

## **Fishery of *Macrobrachium rosenbergii* (de Man) in the Vembanad lake and confluent rivers**

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### **ABSTRACT**

The exploited stock of *Macrobrachium rosenbergii* (de Man) from Vembanad lake and confluent rivers was quantified as 121.14 tonnes annually and the average annual yield was found to be 5.34Kg/ha. Peak landings were observed during October while zone 9 contributed the highest landings. However, the most productive zone based on annual yield/ha was zone 10 (18.64Kg/ha) whereas, zone 1 appeared as the least productive zone (0.197Kg/ha). Cast net operation such as "Pongu Veechal" was found to be the principal method of fishing for *M. rosenbergii* in the lake. Females distinctly predominated over the males. Morphotype wise, Strong Blue Clawed females (SBC) among female population (36.9 tonnes) and Weak Blue Clawed males (WBC) among males constituted the highest landings (14.6 tonnes). Though males in the size range 71 -393mm TL and females of 110-290mm TL could be encountered in the exploited stock, 190-209mm and 210-229mm were found to be the model classes in males and females respectively. On examining the marketable yield structure, it could be seen that 100-150g size group showed distinct dominance among both sexes.

### **Introduction**

Monitoring of the stock of *Macrobrachium rosenbergii* (de Man) of the Vembanad lake and confluent rivers is found inevitable from time to time in order to formulate policies for management and exploitation in view of the dwindling nature of its fishery due to ecological transformations brought about by way of constructing barrages, perils from pollution, reclamation of part of the lake for agriculture and other purposes and also

due to the severe fishing pressure exerted on the stock. Therefore, an attempt is made in the present study, to quantify the exploited stock and to delineate the resource characteristics of this species. Studies on *Macrobrachium* resources of Vembanad lake are those of Raman (1967;1975), Kurup *et al.* (1992), Harikrishnan (1997) and Harikrishnan and Kurup (1997a; 1997b).

### **Materials and methods**

The quantification of the exploited

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stock of *M. rosenbergii* has been made based on the catch data from the specific and non specific gears and fishing methods operated in the Vembanad lake and confluent rivers. The Vembanad lake was apportioned into ten zones, while each of the 5 Km stretch of adjoining rivers influxing into the lake proper viz. Muvattupuzha, Meenachil, Pampa, Achencoil and Manimala were treated as three separate zones (Fig.1). The

giving due emphasis to morphotype (Harikrishnan and Kurup, 1997b), number and weight of male and female, length composition, etc. Sexes were differentiated with the help of external manifestations and other secondary sexual characteristics as described by New and Singholka (1985). The fishing hours of the observed catch and the total hours spent for fishing in the ground were also recorded. Daily landings from each category of gears and methods were thus computed by applying the formula (Kurup *et al.*, 1992).

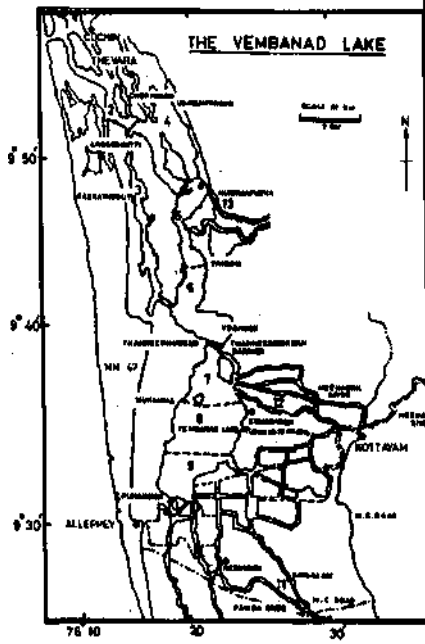


Fig. 1. Vembanad lake and confluent rivers showing zones of survey.

catch was observed at monthly intervals, from various gears and fishing methods (Harikrishnan and Kurup, 1997a) during the fishery survey cruises carried out in the lake and riverine regions from March, 1994 to February, 1996 with the help of *M.B.King Fisher* of the School of Industrial Fisheries. In each zone, the prevailing fishing activity of *M. rosenbergii* was observed for 24hours continuously. Total number of each category of fishing gears and methods of operation were enumerated and the catches were examined in detail from not less than 30% of each type of gear,

$$W = \frac{W}{n} \times N$$

where,

'W' = total weight of *M. rosenbergii* in each zone.

