Fig.2).

Discussion

There have been limited studies conducted in the coastal areas of India, particularly in the Gulf of Mannar region. This study unveiled the initial molecular classification of this family in this specific geographical area. However, *Inimicus sinensis* exhibited distinct variation, with all the Japanese species grouped together, while the Indian species (present study) were also grouped together. These kind of works are very limited in this area. A pore was seen in all species of Inimicus (Inaba and Motomura 2018) and was classified according to the number of pores located above the pectoral fin base of *Minous* sp. similarly it was seen that the sac was connected to the skin, but no connection to any other organs was identified.

The study concludes that the partial sequence information of both the mitochondrial 16S rRNA and COI genes can serve as a molecular marker to identify and resolve taxonomic ambiguity within the Synanceiidae family. The current study emphasises the importance of conducting morphological taxonomy and revisions for bycatch species in the Gulf of Mannar region.The bycatch fish resources in India comprise a diverse range of marine organisms that have been minimally explored.It is recommended to do more comprehensive studies on by-catch fishes and long-term research that combines several aspects of taxonomy in order to strengthen India's database on marine fish species.

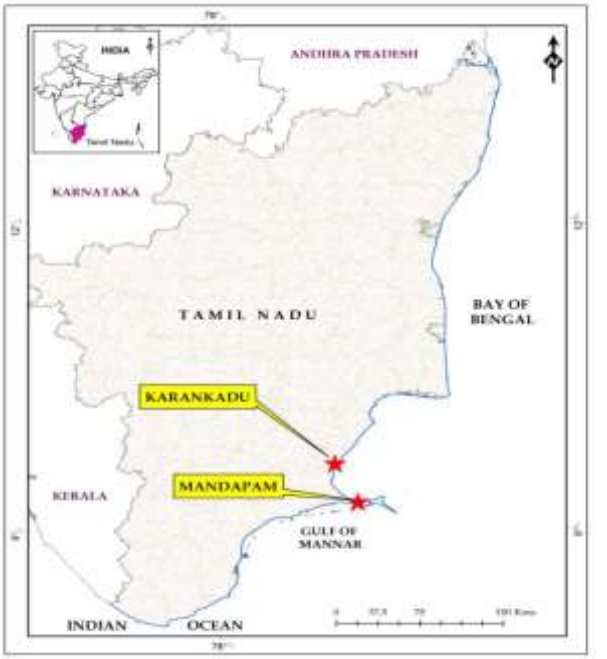

Fig. 1. Map depicting the study area

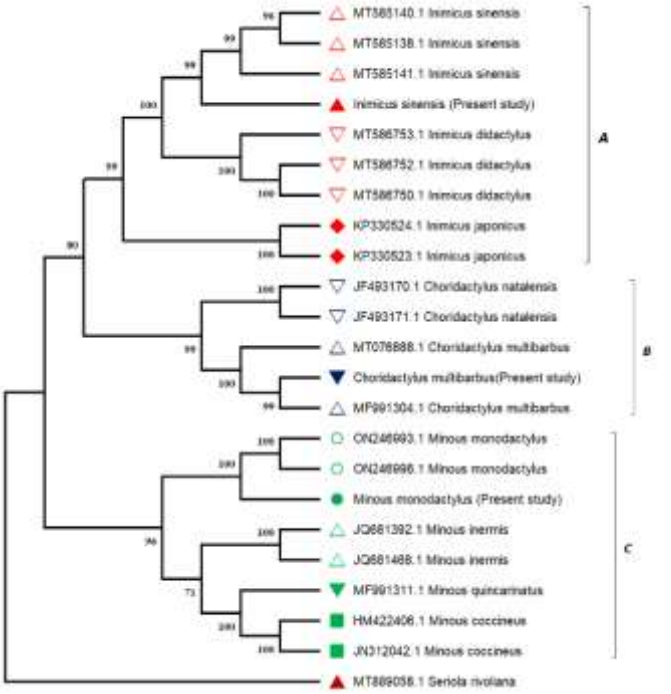

Fig. 2. Neighbour joining (NJ) phylogenetic tree of fishes belonging to family Synanceiidae inferred from DNA Sequences of mitochondrial gene COI

Table 1. Meristic Characters of Stone fish

Si. No	Meristic Characteristics	*Minous monodactylus*	*Choridactylus multinurbas*	*Inimicus sinensis*
1	Dorsal fin rays	X +11	XIII +9	XVII + 9
2	Anal fin soft rays	II + 9	II + 10	II + 12
3	Pectoral fin rays	10+1	9+3	I 10+2
4	Pelvic fin rays	I + 5	I + 5	I + 5
5	caudal fin rays	11	14	14
6	Number of gill rakers (Upper + Lower)	2+7	2+8	2+7
7	Tubed lateral line scale	17	13	12

Table 2. Morphometric Characteristic of Stone fishes

Morphometric characteristic (cm)	*Minous monodactylus* n = 1	*Choridactylus multinurbas* n = 1	*Inimicus sinensis* n =9
Total length	8.6	11.7	12.9
Standard length	6.8	10.1	10.5
Body depth	2.4	3.9	3.2
Body width	1.7	2.7	2.3
Head length	3.0	3.8	3.8
Snout length	1.3	1.8	1.7
Orbit diameter	0.8	0.8	0.4
Interorbital width at mid eye	0.6	0.9	0.9
Upper jaw length	1.5	1.7	1.6
Post orbital length	1.9	2.1	1.7
Pre anal fin length	4.4	6.4	6.0
Pre pelvic fin length	2.9	2.7	2.9
1st dorsal fin spine length	1.4	1.4	1.4
2nd dorsal fin spine length	1.4	1.9	1.9
3rd dorsal fin spine length	1.3	2.2	1.8
4th dorsal fin spine length	1.3	2.0	2.0
5th dorsal fin spine length	1.4	2.0	2.0
6th dorsal fin spine length	1.3	2.0	2.0
7 th dorsal fin spine length	1.5	1.7	2.1
8 th dorsal fin spine length	1.5	1.8	2.2
9 th dorsal fin spine length	1.5	1.8	2.2
10 th dorsal fin spine length	1.5	1.7	2.2
11 th dorsal fin spine length	0.0	1.6	2.1
12 th dorsal fin spine length	0.0	1.6	2.1
13 th dorsal fin spine length	0.0	0.0	2.1
14 th dorsal fin spine length	0.0	0.0	2.0
15 th dorsal fin spine length	0.0	0.0	1.9
16 th dorsal fin spine length	0.0	0.0	1.7

17 th dorsal fin spine length	0.0	0.0	1.5
18 th dorsal fin spine length	0.0	0.0	0.2
1st anal fin spine length	0.7	1.0	0.8
2nd anal fin spine length	0.8	1.3	0.8
Pectoral fin length	2.8	3.2	3.7
Pelvic fin spine length	1.2	1.7	1.2
caudal fin length	2.5	2.6	2.4
Head width	1.9	2.5	2.8
Dorsal fin base length	4.9	7.4	7.6
Anal fin base length	2.9	3.7	4.3
Pectoral fin base length	1.1	1.7	1.4
Pelvic fin base length	1.5	2.5	1.8
1st free pectoral fin ray length	2.0	2.2	2.7
2nd free pectoral fin ray length	0.0	2.3	2.4
3rd free pectoral fin ray length	0.0	4.0	0.0

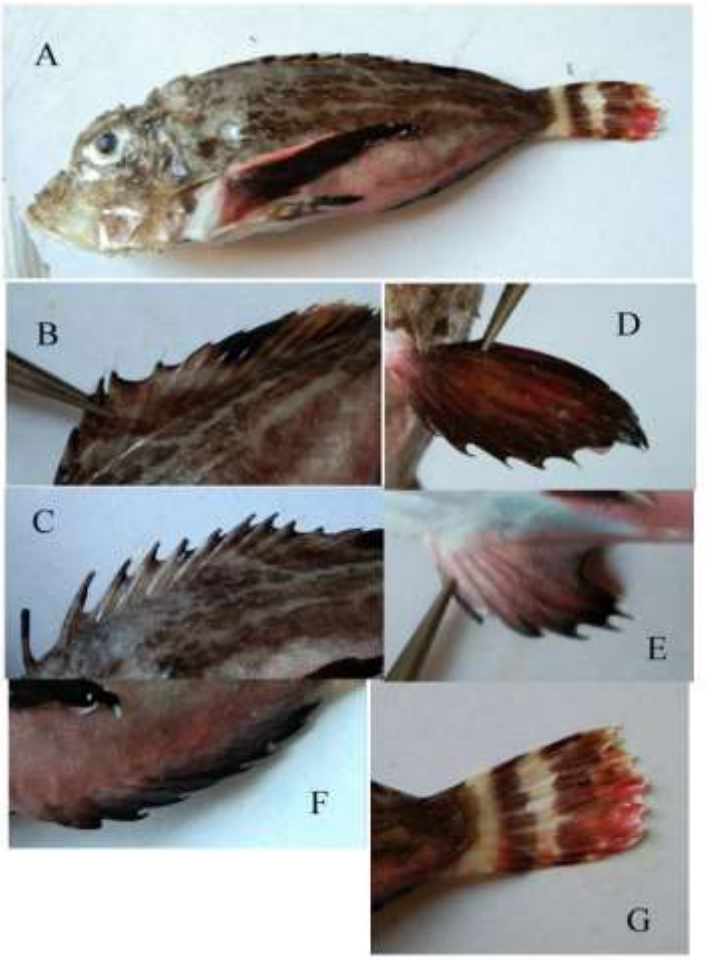

Plate 1 : Specimen of *Minous monodactylus*, A – Complete specimen ; B- 2nd dorsal fin ; C – 1st Dorsal fin ; D- Pectoral fin ; E – Pelvic fin ; F- Anal fin ; G – Caudal fin

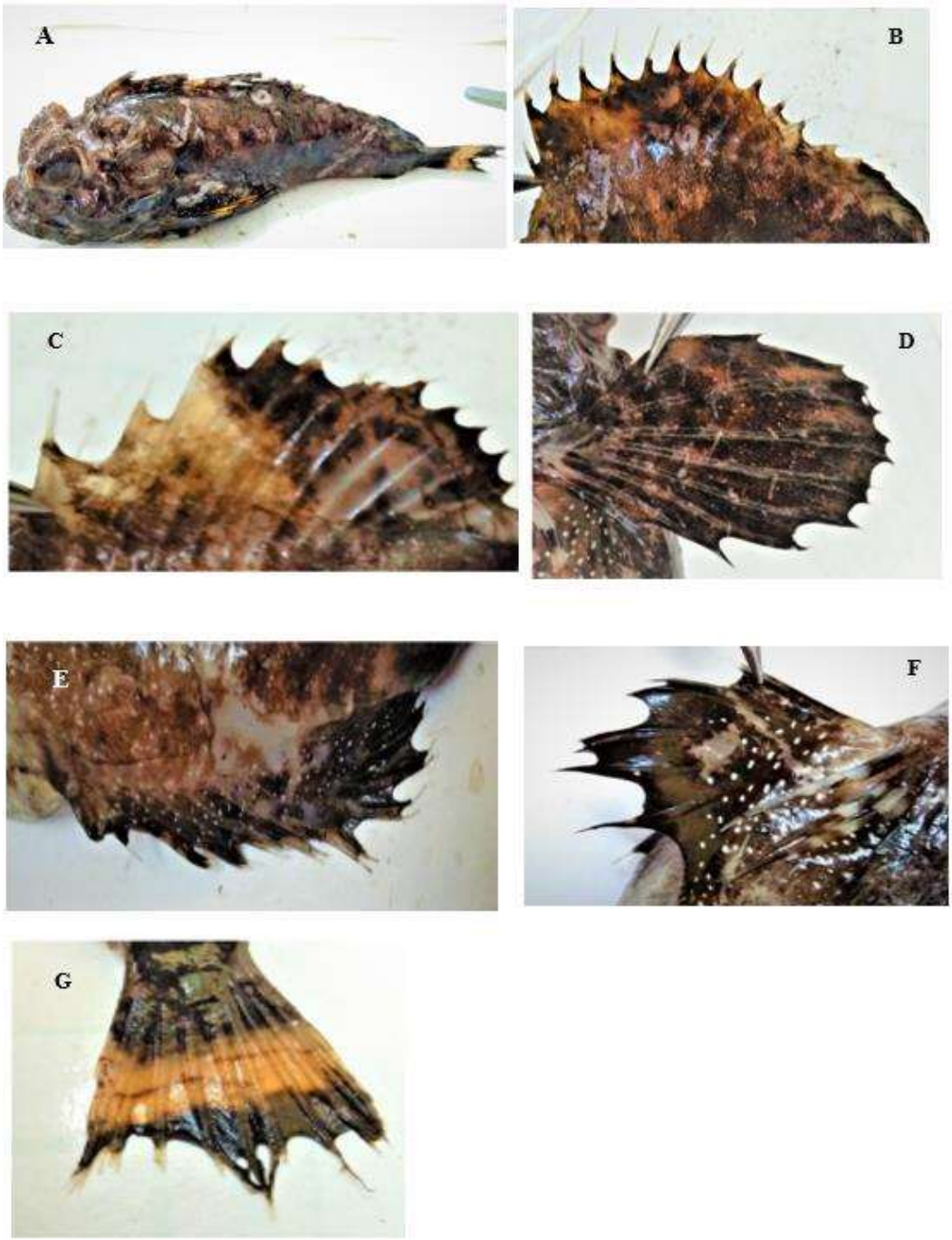

Plate 2. A – Complete specimen of *Choridactylus multibarbus*; B - 1st dorsal fin :

C – 2nd dorsal fin ; D – Pectoral fin ; E – Anal fin ; F – Caudal fin

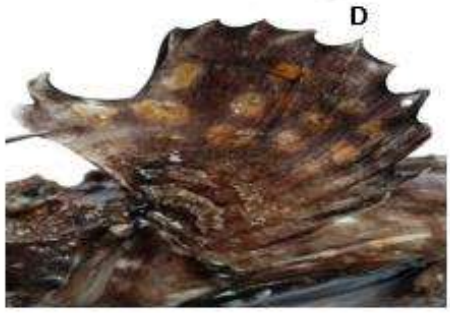

Plate 3. Complete specimen of *Inimicus sinensis*, A – Full specimen ; B- 1st dorsal fin ; C – 2nd Dorsal fin ; D- Pecoral fin ; E – Pelvic fin ; F – Anal fin ; G – Caudal fin

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Seaweeds In Medicines – A Short Insight Into

Urna Banerjee* and Pratap Kumar Mukhopadhyay**

** Department of Fisheries Science, Alagappa University, Karaikudi, Tamil Nadu – 630002*

***Retired Principal Scientist, ICAR-Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar– 750001, India*

Abstract: 'Human health' and 'technological advancement' – these two have an integral interdependency over one another where the rapid progress of the later has a great impact on the former, reflecting a noticeable deviation from the normal physiologic activities of the biological systems sharply. This inefficiency had led to a major proportionate of disease outbreaks within the populational inhabitants which is further being fueled up by detrimental side-effects of the medicines, being consumed for combating those targeted diseases greatly. In this occasion, as medicines have become an integral part of our lives, seaweeds can come forward with its highly valued bioactive components to get its position in the list of medicinal formulations replacing the traditional components that are being used to manufacture them so far, to serve the following functions viz., relieve the burden of the medicinal cost, boosting up the immunity through medications, generating alternate livelihood source by deleting out the side effects completely etc., especially to those whose socio-economic status is below the poverty line etc. Probability of getting the sources of the ingredients at the year-round basis also adds up to this intention of replacement finely.

Keywords: Seaweeds, medicines, pharmaceuticals, replacement, side effects etc.

Introduction:

History of medicines dates back right from the period of the existence of human civilization where the Egyptians, Assyrians, Babylonians, Hebrews, African, Arabians, Chineese etc., used herbal components unknowing the concepts of health and well-being properly and scientifically. Their conceptual understanding had helped them to cure physical 'illness(es)' and/or 'injury' by pasting herbal leaves and layering over the wounded areas of the epidermis in multiples or engulfing them as nutritious input respectively. Following that concept of 'ayurveda', India was also no exception to it where our ancestral descendants used limes, tulsi, ashwagandha, madhu in addition with neem and turmeric as a strong curative measure for various illness like physical cuts or wounds, cold and coughs and other minor physical disorders acutely, as till date, the actual science, rather the scientific basis, behind proper diagionisis of disease and their medications were totally in vogue and were still unknown to the fellow countrymen which were only replaced with the traditional wisdom and parampara hypothesis containing the principal flaw of unintentionally taking

prolonged durations to cure those respective disorders. Sometimes such hypothetical treatments also came out with infections specially at the point of physical contact with the dermal extensions in case of external applications, as were not applied hygienically. But, due to the fast creeping of technological advancements in the each and every aspect of human life viz., in nutrition, in corporate careers, in educational fields, in biotechnology, human genomics, cell culture, oncological sciences, diabetic sciences etc., men had found to accurately diagonize their real causative agents for their respective diseases or illnesses and have succeeded to combat with it accordingly. The scientific relevance of the development of artificial 'medicines', though, had got a new momentum from then onwards and were started its production industrially into the market for relieving the pains considerably with a lesser durational interval, but yet, as an over-due, unfortunately side-by-side had compelled us to come up with numerous diseased conditions in our physiology as a negative side effect of its ingestion. Still, hopefully, these robust side effects can successfully be minimized if we can substitute their compositional formulae with seaweed extracts following the same principle as of applied in case of the pharmaceutical drugs and eventually our noble mission of mitigating the gradually increasing cases of diseases in India can be reached easily. This article only highlights upon such issue shortly.

Fig. 1.A short glimpse of 'Ayurveda' medicine of ancient India

Human health and medicine:

Pharmaceuticals (may sometimes be called as 'drugs') and medicines though go in a close association with each other and are hence used interchangeably, in a true sense they are not actually the same. There lies a hairline difference between the two, the primary one being, 'All medicines, normally defined as chemicals or compounds, used to cure, halt, or prevent disease or to ease its symptoms, are pharmaceuticals but all pharmaceuticals are not medicines', as because drugs, majorly occurring in pulverized form poses a threat of causing addicted habits upon its consumption beyond the excess limits, do not have any authorized shape or structure but medicines will always be identified in a definite structural orientation viz., capsules, pills and tablets either rounded or button shaped, depending upon their various types and kinds respectively. Again, the drugs may sometimes provide an uncertain assurance of relieving the certain misease conditions, whereas medicines hold a guaranteed promise of curing the

certain disease for which it is being ingested. But generally, the manufacturing process of these medicines often involves the use of such ingredients whose bioaccumulation and storage in different parts of the biological systems of human body, owing to their high toxicity levels, may cause adverse effect to the body intensively which may be sometimes due to the occurrence of an elaborative interactive sessions of their typical ingredients with internal anatomical physiology aggressively.

