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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.

The prawn, fish and molluscan seed resources along the Kerala and Tamil Nadu coasts

Front cover photo:
A granite stone used for constructing sea wall at Chavara near Quilon found carpeted with juveniles of brown mussel.

Back cover photo:
A view of the shore line at Chavara where heavy settlement of spat of brown mussel was observed on the granite groynes used for the construction of sea wall.
THE PRAWN, FISH AND MOLLUSCAN SEED RESOURCES ALONG THE KERALA AND TAMILNADU COASTS*

Introduction

The Central Marine Fisheries Research Institute, Cochin launched a pioneering research project during the period 1976-'80 on the seed resources of commercially important prawns, fishes and molluscs in the surf waters, estuaries and backwaters of Kerala and Tamilnadu. The objective of the project was to gain precise information regarding occurrence and quantitative abundance of seed, their spatial, seasonal and diurnal variations, abundance in relation to lunar periodicities, influence of environmental features and pollution on them and areas suitable for brackishwater culture.

The investigations were carried out in three phases. During the first phase (1976-'78) emphasis was given to the seed resources of the surf area, followed by that in the estuaries and backwaters. A total of 246 stations were covered all along the coasts at monthly interval for the purpose. During the second phase which went on for another year (1979) the studies were centred in the estuaries and backwaters, and 49 stations were covered, again at a monthly interval at four regions. The third phase of the survey which was completed in one year (1980) was devoted for an intensive study on the diurnal variations in seed abundance and on the influence of moon on their occurrence and abundance. For this purpose one centre was selected in each of the six regions and quarterly diurnal sampling at hourly interval was carried out during full, half and new moon phases occurring sequentially in a month.

Six teams of scientists and technical personnel operated the project from six different research centres along the coast namely Calicut, Cochin, Vizhinjam, Tuticorin, Mandapam and Madras. Sampling stations were fixed all along the coastal area at every 6 to 10 km distance. However, within the estuaries and backwaters sampling was carried out at shorter intervals of distance. Along with the collection of seed samples, environmental parameters such as temperature, salinity and dissolved oxygen were also monitored. While a variety of gears were used for the qualitative studies, the quantitative estimates were made by employing the bucket-scoop net method in the surf area and a specially designed quantitative seed sampler developed at the Institute in the estuaries and backwaters. Voluminous data were collected during the investigations and the results are being published in the form of a bulletin. The present account brings out the salient findings of the studies.

1. RESULTS OF FIRST PHASE OF SURVEY

Areas covered

The surf sampling for the seed resources was carried out in Kerala from north to south at Kasaragod, Bekal Fort, Thaikkadapuram, Ettukulam, Mattul, Azhikal, Azhikode (north), Cannanore, Dharmadam, Tellicherry, Mahe, Badagara, Iringol, Tikkodi, Quilandy, West Hill (Calicut), Beypore, Kadalundi, Parappanangadi, Tanur and Paravani in the Kasaragod-Ponnani Region; Ponnani, Pulluponnani, Mannalamkunnu, Chavakkadu,

* This work was carried out under the Institute Project 'Survey of Fish, Prawn and Molluscan (bivalves) Seed Resources of Kerala and Tamil Nadu'. Personnel associated with the project:

Project Leader: E.G. Silas (1976-'80)

Project Associates:

Calicut: R.S. Lal Mohan (1976-'80)
K.V. Somasekharan Nair (1976-'80)
N. Gopinatha Menon (1977-'80)
F. Ramadoss (1976-'80)
V. S. Rameshwaran (1976)
K. Nandakumar (1978-'80)
K. Rengarajan (1978-'80)
K. N. Gopalakrishnan (1976-'80)

Cochin: G.S. Daniel Selvaraj (1976-'80)
K. J. Mathew (1976-'80)
K. R. Ramakrishnan (1976-'80)
K. R. Rangarajan (1976-'80)
M. Rajagopalan (1976-'80)
K. S. Subbarao (1976-'80)
T. Dhandapani (1979-'80)

Vizhinjam: K. Prabhakaran Nair (1976-'80)
S. Lazarus (1976-'80)

Tuticorin: P. Bensam (1976-'77) & (1979-'80)
S. Sharmugam (1976-'80)
K. Sasitharan (1976-'80)
Bastin Fernando (1976-'80)

Mandapam: K.M. Ameer Hamsa (1976-'80)
P. Nirmal (1976-'80)
R. Thiagarajan (1977-'80)
G. Nandakumar (1977-'80)

Madras: K. Rangarajan (1976-'80)
M. Rajagopalan (1976-'80)
K.S. Sunderam (1976-'80)
T. Dhandapani (1979-'80)
Chettai, Vadannappally, Nattika, Kaippamangalam, Vemballoor, Azhikode (South), Narakkal, Fort Cochin, Manassery, Chellanum, Anthakaranazhi, Anukkam, Alleppey, Ambalapuza, Thottappally, Thrissur, Vittoria, Chavara and Neendakara in the Poovam-Neendakara Region; Sakhikulangara, Thangassery, Paravur, Edava, Perumathura, Velli, Panathura, Vizhinjam, Adimalathura, Puthiyathura to Parimbiyur in the south and in Tamilnadu on the southwest coast from Thengapattinam, Enayam, Melmidalara, Colachel, Kadiapattinam, Mattom, Azhikkal, Rajakkamangalam, Manakudi, Kanyakumari west and Kanyakumari point in the Neendakara-Kanyakumari Region; Chinnamuttom, Leperumari, Vidyoor, Vatakottai, Uvari, Periyathalai, Alathalai, Naipupal and Yerwadi in the Kanyakumari-Keevakkam Region and Keelakkarai, Sethurakarai, Muthupet, Puthumadom, Seenappan Dharga, Vellalai, Mandapam (Gulf of Mannar), Thonithurai, Pandam, Kundugal, Naduthurai, Rameswaram Road, Hare Island, Manoli Island, Kusadi Island, Shingle Island, Chinnapalam, Rameswaram, Thangachimadam, Pandam, Thonithurai, Mandapam (Palk Bay), Munai, Pallamadam, Dhargavalsali, Athankarai, Mudiveeranadam, Devippattinam, Karangadu, Thondi and Sundarapandippattinam in the Keelakkarai-Sundarapandiapattinam Region. No sampling was carried out in the surf area in the Muthupet-Pulicat Region.

The stations in the estuarine and brackish water areas worked out along the coast for regular studies starting in Kerala from north to south and around Kanyakumari to north upto Pulicat Lake were Chandragiri, Bekel, Nileswarnam, Punnakadavu, Cherukunnu-Thavam, Mattur, Valapattanam, Azhikode (North), Nadal, Anjengadi, Koduvallipuzha, Mahhe, Iringol, Kottakkal, Chovai, Kropuzha, Kalai, Elamakadavu, Muthalakadavu, Beypore, Kadukandi, Poorapuzha and Chamravattom in Kasaragod-Ponnani Region; Ponnani, Puthuponnani, Chettai, Azhikode (South), Kottaparam, Nayarambalam, Puthuvypeen, Thoppumpady, Perumbalama, Anthakaranazhi, Thanneermukkom, Muhama, Thottappally, Aiyramthengu and Ashamudi in the Ponnani-Neendakara Region; Paravur, Edava, Anjengo, Veli, Panathura, Adimalathura, Karichal, Parichi, Trivandrum, Anthakaranazhi, Kolathur, Puthoor, Chinnavilai, Vellai, Azhikkal, Rajakkamangalam and Manakkudi in the Neendakara-Kanyakumari Region; Thattipulam, Kuttapali, Perumal, Uppar, Hanuman Nadhi, Idinakkara, Kothankuzhi, Athankarai, Manapad, Thiruchendur, Karyalappattinam, Arumugasuri, Punnaiyayal, Palayakayal, Mullikad, Mathiappuram, Tuticorin south, Karapad, Arasadi, Melarasi, Kalanthippattu, Kallar, Kallurani, Vaiper, Vembai, Mookayoor, Valinokkam, Palayar, and Mayakulam in the Kanyakumari-Keevakkam Region; Kanjiramgudi, Perappatnam, Seenappan Dharga, Pamban, Chinnapalam, Kadarsapad, Rameswaram Road, Pillaimadam, Athankarai, Kottakkarai, Vattanam, Pasippattinam and Sundarapandiapattinam in the Keelakkarai-Sundarapandiapattinam Region and Muthupet, Vedaranyam, Uppanar, Adappar, Harichandranadhi, Vellaiyar, Kaduvarai, Vettar, Thirumalayar, Arasalai, Virasalanar, Caunery, Coleroon Kallai, Vellai, Pennaiar, Varanganadhi, Kadapakkam, Palar, Kovalam, Adayar, Ennur and Pulicat in the Muthupet-Pulicat Region.