'W' = total weight of *M. rosenbergii* recorded from the gear sampled.

'n' = number of gears sampled.

•'N' = total number of similar gears engaged in fishing.

Monthly catch was estimated by multiplying the daily catch with total number of fishing days of each zone. Average values of all estimates for the two years have been worked out and are presented here. Temperature and salinity were recorded from one station each of 13 zones, the temperature with a sensitive mercury-in-glass centigrade thermometer and salinity by following Mohr Knudson method (Strickland and Parson, 1972) while rainfall data was collected from the Regional Agriculture Station, Mancombu.

## Results

### Rainfall, temperature and salinity

The average annual rainfall in the study area was 2825mm of which monsoon season accounted for 66.41% while post and pre monsoon seasons registered 16.48 and

17.11% respectively. Water temperature was invariably low during June- July (24°C) which gradually increased from August onwards and reached highest value in March (32°C). In zones of the downstream regions of the lake, polyhaline (18-32ppt) and mesohaline (5-18ppt) conditions were prevalent during pre and post monsoon seasons. With the onset of South-West monsoon, the surface salinity came down to less than 2ppt during June to August in most of the zones, however, the bottom salinity remained in the range of 5-10 ppt in zones 1-4 during this period. In the upstream part of the lake, the highest salinity recorded was 8ppt. The saline water intrusion into these part of the lake could only be recorded in March and April.

#### Quantification of the exploited stock

The exploited stock of *M. rosenbergii* from the Vembanad lake and the confluent zones of the rivers during March 94 to February 95 and March 95 to February 96 were quantified as 112.85 tonnes and 129.44 tonnes respectively, with an annual average of 121.14 tonnes. Riverine zones (zones 10,11,12 and 13) contributed 30.23% of the total exploited stock while the share of the upstream part of the lake (zones 7,8 and 9) was 33.20%, whereas 36.43% of the total catch was registered from the downstream part of the lake (zones 1-6). The average annual yield/ha was computed at 5.34Kg/ha; riverine region appeared to be the most productive showing 58.29Kg/ha with the downstream part and upstream part recording 22.89Kg/ha and 15.58Kg/ha respectively. Among various zones, zone 10 was found to be most productive (18.64Kg/ha) whereas zone 1 appeared as the least productive zone (0.19Kg/ha).

#### Month wise landings

The average monthly landings of *M. rosenbergii* from Vembanad lake and confluent rivers for two years are depicted

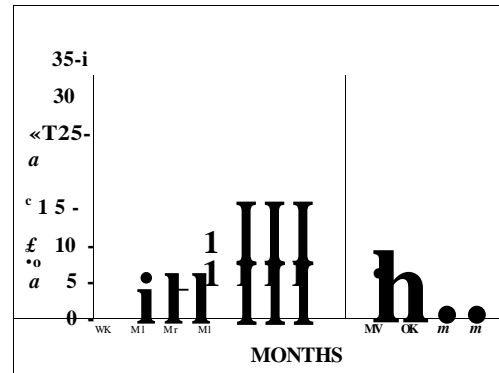


Fig. 2. Average month wise landings of *M. rosenbergii* in Vembanad lake and confluent rivers during 1994-96.

in Fig. 2. The fishery got intensified from June onwards and continued up to December. Peak landings could be recorded in October followed by September (24 tonnes). During January to April, the fishery appeared to be very bleak. The fishery was exclusively contributed by males during March- May period, while during June- July, the predominance of males continued with stray numbers of females. Interestingly, in August, the contribution of male and female in the landing appeared almost in equal proportions while during September to November, the major share of the landings was represented by females. In December, the catch was exclusively represented by females.