Types of medicines and their interactions with human body:

Though there are several groups of medicines as listed out in table I, all of them are grouped into the following sections as: i. Antipyretics ii. Analgesics, iii.Antibiotics, iv. Antiseptics, vi. Stabilizers, vii.Oral contraceptives, viii. Stimulants, ix.Tranquilizers and xii.Statins etc. But anyway, whatever the case may be, the interaction of those chemical ingredients (of medicines and/or pharmaceuticals) follows two pathways, one is regarded as the pharmacodynamics and another one is called the pharmacokinetics (Fig. 2.). First one here is defined as the interactive relationships between the ingested foreign body (medicine) and the respective site of action; where the other two is carried out by the formation of chemical complexes within the haematological parameters followed by their absorption and inter membranous transfer through different cellular veils. Platelet related interactions between the targeted organs affecting the Cox 1 and Cox 2 proteins are sometimes affectively seen in such occasions, leading to internal tissue and organ haemorrhage influencing the cardiovascular system as an excess. Metabolic level interactions may also pose a high threating risk to the potential patients by creating a tight competition between the cytochrome protein enzymes which required extensively for coping up with the phase I oxidation of the major examples of medicines (Cascorbi, 2012) listed in table I.

Hence, following this fine tuning, below is given the list of some of those representative medicines along with their beneficiary effects (table I) and relative side effects in the human physiology as;

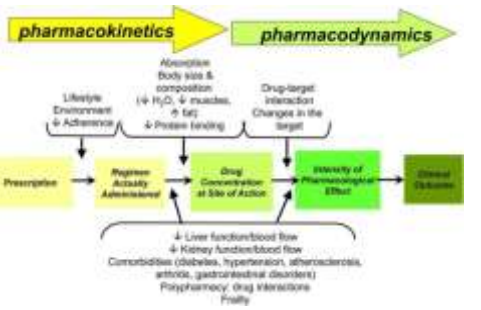

Fig. 2.Pathways of medicinal interactions and its mechanisms

Table I. Some common medical tablets along with composition and remarks

Names of the medicinal tablets	Used for	Relative side effects
Adderall 5mg	Treats glaucoma, high blood pressure, severe anxiety or stimulations, excess thyroid etc.	Abnormal bladder pain, formation of anaemic conditions, kidney failures in excessive conditions.
Doxycycline Hyclate capsules	Treats dental and chest problems, sexually transmitted infections, skin infections etc.	Improper functioning of stomach, overstaying of drowsiness, vomiting etc.
Cymbalta	Treats depressions and chronic muscle pains and stiffness including problems related to bones.	Misfunctioning and even damage of liver, allergic conditions, frequent fluctuations of blood pressure levels, vision impairments etc.
Humira	Treats Arthritis, Crohn's disease, ulcerative colitis etc.	Body and muscles cramps and pains, stomach fullness followed by loss of appetite etc.
Losartan	Treats problems related with improper functioning of heart and arteries and to some extent kidney and diabetic disorders also.	Body cramps, skin problems leading itching, excretory disorders etc.
Otezla	Treats psoriatic ulcers, Bechet disease, oral ulcers etc.	Diarrhea, nausea, vomiting, belly pain, headache, insomnia etc.

Seaweeds and their importance:

For every life on Earth plants are an essential component as it provides sufficient oxygen and also a plenty of food resources. The very same is also true for the lives inhabiting under the layers of the seas and oceans surrounding our country also, as because the seven seas and oceans surrounding our planet traps out a huge number of marine resources under it, which may be fishes or other aquatic lives. Being placed at the very primary stage of the food chain and food web in the aquatic ecosystem, they are of two types: Phaenorogams and Cryptogams. These cryptogams are again classified as: Thallophyta, Bryophyta and Pteridophyta. Algae and Fungi are grouped under Thallophyta. Weeds, again can be classified as macroalgae and microalgae, where macroalgae occurs in oceans and the microalgae occurs in the small water bodies are of very less importance to the aquatic world.

Seaweeds, which are nowadays considered as an important macroalgaeare under-utilized biomass that has its origins in the world's ocean waters. The term seaweed is a combination of the world's "sea" and wēod, meaning "weed". A weed is defined as a plant that grows profusely, at any place and time. Thus, its growth is often considered as unwanted or of

no value. Seaweeds are, therefore, the weeds in marine habitats because they tend to grow profusely similar to the weeds on land and normally are of three types: red algae (Rhodophyceae), brown algae (Phaeophyceae), and green algae (Chlorophyceae), which are considered as multicellular marine plants thriving particularly near the seabed. Thus, they are one of the benthic organisms found near or in marine sedimentary habitats, e.g., along the foreshore and abyssal depths; typically having a thallus body, which is simply an undifferentiated vegetative tissue. They, therefore, do not have true stems, leaves, and roots. A true stem, leaves and roots would have a vascular system as found in higher plants. In spite of this, these macroalgal bodies resemble most terrestrial plants.

The seaweeds are distributed horizontally in different zonations viz. supra tidal (supra littoral), intertidal (littoral) and subtidal (sub littoral) regions of the seas and oceans. Green seaweeds are most commonly found in the intertidal zone. Common green seaweeds are species of *Ulva* (sea lettuce), *Enteromorpha* (green string lettuce), *Chaetomorpha*, *Codium* and *Caulerpa*. Brown seaweeds inhabit in the tidal or upper subtidal zone. Common brown seaweeds are species of *Sargassum*, *Laminaria*, *Turbinaria* and *Dictyota*. Red seaweeds grow in subtidal waters. Common red seaweeds are species of *Gracilaria*, *Gelidiella*, *Eucheuma*, *Ceramium* and *Acanthophora*.

Table II. List of some economically important seaweeds,both in India and abroad with their occurrence and potential yield

Types of Seaweeds	Scientific names	Occurrence and culture sites	Yield potentials
Chlorophyceae (Green Algae)	*Oedogonium termedium* *Ulva clathrata*	In India, 90 % of *Ulva sp.* grow in fresh water and rest in saline and terrestrial habitats of Gujrat, Tamil Nadu, Kerala etc.	Yield of green seaweed was higher during the period of 1950 to 1959 with a projected amount of 120600 t per hectare which unfortunately showed a sharp decline and ended up to the figure of only 4974 t per hectare by 2014.
Rhodophyceae (Red Algae)	*Porphyra Sp.*	rocky shorelines throughout the world, including a few species in the tropics or at the poles. The greatest diversity is	Yield potential of red seaweeds shows very high right from the start of 19th century (from 1950), when it was harvested from wild

		found in cold-temperate and boreal regions of Maharashtra, Kerala, Gujrat and Tamil Nadu.	stocks at @2,75,387 t per hectare which gradually increased up to a volume of 1350223 t till 1999, but later showed a decrease in the harvest from the 2000 and ended in a sharp decline standing to the amount of 105886 by 2014.
	Gracilariopsis lemaneiformis	Found extensively in backwaters of Kerala.	
	Gelidium acerosa.	widely distributed globally, specifically in tropical to temperate regions, inhabiting the intertidal to subtidal zone extensively from the Gulf of Mannar of the Coromandel coast.	
Phyeophyceae (Brown Algae)	*Undaria pinnatifida*	Native region is South coast of France in the Mediterranean	*L. digitata* and *M. pyrifera* are two brown seaweed species that are harvested and cultivated globally. In 2016, *L. digitata* global wild harvest yielded ~45,000 tonnes, with Chile being the highest producer of brown seaweed from natural populations at 300,000 dry tonnes per year by 2012, in a global context 7% of the brown seaweed from natural populations was provided by Macrocystis sourced in Chile and Mexico
	Laminaria japonica	Exclusively grown in marine habitat in comparatively shallow water in rocky shores of calm waters of Atlantic	
	Ascophyllum sp.	found attached to rocky coasts in temperate zones of Northwest coast of Europe and Northeast coast of North America	

Use of seaweeds along with its nutrient profile

Seaweeds are richest source of proteins, lipids, carbohydrates, minerals, vitamins (A, B, C and Niacin) and antioxidants and are considered as valuable food supplement for humans of 21 century and serve as low calorie food. Protein content in brown seaweeds is 5% to 15% while in red and green ones it is 10% to 30 % of dry weight. However, in *Palmaria palmata* (dulse) and Porphyra tenera it is 35% and 47% of dry matter respectively. *Ulva petrusa* contains 20% to 26% and is consumed under the trade name

"Aonori" by Japanese and following such food value, the important food seaweeds are Kombu (*Laminaria japonica*), Wakame (*Undaria sp.*), Nori (*Porphyra sp.*), Ogo Kim Chee (*Gracilaria coronopifolia*), Gulamon sald (*Codium edule / Gracilaria coronopifolia*) and so on. *Ulva*, another important example of green seaweed, on the other hand contains 10% to 26% of protein among the Indian seaweeds.In China also, they were used from prehistoric time. In China and Japan, they had been used as a stable diet for a very long period. Fresh, dried and processed seaweeds are utilized for human consumption in the form of salad, curry, soup, or jam. Though they are traditionally consumed in Asia as "sea vegetables", but in the western countries, they have been used as sources of gelling or thickening agents in surplus. Other uses of seaweeds include its inclusion in biofertilizers, agars, facemasks, anti-toning agents etc., which are described in table III below.

Table III. Uses of different species of seaweeds with their economic potential

Types of seaweeds	Scientific names	Uses	Economic Potential
Chlorophyceae (Green Algae)	*Oedogonium termedium* *Ulva clathrata*	Foods for aquatic organisms, fertilizers, use in burn treatments, as bladder and kidney ailments, packaging material, photography, leather industry, plywood manufacturing, cosmetics, pharmacology for the production of antibacterial, antifungal, and antiviral substances, healing of wounds, burns, and rashes etc.	Though, about 98% of seaweed cultivated across the globe comes from five genera: Saccharina, Undaria, Neopyropia/Pyropia/Porphyra, Eucheuma/Kappaphycus, and Gracilaria, but still among them the economic potential of the green seaweeds (genus *Ulva* and *Undaria*) generally shows a less protectional trend in regard of its market potential as because of its less importance to human activity as of compared to the aquatic lives.
Rhodophyceae (Red Algae)	*Alsidium helminthocorton , Digenea*	Production of hydrocolloids: agar, alginates; as	In 2010, production of red seaweeds surpassed 9.07 million tonnes with a value of over EUR

	simplex , and Corallina officinalis *Chondrus crispus and Gigartina stellata* *Porphyra sp. and Palmaria palmata*	foods, cosmetics, medicinal use as vermifuge, cough, chest, and stomach ailments, anti-scorbutic, producer of bioactive secondary metabolites etc.	1,079 million which also further showed an increased trend in its market potential through its enhanced global production rate of 41% collectively, by 2014; which is a clear pictural forecast of a very high market as well as economic potential of these seaweeds in the highly advanced technical world of today.
Phyeophyceae (Brown Algae)	*Fucus vesiculosus*	Production of Wakame, fertilizers, medicinal use as scrofula, stomach ailments, source for iodine, *Laminaria* stipes used to open wounds and in cervical dilation etc.	The brown seaweed commonly called Japanese kelp, Saccharina japonica, formerly known as Laminaria japonica, was the most cultivated seaweed in the world until 2010. It still retains a considerable market share, commanding 29% of global production in 2014 and over 33% in 2018; which alike the red seaweeds also depict a high projected economic and market potential of its culture and export in the future market.

Relevance of complementing some of the medicinal components with seaweed extracts in Indian context:

Though it is true that, the familiarity of seaweeds to the foreign nationals had dated since from a thousand of years back, the commercial use of them were only inaugurated to the entire nation through the hands of Japanese who started consuming them as their food. But, later in India, the advent of 'Blue revolution' with a view to cope up the fast-growing population and its multiplicating demand for food, had forced to drop a critical attention towards the unexplored resources left out in the three-fold stretches of vast water bodies surrounding our nation. The concept of using it and its extracts in a diversed application by the virtue of its versatility in competing with its multi-functional aspects as of described below in table III, had really made it easy to introduce a new concept of introducing the same in the field of medication and reviving the ill-healths of humans to its normal state. The relevance and the major stress towards the adaptation of this strategic implementation is at a high time as, in terms of health, India is currently at the such a transitional period economically, demographically and demiologically, where, every state of imbalance between the 'rich' and the 'poor' due to an impressive increment of the gross domestic product growth rate in the past few decades, thereby in-turn leading

indirectly, to the huge difference of 'income inequality', has sharply been reflected in the changes of lifestyles (Narain, 2016) and had consequently left over a great impact on ensuring national food security which thereby had led to augment the rates of diseased conditions eventually remaining associated with a couples of causative factors aside nutrition.

Availability at the time of will:

The availability of the seaweeds is another important consideration for its introduction in the medicines as because based upon the culture practices irrespective of its wild capture, they can easily be obtained year-round and this technique of collecting seaweeds at the own time of interest in now done in many developed countries where the ambient rise and fall in temperature is simulated artificially through highly modernized mechanical interventions. Following this, the important culture methods for making a constant flow in their process of 'renewal' is varied, which are like – Collecting the monospores of seaweeds in bundles of bamboo, twigs,rocks or concrete blocks and placing them on the seabed. The materials with their attached monospores are then transferred to the suitable sites such as inshore areas, near shore estuaries for the development of thalli to the desired size. In some of the Asian countries, like Philippines and Taiwan, *Gracilaria* and *Caulerpa* are grown in ponds, following many of the procedures common in fish culture such as pond fertilization, water management and disease and pest control.

These are also cultured using nets made up of palm fibres or synthetic twines, laid flat at a suitable level below the seawater and supported by a series of bamboo poles or wooden stakes driven into the seabed along the length of the net at intervals of 2.5-3 m. About a month after the hibi are spread, small buds can be observed on them and at that time they can be transferred to the growing area which are then collected after the desired height is gained. As seaweed is a highly valued dollar earner, owing to the valuation of 30.1 million tonnes at an estimate of 231.6 billion USD, the total production potential of 844 species of seaweeds stands out near 30 million tonnes, among which, Tamil Nadu and Gujrat seemed to be the pioneers of commercial seaweed culture in India generating about 120-1500mt per year on a basis of dry matter. Whereas, with a similarity to this scenario, the culture yield of alginate-based seaweeds was roughly around 2000mt per year which only projected its peak through intensive farming. Following this trend, later Andhra Pradesh enlisted its name in the activity of culturing the seaweeds, *K. alvarezi* using rafts whose first operational trial was successfully completed in the districts of Prakasam and Krishna in the year of 2004 and 2007 respectively. (Megaranjan, *et al.* 2020)

Fig. 3.Culture practices of seaweed using bamboo poles (left) and in an integrated manner with mussels along with (right).

Therapeutic activities helping out in an efficient carry-on of the metabolic activities:

Health is wealth and good health is really a valuable resource. The major inputs of this 'nutritious rather nourished health' comes from balanced diets in required amount on an average daily routine. This not only helps in preventing the occurrence of major diseased conditions, but also helps keep away medicines from our daily life. Such therapeutic activity naturally can be performed by the seaweeds and in this regard, it can be mentioned that, recently due to the commencement of research applications and experimentation of obtained research findings on the practical fields, these seaweeds have succeeded to creep its feet into the world of medical science by relating itself directly or indirectly in the removal of certain diseases like cancer, stroke, tumor, goiter, oedema and many. In the treatment of bone-related diseases viz., osteoarthritis and osteoporosis, combating the HIV virus etc, their importance is also beyond the horizon. Since, sometimes they are regarded as a valuable source of bioactive compounds, namely, phytochemicals, polysaccharides, fibre, ω-3 fatty acids, and essential amino acids along with almost all vitamins and minerals such as calcium, potassium, sodium, and phosphorus, their extracts are often treated as anti-oxidants to treat health ailments perfectly. As a relevant notation, it may be cited that the extracts of some notable seaweeds viz., G*racilariopsislongissima* (formerly *Gra cilaria verrucosa*), *Ulva intestinalis* (formerly *Enteromorpha intestinalis*), *Saccharina latissima* (formerly *Laminaria saccharina*), *Eisenia bicyclis*, and *Undaria pinnatifida* etc., namely lectin, acrylic acid, polysaccharides, fucoidan, alginic acid are found to prove best results in reflecting antibiotic, antitumor, antiarteriosclerosis, and anticancer properties etc. The derived concentrates of those, also are featured with diverse biological activities viz., antimicrobial, anti-inflammatory, anticoagulant, anticancer, and antihypertension activity etc. It is also interesting to note that, these anti-oxidant properties are mainly due to the presence of carotenoids, polysaccharides, vitamins, and its precursor and polyphenols contributing to the inhibition of oxidation processes that are triggered within the cellular masses

intensely.(Kumar, *et al*. 2021). Dietary supplementation, as shown in fig. 4, to combat with nutritional deficiency disorders can also be availed of by consuming those seaweeds at a certain limit.

Fig. 4.Capsules of seaweeds used as dietary supplements

Reducing the unaffordable high costs involved in its preparation:

Cost referred here may be categorized as three types: social cost, manufacturing cost, labour cost, though the most relevance lies in only the first two ones in our topic of discussion strictly. Social costs may sometimes be attributed towards the benefits that are derived from the medicines leaving off the after effects, while the labouralcosts points towards the manual efforts that are being involved in manufacturing the medicines industrially. Capital investments in procuring the ingredients from inconvenient sources or generating it otherwise by applying laboratory practices may add up to the total cost of manufacturing thereby entailing a considerable rise in the MRP eventually which is also applicable for the imported medicines equally. It is often seen that many essential medicines have not made available to the public at accessible cost, because, the medicinal industries hold market exclusivity which are uniquely endowed by the patent system developed by the manufacturers. This exclusive legality often intends to create a very long period of monopoly market by conferring market power and controlling high price over manufacturing and retailing the upcoming medicinal products, as a result of which, in developing and least developed countries, a large number of patients cannot access to the essential medicines due to unaffordable high price thereby in-turn causing a peak of public health crisis. In this situation, if seaweeds can establish its own footprint in contributing a few more steps towards healing up the due gap between the demand and supply of the national medicines by creating over a substantial reduction of the unnecessary cost of manufacturing the same, including their ingredientsholding notable properties for antibodies, anaesthetics,and many such others in the long runrespectively, (Rahman, 2020), then it can create a notable landmark in the field of medication in India within a very rapid progress side-side freeing our mother nation and her residents from the deadliest clutches of the ‘detrimental threats of medicines’.

End note:

India is such a developing country where 70% of inhabitants are under the below poverty line (BPL). The acute shortage of available liquid fund source had led them to live their lives in extreme nutritional deficiency,

which had led to the development of 20.7% underweight conditions, lowering down their immunity, asides making them more prone to the generation of diseased conditions adversely. In this connection, the seaweeds, a natural organic food source, occurring under the several depths of water surface and containing a plenty of bioactive compounds which apart from nutritious food item may serve as a 'cure' to certain diseases including their 'preventive actions' especially to those communities, as because, sometimes the cost of medications may become a 'burden' to them to bear, in contrast to those who have a constant supply of food to their empty bellies regularly. But nowadays, apart from this malnutrition or deficiency symptoms, which is seriously an alarming condition for those poor helplesses, the after effects of the medicines reviving the ill-healths' of about 37% of population, is diagonised with at least one disease which often becomes life threatening. So, in this regard, though the introduction of seaweeds had already have started its practical implementation in the field of pharmaceuticals, if could get a multi-fold momentum with a more stress towards Indian context by following the same principle as of applied in the above incorporations, then it can hopefully alter our attentional shifts from the traditional medicines towards these seaweed replaced ones, create some alternate source of livelihood as because of the emergence of a modern concept of replacing the constitutional components for manufacturing these 'curative agents', become a 'cure' as well as 'immunity booster' at the same time etc., which according to Indian context has an utmost importance.

