Changes in the near-shore biotope at Foreness Point Margate in relation to harvesting of the common periwinkle Littorina littorea

Ian Humpheryes
Environment Agency, Addington, West Malling ME19 5SH

Introduction

The chalk reefs that surround the Thanet coastline have two distinct patterns of biotope in the upper and mid-shore zones; these are either algal dominated or grazing dominated reefs. High densities of edible periwinkles *Littorina littorea*, scattered limpets and mussel beds characterize the grazing dominated areas. These areas are often adjacent to algal dominated reefs (these are usually blanketed in *Fucus serratus* with fewer grazers present). An ecological study conducted by Carol Torry in 1994 (BSc project for Christ Church University College Canterbury) investigated the impact of periwinkle grazing upon the chalk reef. The survey area was at Foreness Point at Margate (Figure 1).

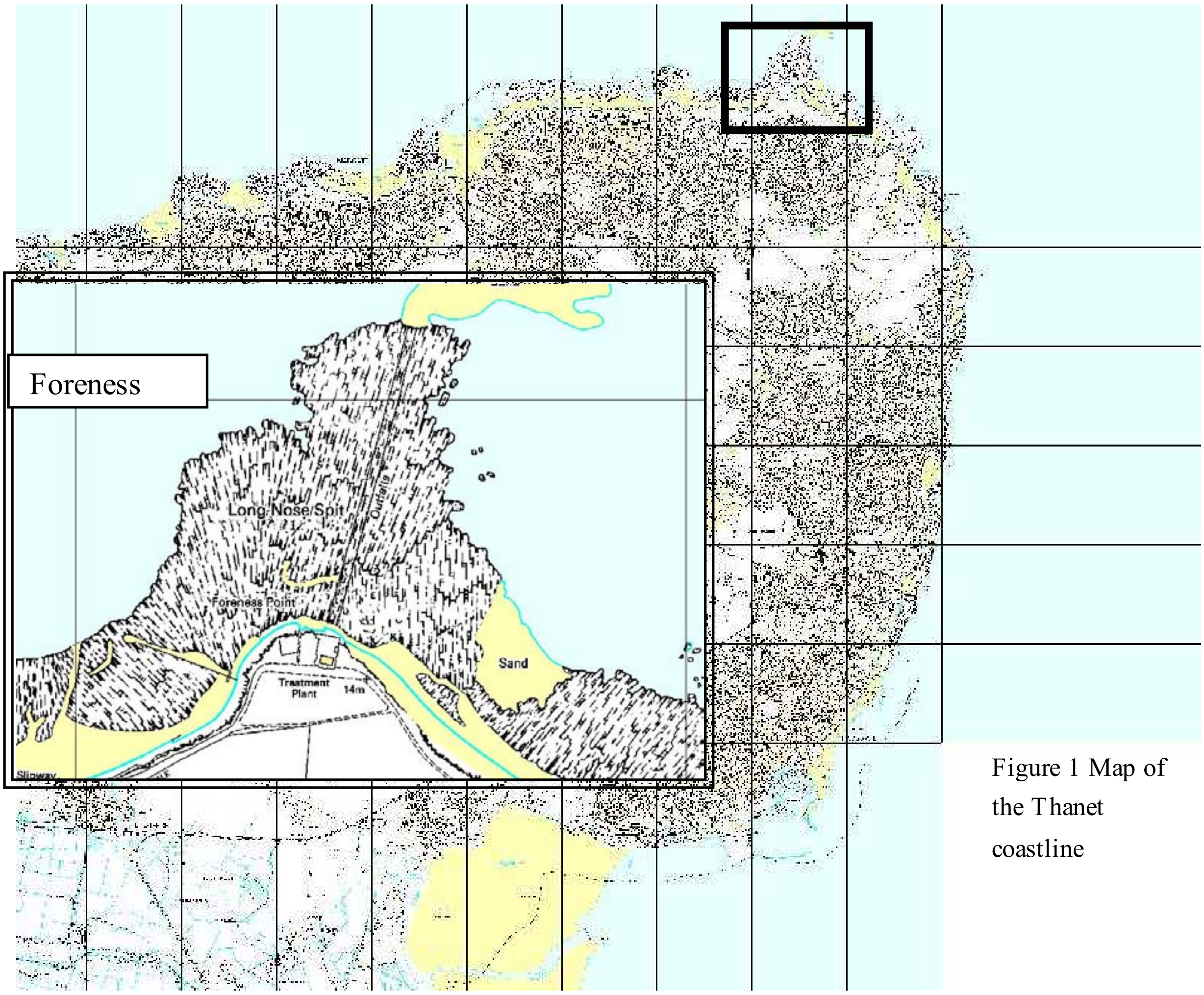

Figure 1 Map of the Thanet coastline

Previous study