#### Zone wise landings

The average annual zone wise landings of *M. rosenbergii* in the lake and confluent rivers during 94-96 are presented in Fig.3. Highest landing was observed in zone 9 (18.92 tonnes) followed by zone 11(16.61 tonnes) and 8 (16.08 tonnes), whereas zone 1 registered the lowest landing (0.32 tonnes). The production pattern from different zones shows a moderate production in zones 2-4 which was succeeded by a less productive area coming under zones 5-7, thereafter, the magnitude

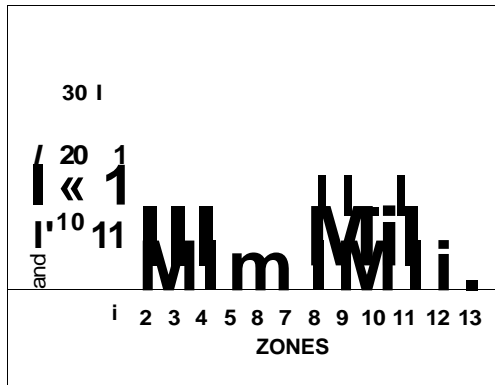


Fig. 3. Average zone wise landings of *M. rosenbergii* in Vembanad lake and confluent rivers during 1994-96.

of fishery got intensified in zones 8-11 and further a sizeable decline in production could be discernible in zones 12 and 13. The variation of average annual yield/ha in the 13 zones is shown in Fig.4. Highest production could be recorded in zone 10 (18.64Kg/ha) whereas zone 1 appeared to be the least productive area. The difference observed in production/ha was very remarkable between zones 10-13 and 5-7.

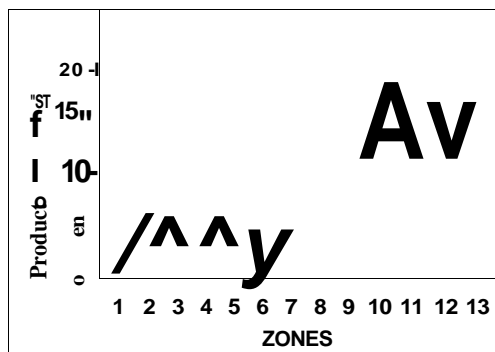


Fig. 4. Zone wise average production per hectare of *M. rosenbergii* in Vembanad lake and confluent rivers during 1994-96.

The rate of diminishment was very glaring from zone 10 to 6, the latter showing only less than one tenth production of the former, however, zones 2 to 4 appeared as comparatively more productive among the downstream zones.

**Gear wine landings**

Percentage exploitation of *M. rosenbergii* from various fishing gears and methods during 1994-96 is depicted in Fig.5. Cast net operation, "Pongu Veechal" appeared to be the principal method employed, contributing 73% of the exploited stock. Other cast net operations : "Koti Kuthi Veechal" and "Thady Veechal" registered only 4 and 3% respectively. Fixed gears like Stake net and Chinese net

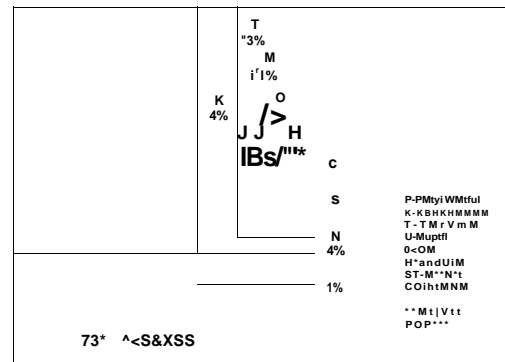


Fig. 5. Average percentage exploitation of *M. rosenbergii* from various fishing gears and methods during 1994-96.