Hydrological features

A summary of the results obtained on the environmental features for the respective zones (zones 1-18) is given in Table 1. Temperature, salinity and dissolved oxygen were found to vary considerably especially in the estuarine and backwater areas and were influenced by several factors such as seasons, tide, rainfall, freshwater discharge, pollution and nearness to bar mouth.

The temperature varied over a wide range in the surf area along both west and east coasts and the variation was between 21 and 36°C. The maximum temperature was observed in Tuticorin and the minimum at Keelakkarai in Tamil Nadu. In the estuarine areas eventhough the minimum remained the same in the surf area the range was still higher and the maximum registered was 40°C in some of the salt-pans in Tuticorin area. Along the Kerala coast, however, the maximum temperature noted in estuaries was 37°C. The relation between temperature and salinity was more pronounced in the interior waters than the surf region.

In the surf area along the Kerala coast the salinity ranged between 11 and 37‰ while in Tamilnadu the range was between 9 and 41‰. In many estuaries and backwaters, salinity came down to near fresh water condition especially during southwest monsoon in Kerala. However, in summer the values almost equaled with the marine conditions. In the estuaries and backwaters of Tamilnadu even in the rainy season, very high salinities, often reaching upto 144‰ were also recorded in and near the salt-pans.

The observed values of dissolved oxygen in the surf and estuaries showed great variations in both the states. Low values of oxygen were generally noticed in the brackish water areas especially where environmental pollution occurred. Surprisingly enough low
Table 1. Hydrological conditions observed in the various zones of observations

<table>
<thead>
<tr>
<th>Zone Zones</th>
<th>SURF</th>
<th>ESTUARY</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Temp. (°C)</td>
<td>Sal. (%)</td>
<td>O₂ (ml/1)</td>
<td>Temp. (°C)</td>
<td>Sal. (%)</td>
<td>O₂ (ml/1)</td>
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<td></td>
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<td>1. Kasaragod–Azhikkal</td>
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<td>34</td>
<td>25</td>
<td>36</td>
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<td>26</td>
<td>36</td>
<td>1</td>
<td>35</td>
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<td>2. Azhikkal–Badagara</td>
<td>26</td>
<td>35</td>
<td>11</td>
<td>36</td>
<td>2.6</td>
<td>5.7</td>
<td>27</td>
<td>36</td>
<td>1</td>
<td>35</td>
<td>6.8</td>
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<td>3. Badagara–Beypore</td>
<td>26</td>
<td>35</td>
<td>24</td>
<td>36</td>
<td>2.7</td>
<td>5.7</td>
<td>27</td>
<td>34</td>
<td>1</td>
<td>36</td>
<td>0.5</td>
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<td>27</td>
<td>35</td>
<td>30</td>
<td>36</td>
<td>2.4</td>
<td>6.3</td>
<td>23</td>
<td>35</td>
<td>—</td>
<td>—</td>
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<td>35</td>
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<td>6.3</td>
<td>23</td>
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<td>2.5</td>
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<td>2.4</td>
<td>6.3</td>
<td>26</td>
<td>33</td>
<td>3</td>
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<td>7. Chellanum–Ambalapuzha</td>
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<td>9. Sakthikulangara–Virinjim</td>
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<td>11. Kanyakumari–Perathalai</td>
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<td>34</td>
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<td>7.8</td>
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<td>36</td>
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<td>12. Manapad–Kalanipattu creek</td>
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<td>35</td>
<td>19</td>
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<td>4.0</td>
<td>8.0</td>
<td>22</td>
<td>40</td>
<td>4</td>
<td>89</td>
<td>2.0</td>
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<tr>
<td>13. Kallar–Mayakulam</td>
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<td>36</td>
<td>9</td>
<td>37</td>
<td>3.0</td>
<td>7.0</td>
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<td>40</td>
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<td>14. Keelakarai–Rameswaram</td>
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<td>35</td>
<td>29</td>
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<td>—</td>
<td>8.3</td>
<td>21</td>
<td>35</td>
<td>2</td>
<td>74</td>
<td>1.4</td>
</tr>
<tr>
<td>15. Rameswaram–Sundara-pandiapatitam</td>
<td>—</td>
<td>35</td>
<td>20</td>
<td>38</td>
<td>—</td>
<td>7.6</td>
<td>24</td>
<td>—</td>
<td>6</td>
<td>83</td>
<td>3.1</td>
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<td>16–18 Muthupet–Pulicat</td>
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<td>No sampling</td>
<td>No sampling</td>
<td>No sampling</td>
<td>No sampling</td>
<td>No sampling</td>
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<td>No sampling</td>
<td>No sampling</td>
<td>No sampling</td>
<td>No sampling</td>
</tr>
</tbody>
</table>

The oxygen value to the level of 1.6 ml/l was obtained for the surf waters in the Kasaragod–Azhikode zone. In the surf area along the Kerala coast the oxygen values ranged between 1.6 and 6.3 ml/l while the range in the surf waters in Tamil Nadu was between 3.0 and 8.3 ml/l.

In certain zones the dissolved oxygen level in the estuarine areas was considerably low. Thus in the Badagara–Beypore zone in Kerala, value as low as 0.5 ml/l was obtained while the maximum recorded was 8.0 ml/l.

Occurrence and abundance of seed

Region: Kasaragod–Ponnani

The commercially important seed occurring in the region Kasaragod to Ponnani belonged to *Penaeus indicus*, *Metapenaeus dobsoni*, *Mugil* sp. and *Sillago* sp.

*P. indicus* occurred during almost all the months. However, the availability differed from place to place. The seed were not available from Kasaragod to Azhikode during January and February. But during March they were available in large numbers especially in places like Chandragiri estuary, Nileswar estuary and Cherukunnu Thavam. During April also the seed were observed at most of the stations of this zone. In October and November the availability of the *Peneaus* seed increased. Maximum number of seed was collected in salinity range 30–34 ‰, dissolved oxygen 5 ml/l and temperature range 29–30°C.

In the second zone from Azhikode to Badagara the *P. indicus* seed were available during February–April and also in July–August period. It was abundant in December also. At Tellicherry, Male and Badagara in the surf and in the nearby estuaries the seed were collected in fairly good quantities (40–600/100 m³ of water).

In the Badagara–Beypore zone (zone 3) good collections of *P. indicus* larvae were made during January, March and April. Quillandy, Elathur, Korapuzha, West Hill and Beypore were the centres where good collections were obtained.

In the Kasaragod–Ponnani zone (zone 4) (1,733/100 m³ of water).
The length of the *P. indicus* seed ranged from 7 to 15 mm with mean size at 10 mm. About 45% of them occurred in salinity range of 30-34‰ (the observed salinity values ranged between 10 and 39‰). Similarly 64% of the seeds occurred in dissolved oxygen content around 5 ml/l. Though the seed were found to occur in temperature range of 27-33°C, 60% of them occurred in the range between 29 and 31°C.

*Metapenaeus dobsoni* seed occurred during February, March and October, with the maximum concentration in the latter month. Chandragiri (44/100 m³), Nileswar (22/100 m³), Mattul and Mahe (96/100 m³) were some of the places from where it was collected. The size of the seed ranged between 6 and 20 mm with the mean size at 9 mm.

Though it was recorded in the salinity range of 1-37‰, 25% of it occurred considerably between 26 and 30‰. 35% of the seed occurred in 5 ml/l of dissolved oxygen and 50% was found in temperature ranging from 35 to 35.9°C.

*Mugil* spp. was the common fish seed collected throughout the year from both surf and estuarine areas. During March, July and October they were found at Mattul, Mahe, Elathur and Beyapore. They occurred in salinities ranging from 0-39‰. When their occurrence in different dissolved oxygen levels was analysed it was observed that 55% occurred in 4-4.9 ml/l of oxygen. They were found to occur in the temperature between 27 and 33°C.

Good number of *Sillago* seed was also collected from both surf and estuarine areas. It was recorded during January, March, July and October in places like Nileswar, Mahe, Dharmadam, Tanur, Korapuzha, Beyapore and Kadalundi. 70% of them was found to occur in salinities 30-34‰. 80% of the seed of *Sillago* was found to prefer temperature ranging from 27.0 to 27.9°C.

The seed of *Perna indica* were available at Tellicherry, Dharmadam, Quilandy and Tikkodi. The season of its abundance was from September to December.

