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ASPECTS OF GROWTH, RECRUITMENT AND CONSERVATION OF THE BROWN MUSSEL *Perna perna* ALONG THE TSITSIKAMMA COAST

R. J. M. CRAWFORD
Sea Fisheries Research Institute
Private Bag X2
Rogge Bay
8012

D.F. BOWER
Tsitsikamma Coastal National Park
P.O. Storms River
6308

Abstract — Beds of brown mussels *Perna perna* are a dominant feature of the lower tidal range of rocky shores in the Tsitsikamma Coastal National Park. Mussels in this region attain a length of 30-40 mm by the end of their first year, and the majority probably exceed 50 mm at two years of age. Secondary settlement of plantigrades occurs from mid-spring through early winter, especially in summer and early autumn, and growth of adult forms is slowest prior to this settlement. Settlement occurs serially and powerful cohorts may be formed. At Nature's Valley density and biomass of mussels inside the park's boundary are significantly higher than in non-protected areas. Older age groups are also more abundant within the park.

Introduction

The brown mussel *Perna perna* is prolific on rocky shores on the Indian Ocean coast of the Republic of South Africa, both subtidally and in the intertidal region (Berry 1978). Along the Tsitsikamma shore large mussel beds are a dominant feature of the lower tidal range (Fig. 1). These beds comprise a variety of other species including *Pseudonereis variegata, Octomeris angulosa, Cirolana venusticauda, Dynamanella huttoni, Cardita variegata, Patella granularis, Burnupena cincta, Thais dubia* and *Patiriella exigua.* Larvae of *P. perna* are planktonic and, as with several other mytilids, there is a primary settlement of early plantigrades on filamentous substrata followed by a secondary settlement of later plantigrades which usually occurs at established mussel beds or clumps (Berry 1978; Beckley 1979).

The Tsitsikamma Coastal National Park (TCNP) was proclaimed in 1964. Initially the Division of Sea Fisheries' regulations regarding collection of bait organisms were implemented, but from 1967 collection of all intertidal fauna has been prohibited. Marine bivalves are harvested from adjacent areas, especially by tourists during

the summer holiday season. The allowable quota of *P. perna* for these regions is 25 per person per day. Casual observations suggested a disparity in size and density of brown mussels inside and outside the park's boundaries (Fig. 2). To investigate the situation comparative sampling was undertaken during 1981 and 1982 in the lower balanoid region of rocky shores located within the TCNP and just outside its boundaries. This paper reports findings and also considers aspects of growth and recruitment of *P. perna* along the southern Cape coast.

Fig. 1. Brown mussel beds in the lower balanoid region near Storms River Mouth in the Tsitsikamma Coastal National Park.

Fig. 2. The lower balanoid region at Blue Rocks, Nature's Valley, showing extensive algal beds but few brown mussels.

Methods

Transect lines extending from the littorina zone to the infratidal fringe were located at Blue Rocks (Nature's Valley) west of the TCNP, Die Punt (Nature's Valley) immediately inside the western boundary of the TCNP, Eerste River east of the TCNP, Blue Bay in the eastern sector of the TCNP and at five sites (Moddervlei, Swembad, Laundry, Swartrif and Tait-se-Baai) within the Storms River Mouth restcamp area at the centre of the TCNP (Fig. 3). Along these transects *P. perna*

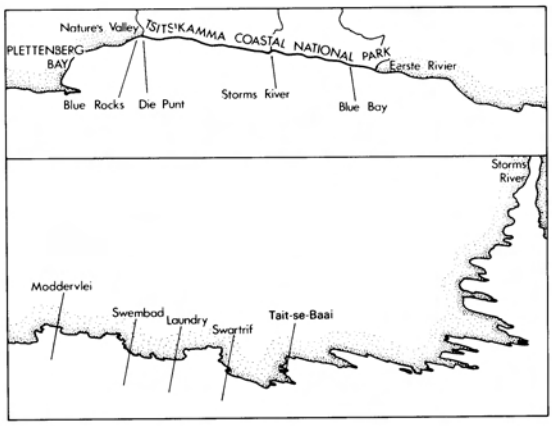

Fig. 3. Locations of sites sampled for brown mussels in the Tsitsikamma Coastal National Park and adjacent areas.

were sampled at spring low tides using 0,1 m^2 or 1,0 m^2 grids placed in a random manner on the lower balanoid zone. Choice of grid size was dependent on density of mussels and available time. Wherever possible randomness was ensured by throwing the grids from a standing height onto the lower balanoid region. On steeply sloping shores it was necessary to place grids, and in an attempt to maintain objectivity this process was left to persons not aware of the eventual use of the samples. All mussels falling within the grids were collected. Where dense concentrations occurred it was necessary to use a spade to remove mussels from the rock substrate and usually a small percentage of the mussels were broken. At lower densities paint scrapers were used or mussels were twisted off the rocks. Whenever one person was responsible for the collection all organisms were removed from the rock surface for later sorting. In a few instances where large areas were covered only mussels were collected, but on such occasions at least two persons searched the sample area to minimise omissions.

