Reviving the *Macrobrachium rosenbergii* (de Man) Fishery in Vembanad Lake, India

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Abstract

In Vembanad Lake and its confluent rivers (Kerala, India), the catches of *Macrobrachium rosenbergii* (de Man) were reported to have dwindled to a mere 39 t in the 1980s from average landings of 300 t during the 1960s. This decline is due to the impact of a number of human interventions affecting the ecosystem and, hence, the stocks of *M. rosenbergii*. Monitoring of landings in 1994-1995 and 1995-1996 indicates an improvement in catches. This paper discusses the reasons for the decline and revival in stocks and suggestions for their replenishment.

Introduction

Monitoring the stock size of the giant freshwater prawn *Macrobrachium rosenbergii* (de Man) of Vembanad Lake and confluent rivers (9°28' and 10°10'N and 76°13' and 31'E) from time to time is necessary to assess the response and reaction of this species to various ecological transformations brought about in its habitat. *M. rosenbergii*, a true denizen of Kuttanad (Kerala State) and known locally as *Kuttanadan konchu*, was known to have provided a lucrative fishery in Vembanad Lake and its confluent rivers during the 1950s and early 1960s. By virtue of being an important component of shrimp exports and an earner of foreign exchange for Kerala, it emerged as the most valuable species in the inland waters of the State. However, this species became a rarity in the late 1980s and the decline in the stocks was attributed to the impact of various human interventions imposed on the ecosystem of Vembanad Lake. Some of these were: reduction in water spread due to reclamation for paddy culture and urbanization; construction and commissioning of a salinity barrier at Thanneermukkam in 1976 (which practically divided the lake into two entirely different types of water bodies); pollution hazards like pesticides, agrochemicals, sewage and industrial effluents; excessive fishing pressure exerted on the stocks; and recruitment overfishing. As the stocks of *M. rosenbergii* are prone to severe stress due to these factors, periodic monitoring of the stock is very essential for the formulation of appropriate conservation and management plans for this waterbody. This paper attempts to estimate the exploited stock of *M. rosenbergii* from Vembanad Lake and its confluent rivers and to make comparisons with similar data for the past four decades. Previous attempts to estimate the landings of *M. rosenbergii* at Vembanad Lake are those of Raman (1967) and Kurup et al. (1992). Harikrishnan and Kurup (1997) attempted to estimate the intensity of exploitation of berried prawns of this species from this waterbody. Fishing methods and fishing intensity of this species by gear in Vembanad Lake have been reported by Harikrishnan and Kurup (1998a).

Materials and Methods

Estimates of the exploited stock of *M. rosenbergii* were made on the basis of catches registered from specific and nonspecific gears at the fishing grounds. Vembanad Lake (Fig. 1) was apportioned into ten zones, while 5 km stretches of each of the adjoining rivers flowing into the lake, namely, Muvattupuzha, Meenachil, Pampa, Achenkovil and Manimala, were treated as three separate zones. Monthly fishery survey cruises were conducted with the help of the *M.B. Kingfisher* of Cochin University of Science and Technology from March 1994 to February 1996. The fishing for *M. rosenbergii* in each zone was observed for a continuous period of 24 hours. The number of fishing gears operated in each category was enumerated and catches from not less than 30% of each type of gears were examined to note total weight, fishing hours monitored, total hours usually spent fishing, sex, morphotypic composition, length, etc. Daily landings from each category of gear and method were computed by applying the formula (Kurup et al. 1992):

$$\mathbf{W = w/n \times N}$$

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.

The monthly catch was estimated by multiplying the daily catch by the number of fishing days for each zone. Previous data

on the landing of *M. rosenbergii* in Vembanad Lake were gathered from Raman (1967) and Kurup et al. (1992). Data on the operation schedule of the Thanneermukkam barrier (Figs. 2a and 2b) have been compiled from the Irrigation Department, Alappuzha, Government of Kerala.

Results and Discussion

The exploited stock of *M. rosenbergii* from the study area during March 1994 to February 1995 was estimated at 112.85 t and during March 1995 to February 1996 at 129.44 t (Fig. 3). The catch increased from July onwards up to December in 1994-1995 with the highest landings being recorded in October. In 1995-1996, it increased from May to December, with peak landings in September. On average, riverine zones (zones 10-13) contributed 30% of total exploited stock. The share of the lake's upstream area (part of the lake south of Thanneermukkam barrier constituting zones 7-9) was 33% and downstream area (part of the lake north of the barrier consisting zones 1-6) was 37%. Castnets were the principal gear employed in the exploitation, and 73% of the exploited stock was contributed by castnet operations called *Pongu Veechal*. Females clearly outnumbered males in the catch in both years. However, the predominance of males during January to June and the predominance of females during August to December were noteworthy. The exploited stock was predominantly of the 150-270 mm size group. During 1994-1995, the modal classes of male and female populations was 180-199 mm and 200-219 mm, respectively, followed by 160-179 mm in males and 180-199 mm in females. In contrast, during 1995-1996, the modal classes were represented by two size groups, 180-199 mm and 200-219 mm for both male and female populations, followed by 220-239 mm in males and 160-179 mm in females.

The predominance of females in the exploited stock was discernible in both years under investigation, comprising 59% and 55% of the total catch, respectively. Among the various female morphotypes of *M. rosenbergii*, strong blue clawed females (SBF) formed the mainstay of landings in both years followed by weak blue clawed females (WBF). Among male morphotypes, the highest contribution was made by strong blue clawed males (SBC) in 1994-1995. In 1995-1996 transforming orange clawed males (t-OC) and weak blue clawed males (WBC) showed a high predominance. On examining the marketability of the exploited stock, the 250-300 g weight group showed predominance in males and contributed 22% in 1994-1995. However, it formed only 7% in the succeeding year. In 1995-1996, the dominance of the weight group 50-100 g was very apparent and contributed 24% of the exploited stock. The contribution of the weight group 200-250 g was almost the same in both years, at 14% and 12%, respectively. There was a wide disparity in the contribution of specimens weighing more than 400 g in the two

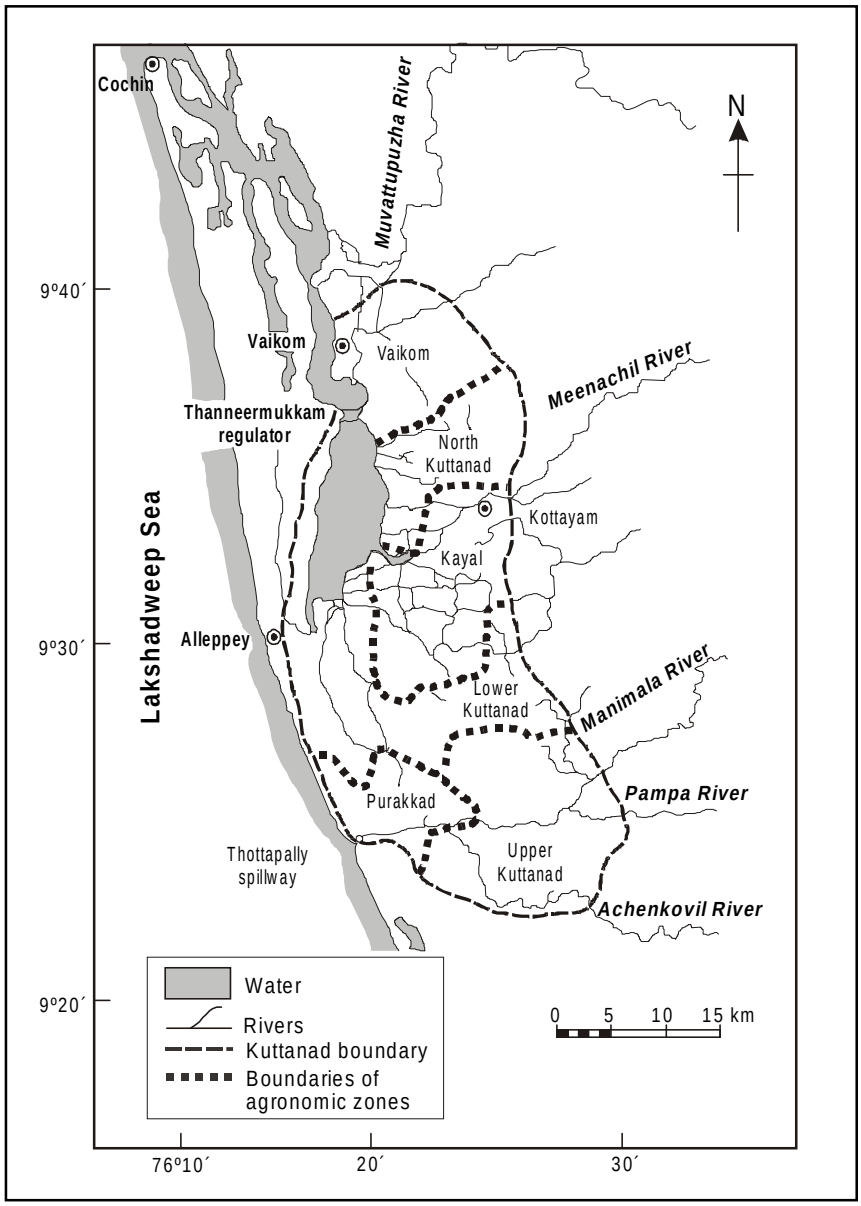

Fig. 1. Vembanad Lake and confluent rivers.

a

b

Figs. 2a and 2b. Thanneermukkam salinity barrier.

years. They formed 17% of the catch in 1994-1995 and only 2% in 1995-1996. For females, the dominance of the weight group 100-150 g was very apparent and formed 44% and 43% of the catch, respectively, in the two years.

The catches of *M. rosenbergii* in Vembanad Lake during the early 1960s and late 1980s are given in Fig. 3. In the early period, the highest catch (429 t) was recorded in 1960 and the lowest (189 t) in 1962. The average for the period 1960-1964 was 300 t (Raman 1962). During 1988-1989, the catch had dwindled to a mere 39 t (Kurup et al. 1992).

The operation schedule of the Thanneermukkam salinity barrier from the date of its commissioning is given in Table 1. Prior to 1990, the barrier remained closed between the first week of December to the first week of June, with an average closure period of 137 days (with some minor exceptions). A significant reduction in the period of closure is seen from 1991 onwards. The reopening was advanced to April or early May, resulting in reducing the closure period to an average of 106 days.

Causes of Decline in Stocks

The stocks of *M. rosenbergii* have been subjected to serious stress due to ecological transformations in the ecosystem of the lake caused by various types of human activities. Kuttanad, the home ground of *M. rosenbergii*, has been subjected to many changes over the years that have affected the fauna and flora of the locality. Extensive habitat alterations, reduction in natural growout, reclamation of the lake, physical obstruction of migratory stocks by the salinity barrier, overfishing and pollution hazards have been the main factors responsible for the alarming depletion in stocks (Kurup et al. 1992). Extensive reclamation of the lake started in 1834 for conversion to paddy cultivation, urbanization

and other agricultural activities. The intensification of paddy cultivation also affected the stocks of *M. rosenbergii* negatively. It led to a shrinkage of nursery grounds and the natural growout habitat of this species. The sub-adults of *M. rosenbergii* move down from the rivers along with the monsoon floods and enter the extensive paddy fields lying fallow after one crop and feed on scattered grains of paddy and decaying debris (John 1957; Raman 1967). With the introduction of the two crop system, a substantial area earlier used for natural growout was no longer available to the prawns.

As part of the efforts for the intensification of paddy production, a 1 405 m long salinity barrier across Vembanad Lake was commissioned in 1976 at Thanneermukkam. The prime objective was to prevent the intrusion of salinity into Kuttanad during the post-monsoon period and thereby facilitate a second (*Punja*) crop in the low lying paddy fields adjacent to the lake. Over 43 000 ha were successfully converted to a two-crop pattern. One of the major impacts of the operation of this barrier was the shifting of the breeding ground of *M. rosenbergii* 40 km north from Kumarakom to the Thevara-Perumpalam area (Kurup et al. 1992). *M. rosenbergii* requires both freshwater and saline areas for the completion of its life history. Prior to the commissioning of the barrier, salinity up to 23 ppt was available at Kumarakom during the post-monsoon months. This provided an ideal breeding ground for the species (Raman 1967). However, due to the closure of the barrier the upstream part of the lake south of the barrier remained more or less freshwater during the post monsoon months, and the highest salinity that could be recorded during this period was only 6 ppt (Kurup et al. 1992). Therefore, the migratory stock had to move farther north in the lake where congenial conditions for larval metamorphosis and optimum salinity of 14 $\pm$ 2 ppt (Sebastian 1990) were available. This resulted in fishing operations moving farther downstream during the breeding season.

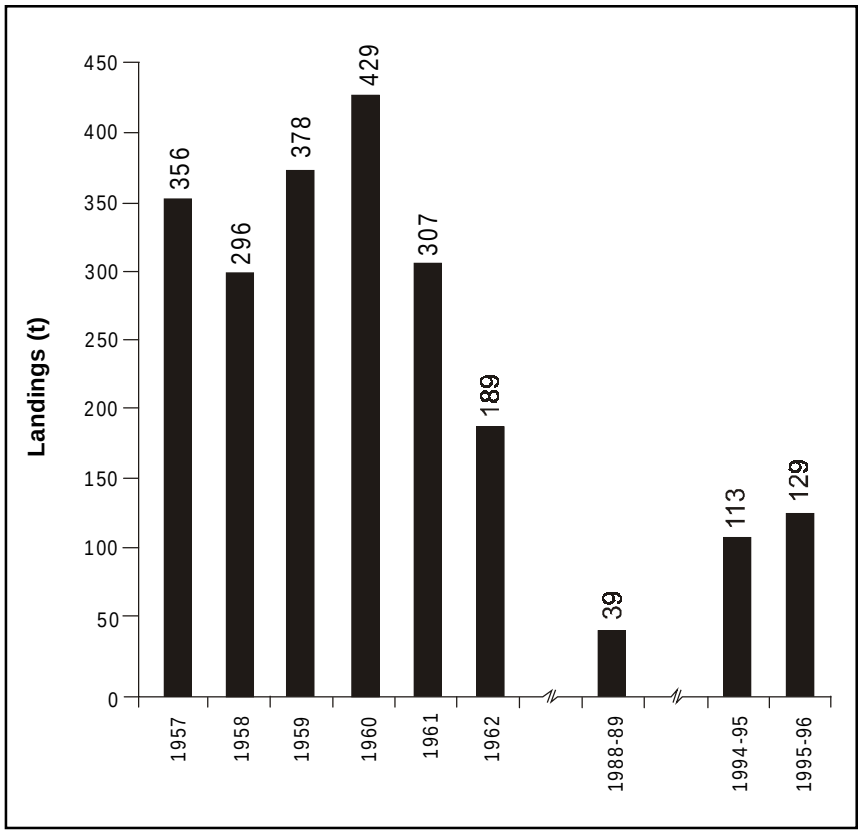

Fig. 3. Landings of* M. rosenbergii *in the Vembanad Lake area.

Kurup et al. (1992) noted that *M. rosenbergii* shows differential migratory patterns for the sexes. The males migrate to the lake first and predominate in the landings during January-June, while the females come later and outnumber the males in landings during August-December. Berried females start appearing in the catches in July-August and increase till October-November. The shutters of the barrier are usually closed before 10 December. Late spawners get stranded in upstream areas where they are subjected to indiscriminate exploitation. Even if a few berries survive, the hatchlings cannot complete their life history without saline water. The eggs that hatch from the berries that have already reached the breeding grounds take 30-40 days for larval metamorphosis and completion of larval history. Upon attaining the postlarval stage, they undertake the return migration. By the time they reach the barrier, the shutters are closed, thereby obstructing the

Table 1. Closing and opening dates of shutters of the Thanneermukkam salinity barrier.

Year	Closing date	Opening date	No. of days closed
1979-1980	01.01.80	14.05.80	135
1980-1981	09.01.81	02.05.81	113
1981-1982	01.01.82	20.04.82	110
1982-1983	19.12.82	07.05.83	139
1983-1984	10.12.83	08.06.84	181
1984-1985	26.12.84	26.05.85	151
1985-1986	30.12.85	14.06.86	166
1986-1987	04.12.86	04.06.87	182
1987-1988	04.01.88	30.04.88	117
1988-1989	10.12.88	24.05.89	165
1989-1990	14.12.89	26.05.90	163
1991-1992	12.12.91	14.04.92	124
1992-1993	15.12.92	08.04.93	114
1993-1994	18.12.93	18.04.94	121
1994-1995	12.12.94	18.04.95	127
1995-1996	22.12.95	22.04.96	122
1996-1997	15.12.96	09.04.97	115
1997-1998	30.12.97	11.05.98	132

migratory pathway. The postlarvae trapped in downstream areas are exposed to severe adverse ecological conditions and a high rate of predation.

The operation of the salinity barrier at Thanneermukkam is responsible for the alarming depletion of catches of *M. rosenbergii* due to the obstruction of the downstream migration of berries and the upstream migration of postlarvae. The impact of the barrier in obstructing upstream migration of postlarvae was confirmed by releasing marked postlarvae into the lake north of the barrier during the period of its closure. It was found that only 0.53% of 40 000 marked postlarvae could be recovered from the lake in zones 7 and 8 in the upstream part during the following fishing season (Harikrishnan and Kurup 1998b). This is similar to the construction of the High Dam across the River Nile that resulted in a substantial reduction in shrimp landings in the area (Bishara 1984; Wadie and Razek 1985).

The threefold increase in landings during 1994-1995 and 1996-1996 as compared to the 1980s could be due to the reduction in the closure period of the barrier from 160 to 106 days. The stocks may have revived, as the opening of the barrier in April helped the postlarvae and juveniles trapped in the downstream part of the lake to continue their return migration to upstream waters. Prior to 1990, when the barrier was opened only in June, it almost synchronized with the monsoon floods flowing downstream. The entrapped postlarvae and juveniles could have been washed off downstream where they faced a high rate of predation and other adverse conditions.

Another reason for the revival of the stocks could be the increased availability of nursery/growout areas. It has been reported that more than 60% of the paddy fields in Lower Kuttanad and Kayal are now fallow during the monsoon months (KWBSP 1990) for various reasons. Most of the polders in Lower Kuttanad and Kayal provide ideal nursery grounds for sub-adults and juveniles. There is also a recent trend towards reducing the use of pesticides in Kuttanad.

The replenishment of stocks of *M. rosenbergii* in Kuttanad waters could also be due to the large-scale ranching of hatchery reared postlarvae in various parts of Vembanad Lake and its confluent rivers. The Department of Fisheries of Kerala, under a Social Fishery scheme, has ranched large numbers of scampi seed in many parts of the lake since 1992. Several research institutions have also followed this practice. Very recently, similar schemes have been implemented by local bodies under the prestigious People's Campaign for Planning, with a view to improving the natural stocks of this species as it supports the livelihood of a large number of inland fishers in Kuttanad.

The stocks of *M. rosenbergii* can be further increased by adopting judicious resource management practices. The closure period of the Thanneermukkam barrier should be reduced to 3-4 months. This will require a proper management of cropping patterns, especially in Kayal and Lower Kuttanad. Sowing of the *Punja* crop has to be done earlier in all areas and the crop must be harvested before 31 March. Sowing of the *Punja* crop as early as October-November has given high yields and has been successfully practiced for the last few years. Sowing after 15 December has been tried in Kayal and is found to be less productive.

The slow moving ovigerous females that become abundant in the lake after August are compelled to undertake a lengthy breeding migration to Thevara-Perumpalam in the downstream region of the lake. En route, they succumb to heavy fishing pressures. It has been reported that over 23 t of berried prawns are exploited annually from the lake, the highest being in October (Harikrishnan and Kurup 1997). It has also been found that only 30% of the total spawner stock successfully reaches the breeding grounds, which suggests the possibility of recruitment overfishing as defined by Pauly (1980). This being one of the reasons for the depletion of the stocks, it calls for suitable management practices for the fishery. The berried population reaches its peak during September-November, during which time a closed season should be enforced in the fishery. Raman (1967) has reported a similar self-imposed closed season by the shrimp freezing industry. Ban on fishing of *M. rosenbergii*, at least in the breeding grounds at Thevara-Perumpalam, during this period would be an important measure for conservation of the stocks. Establishing sanctuaries for berried prawns and young ones has been reported by John (1957). Similar sanctuaries and hatcheries can be set up near the breeding grounds. Live berried prawns can be purchased from fishers and returned to the waters. Harikrishnan and Kurup (1996) have identified areas based on temporal and spatial availability of berried prawns in the lake for establishing berry procurement centers. Establishment of such centers would be more acceptable to the fishers than a closed season or ban on fishing that deprives them of their earnings.

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