**Region: Ponnani-Neendakara**

In this region, among the cultivable species, prawn seed were the most abundant group consisting of *P. indicus*, *M. dobsoni* and *M. monoceros*. Generally speaking, the central part of this region (between Vadanappally and Kayamkulam) was more productive for prawn seed resource.

*Ponaeus indicus*

From the data obtained for three years (1976-'78) it was found that the period of maximum abundance of seed of *P. indicus* in the Ponnani-Neendakara region was from February to August and the highest monthly average number obtained was 7,880 per 100 m³ of water in May.

A centre-wise analysis for the abundance of seed showed that Ashtamudi Lake, with an average annual seed density of 7,200 per 100 m³ of water, ranked first followed by Bharathapuzha estuary (5,618 seed), Thottappally estuary (4,357 seed) and Anthakaranazhi (3,100 seed). In the surf area generally the abundance was moderate or even less and the maximum number obtained was 1,796 per 100 m³ of water at Anthakaranazhi.

Month-wise analysis of data for the different centres revealed that *P. indicus* seed were maximum at the Thottappally and Neendakara zone in August and the rate of occurrence was 30,500 and 16,100 per 100 m³ of water respectively. At Pathuvypeen (near Cochin) they were abundant in February with seed density of 15,000 per 100 m³. A high catch rate of 58,700 per 100 m³ was obtained from the Ponnani river mouth area in May, and the seed were generally abundant there throughout the year.

*Metapenaeus dobsoni*

In this region the estimated number for the average annual abundance of seed of this species both in surf and estuary during the period of investigation was 2,378 per 100 m³ of water. The period from May to August represented their maximum abundance with the peak in July (11,731 seed per 100 m³). In the surf area the maximum abundance was noticed at Vadanappally (31,600 per 100 m³ of water) followed by Narakkai (8,013), Neendakara (7,517) and Nattika (6,564).

As far as the monthly abundance at various stations was concerned, July was found to be the best month for the seed of *M. dobsoni* and the occurrence was of the order of 1,55,400 per 100 m³ of water in the surf area at Vadanappally. During May, Mannalamkunnu with 33,600 seed recorded the maximum catch followed by Azhikode (surf) (11,800). In August, the barmouth at Azhikode was especially productive with seed density of 65,900 per 100 m³ of water.
The seed of *M. monoceros* though present in lesser number, were widely distributed in the Ponnani-Neenda-kara region. The mean annual number was estimated at 85 per 100 m$^2$ of water. The period from May to July appeared to be the best season for the seed of this species. In May an average number of 490 seed occurred per 100 m$^2$ of water.

In this region Mannalamkunnu registered the maximum annual average density of 1,063 seed of *M. monoceros*. Other stations yielded the seed at a rate of 2,800 (Azhikode bar mouth), 2,100 (Chavakkad surf), 1,800 (Chetwai surf) and 1,300 (Anthakaranazhi surf) in the order of abundance.

Fish seed

Among cultivable species, seeds of mullets and *Chanos* were frequently caught in the Ponnani-Neenda-kara region. Mullet seed were abundant during the February-April period. An annual average number of 589 mullet seed was obtained in this region. A station-wise consideration of the annual abundance showed that the maximum number of 920 seed was available at Ayiramthengu estuary. Next in abundance was Puthuvypeen where the occurrence was 800 seed per 100 m$^2$ of water.

Monthly occurrence of mullet seed at the different stations indicated that the Kayamkulam estuary had the highest seed potential of 9,200 per 100 m$^2$ in February while at Puthuponnani river mouth area 2,400 seed per 100 m$^2$ were collected in April. Chetwai-mouth was another productive area where 1,400 seed per 100 m$^2$ were collected in July.

Seed of *Chanos* were least represented in the region. The annual average abundance was of the magnitude of 17 seed per 100 m$^2$ and no remarkable seasonal variation was noticed in their case. However, the period from February–May appeared to be favourable for the seed and its maximum occurrence was in May (50). Among the stations Azhikode estuary was the richest with 1,000 seed per 100 m$^2$ in April. From the Cochin bar mouth area *Chanos* seed at the rate of 600 were caught in May. Other places where appreciable number of seed of this species collected per 100 m$^2$ were Chellanum and Alleppey (500 each in February) and Puthuponnani (400 in May).

Molluscan seed

Mussel seed of the genus *Perna indica* and *P. viridis* were found growing luxuriently wherever suitable substrata like the granite stones of the sea wall were available. Spat settlement was observed in July. It was observed that after reaching 30–35 mm length the mussels in these beds experienced stunted growth due to over population. South of Tharayilkadavu, green and brown mussels were found while in the northern areas, only green mussels were noticed.

River mouths, estuaries and bar mouths in this region were characterised by the presence of clam beds. Rich clam beds were located at Ponnani, Puthuponnani, Chetwai, Azhikode, Cochin, Ayiramthengu and Neenda-kara. *Villorita* sp. was the common clam found in the southern parts while *Meretrix* sp. dominated in the northern parts.

During September–November huge quantities of shells of *Barena* sp. were found to be collected by the fishermen from the surf area. The edible oysters belonging to the genus *Crassostrea* were found to occur in lesser densities at the mouth of rivers and estuaries and also some distance inside.

Region: Neendakara - Kanyakumari

The important species of cultivable organisms available in this region were *P. indicus*, *M. dobsoni*, *Etroplus suratensis*, *Sillago* sp., *Chanos chanos*, *Perna indica*, *Pinctada fucata* and *Crassostrea* sp.

The post larvae and juveniles of *P. indicus* occurred at Sakhthikulangara, Paravur, Perumathura, Veli, Thengapattinam, Kadiapattinam, Azhikkal, Rajakkaman-galam and Manakkudi. The length ranged between 13 and 80 mm. The maximum number of seed were collected during April–June period followed by the January–March and October–December periods.

The seed of *M. dobsoni* were abundant than *P. indicus*. The main centres of occurrence were Sakhthikulangara, Paravur, Edava, Veli, Adimalathura,
Puthiathura, Thengapattinam, Melmidalam, Chinnaveili, Kadiapattinam, Azhikkal, Rajakkamangal and Manakkudi. The length ranged from 8 to 70 mm. Sixty per cent of the seed was obtained in the April-June period followed by 30% in the October-December period.

Mullets were the most important fish seed in the region. The main centres of abundance were Paravur, Perumathura, Panathura, Adimalathura, Puthiathura, Parithiyur, Thengapattinam, Colachel, Kadiapattinam, Rajakkamangal and Manakudi. Fry and fingerlings were found in all the months. However, 70% of occurrence was in the October-December period followed by the April-June and January-March periods. Fry were also found in the rocky surf areas of Kanyakumari and Adimalathura.

The main centres for the seed of pearl spot were Sakthikulangara, Rajakkamangal and Manakkudi. The best period for their abundance was April-June which accounted for 80% of the catch.

Fry and fingerlings of Sillago sp. were obtained from Perumathura, Puthiathura, Parithiyur, Thengapattinam and Kadiapattinam. They were more abundant in the southern part of the region. 70% of the seed was collected during the October-December period.

Seed of Chanos chanos were obtained from Adimalathura and Thengapattinam only. Few numbers were available in March, May and July.

Among bivalve molluscs, the green mussel was found at Sakthikulangara and Edava. Brown mussels occurred at Kovalam, Vizhinjam, Adimalathura, Colachel, Muttom and Kadiapattinam. Rock oysters of Crassostrea sp. were found in the rocky surf regions of Vizhinjam, Colachel, Kadiapattinam, Muttom and Kanyakumari. The pearl oyster occurred on submerged rocks of Vizhinjam, Colachel, Kadiapattinam and Muttom. Clams of the genus Villorita were found at Sakthikulangara, Paravur, Veli and Thengapattinam.

Region: Kanyakumari - Keelakkarai

Except in Kanyakumari district seed of P. indicus were found to occur in all other centres from Kuthankuzhi to Mayakulam in the post rainy months. The range in size was between 7 and 89 mm. Seed of P. semisulcatus were available in good quantities at Tuticorin only. Seed of M. dobsoni were obtained in all estuaries and backwaters in this region and they measured between 9 and 72 mm.

Among fish seed, mullet was available invariably in all the centres in all months in this region although in few numbers. The size ranged from 8 to 80 mm. An inverse relationship in abundance was found with the fry of Chanos. Seed of milkfish were available during April-May in Punnaikayal, Tiruchendur, Vattakottai and Valinokkam. The usual size available was between 15 and 85 mm. Seed of Etothius suratensis were found in negligible number in Kallar, Kayalpattinam, Palayakayal and Punnaikayal. The length ranged between 24 and 63 mm. Elvers of Anguilla bicolor were found in Thattarippu and Vaipar estuaries soon after rains. The length of elvers ranged between 48 and 169 mm. Seed of Sillago sihama were available in less number during rainy season at Vembar, Vaipar, Kallar and Punnaikayal. Their length varied from 9 to 82 mm.