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A survey on the Aquarium shops for the variety of ornamental Fishes in Karaikudi

Argha Biswas, P. Marimuthu, E. Kannapiran
Department of Fisheries Science, Alagappa University, Karaikudi – TN

Abstract

It showed that most of the shop's sale exotic fishes, because they are in high demand throughout the year among the customers. Very few shops sale indigenous fishes and they are not that much popular among customers so their availability is also very low. Availability of Aquatic Plants is also very low in the shops, as they are playing a vital role in aquarium by absorbing Carbon Dioxide and produce Oxygen by Photosynthesis. Aquarium accessories like air pumps, hose, air stones, artificial plants, aquarium stones, artificial houses, drift woods and various commercial fish feeds are available in almost every shop. But they have to sale live feeds also for better growth of ornamental fishes.The status and availability of ornamental fish species in Karaikudi town aquarium shop. The government agencies and policy makers should effectively address the various constraints that small and medium-sized ornamental fish retailers face. These include the distribution of cutting-edge technologies, the creation of a brood bank for ornamental fish, and the granting of licenses for the importation of brooders, as reported by the retailers of ornamental fish.

Introduction

The global ornamental fish trade is estimated at US$ 18-20 billion which is supported by about 100 million hobbyists around the world enterprise and has been expanding at a rapid pace in recent years. India has considerable potential in production and trade of ornamental fish due to the rich biodiversity of species hailing from diverse aquatic ecosystems, a favourable climate and the availability of a huge pool of low cost labour. There are about 5000 ornamental fish producing units spread across the country, wherein about 80% are freshwater based while the rest form brackish water and marine. Despite these endowments, India still continues to be a marginal player in the global ornamental fish trade. A recent estimate of the Marine Products Export Development Authority of India (MPEDA) shows that there are one million fish hobbyists in India. The domestic ornamental fish trade is estimated to be about Rs. 500 crores while the export is close to US$ 1.4 million (2017-18). Presently, the industry grows at an average annual rate of 11-12 per cent. The *Pradhan Mantri Matsya Sampada Yojana* (PMMSY) has an allocation of Rs. 576 crores for catalysing the growth of ornamental fish industry (Shinoj *et.al.*).

Ornamental fish resources in India

India possesses rich resources of marine ornamental fishes such as the lagoons and coral reefs of Lakshadweep and Minicoy islands, Andaman and Nicobar Islands, Gulf of Kutch, Coast of Kerala, Gulf of Mannar and Palk Bay are around with highly attractive and varied species. The potential with regard to the freshwater ornamental fishes inhabiting the hill streams, major river systems, reservoirs and lakes are immense. Rivers of north-eastern states and their Himalayan streams have an abundant variety of ornamental fish species. In India, the north-eastern states play leading role in ornamental fish trade. India has recorded at least 150 commercially important ornamental fish species and trade mainly indigenous freshwater species, collected from rivers, streams, wet lands, etc. Prominent among the freshwater Indian ornamental fish are loaches, eels, barbs, catfish and goby. About 90 per cent of ornamental fish is traded from Kolkata port followed by 8 per cent from Mumbai and 2 per cent from Chennai. India's share to global ornamental fish trade is less than one percent but still she is projected as a "sleeping giant" because of yet untapped potential resources (Pandey *et.al.*).

Market destination of India for ornamental fish export

The major destination for export of ornamental fishes from India is Singapore followed by Japan, USA, Malaysia and Germany. Markets for Indian ornamental fish have never been consistent and there has been a regular fluctuation with respect to destinations since the geographical spread of the markets has exhibited an ever changing hue. Singapore, USA, Hong Kong, Malaysia and Japan were India's favourite top five market destinations during 2003-09 which jointly accounted for about 70% of total export of ornamental fishes from India. Amongst them Singapore alone accounts for almost 43% of total export in ornamental fishes followed by Japan (14%) and Malaysia (10%). USA and Hong Kong both accounted for 7.5% each during the same period (Pandey *et.al.*).Now, ornamental fish farming is included as one of the activities of SHGs and also plays an important role to maintain livelihood of the local people (Pandey *et.al.*).

Materials and Methods

Study area

Survey and Collection of Data from the Aquarium Shops in Karaikudi

Survey was conducted in the month of March, 2023 in the aquarium shops in and around Karaikudi Town, Sivaganga (Dt.), Tamil Nadu on weekly basis. First, select five well known aquarium shop (ARK Aquarium Petshop, KK Aquarium, Friend's Aquarium, SS Aquarium and Sai Balaji Aquarium) in Karaikudi and then collect the data on available fish species and their prices. The survey was concluded with some well-designed questionnaire by interaction with the shop owners.

Fig 1: Map depicting the survey area (Karaikudi, Tamil Nadu)

Result and Discussion

The present study on the status and availability of ornamental fishes in Karaikudi, Sivaganga (Dt.), Tamil Nadu revealed that the income loss due to disease prevalence was higher in small shops. Variation in revenue loss was found to depend on factors like shop size, size of ornamental fishes, establishment of biosecurity systems, technical knowledge in ornamental fish farming methods, disease diagnostics, management practices as well as investment costs. The constraints faced by the small and medium ornamental fish retailers were found numerous and need to be effectively addressed by the government agencies and policy makers, particularly for dissemination of advanced technologies, establishment of brood bank for ornamental fishes and providing license for importing brooders as expressed by the ornamental fish retailers. Consequently, it demonstrated that the majority of the store's inventory consisted of exotic fish, as these are in great demand year-round among customers. Native fish are sold in very few stores, and since they are not very well-liked by consumers, they are also not very readily available. Considering that aquatic plants are essential to aquariums because they absorb carbon dioxide and produce oxygen through photosynthesis, it is also very rare to find them in stores. Nearly all stores carry aquarium accessories such as hoses, air pumps, air stones, artificial plants, drift wood, artificial houses, and a variety of commercial fish feeds. However, in order to improve the

growth of ornamental fish, they also need to sell live feeds.

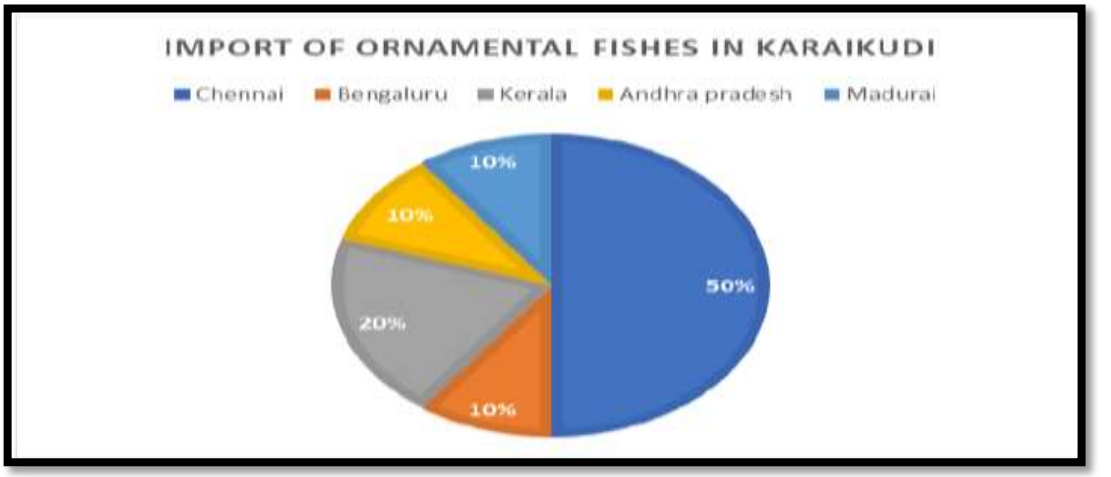

Fig 2: Import of Ornamental Fishes in Karaikudi

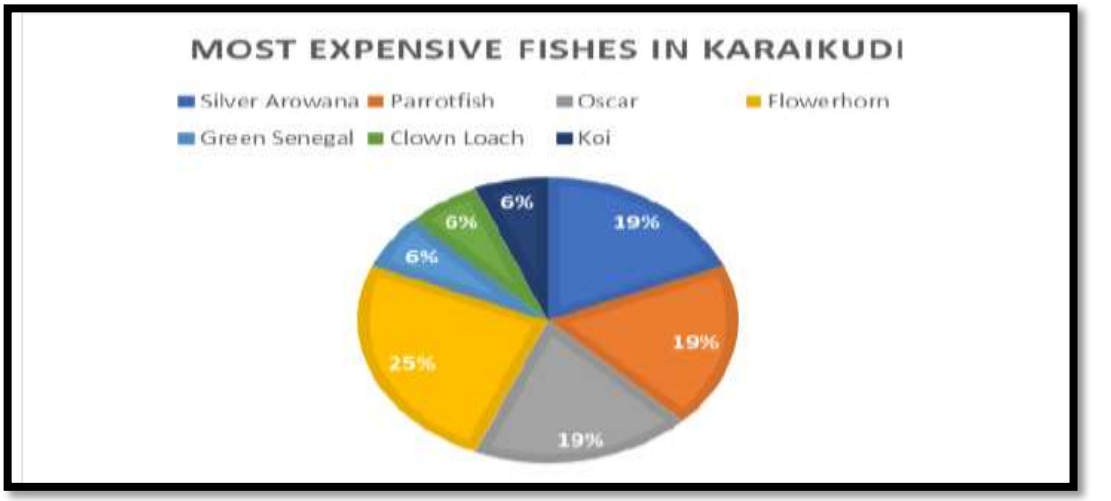

Fig 3: Most Expensive Ornamental Fishes available in Karaikudi

Table 1: Shop wise availability of Ornamental Fishes in Karaikudi

SL. NO.	Family Name	Fish Species	ARK Aquarium Petshop	KK Aquarium	Friend's Aquarium	SS Aquarium	Sai Balaji Aquarium
1	Cichlidae	Parrotfish	++	--	++	++	--
2	Cichlidae	Flowerhorn	++	++	++	++	--
3	Osteoglossidae	*Osteoglossum bicirrhosum*	--	--	++	++	--
4	Cichlidae	*Astronotus ocellatus*	++	--	++	++	--
5	Cyprinidae	*Cyprinus rubrofuscus*	++	++	++	++	++
6	Cyprinidae	*Carassius auratus*	++	++	++	++	++
7	Cyprinidae	*Puntius tetrazona*	--	--	++	++	--

8	Cyprinidae	*Barbonymus schwanenfeldii*	--	--	--	++	--
9	Poeciliidae	*Poecilia sphenops*	++	--	++	++	--
10	Poeciliidae	*Poecilia reticulata*	--	++	++	++	++
11	Poeciliidae	*Xiphophorus helleri*	--	--	--	++	--
12	Characidae	*Hyphessobrycon eques*	--	--	--	++	--
13	Characidae	*Gymnocorymbus ternetzi*	++	++	++	++	--
14	Cyprinidae	*Epalzeorhynchos frenatum*	--	++	++	++	--
15	Cichlidae	*Pterophyllum scalare*	--	--	++	++	--
16	Monodactylidae	*Monodactylus argenteus*	--	--	++	++	--
17	Characidae	*Metynnis argenteus*	--	--	++	--	--
18	Osphronemidae	*Trichopodus trichopterus*	++	--	--	--	--
19	Osphronemidae	Betta splendens	++	++	++	++	++
20	Botiidae	*Chromobotia macracanthus*	--	--	--	++	--
21	Polypteridae	*Polypterus senegalus*	--	--	--	++	--
22	Notopteridae	*Chitala ornata*	--	--	--	++	--
23	Cyprinidae	*Balantiocheilos melanopterus*	--	--	++	++	--
24	Pangasiidae	*Pangasianodon hypophthalmus*	++	++	++	++	--
25	Loricariidae	*Hypostomus plecostomus*	++	--	++	++	--
26	Osphronemidae	*Trichogaster lalius*	--	--	--	++	--
27	Cyprinidae	*Sahyadria denisonii*	--	--	++	--	--
28	Cyprinidae	*Haludaria fasciata*	--	--	--	++	--
29	Cyprinidae	*Danio rerio*	++	--	++	++	--

Table 2: Shop wise aquarium accessories availability and their prices in Karaikudi

SL. No.	Accessories	ARK Aquarium	KK Aquarium	Friend's Aquarium	SS Aquarium		Sai Balaji Aquarium	Average	Range
Minimum					Maximum				
1	Osaka Fish Feed	95	100	60	-	60	79	60	100
2	Taiyo Fish Feed		75	70	75	-	73	70	75
3	Optimum	105	80	80	-	80	86	80	105
4	Lamp	240	-	-	-	-	240	240	240
5	Amber for Flowerhorn	330	-	-	-	-	330	330	330
6	Royal for Fighterfish	80	-	60	80	-	73	60	80
7	Hi red Flowerhorn	180	-	-	-	-	180	180	180
8	Arowana Stick	720	-	-	-	720	720	720	
9	Humpy Head for Flowerhorn	480	-	450	-	-	465	450	480
10	Micro Pellet	320	-	-	-	-	320	320	320
11	Champion Feed	270	-	-	-	-	270	270	270
12	Blood Worm dried	80	-	-	-	-	80	80	80
13	Tetra Bit	170	-	-	-	-	170	170	170

14	Guppy Bit	100	-	-	-	-	100	100	100
15	Worm Out	320	-	-	-	-	320	320	320
16	Methylene Blue	380	-	-	-	-	380	380	380
17	Mr. Green	60	-	-	-	-	60	60	60
18	Filter*	400	-	-	140	-	270	140	400
19	Pump*	200	-	150	150	-	167	150	200
20	Pebbles*	50	40	30	30	-	38	30	50
21	Plastic Plants*	20	20	30	20	-	23	20	30

Conclusion

The current study on the status and availability of ornamental fish in Karaikudi, Sivaganga (Dt.), Tamil Nadu discovered that income loss due to disease prevalence was greater in small shops. The variation in revenue loss was discovered to be dependent on factors such as shop size, ornamental fish size, biosecurity system establishment, technical knowledge in ornamental fish farming methods, disease diagnostics, management practices, and investment costs. Flowerhorn is the most expensive ornamental fish available in Karaikudi. Silver Arowana, Parrotfish, Oscar, Green Senegal, Clown Loach, and Koi follow. The constraints faced by small and medium ornamental fish retailers were discovered to be numerous and must be effectively addressed by government agencies and policymakers, particularly for the dissemination of advanced technologies.

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Assessment of the taxonomy and current status of Flat Fish Trawl by – catch in Gulf of Mannar Region, Tamilnadu, India

R. Kayalvizhi, P. Marimuthu*, E. Kannapiran
Department of Fisheries Science, School of Marine Science, Alagappa University, Karaikudi 630003, Tamilnadu, India

Abstract

In Human's diet, fish and shellfish are play significant role as part of the major aquatic food resources for a long time. Fishes have been exploited using a wide variety of gears from various depths and in all sizes leading to heavy overfishing. Flatfishes are well known organisms as they occur in all the world's oceans, are represented by large numbers of species and genera and in some regions their populations are sufficiently large to constitute major fishery resources. The species of flatfishes collected were examined carefully for their diagnostic characters. A total of 4 families, including 10 species of flatfishes were recorded in Mandapam fish landing center and Kottaipattinam.

Introduction

In tropical areas, flatfishes occur in a variety of habitats including mangrove estuaries and adjacent mudflats, in seagrass beds and on mud bottoms. However there has been limited works on Indian flatfishes, a detailed work on the flatfishes and their availability has been lacking in India. Hence work on flatfishes on these lines demand utmost attention in the present world and is taken up in the present study. India is one of the world's countries renowned for its mega diversity. Gopi and Mishra (2015) reported 2443 marine fish of India which is 75.6% of total fish species so far reported from India. In tropical fisheries, flatfishes captured are very often merely identified as" Pleuronectiformes" much information on the species is not undertaken (Munroe, 2014). Pleuronectiformes were first named in 1758 by Linnaeus; pleuro meaning "on side" and necto meaning "swim". Some of the most extreme environments inhabited by flat fish are those with deep sea, hydrothermal vents, where several species of tonguefishes (Munroe & Hashimoto 2008) inhabit a variety of substrata, including sheeted sulfur flows and conglomerates near high temperature venting and molten sulfur (Tunnicliffe et al. 2010).

Materials and Methods

Study Area

The flatfishes were collected only from the fishing vessels that carried out their fishing and trawling operations in the Gulf of Mannar waters**.** Mechanized trawlers and mechanized boats are mainly employed for fishing. Gill nets and trawl nets are

commonly used gears to collect the sample during the present investigation. The samples were collected in this study from the following two places (Station 1: Mandapam fish landing centre, Station 2: Kottaipattinam).

Measurements

The species of flatfishes collected were examined carefully for their diagnostic characters. Care was taken to photograph most of these fishes in fresh condition. Colour in fresh as well as prominent external features/markings was also noted immediately. The weight was recorded with use of electronic balance to the nearest 0.01g. Finally Morphometric (taken on ocular side mainly, except, where mentioned separately) measurements were noted. Morphometric measurements were also done by measuring Total length (TL), Standard length (SL), Head length (HL), Dorsal fin length (DFL), Anal fin length (AFL), Pre anal length (PAL), Maximum body height (MBH1, Minimum body height (MBH2), Eye diameter (ED) Orbit diameter (OD) and Pectoral fin length (PFL).

Results and Discussion

Flatfishes are deep bodied, laterally compressed fishes, easily recognizable by the presence of both eyes on one side in juvenile and post-metamorphic individuals. They are well known organisms as they occur in all of the world's oceans, are represented by large numbers of species and genera. TheWorld over, only 716 species were recognised as valid, while another 670 names were recognised as synonyms for pleuronectiform fishes (Munroe, 2005). In the present study, flatfishes are caught mostly using bottom trawl nets by fishermen in all stations as the flatfishes are close to the bottom and swim by undulation of the body.

A total of 4 families, including 10 species of flatfishes were recorded in Mandapam fish landing centre and Kottaipattinam (Table 1). The Soleidae family which included 4 genus 4 species, the Cynoglossidae family which included 1 genus 2 species and the Paralichthyidae family which included 1 genus 3 species, the Bothidae family which included 1 genus 1 species were found along the Mandapam fish landing centre and Kottaipattinam in this study. An effort has also been made to depict the scale patterns of the flatfishes across genus which if done in detail will provide a good taxonomic tool by itself. The distribution pattern of flatfishes has been well studied in this work and has yielded interesting results**.**

Table 1: Total number of Flatfish species recorded

S.No	Species list	Family
1	*Cynoglossus puncticeps*	Cynoglossidae
2	*Cynoglossus dispar*	Cynoglossidae
3	*Heteromycteris oculus*	Soleidae

4	*Synaptura albomaculata*	Soleidae
5	*Zebrias quagga*	Soleidae
6	*Pardachirus pavoninus*	Soleidae
7	*Pseudorhombus triocellatus*	Paralichthyidae
8	*Pseudorhombus arsius*	Paralichthyidae
9	*Pseudorhombus elevatus*	Paralichthyidae
10	*Bothus myriaster*	Bothidae

Figure 1: Flat fishes found along the Gulf of Mannar Region, Southeast Coast of Tamil Nadu, India

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Effects of Different types of Feeds on Growth and Reproductive Performances of Guppy (Poecilia Reticulata)

Argha Biswas, P. Marimuthu*, E. Kannapiran
Department of Fisheries Science, Alagappa University, Karaikudi,Tamil Nadu, India

Abstract

Guppies are one of the most popular ornamental fish species in India. The best growth and survival rate in indoor aquarium conditions. The present investigation was carried out on the breeding biology of *P. reticulata* in a controlled aquarium condition. The effects of different diets and determine the optimal feed on the growth performance of guppy. The study has demonstrated that live feed *Daphnia sp*. and *Artemia sp.* has significantly influenced the various growth parameters and survival rate of guppies (*Poecilia reticulata*). Moreover, it establishes the primacy of the live feed Daphnia and Artemia over conventional formulated feed in promoting optimum growth and better health status of the guppies. In all three experiments body weight was significantly higher in females compared to males. During the experimental period mortality rate was high in 3rd Tank (Diet III) compared to other tanks because of parasite attack (Anchor worm).The Body weight, SGR % and survival rates were significantly higher in fish fed on live feeds compared to fish fed with other two feeds.Fish fed live feeds had significantly higher body weights, survival rates, and SGR% than fish fed the other two feeds.