Samples were frozen and mussels from each were later counted (excluding empty shells). Lengths (umbo to ventral margin) of all unbroken specimens were measured to the nearest millimetre using vernier calipers. Samples were then dried to constant mass at 60 °C for a minimum of 48 hours.

Size compositions and modal progressions were used to examine patterns of recruitment and growth at selected localities. Additionally at the Laundry transect in the Storms River Mouth area it was possible to monitor short term growth of a few marked individuals from the upper balanoid region. These mussels had the exterior of their shells dried during exposure at spring lowtide. Numbered monofilament spaghetti tags were then attached using Prattley Putty. Measurements of shell length at time of tagging and subsequently were made using vernier calipers.

Results

Size compositions of mussels collected in the Storms River Mouth region and at Nature's Valley are shown in Figs 4 and 5. Modal progressions, as indicated on the illustrations, were used to examine growth. Results suggest that along the Tsitsikamma coast *P. perna* attain a length of 30-40 mm by the end of their first year (Fig. 6). Subsequent growth is slower but the majority of mussels probably exceed 50 mm at two years of age. Growth appears to have been most rapid from April through June or during October and November. Short term growth of a few marked individuals from the upper balanoid region, although slightly slower, confirms these findings (Fig. 6). Unfortunately tag retention was poor, nearly all tages being lost within six months.

Percentage contribution of mussels with length less than 10 mm to the total number sampled in the Storms River Mouth region, is illustrated for the period January 1981 to January 1982 in Fig. 7. Berry (1978) observed that *P. perna* of up to 9 mm shell length were highly mobile and still capable of detachment and resettlement.

His results were confirmed by Beckley (1979). It is evident that at Storms River Mouth most secondary settlement occurred from mid spring through early winter, but especially in summer and early autumn. At Die Punt (Nature's Valley) samples were only collected in November 1981 (n=707) and April 1982 (n=1 133) when

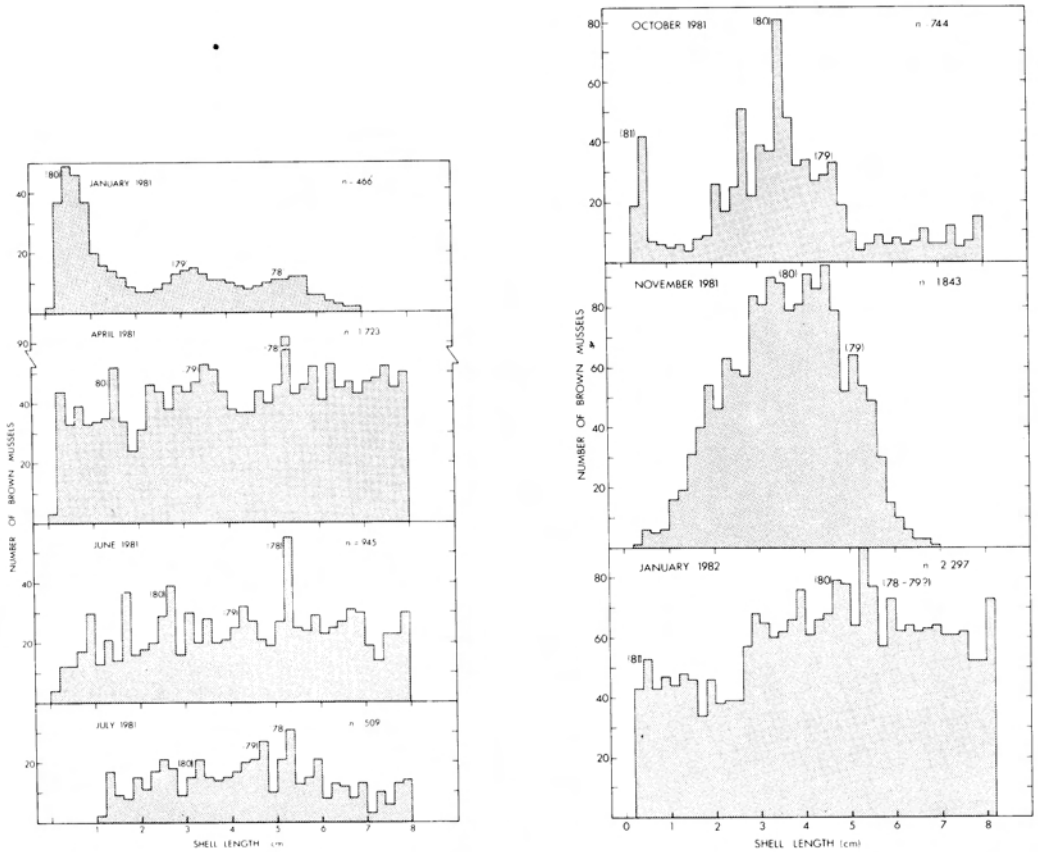

Fig. 4. Size frequency distributions of brown mussels sampled near Storms River Mouth, 1981-1982. Numbers in parentheses indicate yearclasses thought to be responsible for modes.

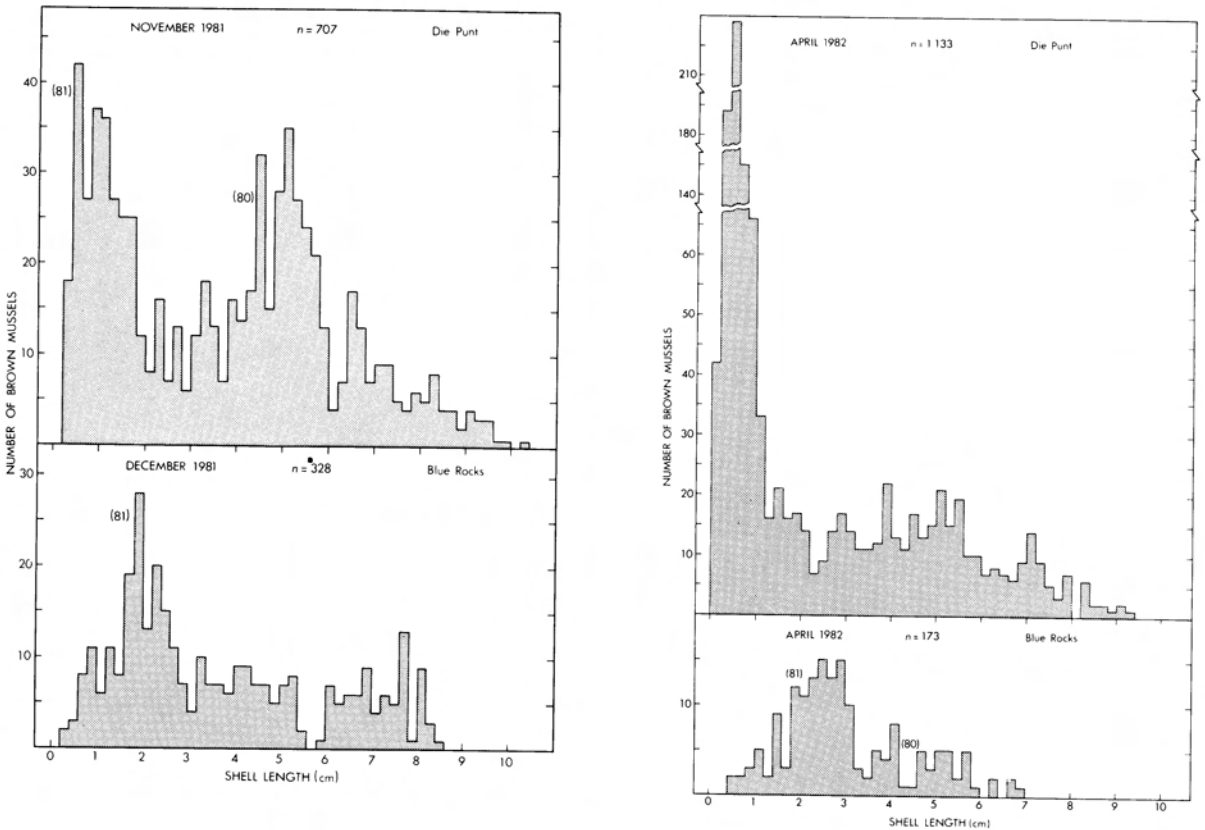

Fig. 5. Size frequency distributions of brown mussels sampled near Nature's Valley, 1981-1982. Numbers in parentheses indicate yearclasses thought to be responsible for modes.