The seed of edible oysters were found in good numbers throughout the year, only in Tuticorin and Punnaikayal estuarine system. Seed of brown mussel were available in plenty in Chinnamuttom area and the sizes ranged between 25 and 50 mm. Species of Mere-trix were found in the exposed mud flats of Punnaikayal central region in smaller number. Plenty of Donax sp. were noticed along the coast between Tuticorin and Veppalodai.

Region: Keelakkarai to Sundarapandlapattinam

Fry and fingerlings of Chanos chanos were collected in good number in April-June period from Kanjiramgudi, Kanyakumari, Penmanikkadu, and Thonithurai in the months of April-June. The size of fry varied between 9 and 82 mm.

Region: Keelakkarai to Sundarapandlapattinam

Prawn seed

Seed of P. indicus were widely distributed along the surf area, Athankarai estuary, backwaters and tidal pools of Gulf of Mannar and Palk Bay. They were especially abundant at Kanjiramgudi (October-December), Muthupet (July-September) and Thonithurai (April-June). In this region seed of P. indicus ranged in size between 12 and 60 mm. Seed of P. monodon were present in the coastal waters of Hare Island, Kru-sadi Island during October-December. In Pillaimadam and Athankarai they occurred in December and April-June respectively. At other centres also they were collected in smaller numbers. Seed of P. semisul-catus were almost equally present as P. monodon in Pasipattinam, Kottakkara and Sundarapandiapattnam. Their size ranged from 16-59 mm. Metapenaeus bunte-ronym was another species whose seed were found widely distributed along the coasts of Gulf of Mannar and Palk Bay. Their size ranged from 15-58 mm.

Fish seed

Fry and fingerlings of Chanos chanos were collected in good number in April-June period from Kanjiramgudi, Kanyakumari, Penmanikkadu, and Thonithurai in the months of April-June. The size of fry varied between 9 and 82 mm.
Collection of fish and prawn seed from the surf beaten area in the sea using bucket-scoop net method.

The collected seed are being cleaned of sand and weed after transferring into a bucket.

The cleaned seed are once again filtered through the scoop net and seed are transferred from the net.

Seed collection from estuarine area using velon screen.

Sampling for juvenile prawn and fish using small meshed cast net.

Different stages of lobster *Panulirus homarus* collected from among the crevices of sea wall at Fort Cochin.
Chinnapalam creek, Pillaimadam and Sundara-pandiapattnam. Their total length ranged from 14–90 mm. The seed of *Mugil* spp. were present throughout the year in all the stations of Gulf of Mannar and Palk Bay. January to March formed their peak period of occurrence. The size ranged between 12 and 75 mm. Seed of *Sillago sihama* were well represented at Sethurkarai, Shingle Island, Hare Island and Athankarai coastal waters. January to June was found to be the best season for their collection. Elvers of *Anguilla bicolor* were recorded in less number in Kanjiramgudi, Periapattinam and Seniappa Dharga.

**Region: Muthupet-Pulicat**

The prawn seed were represented by species of *P.indicus*, *P. monodon*, *M. dobsoni* and *M. monoceros* in this region. Seed of *P. indicus* were collected from all centres. It occurred throughout the year in almost uniform densities. The size of the seed ranged from 8 to 56 mm. Maximum concentration of seed was seen in Vedaranyam swamp and Thirumarayanur and Vellar estuaries. Seed of *P. monodon* were common in this region from October–December. In May, post larvae of this species were found to approach the coast in large numbers. The seed were common in estuaries namely Uppanar, Adappar and Kaduvaliyar. The size of the seed ranged from 30–40 mm. Seed of *M. dobsoni* were abundant during January–March in the following estuaries: Harichara nadi, Arasalar, Canvery, Uppanar, Coleroon, Killai and Vettar. Seed of *M. monoceros* were also common in this region. They were found in good quantities in Adappar, Kaduvaliyar, Varanga nadi and Palar estuaries.

Among fishes, seed of *Mugil* spp. were the commonest and were found in Muthupet swamp, Vettar and Adayar estuaries and Pulicat Lake. Their size was found to range between 16 and 60 mm. Seed of *Chanos chanos* were found in large numbers in Uppanar estuary, Kadapakkam and Kovalam backwaters, Adayar and Korattaliyaer estuaries and Pulicat Lake. They were comparatively more during April–June and their size ranged from 50 to 70 mm. From January to March the seed of *Sillago sihama* of size range 20–34 mm were abundant in Harichandra nadi, Vellaiyar and Pennaiyar.

**Areas suitable for farming**

During the surveys, special attention was given to locate suitable areas for farming. The following is a list of such areas along with the extent in hectares given in brackets.

**Region I:** Kavi in Kavipuzha estuary (200 ha), Ezham near Payyangadi estuary (100 ha), Cherukunu Thavam near Payyangadi river (200 ha), Mappita Bay (500 ha), Dharmadam near Dharmadam estuary (upto 10 km from bar mouth), Koduvally (150 ha), Thiruvanorekada near Korapuzha estuary (25 ha) and Perumthuruthi (15 ha) near Korapuzha estuary.

**Region II:** Chetwai (150 ha), Azhikode (375 ha), Vypeen, Kumbalangi, Aroor, Perumbalam area upto Vaikom and further south in the Vembanad Lake (210 ha), Anthakaranazhi (10 ha), Kayamkulam Lake (80 ha) and Ashtamudi Lake (830 ha).

**Region III:** Paravoor (1 ha), Edava (2 ha), Perumathura (4 ha), Adimalathura, Puthiathura and Parithiyur (extensive areas), Thengappatinam (1 ha), Pudur (about 1 km canal area of 5–10 m width), Kadaspatnam (1 ha), Azhikkal (4 ha), Rajakkamangalam (1 ha), and Manakkudi (2 ha).

**Region IV:** Thiruchendur (8 ha), Arumuganeri (extensive areas), Punalikayal (40 ha), Palayakayal (4 ha), Mullakkad (30 ha) and Kallar (8 ha).

**Region V:** Pamban-Chinnapalam creek (3.3 ha) and Pillaimadam (250 ha).

**Region VI:** Point Calimere (extensive areas), Vedaranyam canal (areas between Thopputhurai and Naluvedapatty), Killai backwaters, Varanganadi estuary Manakkanam backwaters, Kovalam backwaters, Ennore backwaters and Pulicat Lake (extensive areas).

**Source of pollution**

Information were gathered during the surveys on the source of pollution in each of the estuaries and backwaters that paused threat to the seed or farming activities. The following is a summary of the study.

**Region I:** Valapattanam (T.S., Ind. p), Azhikode north (T.S.), Dharmadam (T.S., H.R.), Moorat, Chovai, Korapuzha (H.R.), Kallai, Beypore (T.S.), Chaliyar (Ind. p), Kadulundi, Parappanangadi, Mangalam, Chamravattom (H.R.)

**Region 2:** Ponnani, Puthuponnani, Chetwai, Azhikode (H.R.), Vembanad Lake (Ind. p, H.R., pest), Kayamkulam (H.R.), Ashtamudi (Ind.p, H.R.).

**Region 3:** Edava, Perumathura, Panathura, Adimalathura, Parithiyur, Thengappatinam, Enayam, Pudur and Manakkudi (H.R.)
Region 4: Arumuganeri (Ind.p), Tiruchendur and Vattakottai (H.R.)

Region 5: No major source of pollution.

Region 6: Ennore (Ind.p), Adayar (S.P.), Vedarnyam swamp (Ind.p).


2. RESULTS OF SECOND PHASE OF SURVEY

During the second phase of the seed resources survey carried out during 1979-’80, emphasis was towards sampling in the estuaries and backwaters. Sampling for seed especially of prawns was more effective on account of the use of the Quantitative Seed Sampler designed by Mathew et al. (Proc. Symp. Coastal Aquaculture, Part 1: 302-307, 1982, MBAI, Cochin). The results of the survey, again on a region-wise basis are summarised below.

Region: Kasaragod to Ponnani

The estuaries and other brackishwater areas covered in this region during the second phase of the survey were Chandragiri, Neeliswar, Bekal, Kawai, Chittari, Kuppam, Cherukunnu, Nadal, Mattul, Pazhayangadi, Valapattanam, Dharmadam, Koduvally, Mahe, Kanyamcode, Korapuzha, Bey pore, Kadalundi and Poorapuzha. Of these Chandragiri had three sampling stations while others had one each.

