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# Fishery and population dynamics of the spider prawn, *Nematopalaemon tenuipes* Henderson along the Saurashtra coast

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## ABSTRACT

*Nematopalaemon tenuipes* Henderson forms about 20% of the non-penaeid catch by dol nets operating along the Saurashtra coast. The length-weight relationships were obtained with, $a = 2.153x10^{-5}$ and $b = 2.699$ for males and $a = 1.905x10^{-5}$ and $b = 2.783$ for females. The von Bertalanffy growth equation was derived as $L_t = 73\ [1-e^{-1.38(t+\ 0.02)}]$ for males and $L_t = 78.6\ [1-e^{-1.32(t+\ 0.04)}]$ for females. The lengths attained at the end of 0.5 to 1.5 year/s were estimated as 37.3, 55.1 and 64 mm for males and 40, 59.2 and 69.5 mm for females. The mortality coefficients Z, M and F were 6.31, 3.23, 3.08 and 5.97, 3.08, 2.89 for males and females respectively. The annual exploitation rate U was 0.49 for males and 0.48 for females. The MSY was estimated to be 1,678 t and 5,346 t for males and females respectively, and 7,024 t for the species in Saurashtra. With an average annual production of 5,600 t, the resource does not appear to be under threat of over fishing at present.

Keywords: Fishery, *Nematopalaemon tenuipes*, Population dynamics, Saurashtra coast, Spider prawn

## Introduction

The spider prawn *Nematopalaemon tenuipes* Henderson occupies a prominent place among the non-penaeid shrimp resources of the north-west coast of India. It is an important component of the dol net fishery of Maharashtra (Deshmukh, 1995). Locally called "safed kolmi" and "tendi" in Gujarat, it is chiefly exploited by the dol nets operating along the Saurashtra coast. Although it occurs in trawl catches also, the percentage of occurrence is very less, except during the south-west and north-east monsoon seasons, immediately after the rains. It is usually processed along with other trawl by-catch and used in the fish meal industry. The catch landed by dol nets is usually dried in the sun and used for human consumption.

While there is some amount of documentation from the Maharashtra coast (Kunju, 1979; Sukumaran, 1982; 1983; Deshmukh, 1995), there is not much information on this resource from the Gujarat coast. The present paper attempts to throw light on the fishery, population characteristics and present status of the stock along the Saurashtra coast of Gujarat.

## Materials and methods

The fishery of *N. tenuipes* was observed from the dol net landings at Navabandar, Rajpara and Jaffrabad, which are the three major dol net landing centres of Saurashtra. Samples for length frequency data were collected weekly and pooled for the three centres and raised to the monthly catch. The raised monthly numbers in different size classes were weighted using the estimated length-weight equations to obtain the annual catch of males and females for the period 1999 – 2002.

The length (mm) – weight (g) relationship of the form $W = aL^b$ for male and female *N. tenuipes* was estimated by regression after logarithmic transformation, from the observations made on 195 males in the length range of 26 - 64 mm and 309 females in the length range of 26 –76 mm. Growth parameters estimated using the Powell-Wetherall plot, ELEFAN I following the FiSAT package (Gayanilo *et al*., 1996) and Ford-Walford plot as given in Sparre and Venema (1992) were compared before arriving at the final values.

The annual total mortality 'Z' was calculated by the length-converted catch-curve method (Pauly, 1983). Natural mortality 'M' was calculated by Pauly's empirical formula (Pauly, 1980), assuming the average annual surface temperature to be 27.2 °C (Bapat *et al.,* 1982). Fishing Mortality 'F' was estimated from the relationship $F = Z - M$. The exploitation ratio 'E' was estimated from the relationship $E = F/Z$. The exploitation rate 'U' was estimated from the relationship $U = F/Z(1-e^{-Z})$. The total annual stock 'Y/U' and the average standing stock, 'Y/F'

were estimated by taking the average annual catch of the species during the period 1999 – 2002, as described by Deshmukh (1995). The yield in weight per recruit was estimated by the method of Beverton and Holt (1957) and the MSY was estimated following Corten (1974).