The periwinkle study was designed to minimize the impact of the experiment upon the foreshore. Other studies had used exclusion cages to manipulate the density and number of grazing animals, however, these cages are expensive and liable to vandalism (especially so in areas where the public have unrestricted access).

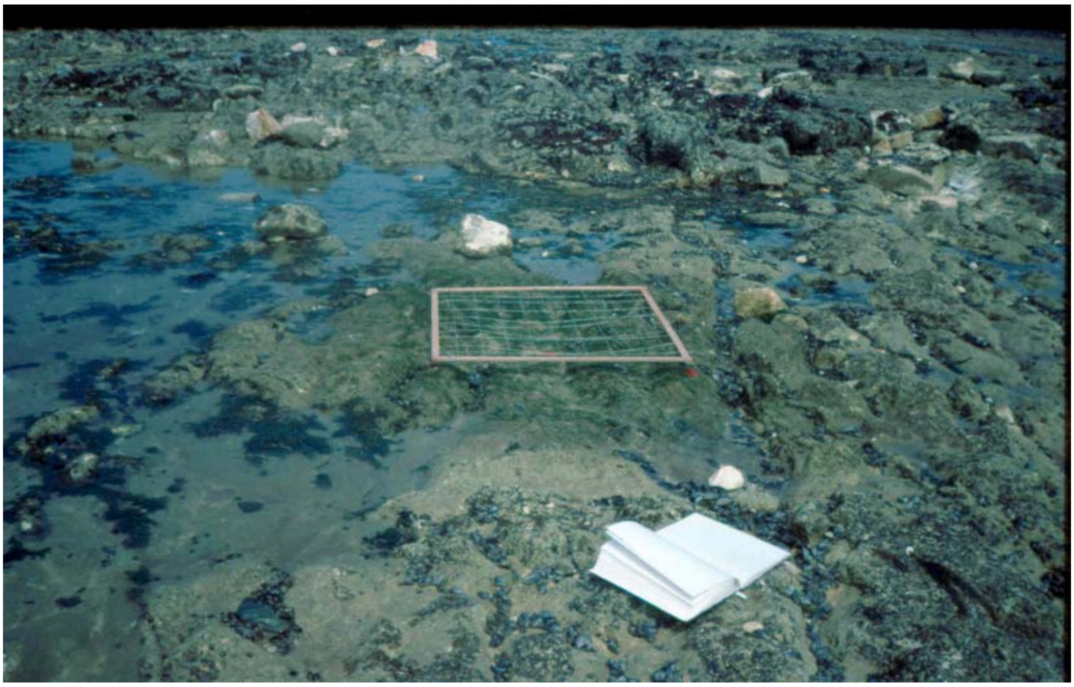

Plate 1. Upper shore Foreness Point in 1994

The placing of an artificial enclosure upon the rocky reef will alter the conditions within the treatment area such that eventual results might be difficult to disentangle from the environmental variances created. The method chosen was simple but extremely labour intensive, four painted galvanized nails were hammered into the chalk to form the corners of a $1m^2$ quadrat. Eight quadrats were located on the high-shore section of the reef and eight in the mid-shore (refer to Figure 2). The quadrats were randomized to divide them into control and treatment areas (four of each at both shore levels).