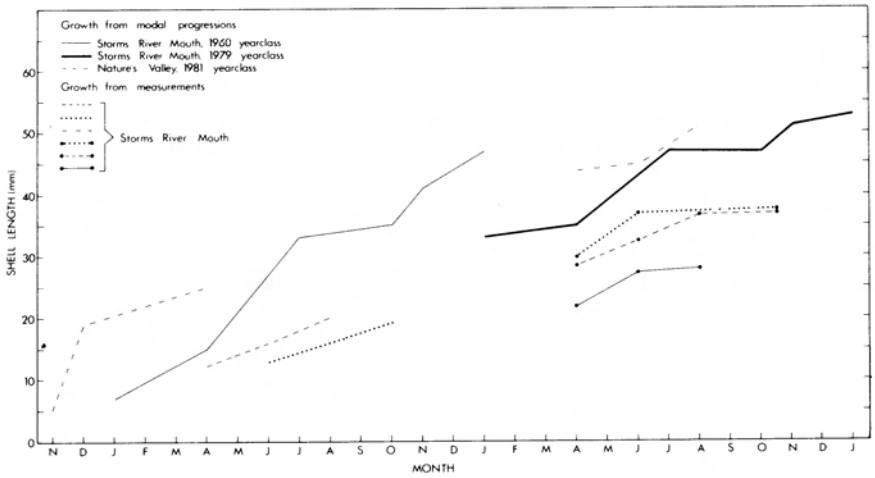

Fig. 6. Growth, deduced from modal progressions, of brown mussels in the lower balanoid regions at Storms River Mouth and at Nature's Valley compared with measured growth of mussels in the upper balanoid region at Storms River Mouth.

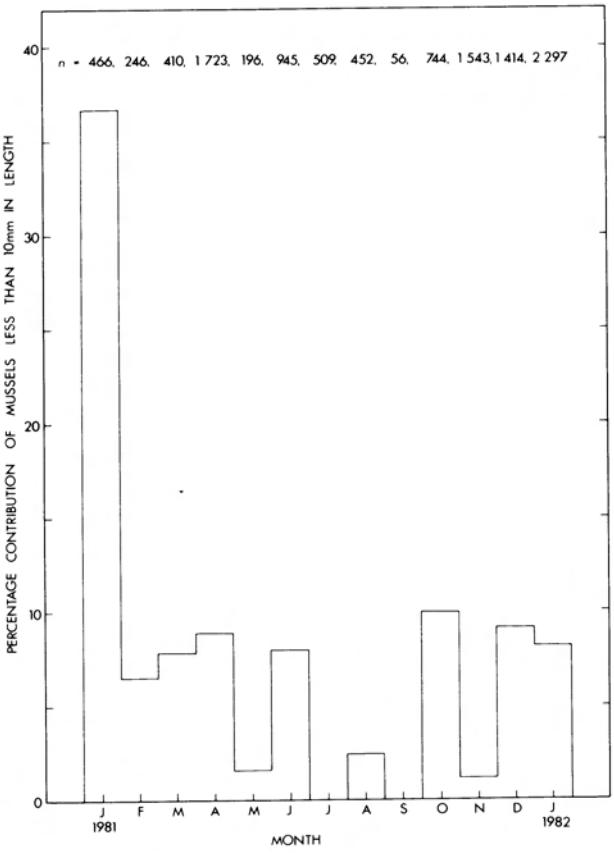

Fig. 7. Percentage contributions of brown mussels less than 10 mm in length to the total numbers of mussels sampled at Storms River Mouth, 1981-1982.

small mobile mussels (<10 mm) contributed 18% and 58% respectively of total numbers measured. The equivalent values at Blue Rocks (Nature's Valley) were 7% for December 1981 (n=328) and 4% for April 1982 (n=173).

A series of modes of smaller *P. perna* for all samples collected at Storms River Mouth between April 1981 and January 1982 (Fig. 4) and also at other localities (Fig. 5) suggests that settlement occurs serially. In particular three batches of later plantigrades appear to have contributed significantly to recruitment of the 1980 yearclass (i.e. the yearclass settling during summer and autumn of 1980/1981).