contributed 7 and 2% respectively while "Neettu Vala" (Gill net) and "Choonda" (Hand lines) accounted for 4 and 3% respectively. Indigenous fishing gears and methods like "Ottal" (2%), "Muppalli" (1%), "Padal" (1%) were also employed in the fishery of *M. rosenbergii* in the lake. Though, size ranging from 60-340mm were represented in the catches from Pongu Veechal, prawns above 20mm formed the major portion of the landings, while size groups of 180mm and 200mm appeared as the modal classes. On the contrary, catches from Thady veechal comprised mainly of large sized prawns ranging from 160-300mm, with the 200 mm size group as the modal class. Landings from Koti Kuthi Veechal comprised mainly of prawns having size ranges of 60-260mm and modal class was constituted by 160mm. Padal, Ottal, Choonda, Seines and Stake nets

caught mainly prawns below 160mm, while the catches from Neettu vala, Muppalli and Chinese net were represented by comparatively larger specimens. Males dominated the catches from Pongu Veechal (53.81%), Koti kuthi veechal (87.49%) and Ottal (52.94%), on the contrary, females clearly predominated in Thady veechal (83.87%), Neettu Vala (97.67%), Chinese net (85.71%) and Padal (72.73%). Exclusive representation of females could be observed in Choonda and Seines. 55.8% of the total female population was comprised of berries and 81.1% of berries was exploited by Pongu Veechal. Thady Veechal (9.45%), Neettu Vala (2.84%) and Stake net (2.27%), Ottal (1.89%) and Choonda (1.70%) were also involved in the exploitation of ovigerous females from the lake.

**Sex and morphotype wise composition**

Females (56.68%) clearly dominated the males (43.32%) in the exploited stock of *M. rosenbergii* in Vembanad lake and confluent rivers. The average annual landings of male and female morphotypes in the the exploited population of *M. rosenbergii* in the study area is shown in Fig. 6. Among various male morphotypes Weak Blue Clawed (WBC) males (14.63 tonnes) followed by Strong Blue Clawed (SBC) males (14.38 tonnes) contributed the highest shares whereas Strong Blue

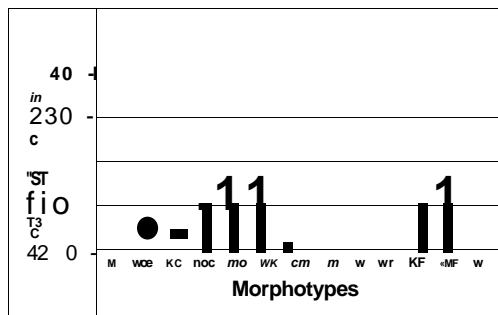


Fig. 6. Average landings of male and female morphotypes of *M. rosenbergii* in Vembanad lake and confluent rivers during 1994-96.

Clawed females (SBC) distinctly predominated among female morphotypes (36.93 tonnes). Blue Clawed morphotypes formed the largest share of the exploited stock in both sexes. The presence of Small Males (SM) could be seen only sparsely. The contribution of Strong Orange Clawed (SOC) and Old Blue Clawed (OBC) among males and Weak Orange clawed Females (WOF) and Strong Orange clawed Females (SOF) among females were insignificant.

**Size frequency distribution**

Males in the range 71-393mm (Total Length) (4-510g Total weight) and females of 141-282mm TL (38-228g TW) could be encountered from the lake during the course of present the investigation (Fig. 7).

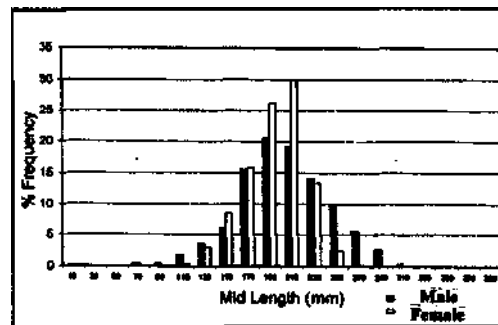


Fig. 7. Length frequency distribution of males and females in the exploited stock of *M. rosenbergii* in Vembanad lake and confluent rivers during 1994-96.

However, the exploited stock was predominantly represented by specimens in the range 150-270mm TL. The modal class in male population was 180-199mm which was closely followed by 200-219mm. On the contrary, the principal modal class in female population was 200-219mm, followed by 180-199mm size class.

**Marketable yield structure**

In consonance with the different grading system and price tariff packages offered by the seafood exporting plants

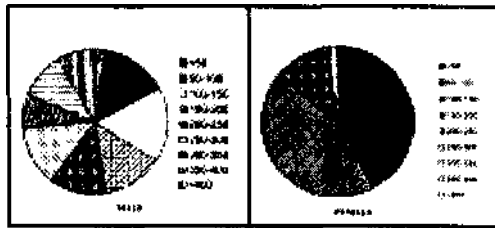


Fig. 8. Marketable weight structure of males and females in the exploited stock of *M. rosenbergii* in Vembanad lake and confluent rivers during 1994-96.

towards procurement of *M. rosenbergii* for export purposes, the exploited quantities from the lake have been apportioned into different marketable weight structures and the results are shown in Fig.8. The major part of male catch was more or less comprised of all size groups between 50 to 300g, whereas in female catch, 50-100g and 100-150g size groups showed the highest percentage contribution. However, 100-150g size group emerged dominant in both males (16.41%) and females (43.79%).

### Discussion

The exploited stock of *M. rosenbergii* from Vembanad lake and 5Km stretch of the confluent rivers viz., Pampa, Manimala, Meenachil and Muvattupuzha was quantified as 112.85 tonnes in 1994-95 and 129.44 tonnes in 1995-96 with an average of 121.14 tonnes. Raman (1967) assessed the stock as 182- 429 tonnes with an annual landing of 300 tonnes during 1957-62 while Kurup *et al.* (1992) reported a heavy decline in the stock size to mere 39 tonnes. The present estimate show a three fold increase over the quantity assessed by Kurup *et al.* (1992).

The depletion of the stock was attributed mainly to the impact of man made changes in the ecosystem such as habitat alteration, reduction in the natural grow-outs due to intensification of paddy cultivation and cropping patterns, reclamation of about 10,000 ha of the lake

as paddy fields, recruitment over-fishing and also the impacts of Thanneermukkam barrier causing pollution hazards, physical obstruction in the migratory pattern of the berries and post larvae and the shifting of breeding ground from Kumarakom to 40Km downwards (Kurup *et al.*, 1992).

As *M. rosenbergii* requires both fresh and saline water for completion of its life history, implication of the barrier is that it might obstruct the downward migrating spawning stock as well as the upwardly migrating post larvae and juveniles. Prior to 1990, the barrier was closed before 10<sup>th</sup> of December and the shutters were lifted by the end of May or by beginning of June. By the closure of the barrier in December, the downward migration of a sizeable number of berries may be obstructed (Kurup *et al.*, 1992) and thereafter, are prone to indiscriminate exploitation in the upstream part of the lake. According to Harikrishnan and Kurup (1997c), highest landings of spawning stock was encountered in October, followed by September which collectively accounted for 82.11% of the berried population of the lake. The authors also reported that about 30.2% of the total 23.43 tonnes of ovigerous female reaches the breeding ground located in zones 2,3 or 4 of the lake during September and October, where the environmental conditions are congenial for hatching and completion of larval metamorphosis (Harikrishnan and Kurup, 1997c). A minimum of 16- 45 days are required for hatching and completion of larval metamorphosis of this species (New and Singholka, 1985). The postlarvae begin to migrate upstream into freshwater conditions with in one or two weeks after metmorphosis and are soon able to swim against rapidly flowing currents or to crawl over the stones at the shallow edges of rivers. Bulk of the post larval stock will get ready for upward migration only by the middle of December onwards, which almost

synchronises with the closure of the barrier.

However, 1990 onwards, the barrier was kept open from the middle of April. A steady improvement in the landings of *M. rosenbergii* from the lake could be noticed during 1994-95 and the succeeding year which can be attributed to the major changes brought in the operation schedule of the barrier. The results of mark-release-recovery studies on *M. rosenbergii* in January-February revealed that only 0.53% of the total marked and released juveniles in the downstream regions could be collected from the upstream part of the lake (Harikrishnan and Kurup, 1998) suggesting the possibility of heavy mortality, mainly due to the rapid increase of salinity and also due to predation.

A critical analysis of the pattern of fishery prevalent in different zones reveal the fishery almost an year round with peak landing during July to October. In contrast, in the zones of downstream region (zones 1-6), the fishery is found generally restricted during June to January. It is also pertinent to note that there is an obvious shift in the onset of the fishery in different zones of the lake, presumably in the descending order from south to north. The appearance of this species could be seen in May- June in zone 6, 5, 4 and 3 which are located proximal to the upstream part of the lake. The fishery was present only in July-August in zones 2 and 1, which form the northern most regions of the lake. Conversely, in zones 11 and 12 which form the confluent portions of river Pampa and Meenachil, the occurrence of stock was observed much early in March and continued till October- November.

It can be inferred that zones 8,9 and 10 is characterized by the presence of a resident stock, which undertakes seasonal upward and downward migration, former towards riverine habitat taking place during summer or pre monsoon season

while the latter takes place during the monsoon and post monsoon. According to Raman(1964), the upward migration of *M. rosenbergii* during summer is mainly for inhabiting the deeper parts of the rivers where bottom is not only slushy but also very cool. Natividad (1982) reported that *M. rosenbergii* inhabiting some Philippine rivers preferred a temperature range of 23.5 -25. 5°C. In the present study also, a steep increase of water temperature in the study area could be observed from February onwards in the lake proper, attaining a peak in April. However, the bottom temperatures of riverine areas were relatively lower when compared to similar values obtained from the lake proper. Juveniles and large males of *M. rosenbergii* are fully at home in the river mouths adjacent to the brackish water areas where salinity was nearly 18ppt indicating that increased salinity alone is not the inducing factor for the ascend of the stock in to the rivers (Raman, 1964). However, in the present study, the salinity values did not exceed 8 ppt in upstream part of the lake and therefore, it can reasonably be asserted that temperature is the only inducing factor for their upward migration.

The descend of the males into the backwater regions of the lake (zones 6 to 1) could be observed only by the end of May or early June and this is found to be fully coinciding with the onset of monsoon. This may be due to heavy discharge of freshets from the adjoining rivers with the onset of south-west monsoon which not only raises the water level in the lake, but also results in lowering of the water temperature, sudden rise in turbidity and conversion of whole lake into a freshwater lentic environment by reducing salinity. In the present study also, lowest temperature was recorded from the lake during June-August when typical oligohaline conditions are prevalent in the lake in most of the zones. Invariably, *Macrobrachium* spp. show their peak abundance in India during monsoon

and post monsoon seasons (George, 1969; Ibrahim, 1967; Rajyalekshmi, 1980; Prakash, 1989). The total yield of *M. rosenbergii* in Irrawady river in Burma is reported as 1782.2 tonnes and the prime period of landings is in September to January (Taw, 1982). In Kolleru lake, highest landing of *M. rosenbergii* was reported in winter and monsoon seasons which accounted for 62% and 28% respectively (Rao, 1992). The distribution and maximum abundance of *M. rosenbergii* in the Vembanad lake and confluent rivers have been observed during the above periods in agreement with the above findings. IncurSION of saline water into the lake could be noticed from September onwards. The gradual penetration of salinity into the zones of downstream regions of the lake make them mesohaline and polyhaline during January-April and the disappearance of stock of the species during January-May in these zones can be attributed to this increase of salinity.

The present study also show that the seasonal fishery of *M. rosenbergii* in the downstream regions of the lake (zone 1-6) is predominantly contributed by migratory stock, characterized by the dominance of males during the earlier period of June and July and females during August- October, presumably as a result of their differential breeding migration. Similar situations also prevail in Bolgoda lake, Sri Lanka where the fishery is supported by spawning stocks. Migratory movement in to the lakes for breeding, hatching or for both have been reported in many Palaemonids such as *Palaemon carcinus* (Johnson, 1966) and *P. mirabilis* (Rajyalekshmi, 1961).

The modal value of male *M. rosenbergii* constituting the fishery of the lake during the present study was observed as 180-199mm which was closely followed by 200-210mm. This was found similar in

comparison with that of Kurup *et al.* (1992), however, when compared to Raman (1967), is on a lower side. Females also maintained the same modal class as reported by Kurup *et al.* (1992), however, appears to be far below when compared to 220-240mm as reported by Raman (1967). The maximum size registered in the present study of males and females were 393 and 289mm respectively which on comparing with that of Kurup *et al.* (1992), is higher in the case of males while in females, the value is identical.

The present study indicate that the stock of *M. rosenbergii* in Vembanad lake shows manifestation of a reviving trend which could be inferred from the three fold increase in the landings recently when compared to that of eighties. The closure of Thanneermukkam salinity barrier is reported to be responsible for imposing physical obstruction to the downwardly migrating ovigerous females and also the upwardly migrating post larvae of this species after completion of its life cycle. (Kurup *et al.*, 1992). Keeping the closure period of the barrier strictly to December-March would call for judicious management of cropping pattern in the low lying paddy fields of Kuttanad. Enroute their downward migration, the berried females succumb to heavy fishing pressure and about 23.43 tonnes of berries are landed in the lake annually (Harikrishnan and Kurup, 1997c). The percentage of berried females reached highest proportion during September- November of which only 30.2% could successfully reach the breeding grounds. Raman (1967) reported a case of self imposed closed season by the freezing industry in Cochin during the period of abundance of breeding stock in the lake. Enforcing a closed season in the fishery of *M. rosenbergii* during this period would, however, deprive a large number of fishermen from earning their livelihood as September and October form the peak fishing months. Imparting a ban on the



fishery of this species, at least, in the breeding grounds such as Thevara-Perumbalam area during September-October would help in the conservation of this stock as it would be beneficial in minimizing the recruitment overfishing. The fishermen engaged in Thady veechal may be adversely affected by such a ban as this method is exclusively used for fishing freshwater prawns in Perumbalam area where berried females form the major share of their catch. Prohibition on gears like gill nets, stake nets and Chinese nets may not be feasible as these gears do not target freshwater prawns. Therefore, educating fishermen about the threat of over exploitation of the spawning stock appears to be feasible. Establishment of sanctuaries as reported by John (1957) at the breeding grounds in zones 3, 4 and 5 would also be another sensible suggestion for improving the stock. Such sanctuaries may be constructed with the involvement of local bodies of Grama Panchayats adjacent to the lake. The berried prawns collected by fishermen in live condition may be released in the sanctuaries for which the fishermen shall be duly rewarded. Ranching of hatchery reared post larvae of *M. rosenbergii* in the lake and confluent rivers would be another step towards stock replenishment. The Department of Fisheries of Govt, of Kerala has implemented a scheme "Social Fishery" by which large scale ranching of scampi post larvae has been carried out in the lake since 1992. A similar act has also been accomplished recently by the local bodies adjacent to the lake under the "People's Campaign for Planning."

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