Seed abundance

Seed of commercially important species of prawns namely Penaeus indicus, Metapenaeus dobsoni and M. monoceros and fish namely Euprostomus suratensis occurred in this region. Seed of P. indicus occurred at the rate of 700 per 100 m² in Chandragiri estuary. 66% of total seed of this species was obtained from the estuaries between Chandragiri and Cherukunnu. Bey pore and Poorapuzha estuaries were not found rich in seed of this species. Two peaks in abundance were observed; one during April and the other during November-January.

M. dobsoni also followed the same pattern of abundance as P. indicus. The estuaries between Kasaragod and Valapattanam accounted for 68% of seed of this species. The peak periods of abundance were April and June. Seed of M. monoceros also were rich in the northern estuaries. Maximum abundance was observed in July and August.

Seed of pearl spot (E. suratensis) were the most common among fish seed. They were abundant in the northern parts. Though present in almost all months, maximum was in December. Seed of mullets were commonly found in the southern part of the region. The zone between Bewpore and Poorapuzha was especially rich in Mugil seed which occurred at the rate of 400 per 100 m² of water area. April and August seemed to be the months of maximum occurrence.

Region: Ponnani-Neendakara

In this region eight estuaries were visited regularly of which Ponnani, Puthuponnani, Azhikode, Puthuvypeen, Kayamkulam and Ashtamudi had one station each while Chetwai estuary and Vembanad Lake had three stations each.

Seed abundance

The annual mean abundance of seed of P. indicus which was the most abundant in this area has been estimated to be 1,000 per 100 m². Maximum quantity was obtained from Chetwai estuary where the annual mean abundance was 3,025 per 100 m². The least abundance of 33 per 100 m² was observed at Thanner-mukkom in Vembanad Lake. When considered on a monthly basis it was found that the maximum abundance was during February–March period (2,758 per 100 m²). A secondary peak was observed during October–December period. A month-wise and centre-wise estimate showed that Chetwai was the most productive estuary where in March the seed of P. indicus occurred at the rate of 21,700 per 100 m².

The seed of P. indicus was more in temperature range between 32 and 34°C and least between 28 and 30°C. With regard to salinity this species was found to prefer a range between 20 and 25%o. With regard to dissolved oxygen the most favourable range was between 3 and 5.

The annual mean abundance of seed of M. dobsoni in the region has been estimated to be 780 per 100 m². In the different estuaries the abundance was between 313 in Ashtamudi Lake and 1,650 in Puthuponnani estuary. The seed were especially abundant during February and December and the rate of occurrence in these months was 1,358 and 1,491 respectively per 100 m². Among the estuaries, Chetwai with 5,400
seed per 100 m² accounted for the maximum quantity which was in February.

The annual mean abundance of *M. monoceros* has been estimated to be 70 per 100 m². The seed of this species enjoyed a wide distribution in this region though in few numbers. Among estuaries the maximum number of seed taken was at Kundukadavu in Chetwai estuary (338/100 m²). July was the month of maximum abundance. The maximum number of seed collected during a single observation was 500 per 100 m² at Puthuvypeen in February.

Though in extremely low numbers, the seed of *M. affinis* were also represented in this region. The annual abundance was only 9 per 100 m². The maximum abundance was in November at Puthuvypeen.

Among fishes the seed of mullet were the most abundant. The average annual abundance for the region was 646 per 100 m². Estuaries of the northern parts of the region had the maximum mullet seed. The maximum of 2,588 per 100 m² were present at Chetwai. The seed of *Chanos* were collected at an annual average rate of 6 per 100 m². An unusual catch of 5,400 per 100 m² was made at Pulikkalkadavu in the Chetwai estuary.

The seed of *Etroplus* sp. were present south of Puthuvypeen. They were common during February to September period. At Kumbalangi in Cochin backwaters they were present at the rate of 100 per 100 m² in March, July and September. Further interior in the estuary at Thanneermukkom they occurred at the rate of 900 per 100 m² in February.

Region: Kanyakumari-Keelakarai

In this region the centres visited regularly were Thattarippu, Vattakottai, Manapad, Thiruchendur, Punnaikayal, Palayakayal, Puvuvalli, Kallar and Valinokkam.

Seed abundance

The annual average occurrence of seed of *P. indicus* was 59 per 100 m². Among estuaries Palayakayal with 149 per 100 m² accounted for the maximum quantity. It was followed by Puvuvalli (121) and Punnsikayal (84). October to January was the best period for this species. A secondary peak was observed in March. In January, 424 seed were recorded in Palayakayal. The annual average number of seed of *M. dobsoni* was 13 per 100 m². Manapad accounted for the maximum seed of 400 per 100 m² in January. At the other centres seed of *M. dobsoni* were least represented.

Seed of mullets were available in all the months in all the estuaries surveyed in this region except at Valinokkam. The average annual abundance was 89 per 100 m². November to April appeared to be the most productive period. The area from Manapad to Kallar was particularly rich in these seed.

The period from March to August proved to be the best for the seed of *Chanos* with maximum abundance in April and May. The average annual occurrence was 12 per 100 m² in this region. Except the creek at Vattakottai the seed were available in all the centres with relatively good density at Thiruchendur and Punnaikayal.

Region: Keelakarai-Sundarapandiappattinam

The estuaries, backwaters and tidal pools covered in this region were Kachhipangudi, Pamban tidal pools, Pamban-Chinnapalam creek, Pillaimadam and Athankarai. Collections were also made from coastal waters at Sethukarai, Thonithurai, Pillaimadam, Athankarai and Devipatnam.

Seed abundance

Important seed encountered were of the species *P. indicus, P. semisulcatus* and *M. burkenroadii*. Among fish, seed of *Chanos, Mugil* and *Sillago* were abundant in this region.

The Pamban tidal pools had the highest concentration of seed of *P. indicus* (2,30,900 per 100 m²), followed by Pamban-Chinnapalam creek with 12,700. April-May was the period of maximum abundance. *P. semisulcatus* occurred at a maximum annual average rate of 300 per 100 m² in Athankarai estuary in April. The maximum number of *M. burkenroadii* collected was 8,400 per 100 m² from Pillaimadam lagoon in January.

Seed of mullet occurred at a rate of 15,500 per 100 m² at Chinnapalam creek. In Pamban tidal pool they were present at a rate of 11,500 in June. Fry of *Chanos* were highly abundant and at Pamban tidal pools they occurred at a rate of 7,74,200 per 100 m² in May. Seed of *Sillago* were present in good numbers in Pillaimadam estuary during March-May and in March the occurrence was at a rate of 17,500 per 100 m².
The QSS (Quantitative Seed Sampler) used for sampling in the estuarine areas is being assembled on the shore.

After placing the QSS at the sampling site repeated sampling for fish and prawn seed is being done using a special scoop net.

The assembled QSS being taken to the sampling site.

The scooped seed are being collected for preservation.

3. RESULTS OF DIURNAL OBSERVATIONS IN RELATION TO LUNAR PHASES AT SELECTED CENTRES IN KERALA AND TAMIL NADU

Influence of moon on the reproductive cycle of animals is well known. Breeding and larval migration in marine penaeid prawns are also considered to be greatly controlled by the moon. The traditional prawn farmers in Kerala regulate the opening and closing of farms sluices only in accordance with the different phases of the moon. In order to understand the influence if any, of moon on the diurnal abundance and on the migration of prawn seed into the estuaries and backwaters, a series of field experiments were carried out which went on for one year at three centres in Kerala and two centres in Tamil Nadu simultaneously at a quarterly interval. In each quarter three consecutive observations were made beginning with a full/new moon, through mid lunar phase and ending with a new/full moon. The schedule of sampling is given in Table 2.

Each observation in a quarter was for a duration of 24 hours: during which hourly sampling was made from 1,600 to 1,600 hrs for seed and environmental features. Seed samples were collected by filtering 1 m³ of water. Numerical estimates for the seed were made per 100 m² of water. The study besides giving information on the influence of moon on the occurrence and abundance of seed of cultivable prawns and fishes, also enabled to understand their abundance during day and night, different seasons, in relation to tide and the influence of environmental parameters on seed. The following is a discussion of the results obtained at the various centres. The quantitative estimates for seed of prawns and fish were made numerically as number per m³ at all the centres.

Korapuzha (Calicut)

1. Seasonal abundance

The important seed occurred were those of P. indicus, M. dobsoni and Mugil sp. Seed of P. indicus
occurred at the rate of 1,200 per 100 m$^2$ during the first quarter and 300 during the 2nd quarter. Maximum abundance of 1,400 was noticed in the 3rd quarter. In the last quarter also they were better represented. The seed of *M. dobsoni* were poorly represented during the entire period of observation. Their number ranged between 200 and 600. The seed of mullet occurred in the first and second quarters. *Chanos* fry were collected at a rate of 1,000 in the first quarter.

### Table 2. Schedule for diurnal sampling followed at the various centres during different phases of the moon in 1978 and 1979

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Date</th>
<th>Duration (24 hrs)</th>
<th>Phase of moon</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>17-18 Oct.</td>
<td>1600-1600</td>
<td>Full moon</td>
</tr>
<tr>
<td></td>
<td>31 Oct. to</td>
<td></td>
<td>Half moon</td>
</tr>
<tr>
<td></td>
<td>1 Nov.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7-8 Nov.</td>
<td></td>
<td>New moon</td>
</tr>
<tr>
<td>II</td>
<td>29-30 Jan.</td>
<td></td>
<td>New moon</td>
</tr>
<tr>
<td></td>
<td>5-6 Feb.</td>
<td></td>
<td>Half moon</td>
</tr>
<tr>
<td></td>
<td>12-13 Feb.</td>
<td></td>
<td>Full moon</td>
</tr>
<tr>
<td>III</td>
<td>26-27 May</td>
<td></td>
<td>New moon</td>
</tr>
<tr>
<td></td>
<td>1-2 Jun.</td>
<td></td>
<td>Half moon</td>
</tr>
<tr>
<td></td>
<td>11-12 Jun.</td>
<td></td>
<td>Full moon</td>
</tr>
<tr>
<td>IV</td>
<td>21-22 Sep.</td>
<td></td>
<td>New moon</td>
</tr>
<tr>
<td></td>
<td>28-29 Sep.</td>
<td></td>
<td>Half moon</td>
</tr>
<tr>
<td></td>
<td>5-6 Oct.</td>
<td></td>
<td>Full moon</td>
</tr>
</tbody>
</table>

2. Day-night abundance

A night time abundance of prawn seed was observed in this estuary. The night abundance was 5,300 while only 3,400 were collected during day. It was also observed that on the whole the abundance was minimum between 12 and 15 hrs.

3. Abundance in relation to lunar phases

The prawn seed were found to be more during the mid lunar phase. On an average while 14,500 prawn seed occurred during mid lunar phase, only 112 and 4,460 were present during the new moon and full moon respectively.

4. Variation in relation to tide

It was observed that the seed were abundant during high tides. Putting all species together 73,700 seed per 100 m$^2$ were collected during high tide against 28,800 during the low tide.

5. Abundance in relation to salinity

During the period of observation the salinity in the estuary varied between 0 and 34.9%. In general it was found that the salinity was not a limiting factor in the occurrence and abundance of prawn seed.

### Neendakara

1. Annual abundance

At Neendakara the most common seed of culture importance were those of prawns. *P. indicus* ranked first whose annual abundance was estimated to be 226 per 100 m$^2$ followed by *M. dobsoni* (210), *M. monoceros*, and *M. affinis*. Among fishes the seed of mullets dominated with 22 larvae per 100 m$^2$. The seed of *Chanos* were present in very few numbers.

2. Seasonal abundance

The second and third quarters were generally good for seed of cultivable species. The maximum number of seed of *P. indicus* was obtained in the 2nd quarter when the estimated value was 644. The seed of *M. dobsoni* were also abundant in the second and third quarter at the rate of 391 and 388 respectively. A few seed of *M. monoceros* were present in the third and fourth quarters while the seed of *M. affinis* occurred in the second quarter alone.

The seed of mullet were present in all the quarters in varying numbers. The maximum of 55 was obtained during the 2nd quarter. In the other quarters they ranged between 9 in the 4th quarter and 12 in the 1st quarter. The occurrence of seed of *Chanos* was highly seasonal. They were absent in the 4th quarter and occurred at the rate of 1 and 3 in the first and third quarters respectively. In the second quarter seed at a rate of 9 were obtained.

3. Day-night abundance in relation to phases of moon

A striking relationship was found between diurnal abundance and lunar phases. Thus during the full moon phase seed of *P. indicus* and *M. dobsoni* were relatively more in day samples than in night samples. The day abundance for *P. indicus* was 677 and for *M. dobsoni* it was 167 during full moons. The night abundance for the respective species was 108 and 144.
During the dark phase of the moon (new moons and half moons) both the species were comparatively more in the night samples. In the case of *M. monoceros* also the day time abundance during full moon phases and night time abundance during half moon phases and new moon phases were quite evident.

The seed of mullets showed night abundance during all the three phases of the moon.

4. Variation in relation to lunar phases

A direct relationship was noticed between different phases of the moon and the seed availability at this centre. As far as *P. indicus* was concerned the full moon periods yielded the maximum seed. The rate of abundance was 404 during full moons, 119 during half moons and 156 during new moons. *M. dobsoni* occurred at the rate of 392 during half moons, 156 during full moons and 83 during new moons. *M. monoceros* and *M. affinis* were more during full and half moon phases and the rate of occurrence was around 26. Seed of *Chanos* were absent in the collections during the new moon phases.

5. Day-night abundance

Out of the six species of prawns and fishes of culture importance considered, seed of species namely *P. indicus*, *M. monoceros*, *M. affinis* and mullets occurred in more number at night samples while the other two species namely *M. dobsoni* and *Chanos* occurred in almost equal number during day and night samples.

When considered numerically, the seed of *P. indicus* were present in the day samples at the rate of 291 against 156 in the night samples. But in the case of *M. dobsoni* while 302 seed were present in the night samples, only 126 occurred in the day samples. Seed of all other species were more in the night samples. In the case of *Chanos* day time abundance was noticed.

6. Abundance in relation to tides and phases of moon

During the full moon phases whenever the prawn seed occurred the rising tides brought in more number of seed of *P. indicus*, *M. dobsoni* and *M. monoceros*. A rhythmic up and down oscillation in the abundance of seed of *P. indicus* in accordance with the tidal amplitudes was evident during the full moon. All the peaks were observed where the tides were at the zenith or started receding. During new moon, the trend in increase of seed was the same as during full moon. During half moons remarkable relationship with the tide was not noticed; instead the variations in abundance was mainly controlled by the day-night phases.

7. Abundance in relation to hydrological features

The prawn and fish seed were found to be influenced by temperature and salinity and the effect was more on the latter. During the entire period of observation the dissolved oxygen was above optimum level and hence had little effect on the seed density.

Seed of *P. indicus* were more abundant in temperature range of 29.4 to 30.9°C. High salinity values of steady nature always favoured a high abundance of seed of *P. indicus*. Seed of *M. dobsoni* were more in temperature between 29.2 and 31.1°C. They were abundant when the salinity range was 29.32 to 34.31%.

Puthiathura (Vizhinjam)

1. Annual abundance

At Puthiathura the fish seed were the most abundant while the prawn seed were only representative. Mullets formed about 96% of the fish seed. *Sillago* sp. and *Etroplus suratensis* (pearl spot) together formed 4%. Prawn seed were represented by *P. indicus*, *M. dobsoni* and *M. monoceros*.

Mullet seed were obtained at an average annual rate of 139 per 100 m², while the seed of other two species formed less than 2 annually. Prawn seed showed the following rate of occurrence: *M. dobsoni* 1, *M. monoceros* 1 and *P. indicus* less than 1.

2. Seasonal abundance

October–November (first quarter) which claimed 37.5% of total seed obtained during the year seemed to be the best season for cultivable species of fishes and prawns in this centre. Of the total quantity of the respective seed, over 72% of *M. monoceros*, 67% of *Sillago* sp. and 37% each of mullets, *M. dobsoni* and *P. indicus* were obtained during this quarter. During the 2nd quarter mullets, *Sillago* and *M. dobsoni* only were present. Seed of all species under consideration occurred during the 3rd quarter. Over 22% of mullet seed came in the 3rd quarter. Almost 97% of the total seed of *E. suratensis* were obtained in the fourth quarter.

3. Day-night abundance

In general the seed were more during day time. 59% of the total number of seed occurred during the
day. The day time abundance was more pronounced in the case of fish seed. Thus 72.8% seed of mullets, 99.3% of *E. suratensis* and 55% of *Sillago* sp. in total were collected during the day hours. In the case of prawns, the occurrence was more during the night. Over 56% of seed of *P. indicus*, 61% of *M. monoceros* and 55% of *M. dobsoni* were collected during night.