Introduction

Popular aquarium fish *Poecilia reticulata* commonly known as 'Guppy' was introduced in various countries for mosquito control and often loosely called 'Mosquito Fish'. It has been found to establish itself in both fresh and polluted waters (Ahmed *et al.* 1985). It introduced in India as early as 1910 to control mosquito (Kaira *et al*. 1967). This species is widely studied as a model species ecology and evolutionary biology, and has had a long and popular history as an ornamental fish. A wide variety of strains differing in colour and fin shape have been developed by aquarists (Axelrod et al. 1985; Sakurai et al. 1993; Wischnath 1993). Males are brightly coloured and vary greatly in their colour patterns within and populations, whereas females do not have conspicuous colour patterns. Their biology, ecology, behaviour and genetics have been reviewed previously (Endler 1978, 1983). Briefly, guppies live in tropical forests, in clear streams with clean gravel or sand bottoms, and occasional patches of leaf litter.The Guppy (*Poecilia reticulata*, Peters 1859) is a Poeciliid fresh water fish ovoviviparous fish native to Trinidad, Venezuela, Barbados, Guyana, Northeast Brazil. It is one of the best-known ornamental fish. Hora & Mukherjee classified the gender

Poecilia in surface feeder which is less efficient owing to their mode of life (Chakraborty *et al*., 2008). An understanding of the breeding biology of *P. reticulata* is a basic requirement for the successful proliferation of the fish, hence successful mosquito control. It is a viviparous fish and is capable of increasing its population in shallow or polluted water (Menon and Rajagopalan, 1977). By providing enough feed and separating babies immediately from the breeding tank, it is possible to save their lives from cannibalism. Therefore, the present experiment was carried out on the growth performance of *P.reticulata* in the controlled aquarium condition.

Materials and Methods

Rearing methods of guppies in indoor condition

This experiment was conducted in Department of Fisheries Science Laboratory of Alagappa University, Science Campus, Karaikudi, Tamil Nadu. A total of 45 fishes was purchased from the aquarium shops of Karaikudi area and was transferred to rearing aquaria at a stocking density of 15 fish /tank at a sex ratio of 1(male):2(female). Males were clearly distinguished by having modified anal fin taking the form of a gonopodium and in females, body color was less bright and had swollen abdomen. Three glass tanks (60×30×30 cm) in the indoor aquarium were filled with tap water and aerated continuously. Each of aquaria contained 20 litres of water. Water was changed manually every three alternate days in the afternoon when the temperature of the aquarium was close to that of the tap water. The guppy prefers hard water and can withstand salinity up to one ppt. So, half a tablespoon (8g) of salt was mixed with 20 litres of water every time during water change. The fishes were provided with three different types of feeds, Live feed (*Artemia sp*. and *Daphnia sp*.), Freeze dried feed (Tubifex worms) and Commercial pellet feed (Optimum) available in market were selected as experimental feeds and given twice a day in the morning and at afternoon. The different water quality parameters like temperature and dissolved oxygen were observed every 3 days. Tanks were cleaned everyday by siphoning faeces and uneaten feed.

Fig. 1: Guppies used for the experiment. A - Male Guppy; B - Female Guppy

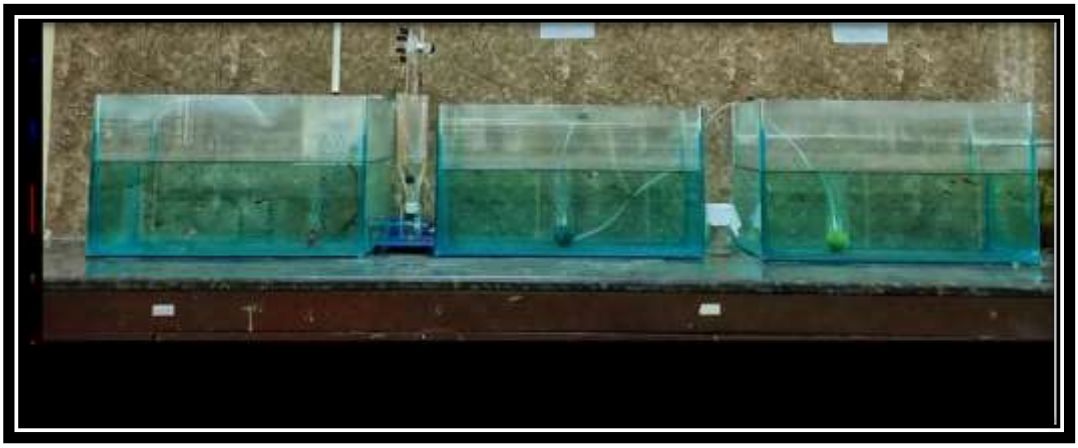

Fig. 6: Three different aquarium setup for rearing guppies.

Determination of fish growth performance

Formula 1: Specific Growth Rate (SGR) = ***In wt-In Wo/t* × 100**

Formula 2: Survival Rate = ***Nt/N0*× 100**

Note:

Wt and Wo are final and initial fish weights (g)

Nt and N0 are the final and initial fish numbers for each replicate

t is the experimental duration in days

Result and Discussion

Significant differences in mean final body weight, SGR %, survival rate was observed among the three experiments (Table 1). Body weight, SGR % and survival rates were significantly higher in fish fed on Live feeds compared to fish fed with other two feeds. In all three experiments body weight was significantly higher in females compared to males. During the experimental period mortality rate was high in 3rd Tank (Diet III) compared to other tanks because of parasite attack (Anchor worm).

The final weight was highest in Diet I than other diets. The enhanced growth performance of fish fed with live feed Daphnia and Artemia may be due to their small size, better nutrition, and feed acceptability. The fishes are typically attracted to live feed due to their movement and exhibit a preference for small-size prey concerning their mouth gape. However, the effective use of live feed mainly depends on its size and nutritional content. Thus, by providing Daphnia and Artemia were suitable for better growth performance, better survival rate and disease tolerance in guppies.In comparison to Diet I, the guppies fed Diet II (Freeze Dried Tubifex) exhibited lower growth parameters. The fact that Dry Tubifex has a diet with little feed variation may be the cause of the reduced growth performance. However, there was no discernible difference in the guppies' survival rate when

compared to those fed Diet I.

Table 1. Growth performance and survival rate of *Poecilia reticulata* fed with different diets for 60 days

Growth Performance	Diet I Daphnia and Artemia	Diet II Freeze Dried Tubifex	Diet III Commercial Pellet Feed
Initial Weight (g)	0.55±0.268	0.91±0.496	0.48±0.243
Final Weight (g)	0.61±0.112	0.98±0.285	0.56±0.248
SGR (%)	3.71±0.005	3.51±0.005	3.48.006
Survival Rate (%)	97±5.34	96±5.43	89±5.45

Conclusion

The study has shown that the different growth parameters and survival rate of guppies (*Poecilia reticulata*) have been significantly influenced by live feed containing Daphnia sp. and Artemia sp. Furthermore, it proves that live feed formulated with Daphnia and Artemia is superior to conventional feed in terms of fostering optimal growth and improved guppies' health.

Ethical Statement

No animal was intentionally harmed during the experiment were conducted. This experiment was done for aquaculture purpose.

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Estimation of heavy metals in commercial important fishes from coast of Bay of Bengal, Tamil Nadu

Naveenkumar M,R. Srinivasan* and E. Kannapiran
Department of Fisheries Science, School of Marine Science, Alagappa University, Karaikudi 630003, Tamilnadu, India

Abstract:

The samples were collected near the seashore of the Bay of Bengal from four different districts in Tamilnadu such as Kasimedu in Chennai, Uppanar in Cuddalore, Adirampattinam in Thanjavur, Velankanni in Nagapattinam during the period from January 2023 to March 2023. A total of 20 different fish species and 4 sediment samples were estimated for heavy metals *viz.*, Lead, Iron, Zinc and Copper. Fish muscles were analyzed and it was fit for human consumption in this region.The order of heavy metals in fish and sediment samples was Fe > Zn > Pb> Cu. The concentrations of heavy metal in the samples were found below when compared with various organizations level.

Keywords: Heavy metals, Lead, Iron, Zinc, Copper, Sediments, Fishes

INTRODUCTION:

India is one of the largest countries in the world, with a combined coastline of 8 041 km in length, and an EEZ of 2.02 million km2 (FAO, 2000). Living organisms require varying amounts of heavy metals. Iron, cobalt, copper, manganese, molybdenum, and zinc are required by humans. All metals are toxic at higher concentrations. Excessive levels can be damaging to the organism. Other heavy metals such as mercury, plutonium, and lead are toxic metals that have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of animals can cause serious illness. Certain elements that are normally toxic are for certain organisms or under certain conditions, beneficial. Examples include vanadium, tungsten, and even cadmium. The Types of heavy metals and their effect on human health with their permissible limits are enumerated Singh, et al. (2011). The concentrations of heavy metals in fish have been extensively studied over the past several decades. Research has shown that extent of accumulation of heavy metals in fish is dependent on the metal types, fish species, and the tissues respectively. Water chemistry directly affects the accumulation of heavy metal in fish. Sediment is also know to an important factor heavy metal accumulation in fish, as it is considered as the major source of contaminants for bottom dwelling and bottom feeding aquatic organisms which in turn represents the Concentrated source of metals in the diet of fish. Fish have been considered good indicates for heavy metal contamination in aquatic system because they occupy different tropic levels with different size and

ayes of fish by humans and polluted the fish may endanger human health.

MATERIALSANDMETHODS

The sediment and fish samples were collected different location in Tamilnadu Kasimedu: (Lat. 13.1251° N; Long. 80.2955° E) in Chennai, Uppanar (Lat. 11.42'° N; Long. 79.46'° E) in Cuddalore, Adirampattinam (Lat. 10.6819'° N; Long. 79.8437'° E) in Thanjavur, Velankanni (Lat. 10.3413'° N; Long. 79.3796'° E) in Nagapattinam during January – March 2023. from all the four locations within 500 meters from the seashore (McGrath and Cunliffe, 1985). The collected fish samples were identified according to FAO identification sheets, GENE bank and FISHBASE database. The fish samples were washed thoroughly with distilled water to remove the sediments and debris. Then the edible parts were separated and frozen at–20 ^{o}C for the analysis. The fish samples were thawed, and then dried in a hot air oven at 60 ^{o}C. After removing the moisture content, the weight was taken again. Heavy metal concentrations were determined by Atomic Absorption Spectrophotometer (AAS).

RESULT AND DISCUSSION

The maximum and minimum concentration of selected metals (Pb, Zn, Fe and Cu) in fishes and sediment samples which was collected from four different stations (Table 1). Among the four heavy metals, the level of Iron was found abundantly in all study areas. The level of lead was found higher in Uppanar sediments (0.3831 mg/l) and collected *Ariusleptonotacanthus* 0.2388 mg/l. Similarly, Thiyagarajan et al., (2012) reported that the level of lead was ranged between 0.14 to 0.50 µg g -1 in Uppanar and Vellar estuaries sediment samples. The level of iron was found higher (7.9401 mg/l) in *Rastrelliger kanagurta* and the minimum (0.7665 mg/l) was found in *Arius leptonotacanthus*. The level of zinc was found higher (2.555 mg/l) in *Selar crumenophthalmus* and the minimum (0.1045 mg/l) was found in Velankanni sediments sample. The level of copper was found higher (0.2298 mg/l) in *Sphyraena jello* and the minimum (0.0011 mg/l) was found in *Nemipterus virgatus*. Mathivanan and Rajaram (2013) reported that the level of toxic heavy metals was found higher in water and sediment samples of Cuddalore coast. The higher values of toxic heavy metals in the study areas were might be due to the anthropogenic activities such as boating and fishing etc. Rajaram et al. (2013) reported that the numbers of deteriorated boats in the boatyard also contribute to the Cu pollution. From the analysis, level of heavy metals in fish and sediment samples was noted within the permissible limits of WHO (2004). Moreover, the marine environment has also been polluted particularly by plastics. These plastics were easily carried by the marine organisms for their feed. Furthermore, the anti corrosive paints and oil leakages by the boats, and ballast water by the ships and which leads to increase the level of toxic heavy metals in the marine environment. These heavy metals can affect the growth and multiplication of

marine organisms. In addition to that, these toxic substances can pollute the marine environment and accumulate in the gut region of marine organisms and it will be reached the humans through food chain. The measurement of heavy metal concentrations and distribution in marine environment leads to betterunderstanding of their behaviour in aquatic environment and is important for detecting the sources of pollution (Unnikrishnan and Nair 2004).

Conclusion

The presence of heavy metal indicates that the oceans and coasts are getting polluted by the industrial effluents and manmade activities. Industries are highly polluting the coasts through heavy metals which are diffusing in the water. This study shows that the heavy metals present in fishes and sediments are very low and lesser than the permissible limits of WHO. In conclusion, the results of the present study suggest for a regular monitoring programme, which will be helpful to improve the better management of the present study area.

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Table:1 The concentration of heavy metal in collected fishes and sediment samples (units in mg/L)

S. NO	SAMPLES	FISH & SEDIMENTS	LEAD (Pb)	IRON (Fe)	ZINC (Zn)	COPPER (Cu)
1	**Sample1**	*Lethrinusnebulosus*	0.3088	2.7634	1.3181	0.0187
2	**Sample2**	*Parupeneusindicus*	0.265	2.2797	0.5104	0.0314
3	**Sample3**	*Rastrelligerkanagurta*	0.2619	2.4687	0.9695	0.0965
4	**Sample4**	*Sardinellalongiceps*	0.2586	1.8727	1.3333	0.0804
5	**Sample5**	*Sillagosihama*	0.2657	2.1609	0.5913	0.0145

6	**Sample6**	Uppanar Sediment	0.3831	3.0835	0.5545	0.1173
7	**Sample7**	*Ariusleptonotacanthus*	0.2388	0.7665	1.3678	0.0371
8	**Sample8**	*Rastrelligerkanagurta*	0.2622	2.3282	0.7021	0.0163
9	**Sample9**	*Priacanthusmacracanthus*	0.2599	2.5169	0.4694	0.0186
10	**Sample10**	*Pampusargenteus*	0.2641	3.4455	0.6722	0.0014
11	**Sample11**	*Nemipterusvirgatus*	0.2715	1.9279	0.8528	0.0011
12	**Sample12**	Velankanni Sediment	0.2925	1.9531	0.1045	0.0055
13	**Sample13**	*Rastrelligerkanagurta*	0.2725	7.9401	0.5404	0.0614
14	**Sample14**	*Pampusargenteus*	0.2725	3.1826	0.7044	0.0537
15	**Sample15**	*Alepesdjedaba*	0.2779	3.1415	1.5087	0.1618
16	**Sample16**	*Sphyraenajello*	0.2823	2.6141	1.4239	0.2298
17	**Sample17**	Strongylurastrongylura	0.2752	3.6289	0.7213	0.1337
18	**Sample18**	Adirampattianm Sediment	0.2397	1.7419	0.0005	0.0217
19	**Sample19**	*Scatophagusargus*	0.2854	1.4643	1.0981	0.0165
20	**Sample20**	*Gerresfilamentosus*	0.2966	1.0556	1.7855	0.0509
21	**Sample21**	*Carangoidesmalabaricus*	0.2645	1.0592	1.1367	0.0336
22	**Sample22**	*Selarcrumenophthalmus*	0.3825	3.6289	2.555	0.0323
23	**Sample23**	*Engraulisencrasicolus*	0.2729	1.7419	1.1236	0.0292
24	**Sample24**	Kasimedu Sediment	0.3017	1.0534	0.3869	0.027
25	**Sample 25**	Blank	0	0	0	0

Microplastics- A Serious Problem for Aquatic Organisms and TheirBioremediation for Environmental Health

Abhishek Bera, R. R. Ravichandran, K. Ishwarya, C. Santhosh Kumar, E. Kannapiran
Department of Fisheries Science, Alagappa University, Karaikudi- 630003, Tamil Nadu, India

Abstract

Microplastics are the very tiny particles of macroplastics that are the major concerned pollutants in aquatic ecosystems. In the time of the Industrial Revolution, plastic production was skyrocketing. The global production of plastics was 299 million tons in 2013, 381 million tons in 2015, 335million tons in 2016, 349million tons in 2017, and 359million tons in 2018. It is a widely used material all over the world because of its low weight, high durability, high flexibility, good strength, low production cost, etc. But, due to the lack of proper treatment strategies of used plastics, a large portion of plastics are entering the sea and ocean where they are degraded into tiny particles with the help of physical, chemical, and biological processes. These tiny particles of plastics are called microplastics (<5 mm) that pose several threats to aquatic organisms like reducing food consumption, changing behavioural and morphological features, reducing fecundity and hatchability, blocking the digestive tract, and even attaining the death of the organisms. These microplastics can be controlled by bioremediation with the help of biodegradation. It can be achieved by various plastic-degrading bacteria, fungi, actinomycetes, etc.

Keywords: Microplastics, Bacteria, Bioremediation, Biodegradation, Impact

Introduction

The global population, currently exceeding 7.9 billion, represents a complex interplay of social, economic, and environmental factors. With the development of technologies for making people's life smooth, various products have been emerged. In the time of the Industrial Revolution along with the development of the chemical and material sciences, a synthetic polymer called plastics was produced from fossil fuels. The word 'plastic' came from the Greek word 'plasticos' meaning able to be molded. This synthetic polymer or plastic is characterized by its various features including lightweight, highly durable, highly flexible, low production cost, good strength, easy transportation, etc. The global production of plastics was 299 million tons in 2013, 381 million tons in 2015, 335million tons in 2016, 349million tons in 2017, and 359million tons in 2018 (Duis et al, 2016; Jeyavani et al, 2021). A huge amount of plastics are not treated properly after use and this man-made plastic takes thousands and thousands of years to degrade. Ultimately these used plastics are reaching into the sea

and ocean and make it unsafe for the aquatic organisms.

In aquatic environments, plastics are degraded into tiny particles by photooxidation, ozonation, thermolysis, etc. These tiny particles are called microplastics which's size is less than 5 mm. Microplastics are posing the threads to the biotic community by blocking the digestive tract, reducing hatchability, changing behavioural and morphological features, reducing fecundity, reducing food consumption, and even attaining the death of the organisms. Therefore, this problematic scenario of microplastics must be restricted. It can be overcome by the process of biodegradation by various living organisms like fungi, bacteria, actinomycetes, etc (Jeyavani et al, 2021; Ajith et al, 2020).