The quadrat was divided into 100 squares (Figure 3) and the percentage cover of all algal species and numbers of grazers were recorded on each transect. The treated squares had all *Littorina spp*. removed from within the quadrat square, and from within a buffer zone that extended for one metre around every quadrat. The control areas were counted but not cleared of any species. This process was repeated everyday at low tide for four weeks during the summer in 1994. The density of *Littorina spp*. was extremely high: 200 m^2 in upper and mid-shore-areas.

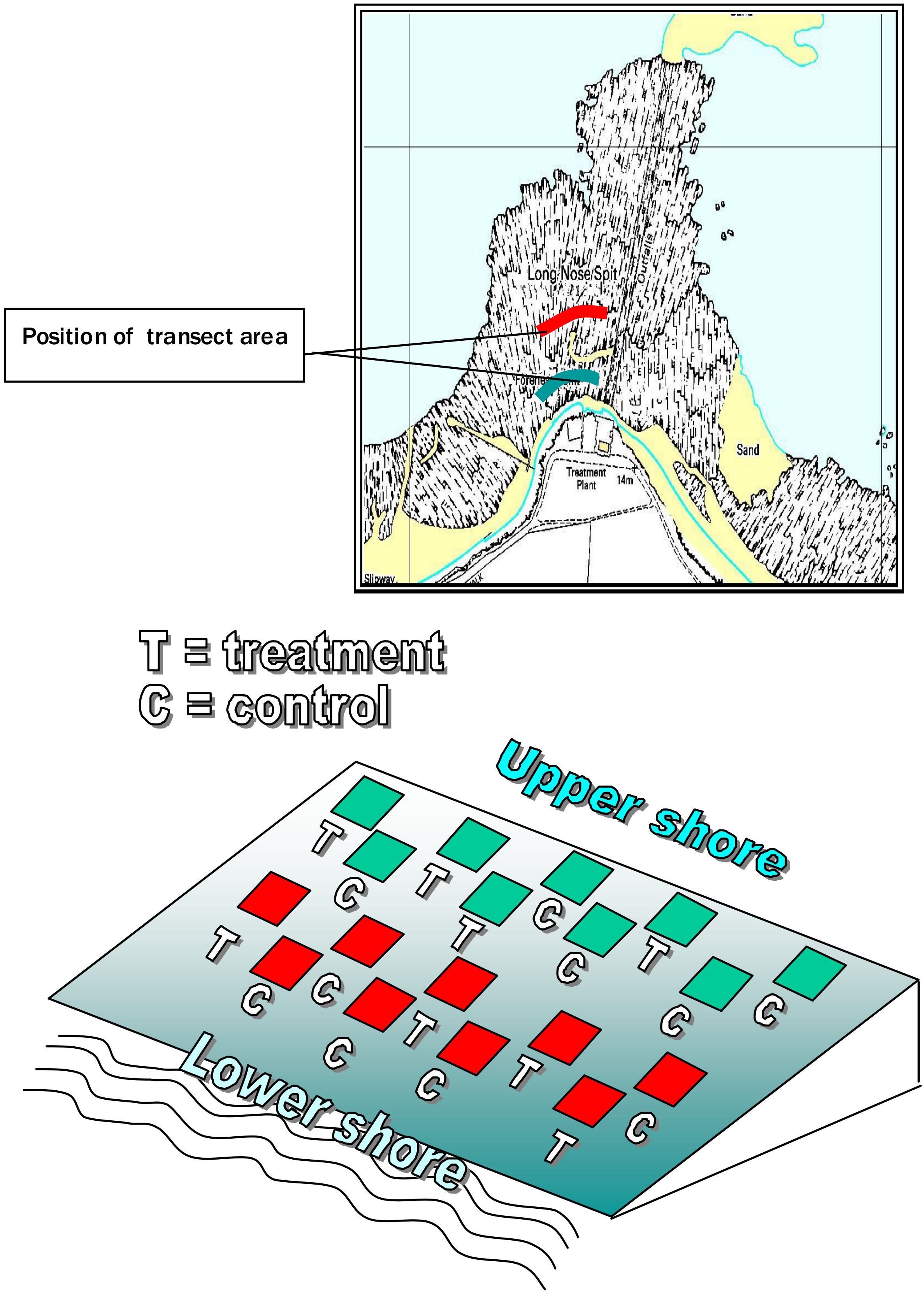

Figure 2. Experimental design used by Carol Torry in 1994 to assess the impact of periwinkle grazing upon the chalk reef