4. Abundance in relation to phases of moon

New moon and half moon phases seemed to be favourable for collection of mullet seed. The number varied between 26 and 485 during new moon phases and between 50 and 389 during the half moon phases while during full moon the number varied from 43 to 106. Out of the total mullet seed collected in the course of one year, 42.2% was obtained in the half moon phases followed by 41.3% during the new moon phases. Over 97% of the seed of pearl spot were obtained during the new moon phases. 75% of seed of *Sillago* sp. occurred during the half moon phases.

Prawn seed occurred in more numbers during the full moon phases. However, *P. indicus* occurred in equal proportion during all phases of moon. In abundance *M. dobsoni* had a tilt towards new moon. *M. monoceros* had a clear abundance during full moon.

5. Day-night abundance during different phases of moon

About 88% of the seed obtained during the full moon phases belonged to day hours. Almost 88% of the mullet seed were taken during day. Other fish and prawn seed showed a similar trend.

The difference in day-night abundance of mullet seed during new moon was not as marked as during the full moon phases. Almost 57% was collected during day. The entire quantity of pearl spot seed came in day time while more seed of *Sillago* sp. and *M. dobsoni* were present during night.

During half moon phase mullet seed formed 83% in the day catch. While there was no seed of *Eroplus* sp. during this phase, the catch of *Sillago* sp. was slightly better during day. All the seed of *P. indicus*, 95% of *M. dobsoni* and 82% of *M. monoceros* occurred during night.

6. Abundance in relation to tides and different phases of moon

It was found that in this centre the tides had very little influence on the abundance of seed irrespective of the phases of moon. The maximum number of mullet seed (3,853) was obtained during a half moon phase. However, the rate of occurrence was almost equal during the high and low tides. Almost the same trend was noticed during the high and low tides of the full and new moon phases.

7. Abundance in relation to hydrological features

Mullet seed were more in temperature between 29 and 31°C during October–November. The maximum number of *Eroplus* seed was obtained in temperature 30.5°C. Prawn seed also occurred in fairly good numbers in temperature between 29.5 and 31°C.

Seed of mullet and *Sillago* sp. occurred in all salinity ranges but their maximum abundance was noticed when the mean values ranged from 2.35 to 5.50‰. The seed of *Eroplus* sp. seemed to prefer very low salinity to the level of 0.53‰. Among prawns both *M. dobsoni* and *M. monoceros* were comparatively more in salinities between 0.49 and 5.90‰.

In general the dissolved O₂ content ranged between 2.20 and 5.40 ml/l. The variations in O₂ did not seem to affect the abundance of seed of either fish or prawn.

Punnaikayal (Tuticorin)

1. Annual abundance

The seed of *P. indicus* which was most common had an annual average abundance of 375 per 100 m². *M. dobsoni* occurred at an average rate of 49 seed. Other prawn species whose seed were encountered had an occurrence rate around 1 seed. Among fish seed, mullet had an annual abundance of 332 seed. All others, composed of seed of *Chanos, Eroplus* and *Sillago* spp. were represented by less than 3 seed.

2. Seasonal abundance

The seed of *P. indicus* had the peak abundance during October–December when they occurred at a rate of 551 seed. During January–February period also, it was some what abundant (390). During July–September period the abundance was of the order of 480.

The period of peak abundance of seed of *M. dobsoni* (102) was from January to March. A secondary peak with 46 seed was observed during July–September period.

In the case of mullet the maximum abundance of seed (654) was noticed during the period from April to
June. From July to September the seed occurred at the rate of 265.

3. Day-night abundance

The prawn seed were more during night, the percentage of occurrence being 58.4% for seed of *P. indicus* and 86.2% for seed of *M. dobsoni*. Seed of mullet were obviously more during day and the percentage of occurrence was 73. Seed of *Chanos* and *Sillago* spp. also were more during day. However, the seed of *Etroplus* sp. were relatively more during night.

4. Abundance in relation to phases of moon

Seed of prawns as well as fishes were comparatively more during the full moon phases. 54.25% of seed of *P. indicus* was obtained during the full moon while only 26.71% and 19.04% were obtained during the half moon and new moon phases respectively. In the case of *M. affinis* and *P. semisulcatus* the trend was just the reverse.

In the case of mullet seed, full and half moons together constituted about 74%. Seed of *Chanos* were found to be more during new moon days. But in regard to seed of *Etroplus* sp. the maximum abundance was noticed during the half moon phases.

5. Day-night abundance in relation to phases of moon

A marked difference in the occurrence of seed of cultivable species between day and night during different phases of the moon was not highly discernible at this centre. Seed of *P. indicus* were slightly more at night during full moon. In the case of *M. dobsoni* seed were more abundant at night during all the 3 phases of moon.

Seed of mullet were particularly more in day during all 3 phases of moon. Seed of *Chanos* were abundant in day of new moon and least during day of full moon. Seed of *Sillago* presented an almost equal abundance during day and night of half and full moons but were more during day times of new moon. *Etroplus* sp. had maximum abundance at night times of half moon followed by night times of full moon.

6. Abundance in relation to tide and lunar phases

High abundance of seed of *P. indicus* on full moon days appeared usually with rising or receding tides. This was particularly so in October, February and June when the tidal amplitudes were high. During half moon phases peak abundance occurred coinciding with higher tidal amplitudes. During new moon phases there was no particular regularity in regard to occurrence of seed of this species with tidal heights.

In the case of *M. dobsoni* the maximum abundance of seed took place coinciding with low tides on half moon phases.

7. Abundance in relation to hydrology

The seed of *P. indicus* showed an increasing trend with increasing temperature. With decreasing salinity from October to November a decrease in the abundance was noticed. With regard to seed of *M. dobsoni*, high abundance was observed between temperature of 27.5 and 30.7°C and salinity of 20 and 47.2‰.

Among fish seed, mullet seed were found to be more in higher temperature of 31 to 32°C. Also higher salinities favoured the abundance of this seed.

Pillaimadam (Mandapam)

1. Annual abundance

At this centre among cultivable prawns, *P. indicus* with an average annual seed density of 10 per 100 m² of water ranked first followed by *P. semisulcatus* with 4 seed. Among fishes seed of *Sillago* sp. and mullet were the most dominant with 6 seed each per 100 m². Even though *Chanos* is a common seed in this area its abundance was not very much reflected in the annual average during these investigations as its abundance is highly seasonal.

2. Seasonal abundance

The maximum quantity of seed of *P. indicus* was obtained during October–November period (35) followed by *P. semisulcatus* during September–October (20). Seed of mullet were abundant during May–June period and occurred at the rate of 26. The period of abundance for seed of *Sillago* was October–November and the rate of occurrence was 21.

3. Day-night abundance

Among cultivable prawns and fishes 80.4% seed of *P. indicus*, 75.0% of *Chanos* and 53.0% of mullets occurred during the day time while 80% seed of *Sillago* sp. and 74% of *P. semisulcatus* occurred in night samples.
4. Abundance in relation to different phases of moon

Seventy seven per cent of seed of *P. indicus* was taken during new moon phase and only 1.3% was present during the full moon phases. However, seed of *P. semisulcatus* were more abundant during the full moon phases (51%) while only 6% occurred in the new moon samples. In the case of mullets the percentage of abundance was more (63%) during mid lunar phases and also during full moon (27%).

5. Day-night abundance in relation to different phases of moon

In general, the day time occurrence of prawn and fish seed increased during new moon. However, in the case of *P. semisulcatus* the seed were abundant during nights of full and mid lunar phases. Mullets contributed more during night in full moon period. However, these were more in day samples of new moon phases. Seed of *Sillago* sp. and *Chanos* occurred in more numbers during night in full moon phases while they occurred in abundance during new moon phases in the day samples.

6. Abundance in relation to tides and different phases of moon

It was observed that during full moon and new moon phases, irrespective of day or night, the rising tides brought in more number of seed of *P. indicus* and *P. semisulcatus*. No relationship was found with regard to day-night abundance during the new and full moon phases. No particular variation was noticed in those months when there was no tidal effect due to the closure of the bar mouth.

With regard to day-night abundance of seed in relation to tides, it was found that *P. indicus* and mullet occurred in day time during high tides. However, more of *P. semisulcatus* occurred at night during the high tides. Seed of *Sillago* sp. were in abundance towards morning and evening during low tides.