## Results and discussion

### *Fishery*

The annual average catch of *N. tenuipes* by dol nets during the period 1999 – 2002 was 5598 t. The average annual CPUE was 6.3 kg per haul. During the same period, the annual average landing of *N. tenuipes* by trawl nets at Veraval trawl landing centre was 453 t. The average annual CPUE was 0.71 kg per haul (Table 1). Females dominated

Table 1. Trend in annual catch and CPUE of *Nematopalaemon tenuipes*

| Year | Dol net | | Trawl net | |
|---|---|---|---|---|
| | Catch (t) | CPUE (kg) | Catch (t) | CPUE (kg) |
| 1999 | 3027 | 4.89 | 418 | 0.59 |
| 2000 | 6620 | 8.21 | 714 | 1.03 |
| 2001 | 5563 | 7.15 | 349 | 0.52 |
| 2002 | 8513 | 6.36 | 330 | 0.66 |

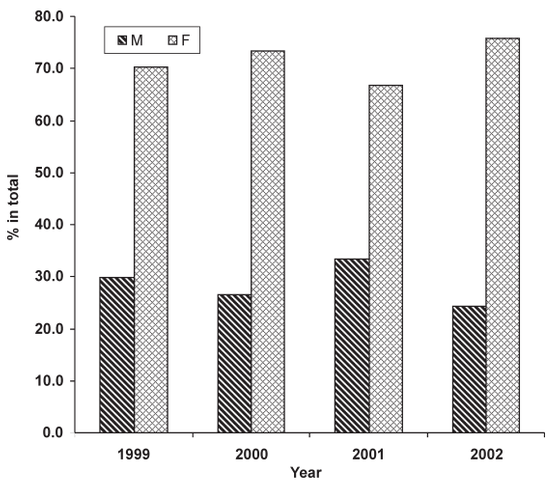


Fig. 1. Sex composition of *N. tenuipes* landed by dol nets in Saurashtra during the period 1999 - 2002.

the dol net catches, forming about 76 % of the annual average catch of the species (Fig. 1).

### *Length-weight relationship*

The length-weight equations obtained for male and female *N. tenuipes* are as follows:

Male : $W = 0.00002153\ L^{2.699}$ (r = 0.927)

Female : $W = 0.00001905\ L^{2.783}$ (r = 0.935)

Analysis of covariance, following Snedecor (1961) revealed that the slopes of the two regression lines differ significantly (F = 8.29; 1,503 d.f.). Deshmukh (1995) estimated the parameters of the length-weight relationship as a = 0.0000157, b = 2.8323 for males and a = 0.000011, b = 2.925 for females along the Maharashtra coast, where *N. tenuipes* contributes to almost 30 % of the catch of non-penaeid shrimps by dol nets.

### *Growth*

The $L_\infty$ for male *N. tenuipes* was estimated as 73.401 mm from Powell – Wetherall plot (Z/k = 4.757). Using the ELEFAN I program, the $L_\infty$ obtained was 73 mm ; k = 1.38. (Fig. 2). The $L_\infty$ for females was estimated as 78.604 mm from Powell – Wetherall plot (Z/k = 4.118). Using the ELEFAN I program, the $L_\infty$ obtained was 78.6 mm ; k = 1.32. (Fig. 3). The value of $t_0$ was estimated to be -0.02 for males and -0.04 for females.

The von Bertalanffy growth equation for male and female *N. tenuipes* off Saurashtra can thus be given as :

Males : $L_t = 73\ [1\text{-}e^{-1.38(t+\ 0.02)}]$

Females : $L_t = 78.6\ [1\text{-}e^{-1.32(t+\ 0.04)}]$

Deshmukh (1995) reported higher values of asymptotic length for both males and females from Maharashtra waters ($L_\infty$ = 77.38 mm, k = 1.31 and $L_\infty$ = 87.23 mm, k = 1.3 for males and females, respectively). In the present study, the lengths attained by the shrimps at the end of 0.5 to 1.5 years were estimated

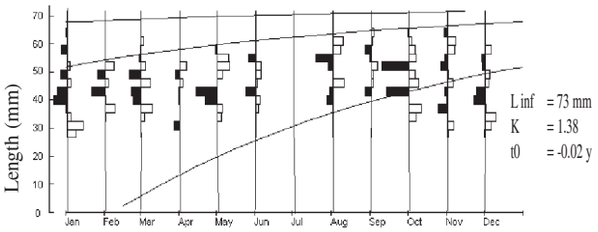


Fig. 2. Restructured length frequency data of male *N. tenuipes* with growth curves (data for the month of July not available)

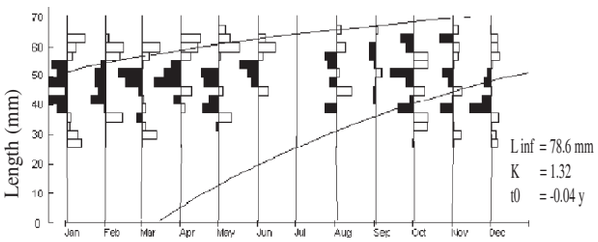


Fig. 3. Restructured length frequency data of female *N. tenuipes* with growth curves (data for the month of July not available)

to be 37.3 mm, 55.1 mm and 64 mm, for males and 40.1mm, 58.9 mm and 68.3 mm for females. The growth rates were estimated at 4.59 mm per month and 4.91 mm per month for males and females respectively, for the first year of their life. The estimate obtained for males is similar to that obtained by Deshmukh (1995) for male *N. tenuipes* from Maharashtra (4.7 mm ). The estimate for females however, is slightly lesser than his estimate of 5.28 mm. The estimates for *N. tenuipes* from Maharashtra (Deshmukh, 1995) for lengths attained at the end of 0.5 to 1.5 years were 37.08 mm, 56.39 mm and 66.46 mm for males and 41.58 mm, 63.35 mm and 74.74 mm for females. The comparatively lower values of $L_{\infty}$ and monthly growth rate for females obtained in the present study must be due to the difference in the minimum and maximum sizes that occurred in the dol net landings in Saurashtra as compared to the size range observed in Maharashtra.

## Mortality and exploitation

The annual instantaneous total mortality coefficient, 'Z' obtained from the length-converted catch curve for the period 1999 – 2002 is shown in Fig. 4a-d and 5a-d. The average annual Z was 6.31 for males and 5.97 for females. The natural mortality coefficient, 'M' was 3.23 for males and 3.08 for females. The fishing mortality, 'F' and the exploitation rate 'U' estimated for the period 1999 – 2002 are given in Table 2. The average F was 3.08 for males and 2.89 for females. The average U was 0.49 and 0.48 for males and females respectively. The M/k ratio obtained was 2.34 for males and 2.33 for females.

Deshmukh (1995) reported average annual instantaneous mortality rates of 9.09 and 7.79 and natural mortality coefficients of 3.54 and 3.52 for males and females, respectively in Maharashtra for the period 1979 –1982. *N. tenuipes* is a targeted component of dol net fishery in Maharashtra and contributes to more than 30% of the non-penaeid shrimps landed by dol nets. It is also caught by trawl nets operating along the Maharashtra coast. The dol net fishery in Gujarat, however, is primarily focused on the exploitation of the Bombay-duck and *N. tenuipes* is not a targeted resource. The quantum of this resource in the trawl net landings along the Saurashtra coast is also very meager. Sukumaran (1982) estimated "Z" to be 3.68 and 3.64 for males from Versova and Sassoon Docks respectively and 2.98 and 3.11 for females from the two areas during the period 1966 – 1975. Deshmukh (1995) states the relatively low fishing intensity during 1966 – 1975 as one of the reasons for such low values of "Z". While the natural mortality coefficient obtained in the present study is almost similar to the values given by Deshmukh (1995) from Maharashtra, the difference between the annual instantaneous mortality rates obtained for the species from Maharastra (Deshmukh, 1995) and Gujarat (present study) can be due to the different intensity of fishing for the resource in the two areas.

### *Stock Assessment*

The estimates of annual stock, standing stock and annual exploitation rate for male and female *N. tenuipes* along the Saurashtra coast are given in Table 2. The average annual stock and standing stock for males was estimated to be 2,726 t and 434 t respectively. The average annual stock and standing stock for females was estimated to be 9,073 t and 1,477 t respectively. The average annual stock of *N. tenuipes* was 12,103 t and the average annual production was 5,600 t. The exploitation rate for the species was thus 0.46.

### *Yield per recruit and MSY*

The input parameters for fitting the yield per recruit model of Beverton and Holt (1957) are given in Table 3. The asymptotic weight (W) was estimated to be 2.305 g for males and 3.587 g for females. The age at recruitment ($T_r$) was estimated to be 0.3 years for both males and

Table 2. Stock assessment of *N. tenuipes* in Saurashtra during 1999-2002

| | Year | Catch in tonnes, Y | Z | M | F (=Z-M) | Exploitation rate, U (=F/Z (1-$e^{-Z}$)) | Total stock Y/U | Standing stock Y/F |
|---|---|---|---|---|---|---|---|---|
| Males | 1999 | 1033 | 6.66 | 3.23 | 3.43 | 0.51 | 2025 | 301 |
| | 2000 | 1330 | 7.65 | 3.23 | 4.42 | 0.58 | 2293 | 304 |
| | 2001 | 1466 | 4.8 | 3.23 | 1.57 | 0.32 | 4581 | 934 |
| | 2002 | 1513 | 6.13 | 3.23 | 2.9 | 0.47 | 3219 | 522 |
| | 1999-2002 | 1335.5 | 6.31 | 3.23 | 3.08 | 0.49 | 2726 | 434 |
| Females | 1999 | 1994 | 6.4 | 3.08 | 3.32 | 0.52 | 3835 | 601 |
| | 2000 | 5290 | 7.38 | 3.08 | 4.3 | 0.58 | 9121 | 1230 |
| | 2001 | 4050 | 5.13 | 3.08 | 2.05 | 0.40 | 10125 | 1976 |
| | 2002 | 5724 | 4.96 | 3.08 | 1.88 | 0.38 | 15063 | 3045 |
| | 1999-2002 | 4264.5 | 5.97 | 3.08 | 2.89 | 0.48 | 9536 | 1477 |
| Total | 5600 | | | | | | 12103 | 1992 |

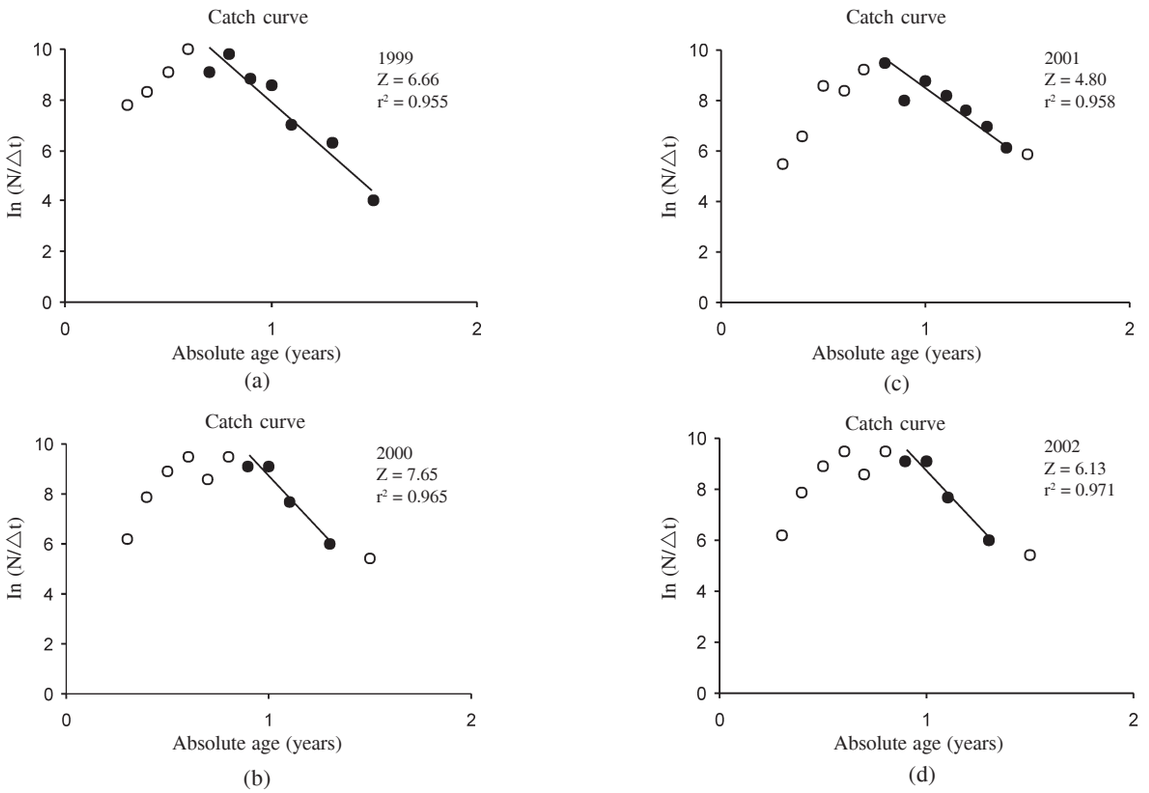


Fig. 4a-d. Estimation of annual 'Z' for male *N. tenuipes*

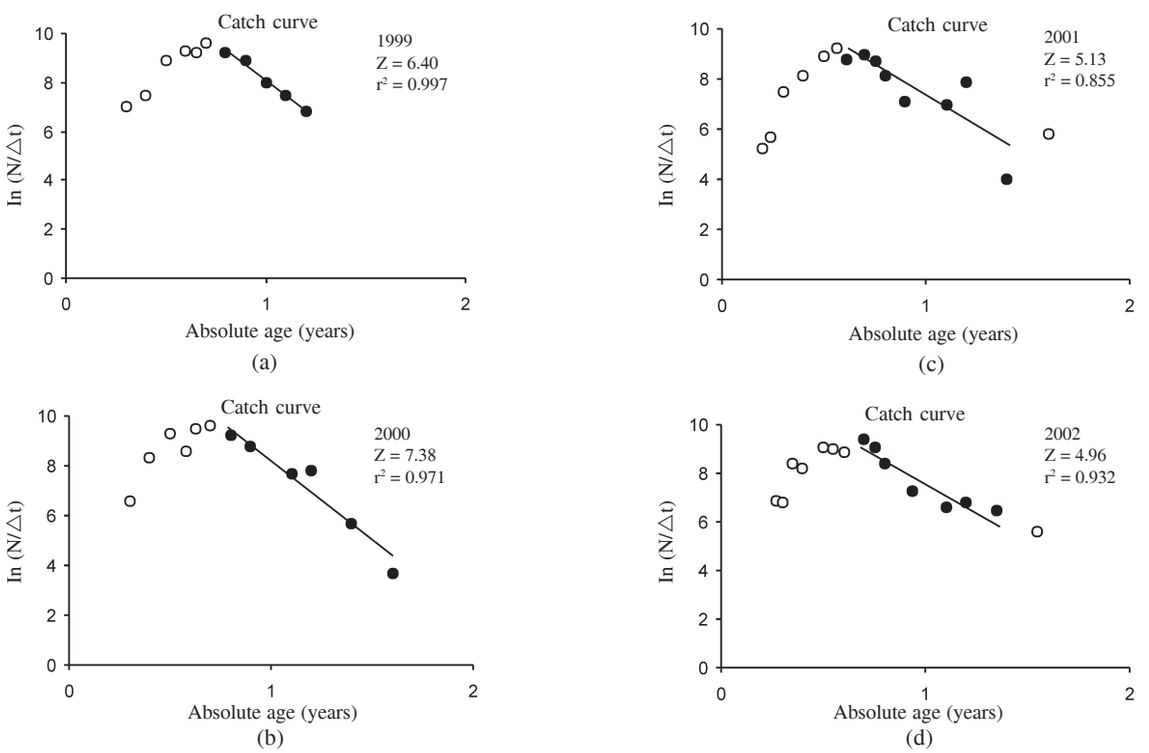


Fig. 5a-d. Estimation of annual 'Z' for female *N. tenuipes*

Table 3. Parameters of the yield per recruit model for *N. tenuipes*

| Parameters | Male | Female |
|---|---|---|
| Length asymptote $L_\infty$ (mm) | 73 | 78.6 |
| Weight asymptote $W_\infty$ (g) | 2.305 | 3.587 |
| Growth coefficient k | 1.38 | 1.32 |
| $t_0$ | -0.02 | -0.04 |
| Natural mortality coefficient M | 3.23 | 3.08 |
| Age at recruitment $t_r$ (years) | 0.299 | 0.271 |
| Age at first capture $t_c$ (years) | 0.57 | 0.59 |

females (0.299 and 0.271 years, respectively), from the smallest sizes observed in the catch (26 mm for males and 26.5 mm for females). The age at first capture ($T_c$) was estimated to be 0.57 years for males and 0.59 years for females from the first mode in annual size frequency calculated from 50 % cumulative size frequency (40.8 mm for males and 44.3 mm for females).

The yield per recruit curves (Fig. 6 and 7) for both males and females, showed that the yield in weight at different levels of F increases and the curves tend towards becoming flat-topped at very high levels of F. The annual values of F for the period 1999 – 2002 being 3.08 and 2.89

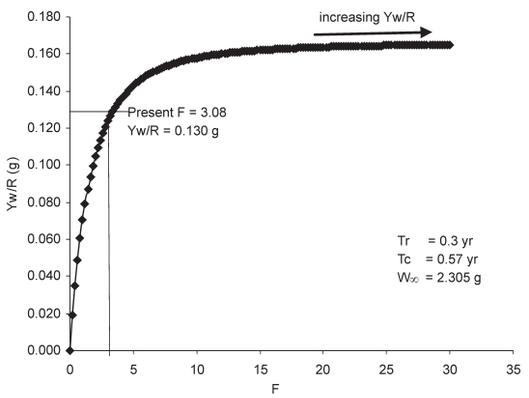


Fig. 6. Yield (in weight) per recruit as a function of 'F' for male *N. tenuipes*.

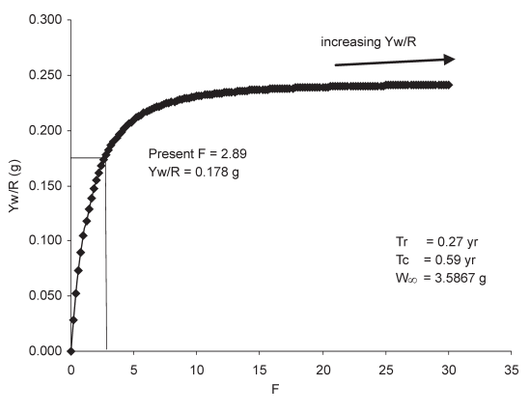


Fig. 7. Yield (in weight) per recruit as a function of 'F' for female *N. tenuipes*.

for males and females respectively, the corresponding Yw/R values were 0.130 g and 0.178 g. The MSY was estimated to be 1,678 t and 5,346 t for males and females respectively, and 7,024 t for the species in Saurashtra. With an average annual production of 5,600 t and exploitation rate of 0.46, the resource does not appear to be under threat of over-fishing and holds scope for increased exploitation. However, changes in the fishing effort cannot be advised based on a resource which, at present, is not a targeted resource and does not influence the economic value of the fishery. From estimates of yield and biomass at different levels of fishing effort 'F' (Fig. 8), an increase in

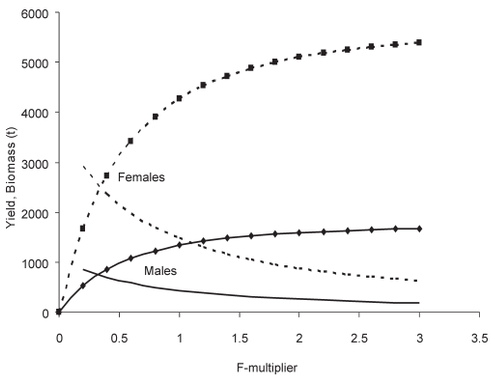


Fig. 8. Yield and Biomass estimates for male and female *N. tenuipes* at different levels of 'F', using Beverton & Holt Yield/Recruit model

F by a factor of 2.5 for males and females can be recommended to maintain the biomass at 25 % of the initial biomass, as conservation measure to avoid collapse of the stock, in the event of the resource gaining more importance in the future.

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