Types of microplastics:

Several plastic materials are available that are recyclable. The recyclable plastic materials include high-density polyethylene (HDPE), low-density polyethylene (LDPE), polyvinyl chloride (PVC), polyethylene terephthalate (PET), polystyrene (PS), etc. Some forms of plastics are difficult to recycle including polylactide (PLA), polycarbonate (PC) and their derivatives, etc (Jeyavani et al, 2021; Ajith et al, 2020).

Microplastics are tiny particles, produced from large plastic debris. Microplastics were first discovered by Charles Moore in 1997 at the North Pacific Ocean. He mentioned microplastics in his book "Plastic ocean" (Jeyavani et al, 2021). Microplastics can be classified mainly into two parts viz., Primary and secondary microplastics based on their origin (Ajith et al, 2020).

Primary microplastics: Primary microplastics can be defined as plastics of microscopic size which is involved in the manufacture of toothpaste, shampoo, hand cleaners, etc. It is also used as the vector for drug delivery systems in medicines (Jeyavani et al, 2021). Microplastics with a range of less than 0.5 mm to less than 0.1 mm are utilized in cosmetics products. It is also involved in drilling fluids for gas and oil exploration. Plastic resin pellets or flakes, plastic powder of fluff which are used for the manufacture of plastic products, are also the source of primary microplastics (Duis et al, 2016).

Secondary microplastics: Secondary microplastics, on the other hand, can be defined as the category of microplastics which is produced by the formation of fragments of large plastic debris. Large plastic materials are found in both aquatic and terrestrial environments where these materials are broken down into smaller pieces by physical, chemical, and biological processes (Jeyavani et al, 2021). An estimation showed that 75-90% of plastic debris in the marine environment comes from the land area whereas 10-25% of plastic debris comes from the oceans. The huge share of plastic debris in marine environments from land-based sources is mainly due to dumping of waste, littering, improper management of the waste, etc (Duis et al, 2016).

Impact of microplastics:

Microplastics, in general, have some negative effects on aquatic organisms. These accumulate in the digestive tract of the organisms and block it. Microplastics are involved in reducing food consumption, reducing fecundity, reducing hatchability, changing behavioural and morphological features, and even attaining death of the organisms (Jeyavani et al, 2021). Some impacts of microplastics on plankton, aquatic invertebrates, finfishes are discussed below-

Impact on plankton: Microplastics have a significant effect on the producers in the food web. Microplastic toxicity is dependent on its particle size. The smaller the size of microplastics, the larger the microplastic toxicity. Polyvinyl chloride (PVC) microplastics of 1 µm size inhibit 39.7% growth ratio of marine microalgae, *Skeletonema costatum*, if they get an exposure of 96 hours. But, normally, 1 mm-sized PVC particles have no effect on the algal growth. These tiny particles of microplastics are transferred from surface water to the deeper ocean through the algal species (Anbumani et al, 2018).

Tiny particles of microplastics have serious effects on the marine zooplankton. Several marine zooplankton species have been identified that are able to ingest 1.7-30.6 µm polystyrene (PS) beads. A copepod species, *Centropages typicus*, typically declined its feeding performance when it is exposed to 7.3 µm sized particles. Microplastics have a negative impact on zooplankton's function and health (Anbumani et al, 2018).

Impact on aquatic invertebrates: Microplastic uptake is not only limited into the primary producers and primary consumers. Various aquatic invertebrates also uptake these particles mistakenly. Bivalves are filter feeder i.e.; they filter the water to procure their food. For this filter-feeding mechanism, the quantity of microplastic uptake is increased which have an effect on their growth and other physiological function. After 3 days of exposure of polystyrene (PS) particles with the size of 3.0 to 9.6 µm in marine mussel, *Mytilus edulis*, this is accumulated in their circulatory system (Anbumani et al, 2018). A 14-day exposure of polystyrene microspheres with the size of 10, 30 and 90 µm significantly increase in energy consumption in *Mytilus edulis*, but it did not disturb the overall energy budget (Duis et al, 2016).

Impact on finfish: Finfish are the species that swim freely in the water current and procure food from the surrounding water environment. Due to the presence of very tiny particles of plastics in the environment, fish consume it as food. In other cases, fishes consume other organisms like plankton or fishes which contain microplastics in their body. Ultimately, the microplastics are concentrated in the gastrointestinal tract of the fish (Ajith et al, 2020). Then, microplastics block the

digestive tract, reduce fecundity and hatchability, change morphologica and behavioural features, etc. The acute effect of polystyrene microspheres (1-5 µm) were studied on the juveniles of common goby, scientifically known as *Pomatoschistus microps*. This fish was kept in two concentrations of microspheres (18.4 and 184 µg/l) for a period of 96 hours. After this period, it was noticed that acetylcholinesterase activity was significantly lowered (approximately 80% of the control level), but it did not affect survival and other biomarkers (Duis et al, 2016).

Environmental Remediation of microplastics:

Bioremediation is a process that is involved in the removal of waste from the environment. Bioremediation, also known as environmental remediation, follows the principle of biodegradation which is defined as the process of breaking down complex organic matter into its simpler form with the help of living organisms. Various bacterial species are found on earth which have the potential to degrade plastic materials or polymers. However, the biodegradation process is dependent on various factors that include the organism's type, polymer's type and its nature, nature of pre-treatment, etc. *Ideonella sakaiensis*(bacteria), *Pseudomonas sp.* (bacteria), *Tenebrio molitor*(mealworm larvae), *Galleria mellonella* (moth), etc. are the plastic degrading organisms. In the degradation process, the molecular weight of the polymer decreases and the polymers convert into dimers or monomers. Generally, the biodegradation process is covered with four steps viz., biodeterioration, bio fragmentation, assimilation, and mineralization.

In natural environments, plastics are degraded by thermo-oxidation, photolysis, thermolysis, photo-oxidation, etc. These processes help to break down the long polymer chain, resulting in the production of free radicals, reduction of molecular weight, and change in chemical properties.

An electrolytic method for the treatment of microplastics in wastewater is also developed that uses high-powered electrodes. These electrodes are able to produce hydroxyl radicles that hit the microplastics which is broken down with the release of carbon dioxide (CO_2) and water (H_2O) (Jeyavani et al, 2021).

Conclusion:

Plastics are a widely used material in every sector all over the world. The production of plastic increased with the Industrial Revolution and modernization. It gained its frame for its unique features including its low weight, high durability, flexibility, low production cost, good strength, etc. But, it creates a problem for the aquatic organisms when it enters into the aquatic water body. In the natural environment, the larger plastic is further degraded into smaller particles called microplastics with the help of various physical, chemical, and biological processes. These microplastics pose threats to the biotic community of aquatic organisms. So, it has to be

ceased. Reducing the use of plastics is an effective way to control the formation of microplastics. But, the existing microplastics can be treated by some plastic-degrading bacteria, fungi, etc. The electrolytic method for microplastic treatment is also developed, but it is an expensive method of microplastic treatment.

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Seaweeds Culture: An Alternative Approach to Prosperity

Bithika Patra, R. Ravichandran, K. Ishwarya, C. Santhosh Kumar, E. Kannapiran
Department of Fisheries Science, School of Marine Science, Alagappa University, Karaikudi, Tamil Nadu, India

Abstract

As the world's population continues to rise and environmental concerns become more serious, finding sustainable and innovative solutions to assure food security and economic success becomes increasingly crucial. Seaweeds, which are a varied collection of macroscopic marine algae, have emerged as a possible option in this setting. This abstract delves into the many facets of seaweed culture and its potential to revolutionise economies by providing a sustainable road to riches. Seaweeds are generally ignored, although they are high in critical nutrients such as protein, minerals, and vitamins, making them a good contender for human consumption and livestock feed. This abstract explores prosperous case studies in which nations and localities have accepted seaweed farming as a sustainable economic endeavour. The benefits of seaweed culture on livelihoods and economic development are apparent, ranging from small coastal villages to huge industrial operations. Seaweed farming not only produces revenue but also increases community resilience by lowering susceptibility to shocks linked to climate change and diversifying sources of income.

Introduction

Seaweeds are amazing aquatic plants that grow in brackish and marine environments as well as shallow coastal areas. Seaweeds hold promise as a novel, sustainable source of food, energy, chemicals, and medicinal products with a wide range of uses. Seaweeds are also known as the "Medical Food of the 21st Century" because of their use in the treatment of cancer, goitre, and the production of pharmaceutical capsules. In India, seaweeds are mostly employed in industry as a source of agar, agarose, and carrageenan, which are used in paint, cardboard, paper, medicines, cosmetics, and processed foods. There are 46 seaweed-based industries: 21 that produce agar and 25 that produce alginate; but, because of a lack of raw materials, these industries are not operating at full capacity. In addition, growing seaweed has no effect on the environment because these creatures can survive without freshwater, arable land, or artificial fertilisers. Using seaweed's rapid growth to reduce pressure on conventional agriculture can provide a resilient solution for areas experiencing difficulties with agriculture brought on by climate change. Beyond its nutritional value, seaweed production has enormous economic possibilities. Bioactive chemicals found in seaweeds have potential uses in biotechnology, cosmetics, and medicines. Seaweed

farming can also aid in the restoration of marine ecosystems by boosting biodiversity and offering habitat to a variety of marine creatures.

Seaweed Resources of India

Some 844 species of seaweeds have been reported from Indian seas. Among them, 221 species are commercially important and abundant along the Tamil Nadu and Gujarat coasts and around Lakshadweep and Andaman & Nicobar Islands. Rich seaweed beds occur around Mumbai, Ratnagiri, Goa, Karwar, Varkala, Vizhinjam and Pulicut in Tamil Nadu & Andhra Pradesh and Chilka in Orissa.

Cultivable species

Red Seaweeds: *Gelidiella acerosa, Gracilaria edulis* and *G. dura* are farmed for manufacturing Agar, while *Kappaphycus alvarezi*i is farmed for manufacturing Carrageenan; Brown Seaweeds: *Sargassum wightii* and *Turbinaria conoides*are farmed for manufacturing Alginates.

Beneficiaries

Coastal fisher families, fisherwomen, their societies/ SHGs, and farmers/ entrepreneurs can participate in Seaweed culture under the Blue Revolution Scheme.

Culture Techniques

Seaweed cultivation would be undertaken in shallow coastal waters of maritime States.

Bamboo Raft Method – The floating bamboo raft method is ideal in locations that are calm and shallow. The floating raft is made of bamboo with dimensions of 12' × 12' for mainframe and 4' x 4' for diagonals. In each raft, around 20 polypropylene-twisted ropes are used for plantation. Around 150 – 200 grams of seaweed fragments are tied at a spacing of 15 cm along the length of the rope. A net is tied at the bottom of the raft to avoid grazing by herbivorous fish species.

Longline or Monoline Method – In locations characterized by moderate wave action, shallow depth and the presence of less herbivorous fishes. A rectangular area of 120 feet × 20 feet is prepared with 24 casuarina poles (10 feet long and 3-4" diameter). The poles are interconnected using a 6mm rope and the seaweed seedling rope is fastened to this. Around 150 grams of seaweed fragments are tied at a spacing of 15 cm along the length of a rope. A fencing is made using HDPE fishing net to avoid drifting and used PET bottles are tied on each rope for floatability.

Tube Net Method – The tube net method can be adopted in locations with higher wave action in coastal states like Andhra Pradesh and Gujarat. The tube nets (10 cm diameter; mesh size of 1.5 cm) of 25 m length are held floating in the water column below the surface with an appropriate number and size of floats and anchor stones. The seed material of 15 kg fresh weight is loaded into the tubes with the aid of a 1.0- or 1.5m long plastic pipe acting as a funnel or a hopper.

Estimated Project Costs & Returns

Item	Amount/Quantity
Set up Cost: Bamboo raft(3x3m) & Inputs per raft	Rs. 1000/-
Set up per cluster of 40 rafts	Rs. 40,000/-
Crops Duration (1 cycle)	45 days
Seaweed Yield/Cluster/45 days	8,000 kg
Estimated Returns/Cluster/Cycle	Rs. 80,000/-
Estimated Costs/Cluster/Cycle	Rs. 40,000/-
Net Returns/Cluster/Cycle	Rs. 40,000/-

Figure 1. Seaweed culture (*Kappaphycus alvarezii*) Thondi, Tamil Nadu

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Aquaponics- A Sustainable Approach in Aquaculture

Monish Jairaam Govindaraj,R. Ravichandran, K. Ishwarya, C. Santhosh Kumar, E. Kannapiran
Department of Fisheries Science, Alagappa University, Karaikudi, Tamil Nadu, India- 630003.

Abstract

The technology known as aquaponics is a subset of the larger field of integrated agri-aquaculture systems, which aims to combine plant and animal culture methods in order to provide benefits and preserve nutrients as well as other biological and financial resources. It first appeared in the USA in the early 1970s, and more recently, it has been popular again, particularly in Europe. Although the term "aquaponics" refers to a broad combination of hydroponic plant cultivation and recirculating fish culture, several technologies also use the title. Aquaponics ability to share nutrients with terrestrial plant cultures may be a better way to identify the combination of fish culture and aquatic plant culture.The ideas of aquaponics include, but are not limited to, the application of biological and ecological techniques to agricultural fish and plant production, the reduction or elimination of environmental effect and the efficient use of water and nutrients. Water sources are essential for providing the nutrients needed for fish and plant growth and system water chemistry is critical for maximizing the growth of both. There are various configuration options for systems, such as decoupled and fully recirculating. Using techniques that offer benefits in terms of technology, biology, chemistry, ecology and economy is a key goal of aquaponics.

Keywords: Aquaponics, Agri-aquaculture, Aquaculture, Agriculture, Fish, Plants, Nutrient.

Introduction

Integrated agri-aquaculture systems (IAAS) is a larger agricultural concept that includes aquaponics as one of its subset technologies.This field focuses on combining plant-based agricultural production with aquaculture techniques of all kinds, primarily fin fish farming. The idea behind integrated agri-aquaculture systems is to leverage the resourcessuch as fertilizers and waterthat are shared by both aquaculture and plant production to create and attain more sustainable primary production methods that are both economically and environmentally feasible. Water is essentially a resource that both aquatic and terrestrial plant production systems share. While fish are normally less water-hungry, their confined culture generates significant waste water streams because of accumulated metabolic wastes. Plants, on the other hand, often consume water through transpiration and release it into the surrounding gaseous environment. Aquaculture can therefore be incorporated into the non-consumptive plant production water supply pathway,

allowing for the production of two crops fish and plants from a water source that is typically used to produce just one crop plants.By using the dissolved and undissolved wastes from the metabolism of fish and other aquatic animals, aquaculture also generates waste nutrients, which is an intriguing bonus of combining it with the irrigation supply pathway for plant development. Because aquaculture contributes to the nutrient requirements of plants, it may also result in waste nutrient streams that are appropriate for and aid in plant production(Lennardand Goddek, 2019).

Components Of Aquaponics

Primary components:fish, plants, and bacteria.

Secondary components: fish tank, grow bed, pumps and plumbing.

Primary Components:

1. Fish

Fish are essential to an aquaponics system because they will provide the plants with natural fertilizer. Therefore, choosing the right fish to raise in your system is essential. You need to know which fish are ideal for your aquaponics system in order for it to succeed(Allen, 2017).

Key things to consider when selecting the fish for aquaponic system:

1. **Purpose:** Starting an aquaponics system is as simple as growing a few fish, such as goldfish or tilapia, for food or recreation. Once you have more experience and expertise, you can grow on a bigger scale.

2. **Temperature:**Different fish have different water temperature requirements. Choosing a fish adaptable to your temperature and weather conditions is essential. Some fish, such as trout, like cold water, while some fish, such as tilapia, prefer warm water (Knausand Palm, 2017).

3. **What crops are to be grown:**Fish should be able to flourish at the same temperature as plants. Verify that the temperature needs of your plants and fish are the same.

4. **Maintenance Difficulty:**You can choose a robust fish that can survive in contaminated water and is resistant to parasites and sickness if you don't want to spend a lot of time maintaining your system. While some fish are delicate and expensive, others are resilient and don't need as much care. The two main employed crops are koi and tilapia (Turnsek et. al, 2020).

2. Plants

An aquaponics system allows you to cultivate a wide variety of plants, and choosing which species to use can be enjoyable. But various plants require different things, and they can flourish in different environments. Selecting the appropriate aquaponics plants is crucial for both the system's performance and the quality of your crop. In aquaponics systems, lettuce, tomatoes, peppers, basil, and cucumbers are the most popular plant varieties. Don't confine your creativity to only these kinds of plants. Almost every type of plant can be grown in an aquaponics system(Allen, 2017).

3. Bacteria

For the fish and plants in an aquaponics system to flourish, helpful microorganisms are necessary. An integral component of the aquaponic cycle is bacteria. The process known as nitrification turns fish excrement into nutrients for the plants. The process of nitrification is the transformation of organic substances first into nitrites and subsequently into nitrates. By changing ammonia into nitrite, the *Nitrosomonas* sp.do this. After that, nitrites are changed into nitrates by the *Nitrobacter* sp.. They can be taken up by the plants when they are transformed into nitrates(Allen, 2017).

The Secondary Components of Aquaponics

1. Fish Tank

Your fish live in the fish tank, so pick the proper one to ensure their health and the smooth operation of your aquaponics system. Recycled barrels, IBC tanks, stock tanks, and bathtubs can all be used as fish tanks. An essential component of system design is the choice of fish tanks. Several important things to think about are: The size of the tanks must be adequate for the chosen species. Since rectangular tanks allow solid waste to gather and decay in corners, they are rarely the best choice. It is advised to use round fish tanks. Tanks should ideally be configured to allow solid waste to exit the tank rapidly or have a central drain in the bottom of the tank.Wastes removed mechanically are at best laborious and, at worst, result in "poop slurry," which is difficult to manage. Select a fish tank that can endure water pressure by being heavy-duty, watertight, sturdy and durable (Allen, 2017).

2. Grow Bed

Depending on your aquaponics arrangement, your plants can be grown in a grow bed, nft pipes, or floating rafts. Your grow bed is the cornerstone of your aquaponics system. Your entire aquaponics system depends on the grow bed you choose because this is where your plants develop. Considerations when selecting a grow bed: In order to support the weight of the plants, grow media, and the force of continuously emptying and refilling water, the grow bed needs to be sturdy and sufficiently thick. Select a non-toxic, food-safe material for your grow bed. Metals should not be used since they corrode easily, can upset your pH balance and cause systemic imbalances(Allen, 2017).

3.Water Pump

To guarantee that water is consistently forced throughout your aquaponics system and supplies nutrients to the fish and plants, you need an appropriate and effective water pump. Building and maintaining your aquaponics system may not be successful if your water pump is not dependable enough to handle the task of distributing the water in the system(Allen, 2017).

4. Plumbing

The pipes or plumbing is a crucial part of an aquaponics system. Fish and plants could not coexist symbiotically without it since water and

nutrients could not circulate. The aquaponics system you intend to build up will determine the pipe diameters required. You must take the size and nature of the system you intend to employ into account when selecting pipes for it. The majority of aquaponics farmers strive for a flow rate that is higher with larger pipes. PVC is the most often utilized material in aquaponic plumbing systems(Allen, 2017).

Conclusion

Aquaponics is a comprehensive strategy to tackling some of the most important global concerns, not just a way to generate food. Adopting aquaponics is a critical step toward a future where ecosystems flourish, local communities prosper, and our plates are adorned with nutrient-dense, organic, and fresh vegetables. This is a future where we will be more ecologically conscious and sustainable. Aquaponics benefits our health, education and social fabric in a profoundly good way, in addition to its obvious ecological and economic benefits. We contribute to a future that is more resilient, sustainable and full of hope for everyone as we investigate and use this amazing agricultural system.

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SOUL OF THE OCEAN

Our ocean, coasts, and estuaries are home to diverse living things. These organisms takemany forms, from the tiniest single-celled plankton to the largest animal on Earth, the bluewhale. Understanding the life cycles, habits, habitats, and inter-relationships of marine lifecontributes to our understanding of the planet as a whole. Human influences and reliance onthese species, as well as changing environmental conditions, will determine the future healthof these marine inhabitants. Toxic spills, oxygen-depleted dead zones, marine debris, increasing ocean temperatures, overfishing, and shoreline development are daily threats tomarine life

Aquatic Food Web

Food webs describe who eats whom in an ecological community. Made of interconnectedfood chains, food webs help us understand how changes to ecosystems — say, removing atop predator or adding nutrients — affect many different species, both directly and indirectly.

Phytoplankton and algae form the bases of aquatic food webs. They are eaten by primaryconsumers like zooplankton, small fish, and crustaceans. Primary consumers are in turneaten by fish, small sharks, corals, and baleen whales. Top ocean predators include largesharks, billfish, dolphins, toothed whales, and large seals. Humans consume aquatic life fromevery section of this food web.

Coral Reef Ecosystem

Coral reefs are some of the most diverse ecosystems in the world. Coral polyps, the animalsprimarily responsible for building reefs, can take many forms: large reef building colonies, graceful flowing fans, and even small, solitary organisms. Thousands of species of coralshave been discovered; some live in warm, shallow, tropical seas and others in the cold, darkdepths of the ocean.

Fisheries and Seafood

Seafood plays an essential role in feeding the world's growing population. Healthy fishpopulations lead to healthy oceans and it's our responsibility to be a part of the solution. Theresilience of our marine ecosystems and coastal communities depend on sustainablefisheries.

Marine mammals

Marine mammals are found in marine ecosystems around the globe. They are a diverse groupof mammals with unique physical adaptations that allow them to thrive in the marineenvironment with extreme temperatures, depths, pressure, and darkness. Marine mammalsare classified into four different taxonomic groups: cetaceans (whales, dolphins, andporpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees and dugongs), andmarine fissipeds (polar bears and sea otters).

Human activities affect marine life and marine habitats through overfishing, pollution, acidification and

the introduction of invasive species. These impact marine ecosystems andfood webs and may result in consequences as yet unrecognised for the biodiversity andcontinuation of marine life formsConservation Measures are taken to protect our marine life's like techniques to acquire, preserve, create, enhance, restore, or manage habitat for endangered or threatened wildlifespecies.

Will Tardigrades be the first interstellar astronauts?

Muthuvijay M U

II Year MSc Marine Biology, Department of Oceanography and Coastal Area Studies,Alagappa University – Thondi – 623409, Tamil Nadu, India.

Tardigrades are the microscopic invertebrate organisms that live all over the world. The aquatic ones are usually a translucent white whereas the terrestrial ones are a coloured.(Garey et al. 1996, 1999; Giribet et al. 1996). They can be seen in many colours. Tardigrades comprises of more than 900 species.(Garey et al. 2008).

Figure 1. Tardigrades – Water bears that are 1.1 mm in size and have four pairs of legs.

Active tardigrades require water in their environments and can be found in three main habitats; marine water, fresh water and terrestrial habitats. Most of the terrestrial tardigrades are bryophyta taxa have a life span ranging 3-4 months (Franceschi et al. 1962-1963), 3-7 months for **Mocrobiotus hufelandi** up to about 3 months for roof- moss dwelling **Echiniscus testudo** , about 2 years of active life (not counting dominant periods). The bryophyte inhabiting taxa are more common in temperature and polar zones than in the topics (Nelson 1991)

All tardigrades are considered aquatic because they need water around their bodies to permit gas exchange as well as to prevent uncontrolled desiccation. They can most easily be found living in a film of water on lichens and mosses, algae as well as in sand dunes, soil, sediments, rooted aquatic vegetation and leaf litter.(Glime, J. M. (2017)).

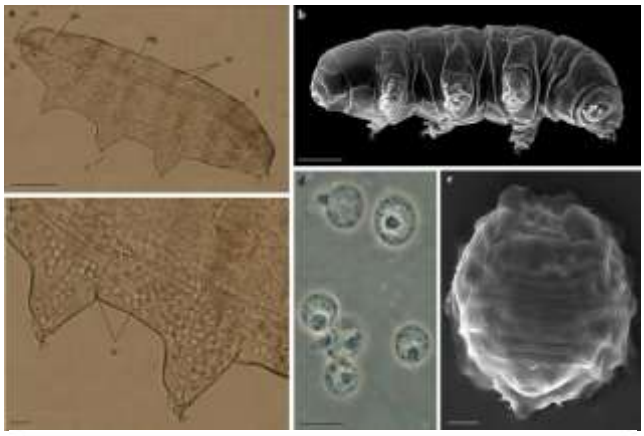
It is thought that tardigrades are so widely distributed because they are carried by the wind. Their eggs, cysts, and tuns are light enough to be

distributed by wind, floating plants or animals for great distances. This theory seems to be supported by the discovery of tardigrades on remote volcanic islands, where they could only have been deposited by wind or birds.(Novey 2009).

Scientist are doing various experiments on it since it can survive all type of conditions such as it can live in the lack of water, extreme cold, extreme hot, lack of oxygen, in extreme pressure and also in vacuum.

Here is why ?

When they are in the active stage (ex. when they crawl around, eat and reproduce) they are no tougher than any other animal. However, when conditions worsen water bears can dry or freeze - this peculiar form of existence is called cryptobiosis (or anabiosis). When cryptobiotic, their metabolism is undetectable. In this anabiotic stage they can be exposed to very high X-ray radiation of 570 000 rads, very high pressure or vacuum, they can withstand temperatures as high as over plus 150°C and as low as minus 272.8°C (almost absolute zero).Tardigrades.,(Kinchin 1994; Nelson 1991.



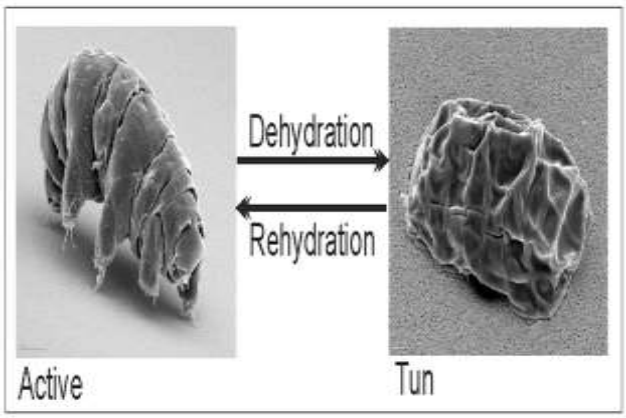


Figure 1.1 Microscopic stage of tardigrades in cytobiosis stage where it can survive without water and other essential factors.

Tardigrades in the space

Tardigrades are extremophiles that can live in extreme conditions. In September 2007 these tardigrades are sent to the open space to check whether it can survive the radiation and microgravity in space. After the experiment it is proven that it can survive the cosmic radiation and space vacuum in active stage.(Bordenstein 2008)

It is believed that it can be an extra-terrestrial organism since its adaptation level and its unusual properties makes it different from other organisms.

Scientist are planning to send these tardigrades to the nearest star alpha centaury which is 4 light years away from us through the light sail method which can reach the star within 20 to 30 years.There is no doubt that tardigrades could travel to the stars amongst the dust on a piece of rock were the earth ever to be destroyed.

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16 Psyche asteroid (richest asteroid)

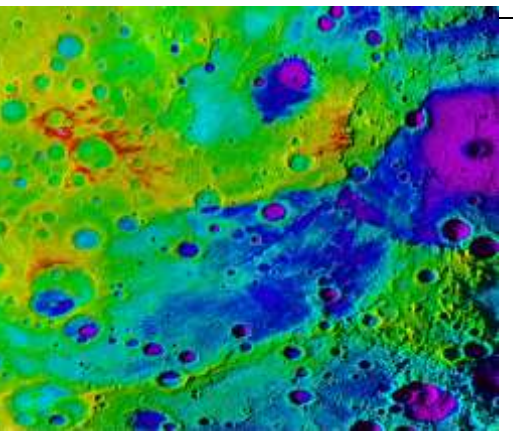
P. Sangeetha

II[nd] M.Sc., Applied Geology,Department of Geology,Alagappa University, Karaikudi-3.

Psyche was discovered in 1852 by Italian astronomer Annibale de Gasparis. Because it was the 16th asteroid to be discovered, it is sometimes referred to as 16 Psyche. It's named for the goddess of the soul in ancient Greek mythology, often depicted as a butterfly-winged female figure. Psyche has an irregular, potato-like shape. If it were sliced in half horizontally at the equator – picture a squished oval – it would measure 173 miles across at its widest point and 144 miles long. Its surface area is 64,000 square miles.The asteroid Psyche consisted mostly of metal. The more recent data indicates that the asteroid is possibly a mix of metal and silicate, the same material found in glass and sand. The best analysis indicates that Psyche is likely made of a mixture of rock and metal, with metal composing 30% to 60% of its volume. The asteroid's composition has been determined by radar observations and by the measurements of the asteroid's thermal inertia.Scientists think Psyche may consist of significant amounts of metal from the core of a planetesimal, one of the building blocks of our solar system. The asteroid is most likely a survivor of multiple violent hit-and-run collisions, common when the solar system was forming. Thus, Psyche may be able to tell us how Earth's core and the cores of

the other rocky, or terrestrial, planets came to be.Psyche orbits the Sun between Mars and Jupiter at a distance ranging from 235 million to 309 million miles from the Sun.That's 2.5 to 3.3 Astronomical Units (AU), with 1 AU being the distance between Earth and the Sun. Psyche takes about five Earth years to complete one orbit of the Sun, but it takes just over four hours to rotate once on its axis.Psyche is a NASA mission to study a metal-rich asteroid with the same name, located in the main asteroid belt between Mars and Jupiter. This is NASA's first mission to study an asteroid that has more metal than rock or ice. Psyche launched Oct. 13, 2023, at 10:19 a.m. EDT from Kennedy Space Center. Psyche lifted off from Launch Pad 39A aboard a SpaceX Falcon Heavy rocket. The spacecraft will be exploring about the 16 psyche asteroid in 2029.

Mercury (Great Valley)



A newly discovered "great valley" in the southern hemisphere of Mercury provides more evidence that the small planet closest to the sun is shrinking.One of these occasions was during MESSENGER's second flyby of Mercury. In the approach images of the hemisphere unseen by an earlier mission, Mariner 10, when the spacecraft was still too far from Mercury to clearly resolve details of the surface, we could just make out the hint of a large impact basin. It turned out to be one of the youngest and largest impact basins on Mercury, now named the Rembrandt basin. The Rembrandt basin is not only remarkable for its size and youth; it's deformed by a major fault that cut across its rim and offset the basin floor. This giant fault scarp, a cliff-like landform now named Enterprise Rupes, turned out to be the largest fault scarp on Mercury.Scientists used stereo images from NASA's MESSENGER spacecraft to create a high-resolution topo map that revealed the broad valley — more than 620 miles (1,000 kilometers) long — extending into the Rembrandt basin, one of the largest and youngest impact basins on Mercury. About 250 miles (400 kilometers) wide and 2 miles (3 kilometers) deep, Mercury's great valley is smaller than Mars' Valles Marineris, but larger than North America's Grand Canyon and wider and deeper than the Great Rift Valley in East Africa.

STARFISH

Anbumani M
II[nd] M.Sc Applied Geology,Department of Geology,Alagappa University,Karaikudi-3.

Starfish are marine invertebrates. They typically have a central disc and usually five arms, though some species have a larger number of arms. The aboral or upper surface may be smooth, granular or spiny, and is covered with overlapping plates. Many species are brightly coloured in various shades of red or orange, while others are blue, grey or brown. Starfish have tube feet operated by a hydraulic system and a mouth at the centre of the oral or lower surface. They are opportunistic feeders and are mostly predators on benthic invertebrates. Several species have specialized feeding behaviors including eversion of their stomachs and suspension feeding. They have complex life cycles and can reproduce both sexually and asexually. Most can regenerate damaged parts or lost arms and they can shed arms as a means of defense. The Asteroidea occupy several significant ecological roles. Starfish, such as the ochre sea star (Pisaster ochraceus) and the reef sea star (Stichaster australis), have become widely known as examples of the keystone species concept in ecology. The tropical crown-of-thorns starfish (Acanthaster planci) is a voracious predator of coral throughout the Indo-

Pacific region, and the Northern Pacific seastar is on the list of the World's 100 Worst Invasive Alien Species. The fossil record for starfish is ancient, dating back to the Ordovician around 450 million years ago, but it is rather sparse, as starfish tend to disintegrate after death. Only the ossicles and spines of the animal are likely to be preserved, making remains hard to locate. With their appealing symmetrical shape, starfish have played a part in literature, legend, design and popular culture. They are sometimes collected as curios, used in design or as logos, and in some cultures, despite possible toxicity, they are eaten.

CLOWNFISH

Karthika Devi
B,IInd M.Sc., Applied Geology, Department of Geology,AlagappaUniversity,Karaikudi-3.

The clownfish can be many different colors, depending on its species, including yellow, orange, red, and black. Most have white details. They are smaller fish, with the smallest around 7 to 8cm long and the longest 17cm long. Clownfish are found in warm waters, such as the Red Sea and Pacific Oceans, in sheltered reefs or lagoons, living in anemone. Clownfish eat various small invertebrates and algae, as well as food scraps the anemone leaves behind. Clownfish survive in a mutually assistive symbiotic relationship with anemone. The anemone protects the clownfish from predators and provides food scraps. In return, the clownfish uses its bright colors to lure fish into the anemone, where they are killed by the anemone's poison and eaten. The

clownfish also fertilizes the anemone with its faces. Though clownfish are not highly threatened, their populations have decreased in some areas. This is because they make up 43% of the global marine ornamental trade, with 75% of these fish captured from the wild. This means, in exploited areas, there is reduced population density. It is important to maintain good practice and protect this unique fish.

DEEP SEA HYDROTHERMAL VENTS

M.M. DIVYA

II[nd] M.Sc., Applied Geology,Department of Geology,Alagappa University, Karaikudi - 3

In 1977, scientists exploring the Galápagos Rift along the mid-ocean ridge in the eastern Pacific noticed a series of temperature spikes in their data. They wondered how deep-ocean temperatures could change so drastically-from near freezing to 400 °C (750 °F)—in such a short distance. The scientists had made a fascinating discovery deep-sea hydrothermal vent. They also realized that an entirely unique ecosystem, including hundreds of new species, existed around the vents. Despite the extreme temperatures and pressures, toxic minerals, and lack of sunlight that characterized the deep-sea vent ecosystem, the species living there were thriving. Scientists later realized that bacteria were converting the toxic vent minerals into usable forms of energy through a process called chemosynthesis, providing food for other vent organisms.Hydrothermal vents are like geysers, or hot springs, on the ocean floor. Along mid-ocean ridges where tectonic plates spread apart, magma rises and cools to form new crust and volcanic mountain chains. Seawater circulates deep in the ocean's crust and becomes superheated by hot magma. As pressure builds and the seawater warms, it begins to dissolve minerals and rise toward the surface of the crust. The hot, mineral-rich waters then exit the oceanic crust and mix with the cool seawater above. As the vent minerals cool and solidify

into mineral deposits, they form different types of hydrothermal vent structures.

Hydrothermal vent structures are characterized by different physical and chemical factors, including the minerals, temperatures, and flow levels of their plumes. Black smokers emit the hottest, darkest plumes, which are high in sulfur content and form chimneys up to 18 stories tall, or 55 meters (180 feet). The plumes of white smokers are lightly colored and rich in barium, calcium, and silicon. Compared to black smokers, white smokers usually emit cooler plumes and form smaller chimneys. Vents with even cooler, weaker flows are often called seeps. They appear to shimmer because of differences in water temperatures or bubble because of the presence of gases, like carbon dioxide.The study of hydrothermal vent ecosystems continues to redefine our understanding of the requirements for life. The ability of vent organisms to survive and thrive in such extreme pressures and

temperatures and in the presence of toxic mineral plumes is fascinating. The conversion of mineral-rich hydrothermal fluid into energy is a key aspect of these unique ecosystems. Through the process of chemosynthesis, bacteria provide energy and nutrients to vent species without the need for sunlight.

ENDOLITHS

K.Mathavan,
II[nd] M.Sc., Applied Geology, Department of Geology, Alagappa university, Karaikudi -3.

Endoliths are fascinating microorganisms that have adapted to live inside rocks. These extremophiles are capable of surviving in environments that would be inhospitable to many other forms of life. Endoliths are found in a variety of geological settings, including rocks on the Earth's surface, as well as deep within the Earth's crust and even beneath the ocean floor. As you mentioned, some endoliths are known to engage in a process called biomineralization, where they dissolve the minerals in rocks as a way of obtaining nutrients. This ability to "eat" rocks sets them apart from many other organisms that rely on more conventional sources of organic matter for sustenance.

The discovery of endoliths living over a mile beneath the ocean floor highlights the resilience of life and its ability to adapt to extreme conditions. These microorganisms play

a role in the cycling of minerals and may have implications for our understanding of life's potential existence in extreme environments beyond Earth. Studying endoliths provides valuable insights into the limits of life on our planet and informs the search for life in other, potentially harsh, environments, such as Mars or icy moons like Europa and Enceladus. The fact that these organisms are among the oldest known life forms on Earth also adds to their significance in the study of the origins and evolution of life.

VERY RARE FOSSILIZED BEE IN "JELLY" OPAL

M. Varshini,
II[nd] M.Sc., Applied geology, Department of Geology, Alagappa University, Karaikudi -3.

The fossilized bee in "Jelly" Opal is a rare and unique find. It was discovered in the Genteng Formation of Java, Indonesia, and is believed to be between 4 and 7 million years old. Believed to be an extremely rare example of a fossilized insect in Opal - not Amber - an ancient bee in white "Jelly" Opal offered here may be only the SECOND such find consubstantial with the fossil insect in Opal now on display at the Perot Museum of Nature and Science in Dallas, Texas. While research is limited at this point, and the Gemological Institute of America (GIA) may soon be writing an article on the fossil, there is some pertinent information relevant to the discovery. This could be a case of something that started as Amber converting to Opal over time or a unique process whereby volcanic fluid fills faults, then cools down leaving water behind that ultimately results in silica deposits, thereby beginning the process of "Opalization" in such a rare instance. Javanese Opal, also known as Kalimaya, has been mined since the 1970s in a number of regions including

the Cilayang Pits known for producing the white "Jelly" Opal. Dating to Lower Pliocene and Upper Miocene in age, fossils found in any such deposits should date to some 4 to 7 million years ago. The fossilized bee is clearly visible preserved in the white Opal free-form specimen of smooth 'organic' shape with hints of colorful Opal confirming its rare and unique natural origin. The discovery of the fossilized bee is significant because it provides new insights into the evolution of bees. The bee's features are similar to those of modern bees, but there are also some key differences. For example, the fossilized bee has a longer abdomen than modern bees, which suggests that it may have had a different diet.