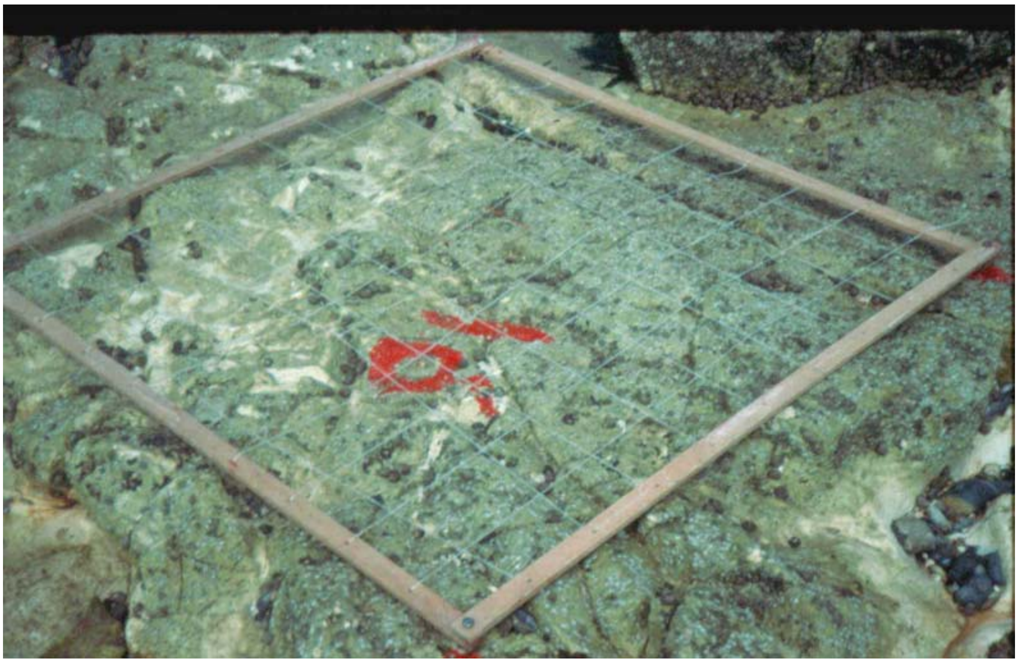

Plate 2. Quadrat divided into 100 (10cm x 10cm) squares

Within two weeks, the treatment areas showed a marked difference from the control areas. A thick layer of *Enteromorhpa spp*. quickly carpeted the reef within the quadrat area in the treatment squares (Plate 4). Within the control squares, the reef remained largely free of *Entermorpha spp.* and the remaining algae did not significantly change in percentage cover. Daily clearance was sufficient to maintain the treatment areas free of littorinids throughout the experiment; the buffer zone worked extremely well protecting the inner square.

Plate 3. Treatment area two weeks into experiment

During the experimental period, large groups of people were regularly observed collecting high numbers of periwinkles around the reef immediately adjacent to and within the experimental area. An intermediate level of harvesting on numerous occasions impacted one control quadrat. This square developed a slight growth of *Entermorpha* spp. (Plate 4). This indicated that complete removal of grazers was not essential to change the balance in algal cover. One year after the experiment, it was noted that some treatment areas had not returned to the pre-treatment condition (bare reef with high densities of periwinkles).

Plate 4. A control area affected by harvesting

Present survey

In the summer of 2002, the near-shore reef at Foreness Point was markedly different to that observed in 1994. Extensive growths of algae covered the reef adjacent to the seawall and up to 80m from the shore (Plate 5).

Plate 5. Reef at Foreness Point in 2002

The area to the East of the reef was examined and was found to be dominated by grazing molluscs. There were large numbers of mussels (approximately 1 year old) covering the reef but the density of periwinkles was still high.