At Storms River Mouth a particular size group, thought to be the 1978 year class contributed powerfully to samples collected in April and June 1981 and to a lesser extent to those of January and July 1981 (Fig. 4). However, its contribution to the

Table 1

Densities ('000s) and dried masses (kg) of brown mussels sampled from the lower balanoid region at various localities in the vicinity of the Tsitsikamma Coastal National Park, 1981-1982

Locality	Number of samples	Mean density per m^2	Standard deviation	Range
Number				
Blue Rocks	6	0,48	0,30	0,15-1,02
Die Punt	5	19,86	18,29	6,70-51,87
Moddervlei	1	2,70	—	—
Swembad	1	2,35	—	—
Laundry	15	1,87	0,85	0,90-3,76
Swartrif	3	2,21	1,61	1,20-4,07
Tait-se-Baai	2	0,90	0,23	0,73-1,06
Blue Bay east	2	2,52	2,84	1,20-3,84
Eerste River	1	1,48	—	—
Mass				
Blue Rocks	6	1,75	0,88	0,67-2,81
Die Punt	5	25,11	15,77	15,42-51,06
Moddervlei	1	4,41	—	—
Swembad	1	11,71	—	—
Laundry	15	6,96	2,72	1,56-11,54
Swartrif	3	8,74	6,53	4,05-16,20
Tait-se-Baai	2	3,68	1,54	2,59-4,78
Blue Bay east	2	5,09	4,87	1,64-8,53
Eerste River	1	0,83	—	—

October and November samples of 1981 was insignificant. Similarly recruitment of the 1980 yearclass at sites of the October 1981, November 1981 and January 1982 samples at Storms River Mouth was considerably better than at those of the June 1981 and July 1981 samples. Thus success of settlement of any particular yearclass varies from place to place even within a relatively small region.

The lowest mean density of mussels was recorded at Blue Rocks (Nature's Valley) and the highest *ca* 2 km east at Die Punt (Nature's Valley) just within the western boundary of the TCNP (Table 1). The highest measured density (52 000 m^{-2}) was also at Die Punt. Values for five of the six samples collected at Blue Rocks fell below one standard deviation from the mean calculated for Die Punt. Means for the two localities differed significantly ($t=2,35$; d.f.=9; $p<,05$). Density of brown mussels at Eerste River was lower than at any transect located within the TCNP except that at Tait-se-Baai. At Storms River Mouth mean densities ranged between 897 m^{-2} (Tait-se-Baai) and 2 700 m^{-2} (one sample at Moddervlei). The three highest densities in this region occurred at transects (Moddervlei, Swembad and Swartrif) exposed to storms driving from the southwest and the lowest at a transect (Tait-se-Baai) relatively sheltered from such storms.

Mean biomass of *P. perna* was lowest at the two transects located outside the TCNP (Table 1). All samples collected at Blue Rocks fell below one standard deviation from the mean calculated for nearby Die Punt, which again provided the highest actual and mean values, 52 and 25 kg m^{-2} respectively. The mean biomass values at these two localities differed significantly ($t=3,31$; d.f.=9; $p<,01$) from each other. Mussels aged one year or older were relatively scarce at Blue Rocks but well represented at Die Punt (Fig. 5) and also at Storms River (Fig. 4).

Discussion

Growth of *P. perna* in the intertidal region at Tsitsikamma is slower than that recorded for Natal, where brown mussels attain a length of 50-65 mm after one year (Berry 1978). High productivity of *P. perna* along the Natal coast has been attributed to physical energy of surf and swell action promoting breakdown of debris to detritus and maintaining detritus in suspension so that it is available as a food resource to filter feeders (Berry 1978). There is much wave energy along the Tsitsikamma coast. The major storms generally arise from the southwest and at Storms River Mouth mussel concentrations are densest on rocks having a southwestern aspect. There are seasonal differences in growth rate in Natal and at Tsitsikamma. However, in Natal slow growth generally occurs from mid-autumn through winter (Berry 1978), a period during which rapid growth was recorded at Tsitsikamma (Fig. 6).

Secondary settlement of brown mussels in the Natal intertidal region takes place from June through October or November (Berry 1978). Almost the opposite situation obtains at Tsitsikamma where most secondary settlement occurs during summer and autumn (Fig. 7). In both instances observed slow growth rates of adult forms preceeded settlement of juvenile brown mussels, suggesting that energy which might otherwise have been used for growth was being diverted towards repro-

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