Assessment of Metal Contaminants in Coastal Aquifer of Thiruvadanai Block, South-East Coast of India

Sivakumar Karthikeyan*, Prabakaran Kulandaisamy, Muruganantham Arumugam, Bangarupriyanga Sundaram, Saravana Kumar Maluventhi, Muthuramalingam Rajendran and Sathish Sugumaran
Department of Geology, Alagappa University, Karaikudi - 630003.

Abstract

There is growing concern over the potential accumulation of trace element concentrations in the groundwater of coastal aquifers owing to industrialization and seawater enrichment in the last several decades. The study was conducted in the Thiruvadanai coastal block of Ramanathapuram district with the objective of finding out the concentration of trace elements in the regional groundwater. A total of 20 groundwater samples were collected for 5 trace elements (Cu, Cr, Co, Fe, and Ni) analysis using atomic absorption spectroscopy. The pH value is crucial for groundwater identification and geochemical equilibrium calculations. Total Dissolved Solids (TDS) values in the study area range from 1003 mg/l to 1719 mg/l, with high concentrations due to salt leaching and domestic sewage percolation. The study reveals that some groundwater samples had marginally high concentrations of Cu, Fe, and Cr, whereas concentrations of Co and Ni are present in water samples. The adverse effect of large-scale industrialization in these areas can now be distinctly observed in the form of deterioration of groundwater quality. Based on this study, proper monitoring of the groundwater system and detailed hydrological studies will be helpful for coastal aquifer management.

Keywords: Trace Metals, Groundwater, Coastal Aquifer, Thiurvadanai Block, Southeast Coast, India

Introduction

Trace element studies are very useful in varied branches of scientific disciplines. The concentration of trace elements in water helps in the circulation and distribution of minerals in rocks and waters. Trace elements are added to groundwater from a variety of natural and anthropogenic sources. Trace elements are required in trace quantities for the proper functioning of the human system, but high quantities cause serious health effects due to their persistence, toxicity, and accumulation in nature. The anthropogenic sources include infiltration from landuse, contaminated soils, leaching through industrial effluents, tailing ponds, urban sewage dumping and contaminated surface water-groundwater interaction (Gnanachandrasamy et al., 2014; Muthusamy et al., 2021). Such interactions often result in groundwater contamination, and the ingestion of contaminated water with trace elements may cause adverse health effects in

human beings. Various anthropogenic activities, under the shadow of urbanisation and industrial development, result in effluent disposal and introduce the groundwater system to a high concentration of trace metals and trace elements that occur in groundwater and are derived from the weathering of rocks (Karthikeyan et al., 2022; Alam et al., 2023).

The concentrations of metal in groundwater vary widely, both regionally and locally. Trace elements are known by different names, such as potentially toxic elements, trace metals, heavy metals, micronutrients, and minor elements. The trace element concentration in groundwater depends on natural factors such as aquifer type, quality of infiltrating water, weathering of the minerals in the aquifers, and resistance time. Groundwater contamination and its management have become the need of the hour because of their far-reaching impact on human health. Contamination of groundwater mainly occurs through industrial effluent discharge and geochemical activities. Some of the trace elements, like Fe, Mn, Ni, Cu, Zn, and As, are essential for the human body to activate vital functions and biological processes. But the trace elements beyond the permissible limit cause several health hazards (USEPA, 2018). The objectives of the present study are trace metal analysis in groundwater, the distribution of trace metals in groundwater, and the evaluation of trace metal contamination in groundwater.

Study area

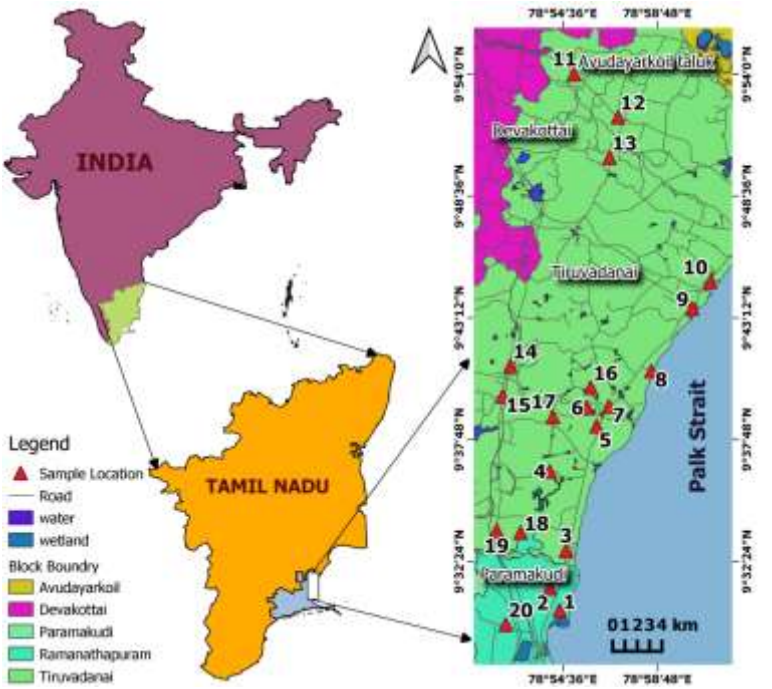


Figure 1.Map shows the location of sampling sites in the study area

The study area is the northern coastal region of Ramanathapuram district that lies between 09˚49' and 09˚90' north latitude and 78˚86' and 79˚01' longitude and has a long coastline of around 260 km (Fig. 1). The coastal areas are flanked by beach ridge complexes, sand dunes, swamps, and backwater. The district is underlain by both porous and fissured formations. The porous formation can be grouped into three aquifer groups, viz., cretaceous sediments, tertiary sediments, and quaternary sediments. The cretaceous aquifer is semi-confined in nature and consists of two zones. The top unit comprises fossiliferous sandstone, which is red in colour and compact in nature.

Methodology

Totally, twenty groundwater samples were collected from dug and bore wells during January 2020. Water samples were collected in 100-ml clean polyethylene bottles, and they were properly labelled to indicate the source of collection and other records. During the time of sample collection, TDS (ppm) and temperature were measured using a portable meter. The trace elements were analysed using atomic absorption spectroscopy (AAS). PH, TDS, TH, and temperature are measured through analyses of samples from the various places in the study area. The suitability of groundwater for domestic purposes was evaluated by comparing the values of different water quality parameters with those of the World Health Organisation (Karthikeyan et al., 2021).

Results and Discussion

Twenty groundwater samples were collected from representative sampling stations established over the entire study area and analysed for their trace element content and physiochemical parameters. The quality standards for drinking water have been recommended by the World Health Organization (WHO, 2008). The behaviour of trace elements (Cu, Cr, Co, Fe, and Ni) and important physic-chemical parameters such as PH, total dissolved solids (TDS), and total hardness (TH) and the suitability of the ground water in the study area are discussed below. The analytical results have been evaluated to ascertain the suitability of groundwater in the study area for drinking. PH is a measure of the balance between the concentration of hydrogen ions and hydroxyl ions in water. The PH of water provides vital information in many types of geochemical equilibrium or solubility calculations. The limit of the PH value for drinking water is specified as 6.5–8.5. The minimum pH value is 7.37, and the highest value of the pH value is 7.45.

According to WHO specifications, TDS up to 500 mg/l is the highest desirable limit, and up to 1,500 mg/l is the maximum permissible limit. In the study area, TDS values range from a minimum of 1003 mg/l to a maximum of 1719 mg/l, indicating that most groundwater samples fall within the maximum permissible limit.

The high TDS concentration in the groundwater could be due to leaching of salts from geological formations and/or the percolation of domestic sewage, which can increase TDS values. Total hardness varies from 276 to 479 mg/l. Groundwater in the entire study area falls within the maximum permissible limit set by ISI. The analysis indicates that the water in the study area is hard to very hard. The hardness is attributed to the presence of alkaline earth minerals, such as calcium and magnesium. The drinking water quality is evaluated by comparing it with the specifications for total hardness (TH) and TDS set by the World Health Organization and Indian standards.

The copper concentration in the groundwater of the study area ranges from 11 ppb to 210 ppb, with an average value of 42.9 ppb. Rocks are the primary source of these metals. Their concentration in groundwater is typically well below the potentially harmful levels. Anthropogenic sources have a minor impact on groundwater. Chromium is usually present in the less toxic trivalent form (Cr^{3+}) in effluents. However, when discharged into the soil, varying environmental conditions can oxidize Cr^{3+} to the toxic hexavalent form (Cr^{6+}), which rarely remains stable. The chromium concentration in the study area's groundwater ranges from 245 ppb to 2079 ppb. Cobalt concentrations are very low in the groundwater samples throughout the study area, ranging from 5.08 ppb to 9.15 ppb. Iron is an essential element, required in small amounts by all living organisms. It's a naturally occurring metallic element present in many types of rocks. The most common sources of iron in groundwater are natural, such as the weathering of iron-bearing minerals. Iron levels in the study area's groundwater range from 2 to 9 ppb. Nickel concentrations in the study area range from 3.00 ppb to 6.67 ppb, as analyzed in samples from the area. Nickel concentrations in groundwater depend on factors like soil, pH, and sampling depth. Nickel is a common trace element in various vitamins. The primary source of nickel in drinking water is leaching from metals in contact with the water, such as pipes and fittings. However, nickel may also be present in some groundwater due to dissolution from nickel ore-bearing rocks.

Conclusion

The high concentration of metal ions in groundwater was probably due to the unsafe discharge of effluent from sugar mills, pulp and paper, cooperative distilleries, municipal wastewater, fertilisers, and other industries. The variability observed within the groundwater samples is closely connected to the sea spray input; hence, it is primarily a consequence of geographical and meteorological factors, such as distance from the ocean and time of year. The trace element levels, in particular those of heavy metals, are very low, suggesting an origin from natural sources rather than from anthropogenic contamination. Groundwater is more enriched in Cu

than natural waters, possibly due to aquifer materials like feldspar, biotite, and muscovite minerals. Trace elements in groundwater are more likely to be a problem than in surface water, unless mining impacts the area. Metals in water used for drinking and sediment can pose a risk to human and aquatic health. Treatment can lower metal levels, and groundwater samples should be tested regularly. Groundwater systems are dynamic and adapt to climate, withdrawal, and land use changes. Hydrological and spatial modelling can help evaluate groundwater resources and determine the location of rainwater harvesting structures in semi-arid regions.

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Environment of Sedimentary Deposits in the Gundar River Estuary, Mookaiyur, Gulf of Mannar Coast, Ramanathapuram District, Tamilnadu, India

Bangarupriyanga Sundaram *, Prabakaran Kulandaisamy, Sivakumar Karthikeyan , Muruganantham Arumugam, Saravana Kumar Maluventhi, Muthuramalingam Rajendran and Sathish Sugumaran
Department of Geology, Alagappa University, Karaikudi - 630003.

Abstract

The current study measured the grain size and its depositional environment for sediments taken from the Mookaiyur area's Gundar River Estuary. The analysis makes it possible to draw conclusions about how the depositional environment changed at the sites during the infilling phase. Between medium sand and medium silt, the sediments' mean size vary, as do their fairly well-sorted to extremely poorly-sorted characteristics, near-symmetrical to extremely finely skewed types, and platykurtic to very leptokutic natures. the area distinguished by certain physical, chemical, and biological characteristics of sedimentary depositional settings. The gundar estuary mouth and beach settings' sediment deposition processes have been identified using the CM pattern. The distribution of sediments, their type, and the presence of sand, silt, and clay in the sediments of the various ecosystems of the Gundar River Estuary and Beach served as representations for the ternary diagram. All of the samples that made up the CM pattern were deposited in a rolling motion and were transported along tributary channels. Aeolian processes are represented by the linear discriminate function of Y1 values (100%) and shallow agitated water is represented by Y2 values (100%) of the samples. Eighty percent of the samples came from a fluvial (deltaic) origin, with the remaining twenty percent falling into shallow marine conditions. Y4 values of 30% from the fluvial deposit and 60% from the turbidity-containing sediment.

Keywords: Depositionalenvironment, Grainsize, riverestuary,Mookaiyur

Introduction

In hydrological, geomorphological, and sedimentological investigations, grain size features play a crucial role (Goudie, 1981). The continents of the planet have been shaped in significant part by rivers. Depending on the geology and climate of the area in which a river flows, the physical and chemical characteristics of the water and sediments change significantly during transportation. The prior researchers primarily used (Folk and Ward 1957) as the methodologies and criteria for differentiating the depositional environments from the grain size distribution. It can be assumed that every environment of

deposition has a characteristic range of energy conditions as functions of location and time, according to Sahu (1964) and Karikilan et al. (2020 a). To further aid in the interpretation of the depositional setting, Sahu's (1964) bivariate plots of the discriminate functions, which were based on grain size parameters, and his suggested scheme for depositional environment classification were also used. It is possible to reconstruct paleoenvironments by utilising the correlation between mineral chemistry and grain size studies of sediments. The ability to distinguish between distinct depositional settings of both recent and ancient sediments can be facilitated by an understanding of sediment size and textural factors (Passega, 1957; Rajamanikam and Gujar, 1985; Li and Heap, 2014). Sedimentologists have classified sedimentary settings and studied transport dynamics by analysing grain size distribution (Friedman 1961; Pruthivraj et al. 2013). The precipitation of sediment upon their return to the natural environment is interpreted by the frequency distributions of grain size analysis of sediment.

Study Area

The Gundar river estuary in Mookaiyur, on the Gulf of Mannar coast, is located in the southern region of Tamil Nadu. The research area's coordinates are 09°08'00''N to 9°10'1''N and longitude 78°28'01''E to 77°30'01''E. The Gundar River rises on the eastern flanks of the Andipatti and Sathuragiri mountain ranges and empties into the Bay of Bengal through the Aruppukkottai junction.Due to excessive use, the estuary is connected to the sea during the rainy season but remains landlocked the rest of the year. Examine the area map (Fig. 1.) Physiographic features such as estuaries, beach ridges, coastal sand dunes, paleo-barriers, paleo-tidal flats, mudflats, and abandoned river channels are examples of both depositional and erosional landforms. There was a dendritic pattern in this area. This gundar river's tributaries are all seasonal and have significant flows during the monsoon season. The Gundar River, the principal branch of the Vaigai River, rises in the Sathuragiri and Andipatti hill ranges, comes into the district close to Anankulam, then continues southeast until it reaches the Mookaiyur region and the Bay of Bengal.

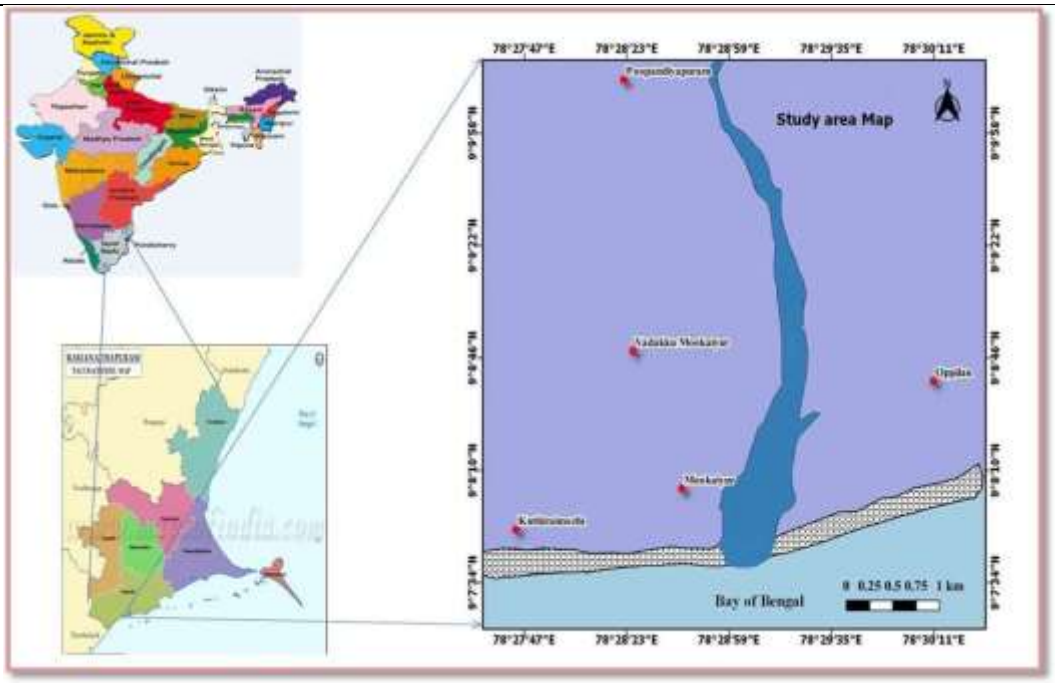


Figure1.Locationmapofthestudyarea

Materials and Methods

Using the 1:50,000 scale survey of India's toposheet No. (58K/12), a base map was created. Various geomorphic characteristics, such as beach ridges, dunes, mudflats, swales, etc., are based on tone, texture, size, shape, drainage pattern, and associations. the total number of 20 sites at 20 samples, the beach area and river estuary sediment sample. To extract the moisture, the sediment samples that were brought in from the field were heated to a steady 60°C in a hot air oven. The 100 gram sample was subjected to additional coning and quartering procedures, and the remaining samples were stored for future use as references. To get rid of the organic waste mixed up in the sediments, 30% by volume of H_2O_2 was added to the sample. After that, it was dried and cleaned with distilled water. It was weighed once it had dried, and the organic material loss was discovered. The calcareous minerals found in the sediments were subsequently extracted from the same sample using HCl treatment. Until there was no more effervescence, this procedure was repeated. Following appropriate cleaning and drying, the sample was weighed, and the weight loss was determined to be the carbonate weight. At this point, if it was discovered that the sands had a ferruginous covering, con. HNO_3 was added to the samples until the sands were completely covered. After washing, if the coating persisted, Con. HNO_3 and a small amount of $SnCl_2$ were added and heated just a little. A sieve shaker is used to analyse the ten beach samples. In order to ensure ¼ intervals, ASTM sieves

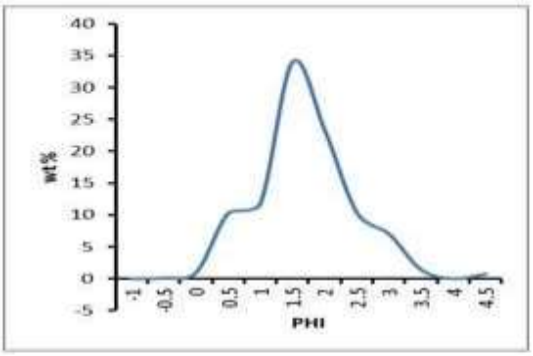
with mesh sizes ranging from +7 to +270 were used for the sieving process. Every sample was sieved for roughly 20 minutes, with the shaker being connected to a timer to ensure consistent timing. Each sieved material was weighed independently.

Results

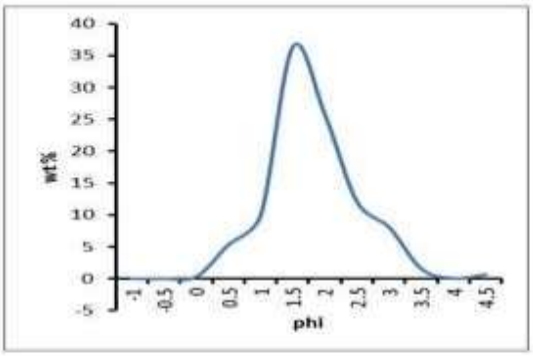
Grain size analysis

Clastic sediments are characterised by grain size analysis. It is thought to be a key instrument for evaluating the hydrodynamic state of sedimentary processes like sediment transport and depositional processes. The majority of the work done in the past few decades on sedimentalogical research has been an attempt to understand the depositional environment and grain size distribution (Folk and Ward, 1957; Passega et al., 1964; Friedman et al., 1961: Visher et al., 1969). The study conducted by Rajamanickam and Gujar et al. (1985) in India employed grain size analysis to get insight into the sediment transit process and deposition environment. The majority of sedimentalogical research focuses on frequency curves and statistical characteristics, such as mean, sorting, skewness, and kurtosis.

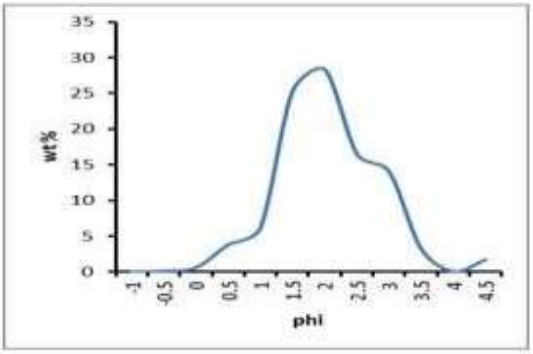
FrequencyCurve(FC)



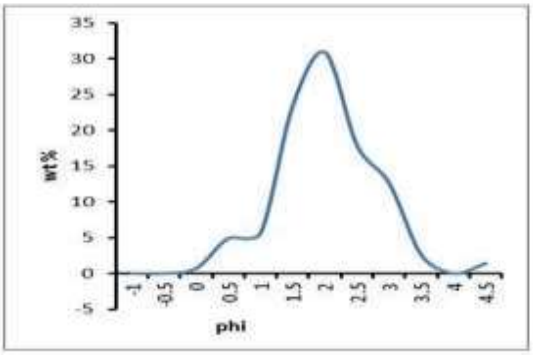
B-1



B-2



B-3



B-4

Figure2. B-1,B-2,B-3andB-4BeachFrequencyCurve

The weight proportion of various sediment fractions is shown graphically by frequency curves (FC) distribution. The nature of sediments is described by FC. One can use an arithmetic ordinate scale to draw the curve. The phi values needed to calculate the statistical parameters were found using the probability chart. The typical samples' frequencies were ascertained by calculating their corresponding weight percentages. The FC from various gundar River estuary locations is displayed in (Table-1) near the estuary mouth; 80% of the sample is bimodal and the remaining 20% is polymodal. Fine sand and silt make up the majority of the flood bank deposits.

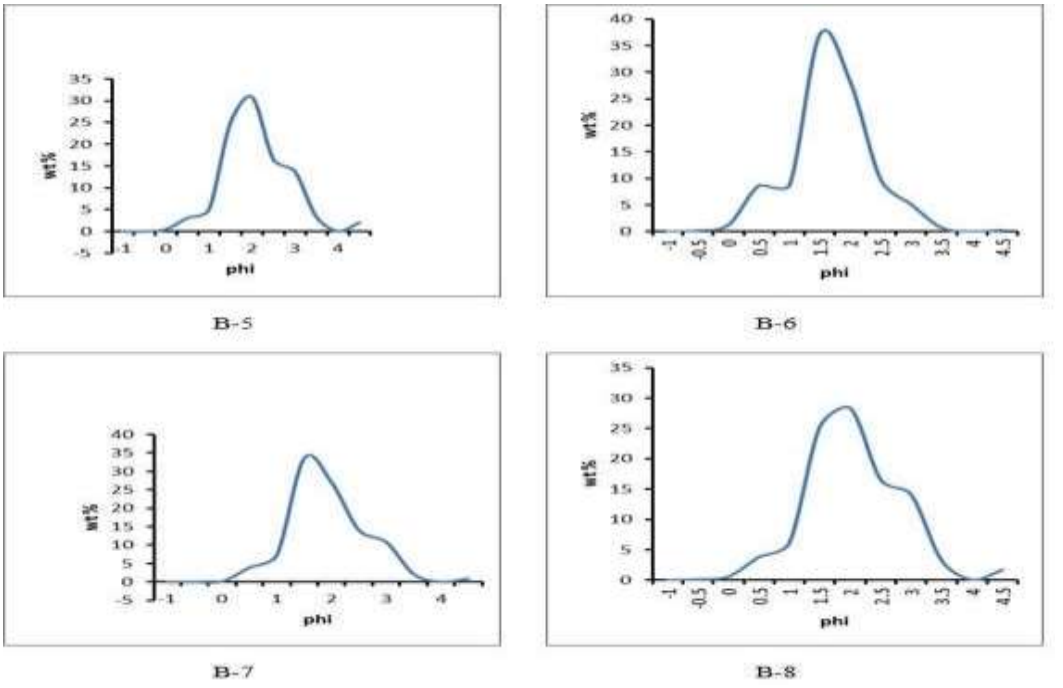


Figure3.B-5,B-6,B-7andB-8BeachFrequencyCurve

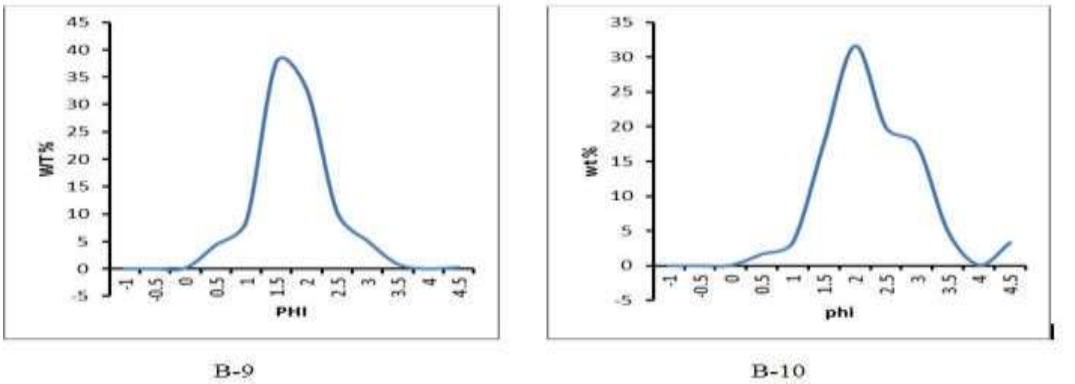


Figure4.B-9andB-10BeachFrequencyCurve

Table-1.Riverestuaryfrequencycurvevalues

SampleNo	SampleType
E1	Bimodal,PoorlySorted
E2	Bimodal,PoorlySorted
E3	polymodal,PoorlySorted
E4	Bimodal,PoorlySorted
E5	Bimodal,PoorlySorted
E6	Bimodal,PoorlySorted
E7	Bimodal,PoorlySorted
E8	polymodal,PoorlySorted
E9	Bimodal,PoorlySorted
E10	Bimodal,PoorlySorted

The Beach sample represented unimodal. (Fig. 2- 4).Due to reflect the deposition ofsedimentsbyprimarilybywavesandcurrents.

Textural parameters Statistics

The distribution of grain sizes is described by four-grain size parameters. like skewness, kurtosis, and mean standard deviation. Furthermore, in order to comprehend the changes in grain size with respect to the energy circumstances and deposition environment, the median and mode are employed. (1957, Folk and Ward) Table 2.

Plot	Mean	Standard Deviation	Skewness	Kurtosis	Remarks			
E1	7.061	1.385	-0.04	0.842	Finesilt	PoorlySorted	Symmetrical	Platykurtic
E2	6.493	1.463	0.126	0.82	MediumSilt	PoorlySorted	FineSkewed	Platykurtic
E3	2.046	1.063	0.263	0.789	Finesand	PoorlySorted	Symmetrical	platykurtic
E4	6.595	1.498	-0.013	0.971	MediumSilt	PoorlySorted	Symmetrical	Mesokurtic
E5	6.37	1.624	0.052	0.811	MediumSilt	PoorlySorted	Symmetrical	Platykurtic
E6	6.245	1.688	0.243	0.793	MediumSilt	PoorlySorted	FineSkewed	Platykurtic
E7	7.725	1.121	-0.152	1.037	FineSilt	PoorlySorted	CoarseSkewed	Mesokurtic
E8	2.138	1.295	0.206	0.554	Finesand	PoorlySorted	FineSkewed	Veryplatykurtic
E9	6.739	1.412	0.027	0.927	MediumSilt	ModeratelySorted	Symmetrical	Mesokurtic
E10	6.47	1.673	0.014	0.776	MediumSilt	PoorlySorted	Symmetrical	Platykurtic
Texturalparametersofbeachsamples								
B1	1.401	0.747	0.047	1.235	MediumSand	ModeratelySorted	Symmetrical	Leptokurtic
B2	1.565	0.662	0.185	1.187	MediumSand	ModeratelyWellSorted	FineSkewed	Leptokurtic
B3	1.787	0.726	0.063	0.994	MediumSand	ModeratelySorted	Symmetrical	Mesokurtic
B4	1.762	0.716	0.002	1.081	MediumSand	ModeratelySorted	Symmetrical	Mesokurtic
B5	1.808	0.697	0.078	1.001	MediumSand	ModeratelyWellSorted	Symmetrical	Mesokurtic
B6	1.413	0.648	-0.013	1.287	MediumSand	ModeratelyWellSorted	Symmetrical	Leptokurtic
B7	1.675	0.679	0.165	1.075	MediumSand	ModeratelyWellSorted	FineSkewed	Mesokurtic
B8	2.118	0.647	0.001	0.887	FineSand	ModeratelyWellSorted	Symmetrical	Platykurtic
B9	1.511	0.554	0.078	1.185	MediumSand	ModeratelyWellSorted	Symmetrical	Leptokurtic
B10	1.958	0.661	0.101	0.922	MediumSand	ModeratelyWellSorted	FineSkewed	Mesokurtic

MeanGrainSize(Mz)

It represents the average size of the total distribution of sediments. The nature of thesedimentsanddepositionalbasincan beexplainedbymean.Grainsizedistribu tionitisinfluencedbyparametersofvelo cityoftransportationagent,shapeandspe cificgravity,composition, durability, resisting nature of the sediments and the amount of tossing duringtransportation. Moreovergrain size of the sediments, are shows to measure the amount ofabrasion, attrition and accretion. The river estuary sediments of a mean value ranged from 7.725to5.848withofaverage6.7.Textur alcharacteristicsofmediumsilt60%,20 %finesandand20%coarsesilt,deposited inriverbanks.Whilebeachsedimentsex hibitedameanvaluerangefrom

2.11 to 1.4 with average of 1.7, represented by medium sand 90% and 10% of fine sand. Thevariations in Phi mean size revealed the different energy conditions, resulting in their deposition.Thisisindicatedthatpanning actionandhighvelocityofwaveswithhig henergyenvironment.

StandardDeviation,SkewnessandKu rtosis

Standard deviation is a measure of sorting or spread of the grain size distribution. Thesorting of grains depends on their size, shape, specific gravity, the velocity of transporting agent,mode and duration of transportation and mode of deposition. River estuary sediments exhibitedfrom 1.968 to 1.121 and average of 1.544. Most of samples shows the poorly sorted 90%, andmoderatelysorted10%duetotheim maturetosub-maturedsedimentsofthefluvialenviron ment.In case of beach all sediments ranged from 0.747 to 0.554 with average of 0.650, sorting 70% ofmoderatelywellsortedand30%inmod eratelysorted.Skewnessis ameasureofthesymmetryofgrainsizedi stributionitisanessentialparameterused toknowntheoriginofvariousenvironme nt(Folk and Ward 1957; Sahu, 1964. River estuary sediments ranged from between 0.243 and -0.4withaverageof0.07.Mostofthesedi mentsexhibitedasymmetricalskewness 60%,fineskewed30%, and coarse skewed 10%. Due to the excessive riverine input. Beach sediments skewnessvalue ranged from 0.185 to -0.013 and average of 0.173, represented by a 70% of symmetricalskewed and 30 % of fine skewed. It measures the ratio of sorting between the tail and the centralportion. The graphic kurtosis measures the part of sediments are sorted the in the high energyenvironmentandlattertransporte dandmodifiedbyanothertypeofenviron ment(FolkandWard 1957). River Estuary sediments of kurtosis value ranged from 1.112 to 0.776 with average of0.944. It is represented by 50%, leptokurtic 30%, platykurtic 20% the nature and contribution bygood sorting in the high energy environment. Beach sediments value ranged from 1.287 to 0.887andaverageof1.087,by60%ofme

sokurticandleptokurtic40%natureofsedimentsarchivedbygood sorting in the high energy environment refers moreover, the continuous addition of finer orcoarser materials after the winnowing action and retention of their original characters duringdeposition.

Discussion

DepositionalFeatures

Theintegratedstudycomprising ofgrainsizeanalysisandmineralogyofGundarestuarine and around beach region have been studied in detail. The cumulative frequency curvessuggested that bimodal modal nature of estuary mouth sediments of Mean value consist of silt.Becausefluvialbasindepositssediments silttoclay.Sortingvalueshowspoorlysorted withHighcontent of silt and clay, due to immature to sub-matured sediments of fluvial environmentalcondition.Skewnessrevealedthatsymmetricalskewness,withthemoreinputofriverinedeposits. Near symmetrical sediments indicates that the mixing of bimodal sources. And kurtosisfallinmesokurtictoleptokurtichatusebyreflectionoftheflowcharacteristicsofthedepositionalmedium. Based on the Scatter plots Mean vs. Standard Deviation revealed that the grain sizeincreased, because of sorting. Decreased In the plot mean vs. skewness, exhibited by mean sizeincreases with negatively skewed. The relationship between mean vs. kurtosis, indicate kurtosisvalue decreased due to the different size standard deviation vs. skewness, plots showed thesedimentspopulationincreasedinskewness,standarddeviation.Incaseofstandarddeviationvs.kurtosis, revealed that kurtosis value increased by different sorting of sediments. The plotsbetweenskewnessandkurtosisshowedthatthekurtosisvaluedecreased.

GundarEstuary

The Gundar river estuary belongs to the coastal plain estuary type. As per the abovedefinitions, the Gundar estuary mouth is a true character. This environment largely covered bydominantfactors,viz.Shorttermchangesresultingfromtides.Markedseasonalchangesinduced by the monsoon cycle.The estuary is influenced by semidiurnal tides throughout the year andtidal aptitude of one meter. The maximum depth of estuary observed during sample collection isabout5m.Thewidthatthemouthofthestuaryisabout600m.

BeachandSanddunes

Black (heavy minerals) sand concentrations are abundant in the both side of the Gundarestuary. In Mookaiyur and Oppilan region, are prominently stabilized inland the sand dunes ofthis region is fine to medium sediments formed by interface between sea and land. Area itbordered the high-tide mark then extend inland from to 2 to 5 km. this stretch run parallel to theshoreline and separated from each other by marked troughs. The crest is flat and ranges in heightfrom 0.5 to 2m. In many places, the channels were diverted or filled

with sediments or newformation of erosion structures was observed. The weight percentage distribution curves showthatthegrainsizevariationwasmor ealongforeshoreduetotheeffectofwave activitycomparedto bermline. The statistical properties of sediment samples illustrate that unimodal and bimodalcharacter is dominated in the backshore, bermline and foreshore along the study area. Thebackshoresedimentspredominantl yhavingthemediumsandwithmoderatel ywell sortedtowellsorted samples. In bermline samples, the fine sand to medium sand with moderately well sortedand well sorted was found. In foreshore, mainly fine sand to medium sand and moderately sortedto moderately well sorted was observed. The study showed that the negatively (coarse) skewedandpositively(fine)skewedsam ples,indicatingstrongdepositionandero siontendencyalongthestudyregion.

TernaryDiagram

The ternary diagram was represented by nature of sediments, the presence of the sand,silt, and clay contents in sediments of the different environments of the gundar river estuary andbeach, the distribution of sediments are show in (Fig. 13 and 14). The river estuary exhibited bysediments populationmixed of siltand fine sand.While beach sedimentsreveled by sandpopulation.The lineardiscriminate functionproposedby Sahu (1964) has been appliedtoconform to the environment of deposition. The derived values are separately tabled in below.(Table.4)

Fig.13.Ternarydiagraminriverestuarysediments

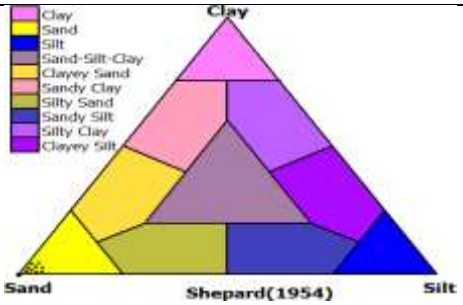


Fig.14.Ternarydiagraminbeachsediments

Conclusion

- RiverestuaryandBeachareasedimentsaremediumsizetofinesizegrains,thesedimentsweredistributedinsizevariationsindicatedifferentenergyconditions.
- The predominance of symmetrical and fine skewed sediments suggested that excessiveriverine input and deposited fine sediments in river estuary, due to the wave action ofsediments.Inriverestuarybimodalvarious sourcessuchasmixedpopulationwasdominatedbywavesandlongshorecurrents,andfluvialprocesses.
- AccordingtoSahu'slineardiscriminantfunctionvaluesofsedimentsdominantlydeposited by processes in shallow agitated water under shallow marine condition ofturbiditycurrents.
- .Thisworkconcludedtheyvariation of mixed sediments deposited by waves, long shore current, wind and fluvialprocess.

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SCHOOL OF MARINE SCIENCES

The Department of Oceanography and Coastal Area Studies is the only one of its kind in Tamil Nadu and it was established in the year 1998 with the vision to conserve the marine resources for sustainable development and to cater to the requirement of manpower generation in the field of marine research, technology and industries. The Department is situated in a satellite campus extending over 13 acres at Thondi about 60 km away from the main campus. The Department is spread along the wave front having the facility of boat landing jetty. The Department has talented, motivated and well-trained staff members with expertise on multi-disciplinary aspects *viz*., Geological, Physical, Chemical and Biological Oceanography, Marine biotechnology, Marine microbiology, and Marine pharmacology. Our University is distinctly projecting Oceanography as the course admitting graduates from various disciplines so that the country will have skilled manpower to concentrate on the future requirements in the sphere of marine science and marine engineering. Later, during 2017the department has bifurcated in to Department of Geology with the vision to create highly competent professionals in Geology who contribute to the academia and industry by undertaking innovative research, making inventions and developing new technology and to collaborate with Western Universities and utilise the experience and expertise of international subject experts for the progress of students followed to that, the Department of Fisheries Sciences is established during 2018 with the vision to encourage sustainable fisheries and robust aquaculture practices for the constant supply of high-quality fish for everyone that complements the economic prosperity of the fishery business. Prof. S. Ravikumar, Head, Department of Oceanography and Coastal Area Studies is the Chairperson of the School of Marine Sciences, Alagappa University, Karaikudi.