7. Abundance in relation to hydrological features

At this centre seed of *P. indicus* were more in temperature between 28 and 29.5°C and salinity between 15 and 20‰. *P. semisulcatus* was dominant in temperature 29°C and salinity 30.5‰. Mullets seemed to prefer a temperature of 31°C and salinity of 32-35‰. *Sillago* sp. was dominant at mean temperature of 30°C and salinity 35‰.
लघुज्ञान का यथाचार दृष्टि स्वार्थ
फेसल तरंग, शरीरलीय और ज्याप्तिकारिक अथवा अन्य संदर्भों में कोई संदर्भ के अन्तर्गत वर्तमान प्रयोगों में उपयोग किया जाता है। इस अन्तर्गत वेबसिटी तथा जीवन में वर्तमान विश्वास तथा तत्कालीक अन्तर्थवाणी और पर्यावरणीय मात्राओं में उपयोग किया जा सकता है।

फेसल तरंग का तापमान 21° C और 36° C के बीच रहता है जब संक्षेपतीम्योजन के लक्षण खाद्य संदर्भ में देखे जा सकते हैं। तरंग देखा गया है जब तक तापमान 37° C रहे।

फेरल के केंद्रीय तरंग की लघुसंधिता 11° से 37° C के बीच थी जबकि तापमान में यह 7° से 41° C तक बढ़ सकता है। तरंग के क्षेत्र के ज्याप्तिकारिक और सांस्कृतिक और ज्याप्तिकारिक अथवा इस के अन्तर्गत उभयनिष्ठता के माध्यम से इसका उपयोग बढ़ा सकता है। तरंग तापमान में 80% से 27.9° C के तापमान में रहते हैं।

पेला इन्फ्रा के बीच अटलसिरी, प्रथम, ब्योमीट्री और इंजनियरिंग के संबंध में अंतर्गत रहता है।

खेत 2: पोषण-नीतिकरण
इस खेत में दिखायी दी गई स्थापना देखी जा सकती है। इन्फ्रा, एम. बिजीनी और एप. मोलिनरी के बीच संबंधित है।

बीजों की उपस्थिति और आवश्यकता
खेत 1 काउलरेड - पोषणीय
हाल ही में करान काव्यिक ग्रंथ से महाद्वीपीय बीज एंटोमिक इन्फ्रा, मेटाप्लास्टिक लिपीडोनी, अन्न और नितिकार एन. थियो।

ची, इन्फ्रा के बारे में की-दी दी-दी किया जा सकता है। तूफान बिशम माही में इसके लक्षण दिखाये जा सकते हैं। भर्ति के नाम पर इस खेत के सारे केंद्रों में नितिकार तथा जीवन में अंतर्गत रहता है। इन्फ्रा में बीजों को आवश्यकता अनुभव करता है। फारवाड-फारवाड-फारवाड के तर्कों में जीवन और जीवन-अंतर्गत के दौरान पी। इन्फ्रा के बीजों को आवश्यकता अनुभव करता है। फारवाड-फारवाड के तर्कों में जीवन और जीवन-अंतर्गत के दौरान पी। इन्फ्रा के बीजों को आवश्यकता अनुभव करता है। फारवाड-फारवाड के तर्कों में जीवन और जीवन-अंतर्गत के दौरान पी। इन्फ्रा के बीजों को आवश्यकता अनुभव करता है।
लेख 3: नीरज-कन्याकुमारी

इस लेख में लिखा गया है कि नीरज-कन्य भारत के कुछ स्थानों में लगातार लिखा गया है। इन्हें अति अधिक मात्रा में बताया गया है। इसलिए, इन कुछ स्थानों में लिखा गया है।

लेख 4: कन्याकुमारी - कीड़कारी

लेख 5: फलस्वरुप-सुदर राहस्यसम्पन्न

लेख 6: सुरुयी-पुरवतक

लेख 7: पोलिया - नीरजकर

लेख 8: नीरजकर

लेख 9: कन्याकुमारी - कीड़कारी
बीज बहुतता: श्री. इंकिस्का बींजों का बारिष्ठ बहुतता 100 m² पर 59 था। उपजाम मात्रा फूलकाल में देखी गई। एम. डोमोकीयो का बारिष्ठ बींज बहुतता 100 m² पर 13 था। उपजाम मात्रा मध्यक देखी गई।

महलेट, काशी सहित महल्लों के बीज भी बहुत हैं। इसका बारिष्ठ बहुतता 100 m² पर लगभग 89 और 12 था।

क्षेत्र: कौवार-कुंदरपान-अम्बेडकर

यह क्षेत्र नापकरपुरी, प्रकाश, प्रयाग-पिंजराम, मिलाइखम और ठाकुरशाही में सर्वेक्षण लगा।

बीज बहुतता: श्री. इंकिस्का, श्री. शेमथिमालसे और एम. अर्कारों के बीज में उपलब्ध थे। श्री. इंकिस्का के बीज लगभग शेरतकार में देखी गई। श्री. शेमथिमालसे का बीज सबसे अधिक जानकारी में प्रति 300 देखा गया। मिलाइखम में एम. अर्कारों के बीज प्रति 100 मिली में 8,400 देखी गई।

पिंजराम में दुःखेजे के बीज (प्रति 100 मिली में 15,500) और पारपाल के पावन में (प्रति 100 मी. में 7,74,200) देखा गया।

पाँच प्रयासों के संक्षेप में केरल और तमिलनाडु के बीजों के बीज के महत्वपूर्ण निरीक्षण का परिणाम।

अनुमानों के जोन के दौरान पर बींज का प्रमाण बहुत ही विशेष है। इसका कारण बींजों के ज्ञानकारी और प्रबंधन पर ध्येय मात्रा होती है। बींज के परिप्रेक्ष्य त्रिकोण में इंथम जी और बींज के बारे में जानकारी है। बींज के बीज और प्रकाशी के बीज अनुग्रह और बींज को देखा गया है। बींज के बीजों का निरीक्षण बहुत प्रभावी था। बींज के प्रयासों के बीज के बीज की तीन दशाओं में निंदा पत्ररूप देखा गया। आधा बीज और पूर्ण बीज के आधार पर बीज की निरीक्षण का परिणाम निंदा पत्ररूप देखा गया।

फॉर्मुला 1. नीसीमी-प्रयुक्त

अंकित संख्या में देखे गये बींज थे। इंकिस्का, एम. डोमोकीयो और मुझे एम. के थे। वर्तमान तारीख और तीसरे प्रतिदिनों में श्री. इंकिस्का का बीज प्रति 100 मी. पर ज्ञानकारी 1,200, 300 और 1,400 था।

सारा अंकित में एम. डोमोकीयो के बीज कम देखे गये। जल्दी के बीज उबालते यह महल्ले के बीज पहले और दूसरी दिनहारा में देखे गये।

2. दिन का बिज्ज्यसंक्रमण प्रयुक्त

दिन के बिज्ज्यसंक्रमण में श्री. इंकिस्का का बीज उपक्रम देखा गया।

3. वृंद प्रयुक्त का आधार पर प्रयुक्त

संध्याकाल का आधार का ज्ञानकारी में भी उपक्रम 14,500 ही बीज देखे गये

4. आधार के आधार पर परिणाम

आधार के समय बींज की संख्या अधिक थी बांट और कम।

5. लक्षणीया का आधार पर प्रयुक्त

1. नीसीमी-प्रयुक्त

श्री. इंकिस्का के बीज दूसरी दिनहारा में ज्ञानकारी प्रयुक्त हुई। एम. डोमोकीयो के बीज भी दूसरी और तीसरी दिनहारा में ज्ञानकारी में देखे गये।

6. वृंद-प्रयुक्त का आधार पर परिणाम

5. वृंद-प्रयुक्त और तीसरी प्रयुक्त का बीज वर्गीय व्यावहार देखा गया।

4. वृंद-प्रयुक्त का आधार पर परिणाम

वृंद की प्रयुक्त और बीज की प्रयुक्त बीज की संख्या देखा गया।

3. दिन-रात प्रयुक्त

श्री. इंकिस्का का बीज दूसरी दिनहारा में ज्ञानकारी प्रयुक्त हुई। एम. डोमोकीयो के बीज भी दूसरी और तीसरी दिनहारा में ज्ञानकारी में देखे गये।

2. तीसरी प्रयुक्त

श्री. इंकिस्का के बीज दूसरी दिनहारा में ज्ञानकारी प्रयुक्त हुई। एम. डोमोकीयो के बीज भी दूसरी और तीसरी दिनहारा में ज्ञानकारी में देखे गये।

1. मीसी-प्रयुक्त

श्री. इंकिस्का के बीज दूसरी दिनहारा में ज्ञानकारी प्रयुक्त हुई।

1. मीसी-प्रयुक्त

श्री. इंकिस्का के बीज दूसरी दिनहारा में ज्ञानकारी प्रयुक्त हुई।
6. प्रत्यूता और दाहर्षितकिलन लक्षणों का सम्बंध

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7. दाहर्षितकिलन (मॉडल)

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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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