Plate 6. Intertidal reef to the east of the 1994 survey area - summer 2002

The exposure to wave action is likely to be similar to that of the reef where new algal growth was observed. There were no significant stands of *Fucus sp*. or mats of *Entermorpha spp.* This set of rocks appeared to be (at least superficially) very similar to the reef where the grazing experiment was conducted in 1994.


Plate 7. Close-up of chalk reef shown in Plate 6

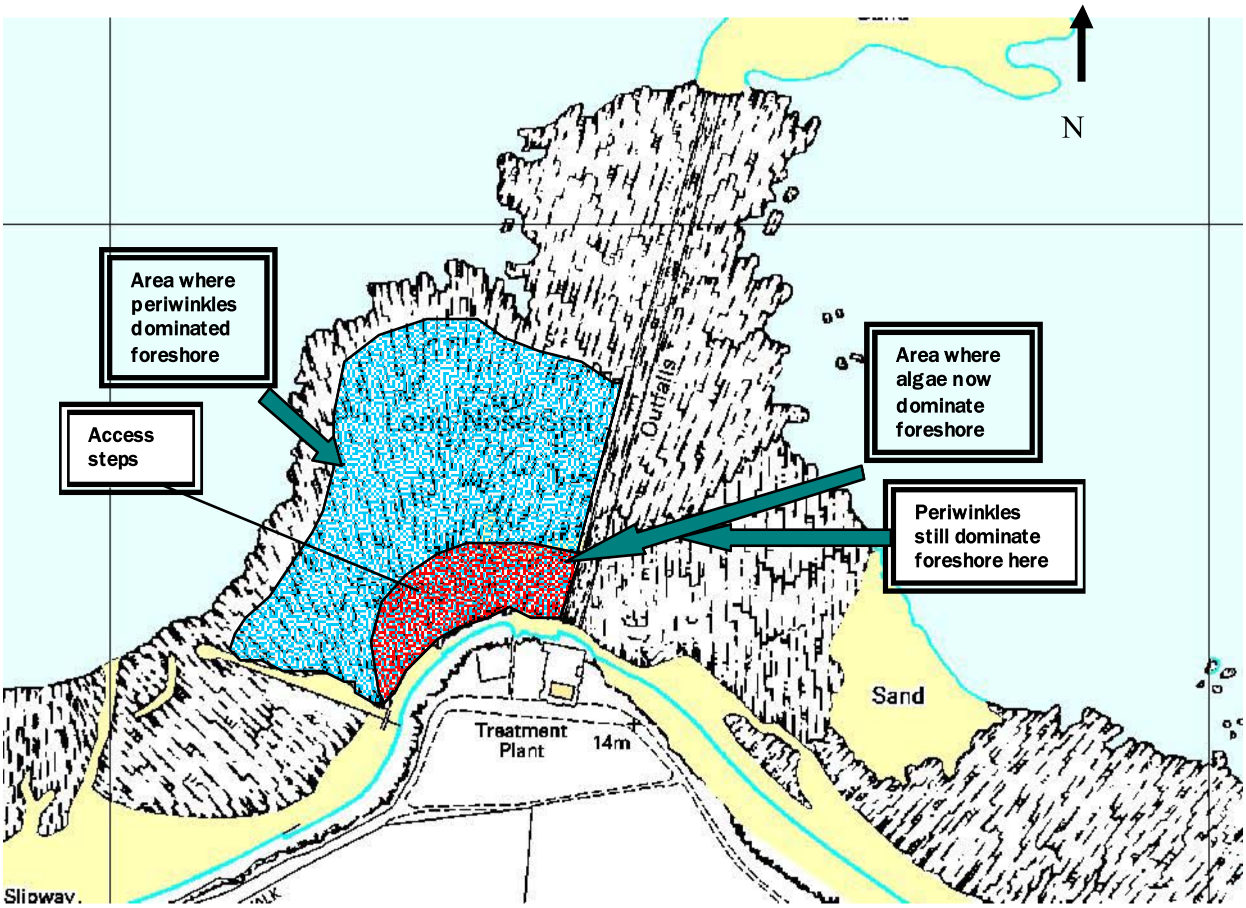

Figure 3. