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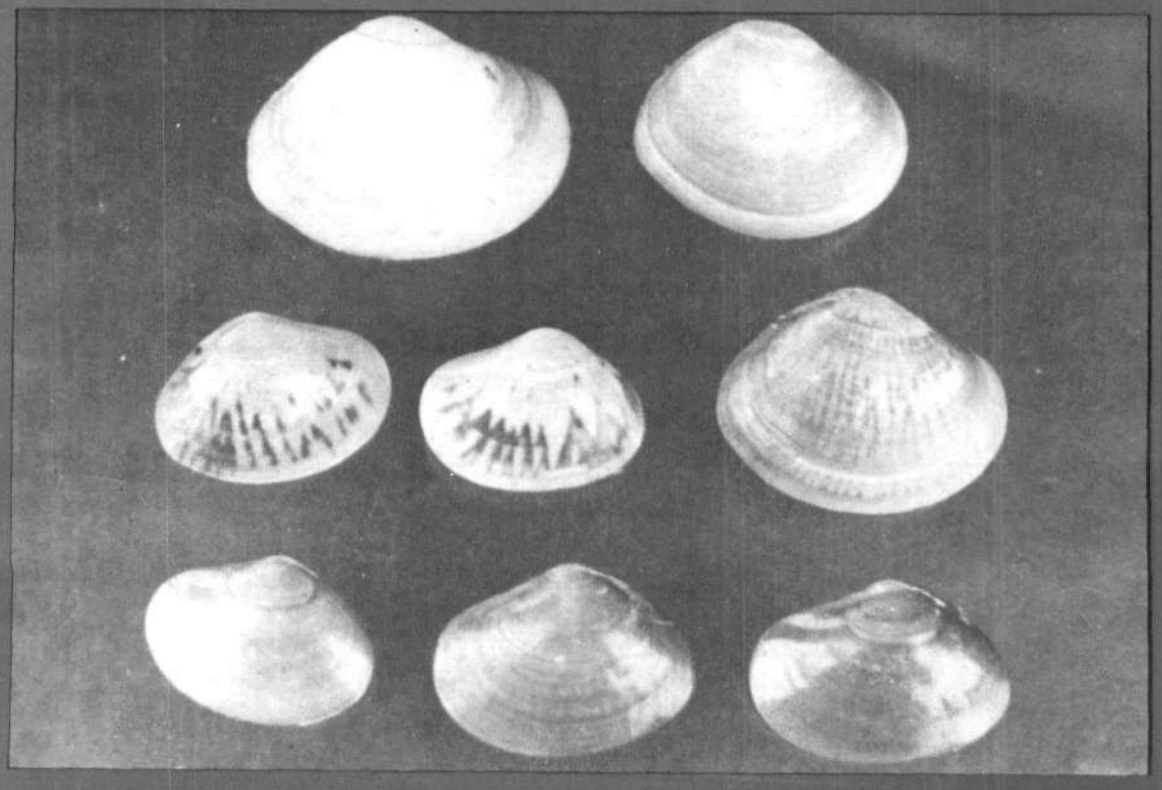

तकनीकी एवं विस्तार अंकावली
TECHNICAL AND EXTENSION SERIES

केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान कोचिन, भारत
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INDIAN COUNCIL OF AGRICULTURAL RESEARCH

समुद्री मात्स्यिकी सूचना सेवा : समुद्री मात्स्यिकी पर आधारित अनुसंधान परिणामों को आयोजकों, मत्स्य उद्योगों और मत्स्य पालकों के बीच प्रसार करना और तकनोलजी का प्रयोगशाला से श्रमशाला तक हस्तांतरित करना इस तकनीकी और विस्तार अंकावली का लक्ष्य है।

THE MARINE FISHERIES INFORMATION SERVICE : Technical and Extension Series envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers and transfer of technology from laboratory to field.

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Front cover photo : *Paphia malabarica* is known to show varying colour patterns of the shell — may be a genetic phenomenon. Some ranched and harvested specimens. (Ref. Article No. 5).

मुख आवरण फोटो : कवचों की वैविद्यता *पाफिया मलबारिका* की विशेषता है - यह एक आनुवंशिक प्रतिभास हो सकता है। रैंचन और संग्रहण किए कुछ नमूने

Back cover photo : *Paphia malabarica* ranched in Ashtamudi Lake after harvest. The seed from an average initial length of 12.4 mm grew to a size of 30.4 mm (average shell-on weight 9.3 g) in five months. (Ref. Article No. 5).

पृष्ठ आवरण फोटो : अष्टमुडी झील में रैंचन किए *पाफिया मलबारिका* का संग्रहणोत्तर दृश्य। यहाँ पाँच महीने में 12.4 मि. मी के बीजों ने 30.44 मि. मी के हो गए। कवच सहित औसत भार 9.3 ग्राम था।

PROCEEDINGS OF THE SEMINAR ON SEA RANCHING HELD AT C. M. F. R. I., COCHIN ON 28.4.1993

Minutes of Proceedings

The Central Marine Fisheries Research Institute has contemplated to conduct a series of seminars on important research findings for the benefit of its scientists and technical personnel as well as those from other institutes. The first seminar was on stock assessment of major marine fish and shellfish resources, conducted at CMFRI on 23rd April, 1993.

The second in the series was on sea ranching, and this was held on 28th April, 1993. Dr. P. S. B. R. James, Director, chaired the seminar which was attended by scientists, technical personnel and students, besides some retired scientists of CMFRI and Central Institute of Brackishwater Aquaculture. Papers on sea ranching of prawn, lobster, pearl oyster, clam and sea cucumber were presented and discussed at the seminar.

After welcoming the participants, the Chairman dealt at length on the origin, concept, and present status of sea ranching in our country and elsewhere. Sea ranching is termed as production and release into natural habitat of aquatic organisms to augment their stock. It was in the United States that the idea of sea ranching originated as back as 1870. Since then many countries have been practising this for enhancing the resources as fishing pressure is evidently felt on many of the resources. Sea ranching also helps in conserving the resources. The Japanese even consider sea ranching as a form of aquaculture as it involves some from of culture and manipulation of the natural population. Since 1975 sea ranching has developed in Japan as an alternative to traditional intensive culture which requires high feed imputs. The proof for the fact that sea ranching has come to stay in Japan is the establishment of the Japanese Sea Farming Association, which has since developed a system of seed production for ranching to supplement the natural stocks, and is currently sea ranching over 45 species. Among fish, the Red Sea bream of the Kagoshima Prefecture is a classical example of sea ranching. There are several other species which are being ranched today. There have been attempts even to transplant salmon from Japan to United States.

The Chairman said that there are many misgivings, often bordered with septicism or even cynicism, about the practice of sea ranching. The question generally asked is as to what is the guarantee that the seeds that are ranched will grow and could be caught? Is any return guaranteed for the money, time and effort that are spent on the process. The answer to these questions is the success story of sea ranching programmes adapted by many countries of the world —U. K., U. S. A., Japan, Tanzania and Norway, to mention a few.

He continued that the idea of sea ranching in our country started with the pearl oyster which appeared to diminish in number since the Gulf of Mannar pearl fishery of 1961 due to many factors. To overcome the erratic natural population of pearl oysters, it was felt that sea ranching would be the currect step. With the establishment of a hatchery at Tuticorin and large-scale production of seed, sea ranching became a possibility. Ranching of prawn seed has become relevant in the context of diminishing returns from the natural resource. The spiny lobster, clams and sea cucumber offer immense scope for sea ranching because of the increasing demand in export trade, decreasing production from fishery, and because of the success in hatchery production of their seed.

The Chairman concluded the introductory speech by saying that the seminar was aimed at not only to review the past work, take the stock of the present status and to project the future plans, but also to generate interest and interaction among scientists and others and to make ourselves clear about the importance of such sea ranching programmes in conserving and enhancing the natural resources.

The Chairman's speech was followed by the presentation of papers on sea ranching by different groups.

SEA RANCHING OF PRAWN*

Sea ranching of prawns is an idea conceived by Japanese. In Japan, the Kuruma shrimp (*Penaeus japonicus*) culture techniques are highly developed and the average annual production through farming was about 1800 tonnes in the early eighties. As the demand for this species was ever increasing and they have only limited culture grounds, they thought of increasing the natural production of this species by releasing large number of hatchery and nursery raised postlarvae/ juveniles into the natural environment which in turn will grow and ultimately get recruited in the commercial catches.

To carryout preliminary experiments, Japanese researchers have selected a lagoon — Hamana-ko Lagoon —one of the largest lagoons having 6900 ha surface area and maximum depth of 12 m and is connected to the sea through a narrow mouth 200 m wide. A good fishery existed for *P. japonicus* in the lagoon which is sustained by naturally recruited seeds of this species from the sea. Large number of hatchery raised seeds were released into this lagoon. Continuous sampling at 5 days interval, during fishing season was made and growth and catch of the released and naturally recruited populations were statistically estimated. By releasing 6.98 million seeds of *P. japonicus* (30mm) in one part of the lagoon (Shirashu) having 200 ha area the production had increased 2.4 times (Uno Yukata, 1984). These trial releases of post larva/juvenile, which grew and subsequently got recruited in capture fishery formed the basis of sea ranching.

Against this background a research programme — "Sea ranching of prawns" — was initiated in CMFRI for the first time in the country in 1985 and continued upto 1992. The technical programme envisaged for the project were :

i) Selection of a species and suitable area for the release of postlarvae/ juveniles

ii) Development of a low cost technology for the large scale production of postlarvae

iii) Study of seasonal movements of the postlarvae in the area selected for ranching

iv) Comparative study of the sturdiness of the hatchery produced seeds *viz-a-viz* those in the natural environment

v) Collection of information on the migration and growth of the sea ranched postlarvae and their recruitment to the commercial fishery

vi) Estimation of the quantum of seed to be released at a time to make a perceptible increase in the local fishery.

Penaeus semisulcatus was selected as the candidate species. Mandapam was selected as the project site considering its suitable topographical features, facilities to establish a hatchery and the existence of *P. semisulcatus* fishery round the year. This species does not show any long range migration. The luxuriant growth of sea grass in this area serves as an ideal nursery ground for this species. The species at its juvenile stage supports a substantial fishery. During 1987, the survey conducted by this Institute revealed that the landings of juveniles in this area equals that of the trawl net fishery for the adults. Survey also revealed the existence of a naturally protected area in Palk Bay side of Mandapam coast where the fishery for juveniles does not exist, due to the presence of patches of corals and rocks. Hence this protected area in the Palk Bay has been selected for sea ranching experiments of *P. semisulcatus*.

CMFRI had already developed a low cost technology for the large scale seed production of *P. indicus* (Silas *et al.*, 1985). This technology has been suitably modified for the seed production of *P. semisulcatus* and a hatchery established at Mandapam. This hatchery having a production capacity of 1 lakh post larvae XV-XX per run was established at a cost of Rs. 50,000/-. The production cost of 1,000 seeds came to Rs.20/-.

* This article is based on the work carried out by the following personnel of sea ranching team of Crustacean Fisheries Division of CMFRI: P. Vedavyasa Rao, N. N. Pillai, E. V. Radhakrishnan, P. E. Sampson Manickam, G. Maheswarudu, M. R. Arputharaj and K. N. Gopalakrishnan. The article was prepared and presented by N. N. Pillai.

Detailed survey revealed that juveniles of *P. semisulcatus* occur in large numbers in shallow inshore areas of Palk Bay and Gulf of Mannar where there are luxuriant sea grass beds. Although *P. semisulcatus* breed through-out the year, peak breeding seasons are January-February and July-August and peak recruitment of juveniles into the fishery is in April-June and October-December.

To study survival, growth and recruitment pattern of the hatchery produced and sea ranched stock, a batch of postlarvae (16-35 mm) numbering 70,366 were released in Pillaimadam lagoon about 1.5 kilometres away from its bar mouth (Rao *et al.*, 1991) . After the release, fixed-bag net made of mosquito netting was operated against the current at regular intervals during the low and high tides. It was observed that the incoming tides were not bringing post larvae of *P. semisulcatus* to this lagoon. But after 24 hrs of release the postlarvae were caught in the bag nets operated during low tide while they were moving out into the sea. Thus it was observed that the post larvae released in to the lagoon, got acclimatised and started moving towards the sea after 24 hrs.

Hatchery produced postlarvae of *P. semisulcatus* (PL XV-XX) were reared in the marine ponds of the institute to study their survival and growth. The experiments revealed that the growth rate of 1.3 mm/day occurred during the first sixty days. The survival of during this period was found to be 85-90%. Further, their growth rate in the pond was found to be equal to that of the wild. Thus it was clearly shown that the hatchery produced postlarvae of *P. semisulcatus* are sturdy as that of the wild and registered the same rate of growth.

After developing a viable technology for postlarval production of *P. semisulcatus* as well as finding out that the post larvae produced under controlled conditions are as sturdy as those from the wild with reference to growth and survival, efforts were directed to find out the percentage of sea ranched postlarvae that grow, migrate and get recruited into the fishery. With the available hatchery facility, 7 lakh postlarvae are ranched annually into Palk Bay. Considering the magnitude of the fishery of this species in this area, the number of sea ranched postlarvae was negligible to attempt any meaningful statistical interpretation. Further the size of the ranched postlarvae was too small to be tagged to obtain direct evidence of its growth and recruitment. Hence it was decided to grow the postlarvae XV-XX in the departmental farm to a size above 60 mm in total length. Thus 2,964 laboratory reared and farm grown *P. semisulcatus* of 60-110 mm size were tagged and released into the Palk Bay (Pillai, 1991). One per cent of these prawns were obtained from the commercial trawl catches landed in 2 near by landing centres within a period of 5 to 53 days (Anon., 1992). During this period the tagged prawns have migrated to a distance of 30-35 kilometres. The possibility of tagged prawns getting caught and landed at other landing centres of the Palk Bay area cannot be ruled out as the recovery efforts were restricted to the nearby landing centre and for a limited period.

The above experiments showed that the sea ranched postlarvae of *P. semisulcatus* survive, migrate, grow and get recruited into the fishery at Palk Bay.

As stated earlier, at an average of 7 lakh PL XV-XX the *P. semisulcatus* were annually released into the Palk Bay area under the sea ranching programme. The series of experiments carried out revealed that in the life history of *P.semisulcatus*, maximum mortality occurs during its development from Nauplius to Post larvae XV-XX. Afterwards the survival was found to be above 85%. Thus when PL XV-XX are sea ranched, their chance of survival, growth and getting recruited into local fishery is very high.

On an average 1,00,000 nauplii are obtained from one spawning of *P. semisulcatus* under laboratory conditions. Providing proper feeding and maintaining good water quality the survival from nauplius to PL XV is 33% (average). But in nature it will be far below and will be less than 0.1%. Taking the survival in nature as 0.1% upto PL XV, sea ranching of seven lakh PL XV obtained at 33% survival rate from 21 spawners in one spawning in the hatchery is equivalent to the product of one spawning of 7,000 animals in the wild.

To make a perceptible increase in the local prawn fishery by increasing the annual production of *P. semisulcatus* by 100 tonnes over the present production, 2,500 lakh PL XV-XX will have to be ranched. For this purpose a hatchery with a production capacity of 2,500 lakh PL XV-XX, will have to be established. This calls for an investment of Rs. 350 lakhs as initial investment

and Rs. 50 lakhs as working capital. At the present market rate of Rs. 200/kg of prawns, the envisaged increase of 100 tonnes is equivalent to Rs. 200 lakhs per annum. In real terms this increase will be reflected in the overall prawn catch of this area and hence an addition to the resources. The social benefit deriving out of it to the local population is tremendous, as also to the direct increase in export earnings of the country. CMFRI being a research organisation has played its part by developing a suitable technology and perfecting the same, and it is available for adoption. Therefore the Govt. or a developmental agency should consider the funding for this project for the social benefits which can be derived out.

Discussion

K. Rangarajan: Are tagging of prawns and sea ranching of their seed correlated? Since the tagged prawns are larger and more aclimatized, is the rate of survival more in them?

N. N. Pillai: The rate of survival in hatchery from nauplii to PL 15 is about 33%. Afterwards, upto juveniles of about 70 days, survival was found to be 95%. A very reasonable estimate will be that 10% of the ranched seed grow to get recruited in to the fishery.

K. H. Mohamed: The idea of sea ranching came up in Japan because of the surplus seed produced by the hatcheries whereas in our country, though there are a number of prawn hatcheries, the production is far below the needs. Therefore, sea ranching has to be attempted with caution. More over, this species (*Penaeus semisulcatus*) does not seem to be ideal for sea ranching because of many disadvantages: the demand for this prawn is much less than for others, its growth is very slow, and the species is highly localised. Nevertheless, since we have already developed the technology, we can try to get funding from other agencies for pursuing the work.

N. N. Pillai: We have studied the growth of this species. The seed prawn grows at the rate of 1-1.3 mm/day. When it grows to 60-80 mm, the growth gets stunted in farm conditions. Tagging and releasing of 60-80 mm size groups revealed that in the sea there is continuous growth. As for funding by other agencies, we have already submitted two projects.

K. H. Mohamed: To overcome such a stage of stunted growth, a smaller size, about 40-45 mm, can be suggested for ranching into the sea.

N. N. Pillai: It will be very expensive to grow the prawns upto 45 mm in hatchery/nursery and then ranch into sea.

P. R. S. Thampi: Private agencies will be interested only in farming and not in sea ranching where monitary returns is uncertain and therefore no funding can be excepted from them.

K. A. Narasimham : Private agencies may not be interested but Government bodies can help. For information, the MPEDA is funding two CMFRI projects for sea ranching of clams and sea cucumber.

E. V. Radhakrishnan: We have not attempted culture of this species in ideal conditions, but since it was found that the seed grows to a weight of 30 g in five months, it cannot be said that this is not an ideal species for farming or ranching.

C. Suseelan: The results obtained so far (with many constraints, mainly financial) in hatchery rearing and ranching are not adequate enough to advice any agency about ranching. More research has to be done in this field. State governments should take up such studies for conserving and enhancing the resources.

Joe Kizhakudan: Does the breeding period of sea ranched prawns coincide with that of the natural population? Does sea ranching affect recruitment pattern?

N. N. Pillai: We have adequate data at present to show that *P. semisulcatus* is an ideal species for sea ranching at Mandapam. Regarding the aspect whether there is coincidence of breeding periods, it remains to be studied.

S. Sivakami: How long it will take for sea ranching to reflect on the fishery? Can't we grow the seed to a larger size and then release them so as to increase the survival?

N. N. Pillai: We will get some idea about the contribution of sea ranching to the fishery if the juvenile fishery is prevented. The number of seed ranched is at present small to come to any conclusion. Ranching of larger seed may be more expensive.

V. Sriramachandra Murti: If induced breeding is done during the non-breeding period of the wild prawns, it will enable us to sea ranch continuously and increase the population in the natural habitat.

K. Raman: The team deserves praise for the work it has done. We have to demonstrate a complete proposition in a ranched area and in stocked area.

Winding up the discussion on sea ranching of prawns, the Chairman concluded that sea ranching of this species cannot go on for many reasons but studies on its scientific aspects will have to continue with the farming prospects in view, since this is a potential species next to *Penaeus indicus* and *P. monodon*.

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SEA RANCHING OF SPINY LOBSTERS*

The production and release of juvenile marine organisms in order to augment the fishery is termed as sea ranching. The concept of sea ranching actually originated in USA way back 1870, the main objective being socking the fishing grounds with hatchery reared juveniles and capturing them subsequently. Japanese considered sea ranching as a form of aquaculture and included under sea farming as it involves a degree of manipulation of the natural population and a measure of husbandry. In Japan, sea farming began in 1962, came into focus in 1975 and developed as an alternative to traditional intensive culture systems, requiring high feed inputs. The Japanese Sea Farming Association since then has developed a system of seedling production to supplement the natural stocks and has released more than 45 species; another 80 species are being developed as future culture species. (Davy, F. B. Mariculture Research and Development in Japan, 1991, IDRC). The spiny lobster *Panulirus japonicus* is one among them.

Lobster fisheries throughout the world encounter decrease in harvest and catch per unit effort. In India, spiny lobster fishery has been fluctuating around 2,000 tonnes/year for several years and it is mainly due to indiscriminate exploitation of the resource. India though not a major exporter of lobsters (seventh place in the world) earns around Rs. 30 crores annually in foreign exchange. Diversification of lobster products for export from the traditional frozen lobster tails to the more lucrative whole cooked lobsters to newer markets has resulted in heavy demand for lobsters. Lobsters, unlike the fishes and other commercially important crustaceans are distributed only in certain pockets along the Indian coasts. Among the six species of spiny lobsters occurring in Indian waters namely, *Panulirus homarus*, *P. ornatus*, *P. polyphagus*, *P. versicolor*, *P. longipes* and *P. penicillatus*, only three species, *P. homarus*, *P. ornatus* and *P. polyphagus* contribute to commercial fishery. *P. polyphagus* which occurs along the northwest coast of India is listed in commercial quantities and form almost 79% of the total landings. *P. homarus* and *P. ornatus* contribute the rest and they occur along the southwest and southeast coasts and the south east cost respectively.

* This article was prepared and presented by E. V. Rahdakrishnan.

Unlike majority of the lobster fishing and exporting countries, no management regulations are enforced in India. In many areas, peak fishing coincides with peak breeding season and during this period, 60-70% of the catch is constituted by active breeders. These breeders are excepted to maintain the population by spawning several times before they are caught at a large size. The indiscriminate exploitation of these breeding populations will have strong repercussions on the fishery in the long run. Probably, the enforcement of a minimum legal size would have saved a major percentage of these breeders. Besides, exploitation by non-selective gears such as trammel nets compounds the ongoing degradation of portions of the Indian lobster fishery and diminishes the long term benefits that are available. In certain parts, the present harvest is only 20-25% of the peak catches. The problem become acute with the export of smaller lobsters in whole cooked condition which offered the maximum price. Probably, this maybe advantageous for the lobster farmer, as they need to grow the lobsters only to 150 g to fetch the maximum price. The mean sizes of lobsters captured are decreasing more rapidly in certain areas (Kanyakumari district). Of the females harvested in Madras by trammel net, 60-70% had not yet reached their reproductive maturity. The situation is so alarming that effective management regulations are to be implemented to conserve the fishery. It is true that enforcement of a uniform pattern of a minimum size of capture to multispecies fishery which employs a variety of gears is difficult. But enforcement of this regulation would contribute to the production of the breeding population and enhance yield per recruit. Probably, the most sensible approach may be banning the export of smaller lobsters which are below a minimum size. Unlike other commercially important crustaceans like prawns, spiny lobsters have a protracted larval life and these larvae are carried to offshore by the currents. Only a very small portion of these larvae were estimated to come back to the coastal areas for settling. Regular removal of the breeding population will slowly lead to decrease in reproduction potential of the population and consequent decline in new recruits to the fishery every year. Once this balance is disturbed, by excessive exploitation, it may take years for the fishery to recover and beyond a critical stage, the fishery may not recover at all. In this context, searching is one management strategy to consider to cope with intensifying fishing effort and decreasing lobster stocks. The hatchery produced seeds could be used to restock areas where populations once flourished, but are now depleted or are in the decline. Inorder to achieve this, high priority research is required to develop a mass seed production technology. The seeds produced thus may be either released in the natural habitats of the juveniles or in artificial habitats developed in suitable area along the coast. Certain species of lobsters, especially the shallow water lobster *P. homarus* were found to inhabit the rocks and tripods which are dumped in the coastal areas to prevent sea erosion.

Spiny lobsters are ideal species for sea ranching as they have very limited migration and can be grown in their natural habitats and harvested when they reach commercial sizes. Determination of the extent to which hatchery reared lobsters contribute to the natural populations is very essential. Tagging studies and detailed ecological investigations have to be conducted regularly to assess the contribution of the ranched population to the fishery. Private entrepreneurs may be encouraged to take up the searching programme as was done in salmon ranching in USA. Private hatcheries release young salmons into the sea near river mouths when the population return to the same area for spawning, are caught. Suitable coastal areas could be leased out to the private entrepreneurs to develop artificial habitats and farm the hatchery produced seeds in the natural conditions. They could be either harvested when they attain juvenile size and farm them in land based ponds or in cages in the sea. The concept of sea ranching of lobster can be thought of only if a mass seed production technology is developed. So, let us examine the prospects and problems in developing a hatchery technology for spiny lobsters. Earlier studies by the Institute have collected lot of information on the larval rearing of the lobsters.

Constraints

The major constriant facing culture of spiny lobster larvae is the prolonged larval life. The characteristically delicate and transparent phyllosoma larvae undergo complex series of metamorphic moults, before settling at the bottom as benthic puerulii. The larvae were estimated to take 4-8 months to change into the post larvae. Lack of complete information on the

food requirements of the larvae during different larval stages further complicates the problem. Phyllosoma larvae of a number of species have been cultured half way through their life cycle. The first attempt to rear the larvae of a spiny lobster upto the last larval stage was unsuccessful in producing the puerulii. The spiny lobster, *P. homarus* , *P. interrupts* , *Jasus lalandii* and *P. polyphagus* were spawned in the laboratory and their larvae reared to 3-6 stages feeding with a variety of diets. The Japanese scientist Jiro Kittaka was the first to rear the larvae of a spiny lobster to puerulus to stage. He reared the phyllosoma larvae of three temperate species of lobsters, *P. elaphas*, *J. lalandii*, hybrid of *J.verreauxi* and *J. novahollandiae* under laboratory conditions. However, tropical lobster larvae are yet to be reared through its entire life cycle. Though the survival is low, it opens up the possibility of culturing the phyllosoma larvae in captivity.

In India, phyllosoma larvae of the spiny lobster *P. homarus* were reared upto six stages in the field laboratory of CMFRI, Kovalam, Madras. The larvae were reared on a diet of brine shrimp nauplii upto the sixth stage in a period of sixty days. According to the estimate, the larvae could be reared to postlarvae (puerulii) in 3 1/2 to 4 months. Change in feeding habits was the main reason for mortality of the larvae. The larvae were reared initially in a mass culture and later they were shifted to individual containers inorder to study the feeding requirements and the moulting behaviour. Food was a significant factor for survival and moulting frequency of the larvae. Phyllosoma larvae require slow moving fleshy organisms as feed during the initial stages. But as they grow, the larvae failed to catch the small brine shrimp nauplii which indicate that they require larger organisms as feed in later stages. Studies show that larvae will fed on fish larvae, zooplankton such as *Sagitta* and hydromedusae and also on frozen adult *Artemia*. Artificial feeds should be of suitable size and buoyancy, so that the feed will suspend in the water column for a longer time and will be available for the larvae.

Another area which needs careful attention is the diseases. Larvae were found to be infected with the plumose protozoan parasites like vorticellids which grow on the various appendages and interfere with the normal swimming activity. Weak larvae are infected with free swimming ciliates. The larvae were successfully treated with 100 ppm formalin. The source of infection was mainly the food. Treatment of brine shrimp nauplii for 10 minutes in 20 ppm malachite green killed the disease organisms. The water used for rearing should be filtered and sterilised by UV lamp. The mother lobster could be a potential disease carrier. The eggs carried by the lobster was generally contaminated by bacteria or fungus. Dip treatment of the lobster in antibiotics or malachite green may be required for 15 minutes daily until hatching. The larvae collected from the spawning tank should be given preventive treatment before releasing into a rearing container. Extreme sanitation of the rearing containers and the hatchery are essential to prevent infection of the larvae. Healthy phyllosoma larvae swims toward a light source and such larvae alone should be used for rearing. A treatment schedule was formulated which include treatment of the breeders, larvae as well as the feed.

Rearing containers

The successful hatchery operation will depend upon the shape of the rearing container and hydrodynamic characteristic of the system. American lobster larvae were successfully reared using a conical bottom tank called plankton kriesel. The system developed by Massachusetts State Lobster Hatchery was successfully utilised by many hatcheries in USA, UK and France. The rearing container is a 40 l capacity subcylindrical fibreglass tank in which fresh filtered sea water is forced out at the bottom of the tank. The effluent water passes through a central screen and flows out. The hydrodynamic characteristic of the circulation device constantly stirred the larvae and the food in a spiral upwelling pattern. This system may be useful for rearing the phyllosoma larvae as the circulation pattern will prevent entanglement of the larvae and may help in uniform mixing of larvae and food. A maximum of 3,000 larvae can be stocked in each tank. The advantage of the system is that a battery of such tanks could be serially connected and this will avoid mass infection of larvae in case of any out break of these epidemics. Moreover tanks infected alone can be disconnected. Development of a suitable culture system, appropriate prophylactic measures to prevent larval infection and suitable diet for the various larval stages are essential for successful culture of phyllosoma larvae. Once the technology for larval culture is perfected, mass seed production

technology could be developed. The puerulii after rearing in the nurseries could be sea ranched after a month.

Discussion

D. B. James: For feeding phyllosoma larvae, did you try copepods?

E. V. Radhakrishnan: No, the larvae cannot eat copepods because of the exoskeleton of the latter.

V. D. Deshmukh: Did you try rearing experiments with *Panulirus polyphagus*?

E. V. Radhakrishnan: No, only with *Panulirus homarus*.

K. H. Mohmed: From what all information we have at present, sea ranching of spiny lobster is a distant possibility. As far as *Panulirus* is concerned, nobody has been able to rear it through all the stages.

The Chairman concluded the discussion by saying that the present discussion on spiny lobster is to create an awareness about the drastic decline in the fishery, the growing demand in the export market, and the urgent need to conserve and enhance the resource. True, there are lot of research gaps which are linked with lack of infrastructure facilities but the projection for the future will resolve sound sea ranching which seem to be the right step in the context of depletion versus demand.

SEA RANCHING OF PEARL OYSTER*

Introduction

Sea ranching of laboratory/ captive reared organisms/animals is a technique which aims at rebuilding the wild population from its destruction/catastrophe by man-made and natural causes. The main aim of sea ranching pearl oysters in their natural habitat is to revive the pearl oyster population from extinction and create new beds. The main difference between land-rancher and sea-rancher is that the land-rancher retains ownership of his animals whereas the sea rancher cannot possess the ownership of the animals since they are ranched in the sea. The ranched animals became part of the wealth of the sea which can be harvested by anybody.

Sea ranching of commercially important molluscs dates back 1977. Japan is the first country to sea ranch molluscs. They produced abalones in the hatchery and transplanted in the sea, a practice to increase the production (Imai, 1977). Till the beginning of 1985, no attempt has been made to sea ranch the hatchery produced pearl oyster seed in the natural pearl oyster beds. The development of hatchery technology for mass production of pearl oyster spat under controlled condition in 1981 (Alagarswami. *et al* 1983) has opened the possibility of sea ranching pearl oysters. An experimental sea ranching was commenced in December, 1985 in the pearl oyster beds of Tuticorin waters.

Fluctuation of pearl oyster in natural beds

The wide spread mortality of young and old pearl oysters in the pearl banks may be due to certain physical causes such as shifting of sand, strong currents, destruction by natural enemies etc. Factors like overfishing, over crowding of oysters and diseases may also be responsible for the depletion of pearl oyster population (Hornell, 1903). Hornell (1922) found that the predatory fishes such as *Balistes* sp. and *Serranus* sp. destroy the oyster population. Chacko (1956) considered the starfish *Pentaceros linckl* as the greatest enemy of pearl oysters and suggested for their removal from the beds. Salvadori (1962) considered moray seals and octopi as the destructive agents of pearl oysters. Covering the spat by the weaving mussel *Modiolus* sp. in the form of a mat (Mahadevan and Nayar, 1976) and predation by gastropod molluscs *Cymatium* sp. (Chellam *et el*, 1983) are also some of the agents responsible for the destruction of oysters.

Replenishment of natural stock on the beds is possible, if only mass settlement of spat takes place every year. Devanesan and Chidambaram (1956) are of the opinion that the water drift and current over the pearl banks of Ceylon and India may carry the larvae of pearl oysters from one coast to the other. Alagarswami (1977) observed good spat settlement in the inshore area and incursion of multi species *Pinctada* population in

* This article is based on the work carried out by A. C. C. Victor, A. Chellam, S. Dharmaraj, T. S. Velayudhan, K. Srinivasagan, A. Dasman Fernando, F. Soosai V. Rajan, N. Jesuraj and K. Shanmugasundaram. The article was prepared and presented by A. C. C. Victor.

the paars which he had attributed to coastal larval drift.

Conservation of pearl oyster in the natural bed

Herdman(1906) suggested transplantation of young 'strides' or brood of oysters from unproductive paars to productive paars where better growing conditions prevail. Devanesan and Chidambaram (1956) recommended for the creation of a sanctuary of 1 sq. km in the pearl oyster beds which should not be fished at all, and creation of a 'Breeding Reserve' to resuscitate the population. Salvadori (1962) suggested 'stock improvement' by development of 'hallows' in the oyster beds by dumping rocks to provide better anchorage for oysters.

Sea ranching

Subsequent to the success achieved in the large-scale production of pearl oyster seed in 1981, an experimental sea ranching programme was commenced at Tuticorin. For this purpose, 3 nearby paars namely Van Thivu Arupagam paar, Kurichan paar and Fernado paar were selected. The depth of these paars is 12 m. Between December, 1985 and December, 1990, a total of 10,25,00 spat of *Pinctada fucata* were sea ranched on 17 occasions. The size of the spat ranged from 0.9 to 11.3 mm with an average length of 1.53 to 5.7 mm (Table 4).

Mode of ranching

The spat to be sea ranched are kept in the hatchery tank and the spat are allowed to settle on synthetic materials like old fish nets, velon screen fabric and tufts of monofilaments. These materials with the spat were placed in large rectangular cages (90 x 60 x 15 cm) covered with synthetic webbing. The cages were further enclosed with old fishnets. The spat could crawl out though the meshes for dispersal on the paar. The spat-filled cages were lowered and kept inside hollows or secured coralline projections with synthetic ropes to prevent drifting.

Trend of fisheries

The pearl banks located off the coastline of Tuticorin and Thiruchendur accounted for the longest pearl fishing operations from 1955 to 1961. A total of 95,867,460 pearl oysters were fished. The details of pearl oysters fished during the pearl fisheries of 1955 to 1961 are shown in Table 1. Tholayiram paar was fished moderately in 1955 and 1956 and left out during 1957, 1958 and 1959 respectively. The other paars viz. Karual, Rajavukku Sippi, Sothitha paar, Kudamuthu group etc. were fished heavily during 1957, 1958 and 1959 and there were no fishable stock in the succeeding years.

From 1961 to till date, the Tamil Nadu Government has not announced pearl fishing due to the reason that there were no fishable stock of oysters in the paars. The Central Marine Fisheries Research Institute took up the survey of the pearl oyster beds of the Gulf of Mannar from 1975-76 onwards. The facility of SCUBA diving was utilized for the survey. During the period 1975 to 1986, a total of 289 sea trips were made to different pearl oyster beds and collected 2,39,025 oysters. Table 2 gives the diving effort and number of oysters collected season-wise for the period 1975 to 1986. Table 3 gives the

TABLE 1. *The number of pearl oyster fished during the longest fishery series 1955-1961*

Year	Tholayiram (T) and Koothadiar (K)	Name of peral oyster				
		Karuval	Rajavakku Sippisothicha	Kodamuthu	Saithu Kodamuthu	Total
1955	3,200,000	—	—	—	—	3.200,000
1956	2,129,058	—	—	—	—	2,129,058
1957	—	272,263	2,037,012	4,611,597	3,984,800	10,905,672
1958	—	7,638,997	3,430,366	4,604,872	5,547,977	21,222,212
1959	—	4,154,250	430,806	19,040,945	3,387,054	26,986,055
	219,093			219,093		
1960	12,040,009 (T)	—	—	—	—	12,040,009
	3,768,429 (K)	—	—	—	—	3,768,429
1961	15,073,838 (T)	—	—	—	—	15,073,838
	323,094 (K)	—	—	—	—	323,094
Total	36,534,428	12,284,603	5,871,184	28,257,414	12,919,831	95,867,460

picture of the paar-wise collection of oysters during the years 1975-86. It is evident from the table that the least number of oysters were collected during 1980-81 and the more successful season was 1981-82, the one following the unproductive season. The number of oysters collected per diving hour was as high as 2,164 oysters in the year 1981-82, whereas it was just 3 in 1980-81. Fig.1 illustrates the collection of oysters from different pearl oyster bed and the number of the oysters per diving hour. Nagarai paar accounted for the maximum collection 2,282 oysters per diving hour, in 1981-82.

TABLE 2. *Season-wise collection of pearl oysters during the period 1975 to 1986 from the pearl banks of the Gulf of Mannar*

Season	No. of sea trips	Diving effort in hrs.	Total No. of oysters collected	%
1975-76	32	81.00	1,244	0.52
1976-77	50	120.03	27,208	11.38
1977-78	43	67.22	12,322	5.16
1978-79	38	110.23	35,919	15.03
1979-80	31	56.52	12,335	5.16
1980-81	25	35.09	101	0.04
1981-82	21	46.25	99,569	41.66
1982-83	23	44.36	36,457	15.25
1984-85	18	42.45	13,621	5.70
1985-86	8	8.25	249	0.10
Total	289	595.00	2,39,025	100.00

General remarks

The present investigation undertaken with the aim of correlating the sea-ranching of pearl oysters with the revival of pearl oyster population in the pearl banks has provided many interesting results. A comparison of 96 million oysters collected during 1955-1961 with that of the 0.2 million oysters collected during the period 1975-1986 clearly shows that the pearl oyster population in the pearl banks have become dwindled.

TABLE 3. *Paar-wise collection of pearl oysters during the period 1975 to 1986 from the pearl banks of the Gulf of Mannar*

Name of the paar	No. of sea trips	Diving effort in hours	Time spent %	Total No. of oysters collected	Percentage in total
NORTHERN PAARS:					
Devi paar	101	220.00	36.97	66,181	27.690
Nagarai paar	39	80.13	13.47	1,26,038	52.730
Vaipar Periya paar	15	41.78	7.02	14,394	6.020
Kurichan paar	20	40.30	6.77	12,824	5.370
Fernando paar	13	27.00	4.54	8,328	3.480
Van Thivu Arupagam paar	10	13.60	2.29	1,328	0.560
Padutha Marikan paar	4	7.63	1.28	501	0.210
Karai paar	4	7.22	12.10	36	0.020
Uttipaar and Uduruvi paar	2	4.00	0.67	2,676	1.120
SOUTHERN PAARS:					
Tholayiram paar	40	73.35	12.33	4,428	1.850
Saith Kudamuthu paar	12	38.63	6.49	876	0.370
Karuval paar	7	15.72	2.64	1,300	0.540
Poonthottam paar	4	5.42	0.91	25	0.010
Pulipundu paar	7	4.35	0.67	12	0.005
Kudamuthu paar	3	3.97	0.67	12	0.005
Vada Onpathu paar	2	3.42	0.57	8	0.003
Sayath Onpathu paar	1	2.33	0.39	—	—
Koothadiar paar	1	2.00	0.34	33	0.013
Vada Kudamuthu paar	2	1.97	0.33	3	0.001
Karai Kudamuthu paar	1	1.92	0.32	—	—
Rajavukku Sippi Sothitha paar	1	0.25	0.04	1	0.004
Total	289	595.00	99.98	2,39,025	100.000

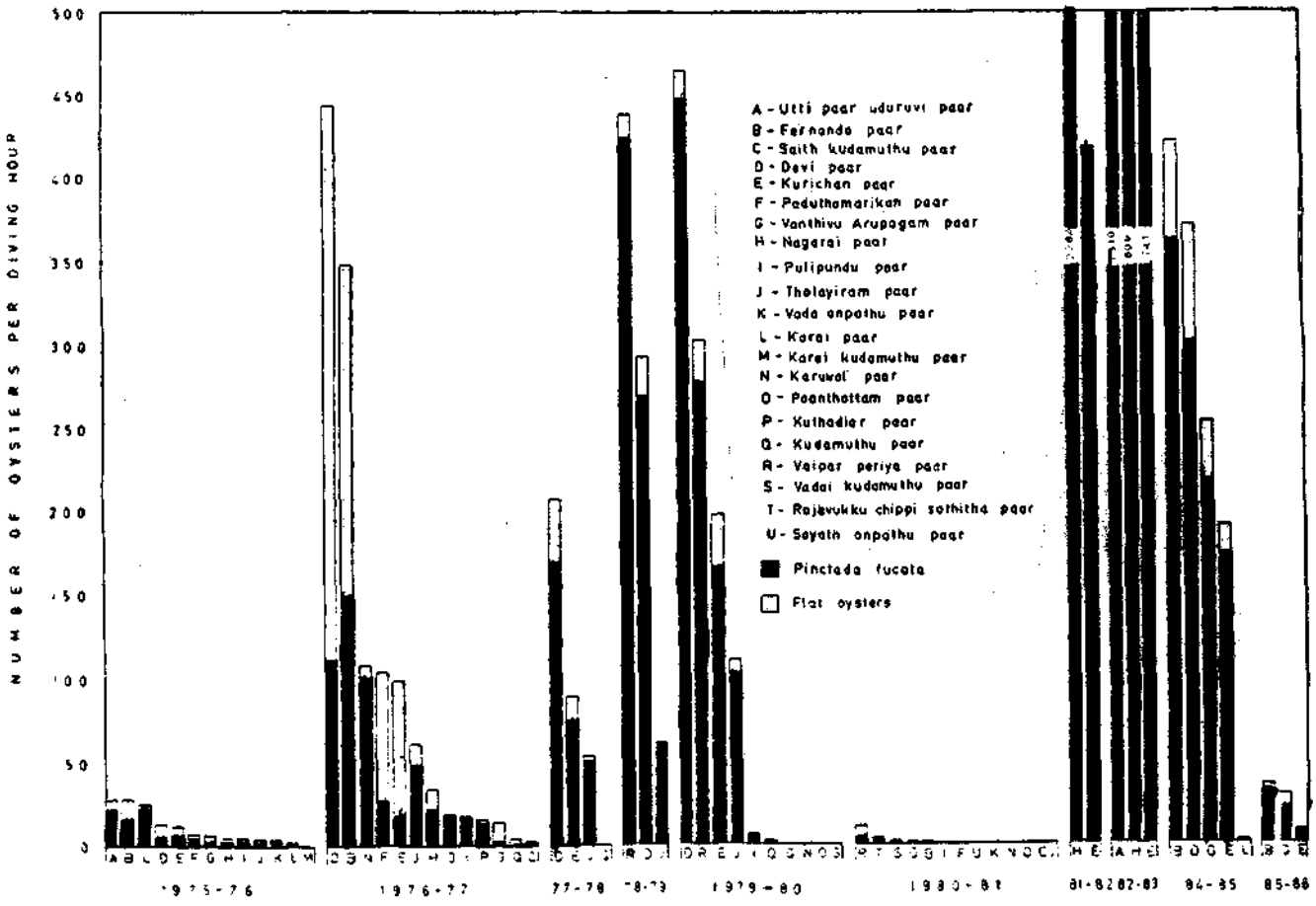

Fig. 1. Collection of pearl oysters from the pearl banks of Gulf of Mannar during 1975 to 1986.

TABLE 4. *Number of pearl oyster ranched during 1985-90*

Date of spawing	Number of spat ranched	Size range of spat in (mm)	Mean size (mm)	Oyster series & date of spawning		Name of paar where ranched
10.12.1985	5,92,000	2.8 — 6.2	4.78	22S	28.08.85	Van Thivu Arupagam
15.02.1986	70,800	1.5 — 3.1	2.29	24S	10.12.85	Van Thivu Arupagam
15.03.1986	5,500	2.1 — 5.2	3.45	24S	10.12.85	Van Thivu Arupagam
	6,68,300					
11.04.1986	32,000	1.0 — 2.5	1.67	25S	15.02.86	Kurichan
30.06.1986	12,000	1.7 — 3.6	2.80	25S	15.02.86	Van Thivu Arupagam
28.07.1986	6,000	2.4 — 4.8	3.54	25S	15.02.86	Van Thivu Arupagam
23.11.1986	10,500	2.1 — 6.6	4.66	27S	26.06.86	Fernando
12.01.1987	53,500	1.0 — 2.5	1.53	28S	13.10.86	Van Thivu Arupagam
20.03.1987	10,000	3.8 — 8.4	5.70	28S	13.10.86	Van Thivu Arupagam
20.03.1987	54,800	1.0 — 2.0	1.70	29S	28.11.86	Van Thivu Arupagam
	1,78,800					
24.04.1987	59,600	1.8 — 11.3	6.50	29S	28.11.86	Van Thivu Arupagam
28.11.1987	34,600	0.9 — 2.1	1.39	31S	18.09.87	Van Thivu Arupagam
	94,200					
18.06.1988	15,000	1.3 — 5.8	3.00	33S	02.04.88	Van Thivu Arupagam
28.12.1988	15,000	1.3 — 5.8	2.80	35S	24.07.88	Van Thivu Arupagam
	30,000					
30.12.1989	34,000	2.0 — 2.5	2.20	39S	24.08.89	Van Thivu Arupagam
16.08.1990	10,000	2.5 — 4.0	3.00	41S	15.06.90	Van Thivu Arupagam
30.12.1990	10,000	2.1 — 5.2	3.60	42S	22.09.90	Van Thivu Arupagam
	20,000					
Total	10,25,300					

During the period 1955 to 1961, the southern group of paars namely Tholayiram paar, Karuval paar, Rajavukku Sippi, Sothitha paar and Kudamuthu group of paars supported the pearl fishery which yielded a total of 96 million oysters whereas the same group of paars yielded a mere 6,700 oysters during the years 1975-1986. The number of sea trips made to these paars during 1975-1986 was 81 and the average number of oysters collected per trip amounted to 82. The number of oysters collected per diving hour was 43. In the 1986-1991 period, a total of 6137 oysters were collected from a mere 15 trips to the same southern group of paars (Table. 5). The collection of oysters per trip was 498 which is almost 5 times more than that of the 1975-1986 season. Similarly the number of oysters collected per diving hour was 365 which is almost 9 times more than that of the 1975-86 season. On 20.7.1990 in about 10 minutes of diving, a total of 215 oysters were collected which amounted to 2,388 oysters per diving hour. This clearly shows that the programme of sea ranching of pearl oysters has begun to show signs of revival.

While ranching the pearl oyster spat in the paar, several billion pearl oyster larvae were also released in the paar. It is a known fact that the water current plays a vital role in the dispersal of pearl oyster larvae. Very little is known about the water movement pattern over the paar area

TABLE 5. *Paar-wise collection of pearl oysters during the period 1986 to 1991 from the pearl banks of the Gulf of Mannar*

Name of the paar	No. of sea trips	Diving effort in hours	Time spent %	Total No. of oysters collected	% in total	No. of oysters per diving hr.
NORTHERN PAARS:						
Devi paar	4	4.20	8.64	11	0.18	3
Vaipur periya paar	1	1.45	3.49	—	—	—
Nagarai paar	2	3.05	6.15	—	—	—
Van Thivu Arupagam paar	7	10.30	20.93	—	—	—
Padutha Marikan paar	1	1.35	3.15	—	—	—
Fernando paar	3	4.30	8.97	6	0.10	1
Kurichan paar	2	2.55	5.81	—	—	—
Klathi paar	1	1.45	3.45	—	—	—
Petha paar	1	1.35	3.15	—	—	—
Utti paar	1	1.30	2.99	—	—	—
Karai paar	1	—	—	—	—	—
SOUTHERN PAARS:						
Koothidiar paar	1	1.30	2.99	—	—	—
Tholayiram paar	2	2.15	4.49	—	—	—
Pulipundu paar	3	2.10	4.32	279	4.54	129
Kanava paar	1	1.15	2.49	1,261	20.50	1,009
Kadayan paar	1	1.30	2.99	155	2.52	103
Vadai Kudamuthu paar	1	1.00	1.99	670	10.90	670
Kuruval paar	1	1.00	1.99	707	11.50	707
Pullavali	1	0.30	1.00	29	0.47	58
Kudamuthu paar	2	3.00	5.98	2,585	42.04	862
Poonthottam paar	1	1.00	1.99	101	1.64	101
Rajavukku Sippi Sothitha paar	1	1.30	2.99	345	5.61	230
Total	39	50.10	99.99	6,419	100.000	3,773

excepting extrapolation from local current and tide conditions. There is a general drift of water over pearl banks from south to north between April to September and north to south during October to April. Hence the pearl oyster larvae that were released over a particular paar need not necessarily settle on the same paar but can be carried away from the paar by the water current. The current velocity in the coastal waters of Tuticorin ranged from 0.047 knot/hour to 1.15 knots/hour. Therefore the larvae released over the paar may be carried to the distant paars and settle down as spat. If the sea bottom is conducive for their survival and growth, they may attach themselves to the substratum and grow. Otherwise they perish after settlement. Another assumption is that the sea ranched spat in the paar grow and attain sexual maturity within an year. These oysters act as 'breeding reserve' to resuscitate the population. The larvae resulted from the spawning of these oysters may also be carried away to distant paars and settle down as spat.

In order to study the effect of ranching on the revival of pearl oyster population, several sea trips were made to different pearl beds and collected data on the population density of oysters by direct underwater observations utilizing the facilities of SCUBA diving. On several occasions the ranched spat could not be traced at the sea bottom. Unless a scientific method is devised to locate the site, it would be impossible to make further observations on the survival and growth of ranched spat.

From 1975 onwards, the pearl oyster beds of Gulf of Mannar were inspected at regular intervals and oysters from the paars were collected for mother oyster culture and seeding operations. When the technology for mass production of pearl oyster spat in the hatchery laboratory was perfected, the collection of oysters from the natural beds for farming purposes came to a stand still in 1986. Thereafter from 1986 onwards the number of trips to the various oyster beds have been reduced. Between the years 1986 and 1993, only 39 sea trips were made and as a result many paars were not surveyed. However, some data on the pearl oyster population could be obtained from M/S TNFDC, Tamil Nadu through personal communication. Dense population of pearl oysters were recorded both in the southern as well as northern group of paars.

Discussion

C. S. G. Pillai : How can we say that the increase in the pearl oyster population is due to searanching ?

A. C. C. Victor : Eventhough locating the ranched oysters is a major problem, the considerable increase in number of oysters per diving over that prior to sea ranching is clear indication that the increased population is due to sea ranching.

S. Sivakami : Can pearl oyster seed be ranched into bays or other enclosed areas for enabling us to re-locate tham at a later stage ?

A. C. C. Victor : No, they can be ranched only on paars as they require hard substratum and other ecological conditions.

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RANCHING OF CLAMS IN THE ASHTAMUDI LAKE*

Introduction

It is well known that ranching of the hatchery-produced seed of commercially important finish and shellfish in the natural habitat or the other suitable areas would enhance their population. Certain aspects in the ecology and biology of the clams such as their restricted movements, feeding by filtering the naturally available plankton in the water and their occurrence in shallow coastal waters which renders monitoring easy, make the clams highly suitable for ranching.

Clam resources, exploitation and utilisation

Among the exploited bivalve resources, clam occupy top position with an annual production of about 50,000 t. Kerala ranks first accounting for 72% of clam landings. Several species of clams contribute to the fisheries, the notable being *Villorita cyprinoides*, *Meretrix meretrix*, *M. casta*, *Katelysia opima*, *Paphia malabarica* and *Anadara granosa*. They are fished all along the Indian coasts in numerous estuaries and bays. Men, women and children collect the clams usually during low tide either by hand-picking or with the help of a hand-operated scoop net or dredge. They are a cheap source of animal protein for coastal people and play an important role in the rural economy. The shell is used in several lime-based industries.

A beginning was made in the export of frozen clam meat to Japan in 1981 and since then the market has expanded and now the clam products are being exported to several countries like U. S. A., Australia, Kuwait, Belgium, France, Italy and U. K. In 1990 the exports amounted to 520.7 t valued at Rs. 1.01 crores. Among the clams, *P. malabarica* followed by *K. opima* are much sought after in the export trade. A recent addition to the exports is the individually quick frozen meat of *M. casta* and *V. cyprinoides*.

Development of hatchery technology

The Central Marine Fisheries Research Institute at its Tuticorin Research Centre has initiated work in 1987 to develop hatchery technology for the production of clam seed. A break through was achieved and hatchery technology has been developed for the production of the seed of *M. casta*, *A. granosa* and *P. malabarica*. The methods are being standardised by scaling-up the operations.

Selection of species for ranching

In view of its ready acceptance and the high value it fetches, *P. malabarica* holds a prime place in the overseas markets. The meat is sold at Rs. 20 to Rs. 30/ kg depending upon the size, at the production centres to the processing plants. This species contributes to the bulk of clam export earnings and a 20 hactare bed in the Ashtamudi area is contributing significantly to the export earnings. In view of its importance in the export market, *P. malabarica* has been chosen as a candidate species for ranching.

Ranching of *P. malabarica* at Ashtamudi and Munambam

P. malabarica was spawned at the Tuticorin hatchery in September 1992, and after nursery rearing in the Tuticorin Bay the seed were transported to Ashtamudi and Munambam near Cochin.

In Ashtamudi near Delavapuram, a total of 64,000 seed of *P. Malabarica* measuring 12.4 mm average length were ranched on 18.2.1993 in 25 m^2 area in 1 m depth and the site was fenced with 3.0 mm netlon screen. On 19.3.93 they measured 20.4 mm and by 3.5.93 they grew to 30.3 mm. In the same area a total of 30,000 seed of *P. malabarica* measuring 4.9 mm length were reared in cages as their size was small for planting in the field. By 3.5.93 they attained 12.2 mm and were ranched in the same area. These seed were covered with 1 cm mesh synthetic net to protect them from predators.

At Munambam, *P. malabarica* occurs rarely and with a view to study whether a population of this species can be established by introduction, a consignment of 8,500 seed were ranched in 10 m^2 area on 19.2.93 in 0.5 m depth. The clam seed measured 12.4 mm and they were covered

* This article is based on the work carried out by K. A. Narasimham, D. Sivalingam, T. S. Velayudhan, V. Kripa, K. Jayapalan and M. Enose. The article was prepared and presented by K. A. Narasimham.

RANCHING OF CLAMS IN THE ASHTAMUDI LAKE*

Introduction

It is well known that ranching of the hatchery-produced seed of commercially important finish and shellfish in the natural habitat or the other suitable areas would enhance their population. Certain aspects in the ecology and biology of the clams such as their restricted movements, feeding by filtering the naturally available plankton in the water and their occurrence in shallow coastal waters which renders monitoring easy, make the clams highly suitable for ranching.

Clam resources, exploitation and utilisation

Among the exploited bivalve resources, clam occupy top position with an annual production of about 50,000 t. Kerala ranks first accounting for 72% of clam landings. Several species of clams contribute to the fisheries, the notable being *Villorita cyprinoides, Meretrix meretrix, M. casta, Katelysia opima, Paphia malabarica* and *Anadara granosa.* They are fished all along the Indian coasts in numerous estuaries and bays. Men, women and children collect the clams usually during low tide either by hand-picking or with the help of a hand-operated scoop net or dredge. They are a cheap source of animal protein for coastal people and play an important role in the rural economy. The shell is used in several lime-based industries.

A beginning was made in the export of frozen clam meat to Japan in 1981 and since then the market has expanded and now the clam products are being exported to several countries like U. S. A., Australia, Kuwait, Belgium, France, Italy and U. K. In 1990 the exports amounted to 520.7 t valued at Rs. 1.01 crores. Among the clams, *P. malabarica* followed by *K. opima* are much sought after in the export trade. A recent addition to the exports is the individually quick frozen meat of *M. casta* and *V. cyprinoides.*

Development of hatchery technology

The Central Marine Fisheries Research Institute at its Tuticorin Research Centre has initiated work in 1987 to develop hatchery technology for the production of clam seed. A break through was achieved and hatchery technology has been developed for the production of the seed of *M. casta, A. granosa* and *P. malabarica.* The methods are being standardised by scaling-up the operations.

Selection of species for ranching

In view of its ready acceptance and the high value it fetches, *P. malabarica* holds a prime place in the overseas markets. The meat is sold at Rs. 20 to Rs. 30/ kg depending upon the size, at the production centres to the processing plants. This species contributes to the bulk of clam export earnings and a 20 hactare bed in the Ashtamudi area is contributing significantly to the export earnings. In view of its importance in the export market, *P. malabarica* has been chosen as a candidate species for ranching.

Ranching of *P. malabarica* at Ashtamudi and Munambam

P. malabarica was spawned at the Tuticorin hatchery in September 1992, and after nursery rearing in the Tuticorin Bay the seed were transported to Ashtamudi and Munambam near Cochin.

In Ashtamudi near Delavapuram, a total of 64,000 seed of *P. Malabarica* measuring 12.4 mm average length were ranched on 18.2.1993 in 25 m^2 area in 1 m depth and the site was fenced with 3.0 mm netlon screen. On 19.3.93 they measured 20.4 mm and by 3.5.93 they grew to 30.3 mm. In the same area a total of 30,000 seed of *P. malabarica* measuring 4.9 mm length were reared in cages as their size was small for planting in the field. By 3.5.93 they attained 12.2 mm and were ranched in the same area. These seed were covered with 1 cm mesh synthetic net to protect them from predators.

At Munambam, *P. malabarica* occurs rarely and with a view to study whether a population of this species can be established by introduction, a consignment of 8,500 seed were ranched in 10 m^2 area on 19.2.93 in 0.5 m depth. The clam seed measured 12.4 mm and they were covered

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with 1 cm mesh synthetic net. By the end of April they attained 23.4 mm length.

Future work

A beginning has been made in ranching the seed of *P. malabarica* at two different places in Kerala. The seed production programme will be intensified and the ranching will be scaled-up in the coming years and studies will be taken up to assess the effect of ranching of seed on the population structure of clams in the study area.

Discussion

G. Luther: What is the shell-meat ratio in *Paphia malabarica*?

K. A. Narasimham: The meat is about 11-14% of the total weight (shell-on weight).

K. H. Mohamed: Why was *Paphia* selected for sea ranching experiments?

K. A. Narasimham: This is one clam which has got much demand in export market but the resource is limited.

SEA RANCHING OF SEA CUCUMBERS*

Introduction

Sea ranching is resorted to when natural populations in the sea have been depleted due to overfishing. Sea cucumbers being defenceless animals offer no resistance at the time of capture and are indiscriminately fished out. They also do not make any attempts to move away like fish or prawns. This has resulted in large scale capture of sea cucumbers including small and immature forms. To check this population depletion, Government of India took a decision to ban the export of processed material which is less than 75 mm. This is the first step in the right direction. A programme on intensive seed production and sea ranching of sea cucumbers has been taken up as a joint project with MPEDA. This Project is partly funded by the MPEDA.

Background information

In case of sea cucumbers, seed was produced only in China and Japan earlier and in recent years, also in Korea and Russia for the species *Stichopus japonicus*. Since the longevity of *S. japonicus* is more and growth rate is slow when compared to Indian species and hence is very expensive to maintain in the laboratory for long periods their seeds are only sea ranched. Normally they sea ranch the seed when it reaches a length of 20-40 mm. In India though some seed is produced in case of *Holothuria scabra* so far no sea ranching programme is undertaken due to the limited seed produced. This seed is used to conduct experiments on growth and survival of the seed.

Sea cucumber as material for sea ranching

Sea cucumber lend themselves well for sea ranching since they immediately settle down to the bottom and also remain at the same place where they are sea ranched since sea cucumbers have limited movements. Also young forms are known to live among coral reefs for protection. This habit also helps them to survive better and contribute to the fishery.

Selection of sea ranching site

Selection of suitable site for sea ranching is the most important for the success of the programme. Sea cucumbers being stenohaline cannot tolerate wide ranges is salinity. Therefore river mouth, estuaries and other bays where the salinity goes down below 10 ppt during the monsoon season have to be avoided. Also rocky beds have to be avoided since the sea cucumbers live on the mud or sand and fixed on the organic matter present in the same. Too much of vegetation like algal beds are also not suitable as sea ranching sites. It is best to make a survey first for natural beds and then to sea ranch the juveniles in nearby coral reefs. The most important aspect in this programme is that the area where sea cucumber is sea ranched should be a protected area and free from activities of the fishermen and fishing operations. If trawl net is operated over the area all the juveniles sea ranched will enter the net resulting in total failure of the programme. Another aspect to be borne in mind is that the area where the juveniles are left should be free from strong currents which will

*This article is based on the work carried out by D. B. James, A. D. Gandhi and N. Palaniswami. The article was prepared and presented by D. B. James.

sweep away all the seed sea ranched. Therefore the ideal sites for sea ranching are coral reefs near natural beds where there is not much fishing. National marine park at Wondoor can be as a biological reserve for *H. scabra*.

Effect of sea ranching

Simply dumping the seed into the sea makes the sea ranching programme meaningless. If the sea ranching is to have some effect on the populations that contribute to the fishery naturally large number, preferably millions of seed have to be sea ranched to offset the natural mortality before they reach harvestable size. The catches from the nearby areas have to be continuously monitored. If the catches significantly increase we can put it down to the success of sea ranching programme. It has to be admitted that this programme has not produced any tangible results in the Pacific.

Feed back information essential

In order to know the success of this programme feed back information is essential. One way to do this is to first select a suitable site where natural populations are distributed. Then a survey has to be conducted with the help of divers to note the number of specimens distributed in unit areas like 100 sq. m. In this area the seed produced in the hatchery has to be sea ranched. For an area of 100 sq. m. about 300 juveniles can be sea ranched. After a period of six months the same area has to be surveyed to find out the number of large specimens. This gives an idea about the effect of sea ranching. The longevity of sea cucumbers is more and they take a long time to reach harvestable size. For example the longevity of *Holothuria scabra* is estimated to be 10 years and the species reaches harvestable size in 18 months. Sea cucumbers can also be tagged at the time of release to find out their contribution to the fishery. For tagging special tagging guns are available. The tags used for sea cucumbers are known as Dennison tags. Body sites for tagging in different species of holothurians are different. *Actinopyga echinites* can be tagged at mid-doral, anterior and posterior ends. *Thelenota ananas* can be tagged at either end. The tagging positions for *Holothuria nobilis* are also the same. The animals were injected with micro tags. They can later be detected only by X-ray or tag detector. Small individuals seem to lose the tags readily than the larger ones. Also it was found that tags injected near the anterior end retained for longer period than those injected at other sites. Some of the tags are recovered after one and half years. Tagging is labourious, cumbersome and time consuming.

Marking the animals with biological stains

If the juvenile sea cucumbers are marked with some biological stains which will remain for the rest of life without affecting the animal, this can be tried. In this way large number of juveniles can be marked at a time and this method will be best suited for sea ranching programme. By the earlier method of tagging only limited number of specimens can be marked. At present various colouring substances are marked on the ventral side of *H. scabra* which is white, to see how long they will be retained in the laboratory.

Discussion

K. H. Mohamed: Since sea cucumber is a limited resource but in good demand, culture prospects may also be explored along with sea ranching if enough seed can be produced. Lakshadweep and Andaman & Nicobar Islands will be ideal areas for sea ranching.

T. S. Velayudhan: Have you made any survey to locate areas suited for the survival of sea cucumbers?

D. B. James: This work is under way.

Conclusion

After the presentation of each of the papers followed by discussion on it, the Chairman invited the participants for further comments as conclusion as to how programme of sea ranching should go further.

K. H. Mohamed: apart from the groups covered already, others like mussels, seaweeds and fishes such as mullets and chanos must also be considered for sea ranching, if not in the near future.

Daniel Selvaraj: Since we are not fully sure about the prospects of sea ranching the groups of which the hatchery technology is known, it may be economical to include other groups at present.

V. Sreeramachandra Murty: First we have to make an assessment of the impact of sea ranching on the natural population, and

then only we can proceed further to make it a meaningful proposition.

K. Rengarajan: Some resource need conservation, some others need enhancement, and still others require both. We must be very clear about the objectives while embarking upon sea ranching.

D. B. S. Sehara: Economic and social aspects of sea ranching are important factors, and unless some profitability is assured, no private agency will be inclined to fund any sea ranching programme.

Winding up the seminar, the Chairman again stressed the need to have a correct perspective about the whole aspects of sea ranching and its necessity in the present national context. Repopulation of the natural habitat necessitated either by excessive exploitation, as in the case of spiny lobster, or by devastation due to natural causes as in the case of clam which are often destroyed by freshwater run off, can be achieved by sea ranching. Apart from the groups for which we have hatchery technology, the ornamental molluscs *Trochus* and *Turbo* of Andaman Islands are promising species. A good hatchery is a prime requisite for production of seed which can be used not only for ranching but also for farming. Sea ranching becomes more important when pressure is felt for land-water bodies for farming. Scaling-up needs proper funding, for which sufficient justification and profitability have to be established and projected. The Chairman thanked all those participated in the seminar, and hoped that the interest generated by it will sustain to create more awareness and motivation.

सी एम एफ आर आइ कोचीन में दिनांक 28-4-1993 को समुद्र रैंचन पर आयोजित संगोष्ठी की कार्यवाही

केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान ने, इस संस्थान और अन्य संस्थानों के वैज्ञानिकों और तकनीकी अधिकारियों के हित केलिए अनुसंधान आविष्कारों पर संगोष्ठियाँ चलाने का निश्चय किया है। इस तरह की पहली संगोष्ठी प्रमुख समुद्री मछली और कवच प्राणियों के स्टॉक निर्धारण पर था, जिसका आयोजन केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान में अप्रैल 23, 1993 को किया था।

दूसरी संगोष्ठी समुद्र रैंचन पर था और इसका आयोजन डॉ पी. एस. बी. आर. जेम्स, निदेशक की अध्यक्षता में अप्रैल 28, 1993 को संपन्न हुआ था। इस संगोष्ठी में झींगे, महाचिंगट, मुक्ता शुक्ति, सीपी और समुद्री ककडी पर चर्चा की गई।

भागीदारों को स्वागत करने के बाद अध्यक्ष ने समुद्र रैंचन के प्रारंभ, संकल्प और वर्तमान स्थिति पर विस्तृत भाषण दिया। समुद्र रैंचन का विचार पहले पहल 1870 में अमरीका में प्रारंभ हुआ था। इसके बाद अनेक देश संपदाओं को बढाने केलिए समुद्र रैंचन कर रहे हैं। संपदाओं के आरक्षण केलिए भी समुद्र रैंचन सहायक है। 1975 से जापान में समुद्र रैंचन का विकास हुआ और जपानिस सीफार्मिंग एसोसियेशन की स्थापना हुई जिसने रैंचन केलिए बीजोत्पादन की एक प्रणाली विकसित की। आजकल 45 से अधिक जातियों का समुद्र रैंचन यहाँ हो रहा है। मछलियों में कागेशिमा के रेड सी ब्रीम समुद्र रैंचन का एक उत्तम उदाहरण है। इसके अतिरिक्त आज कई अन्य जातियों का रैंचन हो रहा है। जापान से साल्मन को अमरिका में प्रतिरोपित करने केलिए भी प्रयत्न हो रहा है।

समुद्र रैंचन पर कई आशंकाएं भी है कि रैंचन किये गए बीज हमारी आशा के अनुसार बढेंगे और उन्हें पकड सकेंगे और इस पर व्यय किए गए धन और समय का कोई गारंटी नहीं है। दुनिया भर के कई देशों द्वारा समुद्र रैंचन पर प्राप्त सफलता ही इसका उत्तर है।

समुद्र रैंचन का विचार भारत में तब शुरू हुआ था जब 1961 में मान्नार खाडी में मुक्ता मात्स्यिकी की घटती होने लगी थी। इसका परिहार समुद्र रैंचन ही समझा गया और टूटिकोरिन में एक हैचरी की स्थापना करके भारी मात्रा में बीजोत्पादन किया गया और यह कार्य समुद्र रैंचन को आसान बना दिया। प्रकृतिजन्य श्रोतों से झींगों की पकड में आज बडी कमी महसूस की जा रही है। झींगा बीजों का रैंचन इस प्रसंग में बहुत ही अनिवार्य है। इसके अलावा शूली महाचिंगट, सीपी और समुद्री ककडी जिसकी निर्यात की दृष्टि से बढती मांग है, का समुद्र रैंचन करना चाहिए क्योंकि इनके बीजों का उत्पादन हैचरियों में सफलता से किया जा सकता है।

झींगों का समुद्र रैंचन

झींगों के समुद्र रैंचन का विचार पहले पहल जापानियों के मन में हुआ था। उन्नीस सौ अस्सी के आरंभ में जापान ने *पेनिअस जापोनिकस* जाति के झींगों का वैज्ञानिक संवर्धन में सफलता प्राप्त की थी जिस से उत्पादन बढ गया था। इस जाति की माँग आजकल बहुत बढ गयी है। इसका एक कारण इसका वैज्ञानिक संवर्धन करने केलिए अनुकूल खेतों की कमी है। दूसरा कारण इसके संवर्धित पश्चडिंभकों की बढती माँग है। ये समुद्र रैंचन केलिए अनुयोज्य माने जाते है।

पी. जापोनिकस का समुद्र रैंचन संबंधी परीक्षण जापानियों ने जापान के हमना-को लैगूण में किया था। समुद्र,जल पानी का मेल होने वाला इस लैगूण का विस्तार 6900 हेक्टर है। यहाँ *पी. जापोनिकस* जाति की झींगा अच्छी तरह बढती थी। यहाँ के प्राकृतिक झींगे के साथ जापान के वैज्ञानिकों ने नर्सरी में बढ़ाये बीजों का रोपण किया। पकड संबंधी सांख्यिकीय अध्ययनों ने व्यक्त किया कि पकड में 2.4 गुनी वृद्धि हुई है।

जापान के इस अनुभव को आगे रखते हुये सी एम एफ आर आइ में पहली बार समुद्र रैंचन कार्यक्रम वर्ष 1985 में शुरू किया और 1992 तक जारी रखा। इस परियोजना में लक्षित कार्यक्रम ये हैं।

1. अनुयोज्य झींगा जाति और खेत का चयन
2. पश्चडिंभकों की बडी मात्रा में उत्पादन केलिए कम आय की तकनोलजी का विकास
3. रैंचन केलिए चुने गये खेत में पश्चडिंभकों का मौसमिक व्यतियान संबंधी अध्ययन
4. संवर्धित और प्राकृतिक बीजों की शक्ति संबंधी तुलनात्मक अध्ययन
5. समुद्र में रोपण किये बीजों का प्रवास, बढती और पकड संबंधी अध्ययन
6. झींगा मात्स्यिकी की बढती पकड की दृष्टि से एक ही क्षेत्र में रोपण करने के बीजों की मात्रा

रोपण केलिए *पेनिअस सेमिसुलकाटस* जाति और मंडपम के पाक खाडी क्षेत्र को खेत के रूप में चुन लिया। सी एम एफ आर आइ ने पहले ही *पी. इंडिकस* बीजों का बडी मात्रा में उत्पादन केलिए एक तकनोलजी का विकास किया था। इसको अनुकूल परिवर्तन करके *पी. सेमिसुलकाटस* बीजों के उत्पादन केलिए लागू किया गया। हैचरी के निर्माण केलिए 50000 रु बिताया और इस से एक ही चक्र में एक लाख पश्चडिंभक का उत्पादन लक्षित किया।

इस क्षेत्र में किये गये विशद सर्वेक्षणों ने व्यक्त किया कि मान्नार और पाक की खाडी में तरुणावस्था के *पी. सेमिसुलकाटस* भारी मात्रा में वर्तमान है। इसका प्रजनन पूरे वर्ष में होता है। पर अनुकूल प्रजनन काल जनवरी-फरवरी और जुलाई-अगस्त देखा गया। तरुण झींगों को पकडने का अनुकूल समय अप्रैल-जून और अक्तूबर-दिसंबर है।

हैचरी में उत्पादित और रोपित पश्चडिंभकों पर किए गये अध्ययनों से व्यक्त हुआ कि इन डिंभकों ने 24 घंटों के अंदर लैगून की परिस्थिति से सामंजस्य किया और समुद्र की ओर प्रवास किया।

हैचरी में बढाई *पी. सेमिसुलकेटस* के पश्चडिंभकों की अतिजीविता और बढती को समझने केलिए इन्हें संस्थान के समुद्री तालाबों में पालन किया। इन में 85-95% जिन्दा रहे और बढती का दर दोनों हैचरियों में बढाई और समुद्र में बढी जातियों के समान ही रहा।

पश्चडिंभकों की शक्ति संबंधी उपर्युक्त तुलनात्मक अध्ययन के बाद इसकी बढती, प्रवास और पकड संबंधी अध्ययन चलाया गया। बहुत ही छोटी अवस्था में टैगन के बिना पश्चडिंभकों का रौंचन करने के कारण इस पर अध्ययन आसान नहीं था। इसलिए पश्चडिंभकों का पालन 60 मि मी का होने तक करके उनके टैगन करके पाक की खाडी में वर्ष 1991 में रैंचन किया। रोपण किये पश्चडिंभकों का एक प्रतिशत निकटस्थ अवतरण केन्द्रों की पकड में मौजूद था। इनको 5-53 दिनों में 30-35 कि मी की दूरी से प्राप्त हुये थे। उपर्युक्त परीक्षणों से स्पष्ट हुआ है कि समुद्र रैंचन किये झींगा पश्चडिंभकों का प्रवास, बढाव और पुनः पकड संभव है। अतिजीविता संबंधी विशेष अध्ययनों ने व्यक्त किया कि मृत्यु दर नोप्ली से पश्चडिंभक के रूपांतरणावस्था में अधिक है इसलिए पश्चडिंभक की XV-XX अवस्था में रैंचन करना उचित है।

प्रयोगशाला में *पी. सेमिसुलकाटस* का स्फुटन करने पर एक ही स्फुटन में 1,00,000 नोप्लियाँ मिलती है। इसके उचित अनुरक्षण से 33% ज़िंदा रहेंगे जबकि प्राकृतिक वातावरण में सिर्फ 0.1%। इसका सांख्यिकीय अध्ययन से स्पष्ट है कि प्रयोगशाला का 21 अंडजक समुद्र के 7000 अंडजकों से तुल्य है।

पी. सेमिसुलकाटस के वार्षिक उत्पादन में 100 टन वृद्धि लाने को 2500 लाख PL XV-XX डिंभकों का रैंचन करना है। इसकेलिए स्फुटनशाला स्थापित करने केलिए 350 लाख रुपये का प्रारंभिक निवेश और 50 लाख रुपये का प्रचालन पूँजी चाहिए। अब एक कि ग्राम झींगे का बाज़ार भाव 200 रुपये है। यदि उत्पादन 100 टन बढाया जाएं तो वार्षिक आय भी 200 लाख रुपए में बढ जाएगा। सी एम एफ आर आइ को झींगा संवर्धन केलिए अनुयोज्य तकनोलजी का विकास करने का दायित्व है इसका कार्यान्वियन सरकार का या अन्य विकासात्मक अभिकरणों का काम है।

यह लेख सी एम एफ आर आइ के क्रस्टेशिया मात्स्यिकी प्रभाग समुद्र रैंचन टीम के अधिकारियों पी. वेदव्यास राव, एन. एन. पिल्लै, ई. वी. राधाकृष्णन, पी. ई सामसन माणिक्कम, जी. महेश्वरुडु, एम. आर. अर्पुतराज और के. एन. गोपालकृष्णन द्वारा किए गए अनुसंधान कार्य के आधार पर है।
एन. एन. पिल्लै ने यह लेख तैयार करके प्रस्तुत किया।

शूली महाचिंगटों का समुद्र रैंचन

समुद्र जीवियों का उत्पादन करके समुद्र में तरुणावस्था में छोडने की रीति को समुद्र रैंचन कहता है। इसकी संकल्पना पहले पहल अमेरिका में 1870 में हुई थी, उन्होंने खेतों में तरुण मछलियों का संग्रहण करके उन्हें बाद में पकडने के कार्यक्रम के रूप में समुद्र रैंचन की संकल्पना की थी। जापानियों ने समुद्र रैंचन को जलजीवकृषि के एक अंग के रूप में माना था। यहाँ वर्ष 1962 में समुद्र कृषि प्रारंभ किया था जिसको वर्ष 1975 के होने पर बडा प्रचार मिला था। जापानियों ने समुद्र जीवियों का तीव्र संवर्धन करीब 45 के जाति समुद्र जीवियों के नवोद्भिदों (Seedlings) का विकास किया है। इसके अलावा 80 जातियों से नवोद्भिदों का विकास करने का श्रम हो रहा है। शूली महाचिंगट *पानुलिरस जापोनिकस* इन में एक है।

महाचिंगटों की कमी सारे विश्व में महसूस की जा रही है। भारत में पिछले कुछ वर्षों से इसकी पकड 2000 टन और निर्यात आय 30 करोड रुपये के निकट है। निर्यात करने की रीति में लाए परिवर्तन ने आजकल इसकी माँग बढाई है। भारत में 6 जाति के शूली चिंगट दिखाये पडते है इन में *पी. पोलिफागस* जाति सब से अधिक पकडी जाती है। शूली महाचिंगटों की सविशेषता यह है कि चुने हुये स्थानों में ही इनकी उपस्थिति होती है।

भारत में महाचिंगटों की पकड में कोई नियंत्रण लागू नहीं किया है जबकि इसके निर्यात करनेवाले देशों में परिरक्षण केलिये नियम हैं। भारत में कई स्थानों में प्रजननकाल में इसकी पकड ज्यादा होती है। इसके संरक्षण केलिए जालों के चयन और जीवों के आकार पर कोई न कोई नियम लागू करना चाहिए। हाल ही में पूर्ण आकार में पकडी गई छोटी चिंगटों को निर्यात बाजारों में हुई माँग ने इस अवस्था को और भी खराब किया है। करीब 150 ग्राम के पूर्णाकार महाचिंगटों को बाजार में बडा भाव मिलता है। मद्रास में इन दिनों ट्रामल नेट से पकडी गई मादा महाचिंगटों में 60-70% प्रौढावस्था तक नहीं पहुँचे थे। इसलिए छोटी जातियों की पकड में या छोटी जातियों के निर्यात में पाबंदी लगाना आवश्यक है। झींगों के समान शूली चिंगटों का डिंभकीय चक्र बहुत लंबा है। डिंभकों में एक बडा भाग गहरे समुद्र में बह जाता है और इन में बहुत कम डिंभक तटीय समुद्र में बसने केलिए वापस आता है। यदि अंडजनन और कम आकार की अवस्था में पकडना बंद न करें तो इस मछली का परिरक्षण करना मुश्किल हो जाएगा। इस अवस्था में संतुलनावस्था लाने केलिए समुद्र रैंचन कार्यक्रम बहुत ही उपयोगी होगा। महाचिंगटों की अच्छी पकड जिन भागों से पहले मिली थी उन भागों में बीजों को मुक्त किया जा सकता है। बडी मात्रा में बीजों का उत्पादन करने केलिए अनुसंधान पर प्राथमिकता दी जाती है। इस प्रकार उत्पादित बीजों को प्रकृतिजन्य आवासों में या इसकेलिए विकसित कृत्रिम आवास स्थानों में मुक्त किया जा सकता है।

समुद्र रैंचन केलिये शूली महाचिंगट अनुयोज्य जाति मानी जाती है। इसका पालन प्रकृतिजन्य पंजरों में किया जा सकता है और परिपक्व होने पर वहीं से आसानी से पकडा जा सकता है। इसके अलावा समुद्र की ओर प्रवास करने की आदत इस जाति में बहुत कम है। लेकिन समुद्र रैंचन से उत्पादकता में प्राप्त उपलब्धियों पर और भी अध्ययन की ज़रूरत है।

ई. वी. राधाकृष्णन ने यह लेख तैयार करके प्रस्तुत किया।

मुक्ता शुक्ति का समुद्र रैंचन

आमुख

मुक्ता शुक्तियों के समुद्र रैंचन का मुख्य लक्ष्य उनकी जीवसंख्या बढ़ाना और उनकी खेती केलिए नए संस्तर बनाना है। खेत रैंचन और समुद्र रैंचन में मुख्य अन्तर यह है कि खेत रैंचन में रैंचन किये गये, जीवियों का स्वामित्व, रैंचक का होता है लेकिन समुद्र रैंचन में, ऐसा नहीं किया जा सकता क्योंकि रैंचन समुद्र में होने के कारण स्वामित्व सबका हो जाता है।

खतरे में पडी कुछ जातियों के रैंचन केलिए परिश्रम तो वर्ष 1979 से शुरू किया लेकिन प्रतीक्षा के अनुसार सफलता नहीं प्राप्त हुई।

वाणिज्यिक दृष्टि से प्रमुख मलस्कों का रैंचन 1977 में प्रारंभ हुआ था। मलस्कों का रैंचन पहले पहल जापान ने किया था। वर्ष 1985 के आरंभ तक हैचरी में उत्पादित मुक्ता शुक्तियों के प्राकृतिक संस्तरों में रैंचन करने का कोई कार्य नहीं किया गया था। मुक्ता शुक्तियों के बढती उत्पादन केलिए विकसित हैचरी तकनोलजी ने मुक्ता शुक्तियों के समुद्र रैंचन केलिए रास्ता खोली। इस प्रकार 1985 में एक परीक्षण के रूप में टूटिकोरिन के मुक्ता शुक्ति संस्तरों में समुद्र रैंचन शुरू हुआ।

प्राकृतिक संस्तरों में मुक्ता शुक्तियों का उतार-चढाव

मुक्ता शुक्तियों की व्यापक मृत्यु मिट्टी का अपरदन, तेज़ प्रवाह और शत्रु जीवियों के आक्रमण से होता है। इसके अतिरिक्त अतिमत्स्यन और रोग भी मुक्ता शुक्तियों के अवक्षय का कारण होता है। *बालिस्टीम सेरानस* और नक्षत्र मछली *पेक्टासिरोस लिंकी* आदि परभक्षियों से भी मुक्ता शुक्तियों के नाश होते हैं। कुछ जाँच कर्ताओं के अनुसार ईल, अक्टोपाइ आदि से भी इसका नाश हो सकता है।

प्राकृतिक संस्तरों में मुक्ता शुक्तियों का परिरक्षण

हेर्डमान (1906) ने छोटे "स्ट्राइड्स" या मुक्ता शैवों को अनुत्पादी क्षेत्रों से उत्पादी क्षेत्रों में प्रतिरोपित करने का सुझाव दिया है। देवनेशन और चितंबरम ने मुक्ता शुक्ति संस्तरों का एक वर्ग कि. मी का एक सांक्चुरी बनाने केलिए सिफारिश किया, जिसका मत्स्यन नहीं करना है।

समुद्र रैंचन

मुक्ता शुक्ति बीजों के 1981 में बडे पैमाने पर उत्पादन सफलता प्राप्ति के बाद, टूटिकोरिन में एक परीक्षणात्मक समुद्र रैंचन कार्यक्रम का प्रारंभ किया था। इसकेलिए बान, तिवु, अरुपगम पार, कुरिचन पार और फरेनान्डो पार के चयन किये थे। इनकी गहराई 12 मी थी। दिसंबर 1985 और 1990 के बीच 17 अवसरों में 1,02,500 *पिंक्टाडा फ्यूटकेटा* बीजों का रैंचन हुआ। रैंचन किये गये स्पाटों की औसत लंबाई 1.53 से 5.7 मि मी और 0.9 मि मी से 11.3 मि मी के बीच में थी।

रैंचन तरीका

रैंचन किए जाने वाले स्पाटों को हैचरी टैकों में डालते है और पुराने फिश जाल, वेलोन स्क्रीन फाब्रिक और मोनोफिलमेन्ट टफटस आदि सिन्तेटिक वस्तुओं पर बसने का अवसर देता है। इन सिन्तेटिक वस्तुओं को स्पाटों के साथ बडे समकोणीय पंजरों में (90x60x15 Cm) सिन्तेटिक वेब्बिंग से आवृत करके रखते है। इसके बाद पंजरें पुराने फिश जालों से और भी आवृत करता है। स्पाटों से भरे पंजरों को धागों से बाँधकर बह जाने से रोकने केलिए खोकले में प्रबल से रखे जाते है।

मात्स्यिकी का झुकाव

टूटिकोरिन और तिरुचेन्दूर के तटरेखाओं में स्थित मुक्ता बैंकों में 1955 से 1961 तक मुक्ता मत्स्यन का लंबा प्रचालन हुआ था। कुल 95,867,460 मुक्ता शुक्तियों का संग्रहण हुआ था। तोलायिरम पार का मत्स्यन 1955 और 1956 में हुआ और 1957, 1958 और 1959 के दौरान इस क्षेत्र को छोड दिया। कारुअल, राजवुक्कु, चिप्पि, सोतितापार, कुडमुत्तु ग्रूप आदि क्षेत्रों में 1957, 1958 और 1959 में भारी मत्स्यन हुआ।

तमिलनाडु सरकार ने 1961 से आज तक मुक्ता स्टॉक की कमी के कारण मुक्ता मत्स्यन पर रोक लगाया है। केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान ने 1975-76 से मुक्ता शुक्ति संस्तरों का सर्वेक्षण करने का दायित्व लिया था। 1975 से 1986 तक की अवधि में मुक्ता शुक्ति संस्तरों में 289 समुद्र यात्र चलायी और 2,39,025 मुक्ताओं का संग्रहण किया। 1980-81 की अवधि में संग्रहण कम था और 1981-82 में संग्रहण काफी अच्छा था। इस अवधि में अधिकतम संग्रहण नागराइ पार से हुआ था।

सामान्य अभ्युक्तियाँ

मुक्ता शुक्तियों के समुद्र रैंचन और मुक्ता तटों में शुक्तियों की संख्या के सहसंबंध पर किए गए अध्ययनों से कई अच्छे परिणाम निकले हैं। वर्ष 1955-1961 के दौरान प्राप्त 96 मिलियन और वर्ष 1975-1986 के दौरान प्राप्त 0.2 मिलियन मुक्ताओं की तुलना से मुक्ता बैंकों में मुक्ता शुक्तियों की कमी

महसूस हो जाती है। वर्ष 1955-1961 के दौरान दक्षिण से 96 मिलियन शुक्तियाँ प्राप्त की हैं लेकिन इन क्षेत्रों से वर्ष 1975-1986 की अवधि में सिर्फ 6,700 शुक्तियाँ प्राप्त की हैं। इस अवधि में इस क्षेत्र में 81 समुद्री पर्यटन किए गए हैं। वर्ष 1986-1991 की अवधि में किए गए 15 पर्यटनों से 6137 शुक्तियाँ प्राप्त हुई है। यह रैंच पहली अवधि से ज़्यादा है। दिनांक 20-7-1990 को दस मिनट के निमज्जन से कुल 215 शुक्तियाँ प्राप्त हुई। इन बातों से यह व्यक्त हो जाता है कि मुक्ता शुक्तियों के समुद्र रैंचन कार्यक्रम में पुनरुज्जीवन का समय आया है।

पार में मुक्ता शुक्ति स्पाटों का समुद्र रैंचन करते वक्त प्रबल जल तरंगों के कारण अधिकांश डिंभक बह जाते हैं। इस प्रकार बह गए डिंभक कहीं दूर उचित स्थान में स्पाट के रूप में बढ़ने लगते हैं। इसके बारे में दूसरा अनुमान यह है कि पार में रैंचन किए गए स्पाट बढ़कर एक वर्ष के अंदर प्रौढ़ हो जाते हैं और अंडजनन के बाद होने वाले डिंभक कहीं दूर बहकर स्पाट के रूप में बस जाते है।

मुक्ता शुक्ति की जीवसंख्या के पुनरुज्जीवन पर समुद्र रैंचन के प्रभाव का अध्ययन करने के लिए मुक्ता संस्तरों से आंकडा लेने के उद्देश्य से कई समुद्री पर्यटन किए गए। अधिकांश अवसरों में रैंचन किए गए स्पाटों को उसी स्थान में देख नहीं पाया। इसकेलिए सी आइ एफ एन ई टी की सहकारिता भी मांगी गई और वहाँ के मुख्य अनुदेशक पर्यटन के वक्त पोत में आया। उनके नेतृत्व में किए गए पर्यटन में मुक्ता शुक्ति का पंजर निश्चित स्थान में रखा गया और अगले दिन फिर से पर्यटन करने पर यह पंजर उसी स्थान में नहीं दिखाया पडा। बार बार यह परीक्षण करने पर भी रैंचन का स्थान देख नहीं पाया। इसके लिए वैज्ञानिक रूप से कोई तरीका ढूँढने पर भी रैंचन किए गए स्पाट की अतिजीविता और बढ़ती आंकना मुश्किल होगा।

वर्ष 1975 से लेकर मान्नार खाडी के मुक्ता शुक्ति संस्तरों का नियमित रूप से निरीक्षण किया और कुछ मुक्ताओं को बीजोत्पादन केलिए संग्रहित किया गया। स्फुटनशाला में मुक्ता शुक्ति बीजों के बडे पैमाने में उत्पादन करने की तकनोलजी ढूँढने के बाद प्राकृतिक संस्तरों से शुक्तियों का संग्रहण रोका गया। वर्ष 1986 के बाद विभिन्न शुक्ति संस्तरों तक के पर्यटन की संख्या काट कर ली। इसके अनुसार वर्ष 1986 और वर्ष 1993 के बीच में केवल 39 पर्यटन किए गए। तमिलनाडु के एक निजी संस्था से मुक्ता शुक्ति की जीव संख्या पर कुछ आंकडा मिल सका। दक्षिण एवं उत्तर पार ग्रूपों में मुक्ता शुक्तियों की भारी संख्या देखी गई।

यह लेख ए. सी. सी. विक्टर, ए. चेल्लम, एस. धर्मराज, टी. एस. वेलायुधन, के. श्रीनिवासगम, ए. धर्मन फेर्नान्डस, एफ. शूसै बी. रायन, एन. जेसुराज और के. षण्मुखसुन्दरम द्वारा किए गए अनुसंधान कार्य के आधार पर है। यह लेख ए. सी. सी. विक्टर ने तैयार करके प्रस्तुत किया।

अष्टमुडी झील में सीपियों का रैंचन

आमुख

वाणिज्यिक दृष्टि से महत्वपूर्ण फिनफिश और कवच प्राणियों के हैचरी में उत्पादित बीजों को प्राकृतिक या अन्य क्षेत्रों में पालने से उनकी संख्या बढ़ जाती है। सीपियों के पारिस्थितिक और जीव-विज्ञान संबन्धी कुछ विशेषताएं जैसे इनकी मंद चलन, जल में पाये जानेवाले प्लवकों को खाने की आदत, उथले तटीय जल में इनकी उपस्थिति आदि इनका संवर्धन आसान बनाते हैं।

सीपी संपदाएं, शोषण और उपयोग

द्विकपाटी संपदाओं में 50,000 टन वार्षिक उत्पादन के साथ सीपी का पहला स्थान है। सीपी अवतरण में 72% के साथ केरल सबसे आगे है। इनकी कई जातियाँ है, जिनमें *विल्लोरिटा साइप्रिनोइड्स, मेरिट्रिक्स मेरिट्रिक्स, एम. कास्टा, काटेलीसिया ओपिमा, पाफिया मालबारिका* और *अनाडारा ग्रानोसा* मुख्य है। भारतीय तट के असंख्य ज्वारनदमुखियों और खाडियों से इन्हें पकडे जाते है। मर्द, औरतें और बच्चे निम्नज्वार के दौरान हाथों से या हाथ से प्रचालित स्कूप जाल या ड्रेडज से इनका संग्रहण करते हैं। यह प्रोटीन का एक सस्ता मार्ग है और गाँवों की आर्थिक व्यवस्था में भी इनका प्रमुख स्थान है। इनके कवच चूना उद्योगों केलिए उपयोग करते हैं।

1981 में पहले पहल हिमशीतित सीपी मांस का निर्यात जापान में किया था और उस समय से सीपी उत्पादों का निर्यात यू. एस. ए., आस्ट्रेलिया, कुवाइट, बेलजियम, फ्रान्स, इटली और यू.के. आदि अनेक देशों राज्यों में निर्यात होता रहता है। वर्ष 1990 में 1.01 करोड रुपये का 520.7 टन मांस का निर्यात हुआ था। निर्यात व्यापार में सबसे अधिक मांग *पी. मालबारिका* की और इसके बाद के. *ओपिमा* की होती है। *एम. कास्टा* और *वी. साइप्रिनोइड्स* के हिमशीतित मांस का निर्यात भी आजकल होता है।

हैचरी तकनोलजी का विकास

केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान ने इसके टूटिकोरिन अनुसंधान केन्द्र में 1987 में सीपी बीजों के उत्पादन केलिए हैचरी तकनोलजी के विकास का काम शुरू किया। इसमें सफलता प्राप्त हुई और *एम. कास्टा, ए. ग्रानोसा* और

पी. मालबारिका के बीजों के उत्पादन केलिए हैचरी तकनोलजी का विकास किया गया।

रैंचन केलिए जातियों का चयन

अनायास उपलब्धता और उच्च मूल्य प्राप्ति के कारण विदेशी बाज़ारों में *पी. मालबारिका* का महत्वपूर्ण स्थान है। आयाम के आधार पर इसका मांस प्रति कि. ग्रा 20 से 30 रु की दर में बेच दिया। निर्यात अर्जन में इस जाति का योगदान उल्लेखनीय है। निर्यात बाज़ार में प्राप्त महत्व की दृष्टि से *पी. मालबारिका* को रैंचन केलिए चुन लिया गया है।

अष्टमुडी और मुनम्बम में *पी. मालबारिका* का रैंचन

टूटिकोरिन हैचरी में सितंबर, 1992 के दौरान अंडजनन किये गए *पी. मालबारिका* को टूटिकोरिन खाडी में नर्सरी पालन के बाद कोचिन के निकट अष्टमुडी और मुनम्बम की ओर परिवहित किया।

दलवपुरम के निकट अष्टमुडी में 18-2-1993 को एक मीटर गहराई के 25 मी क्षेत्र में 12.4 मि मी औसत लंबाई के 64,000 बीजों का रैंचन किया गया। 19.3.1993 को इन बीजों ने 20.4 मि मी लंबाई प्राप्त की और 3-5-1993 को 30.3 मि मी। इसी क्षेत्र में 4.9 मि मी लंबाई के 30,000 *पी. मलबारिका* बीजों को छोटे आकार के कारण खेतों में न डालकर पंजरों में पाले थे और 3-5-1993 तक 12.2 मि मी लंबाई प्राप्त की। इन बीजों को परभक्षियों से बचाने केलिए एक से मी जालाक्षियों वाला सिन्तेटिक जाल से आवृत करता है।

मुनम्बम में *पी. मालबारिका* बहुत विरल है। इस जाति को यहाँ बढाने केलिए 19-2-1993 को 0.5 मी गहराई के 10 मी क्षेत्र में 8,500 बीजों का पालन किया था। अप्रैल अन्त तक इन बीजों ने 23.4 मि मी की लंबाई प्राप्त की।

भविष्य कार्य

बीजोत्पादन कार्यक्रम बढाने का और इनकी आबादी पर बीजों के रैंचन का प्रभाव निर्धारित किए जाने का कार्य भविष्य में किया जाएगा।

यह लेख के. ए. नरसिंहम, डी. शिवलिंगम, टी. एस. वेलायुधन, वी. कृपा, के. जयपालन और ई. इनोस द्वारा किए गए अनुसंधान कार्य के आधार पर है। यह लेख के. ए. नरसिंहम ने तैयार करके प्रस्तुत किया।

समुद्री ककड़ी का समुद्र रैंचन

अतिमत्स्यन के कारण समुद्र में प्राकृतिक संपदा की कमी होने पर समुद्र रैंचन का प्रयोग किया जाता है। समुद्री ककड़ियाँ खतरनाक जीव नहीं और पकड के अवसर पर झींगे और मछलियों की तरह प्रतिरोध नहीं करती। इसलिए इनका शोषण क्रमातीत होता है और किशोर ककड़ियों की संख्या कम हो जाती है। इस अवस्था को हल करने के लिए भारत सरकार ने 75 मि मी से कम लंबाई होने वाली ककडियों के निर्यात पर रोक लगाया। एम पी ई डी ए के सुयक्त सहयोग से समुद्री ककड़ियों के बीजों के उत्पादन एवं समुद्र रैंचन पर एक गहन कार्यक्रम शुरु हुआ है।

समुद्री ककड़ी का बीजोत्पादन पहले चीन, जापान और हाल के वर्षों में कोरिया और रूस में किया जा रहा था। अन्य जातियों की अपेक्षा *एस. जापोनिकस* की दीर्घ आयु और बढ़ती दर कम होने के कारण इसका समुद्र रैंचन करना अच्छा तरीका देखा गया क्योंकि लंबी अवधि तक प्रयोगशाला में इसके पालन केलिए ज़्यादा खर्च होगा। भारत में बीजों की कम उपलब्धता के कारण समुद्र रैंचन नहीं किया था।

समुद्री ककड़ी-समुद्र रैंचन के क्षेत्र में

ये बहुत मंदगति के जीव होने के कारण समुद्र रैंचन करना आसान है। क्योंकि जहाँ इनका समुद्र रैंचन किया है उसी स्थान में ही ये बढ़ती है। इनकी यह आदत मात्स्यिकी केलिए सहायक बन जाता है।

समुद्र रैंचन केलिए स्थान चयन

समुद्र रैंचन कार्यक्रम की सफलता केलिए स्थान चयन सबसे प्रमुख है। अधिक लवणता में समुद्री ककड़ियाँ जी नहीं सकती। इसलिए नदी मुख, ज्वारनदमुख और अन्य उपसागर जहाँ मानसून के अवसर पर लवणता 10% से कम हो जाती है, का चयन नहीं करना है। ये पंक और रेत में पडे हुए खाद्य खाने और इनमें मिश्रित जैव पदार्थों में रहने का कारण चट्टानी संस्तरों का चयन भी नहीं करना है। इस तरह शैवाल जैसे पौधे खूब रहनेवाले स्थान भी उचित नहीं है। समुद्र रैंचन कार्यक्रम का सबसे महत्वपूर्ण पहलू यह है कि चुना गया स्थान मत्स्यन कार्य नहीं होने वाला और सुरक्षित और शक्त तरंगों से मुक्त होना है। नहीं तो मत्स्यन जाल में पडकर या शक्त तरंगों के प्रवाह में रैंचन किए गए किशोरों का नाश होने की संभावना है। प्राकृतिक संस्तरों के पास की प्रवाल भित्तियाँ समुद्र रैंचन के लिए उचित स्थान देखी गई है।

समुद्र रैंचन का परिणाम

समुद्र में सिर्फ बीज डालने से समुद्र रैंचन कार्यक्रम बेकार हो जाएगा। इस कार्यक्रम से मात्स्यिकी में लाभ होने के लिए लाखों बीजों का रैंचन किया जाना है। रैंचन किए गए स्थान के निकटवर्ती स्थानों में मछली पकड का निरंतर मानीटरन भी किया जाना है।

परिशोधन की सूचना

समुद्र रैंचन की सफलता जानने केलिए परिशोधित सूचना प्राप्त करना अनिवार्य है। इसके लिए अनुयोज्य स्थान के चयन के बाद वहाँ यह सर्वेक्षण किया जाना है कि 100 मी.^{2} क्षेत्र में कितने बीजों का रैंचन किया जा सकता है। वास्तव में इस क्षेत्र में 300 किशोरों का रैंचन हो सकता है। छः महीनों के बाद क्षेत्र के बडे नमूनों की संख्या भी देखनी है जिससे रैंचन का प्रभाव या सफलता समझ सकते हैं। समुद्री ककड़ियाँ दीर्घ आयु वाले जीव हैं। उदाहरणार्थ होलोथूरिया स्काब्रा की आयु लगभग 10 वर्ष आकलित किया गया है और रैंचन किए गए नमूने 18 महीनों के बाद संग्रहण योग्य आकार तक पहुँच जाते हैं। मात्स्यिकी में इनका योगदान पहचानने केलिए टैगन तरीका भी अच्छा है। इसके लिए उपयुक्त टैगों को डेन्निसन टैग कहलाते हैं। विभिन्न जाति ककड़ियों के शरीर में टैगन करने का स्थान भिन्न भिन्न हैं। इनमें लगाए गए माइक्रो टैग एक्स-रे या टैग डिटेक्टर से पहचान कर सकते है। टैगन तरीका श्रमपूर्ण और समय लगाने वाली प्रक्रिया है।

जैव अभिरंजक से अंकन

किशोर ककड़ियों को जैव अभिरंजकों (Biological stains) से अंकन करना भी एक अच्छा तरीका है। इन अभिरंजकों से ककड़ियों को कोई भी नुकसान नहीं होगा और वर्षों तक इनका रंग भी नष्ट नहीं होता। इसलिए रैंचन के बाद कई वर्षों बाद संग्रहण करने पर भी अभिरंजक के रंग से पहचान कर सकते है। इस तरीके केलिए विभिन्न रंग के अभिरंजक भी उपलब्ध हैं। यह तरीका टैगन से भी आसान देखा गया है।

यह लेख डी. बी. जेम्स, ए. डी. गांधी और पलनि सामी द्वारा किए गए अनुसंधान कार्य के आधार पर है। डी. बी. जेम्स ने यह लेख तैयार करके प्रस्तुत किया।

GUIDE TO CONTRIBUTORS

The articles intended for publication in the MFIS should be based on actual research findings on long-term or short-term projects of the CMFRI and should be in a language comprehensible to the layman. Elaborate perspectives, material and methods, taxonomy, keys to species and genera, statistical methods and models, elaborate tables, references and such, being only useful to specialists, are to be avoided. Field keys that may be of help to fishermen or industry are acceptable. Self-speaking photographs may be profusely included, but histograms should be carefully selected for easy understanding to the non-technical eye. The write-up should not be in the format of a scientific paper. Unlike in journals, suggestions and advices based on tested research results intended for fishing industry, fishery managers and planners can be given in definitive terms. Whereas only cost benefit ratios and indices worked out based on observed costs and values are acceptable in a journal, the observed costs and values, inspite of their transitionality, are more appropriate for MFIS. Any article intended for MFIS should not exceed 15 pages typed in double space on foolscap paper.

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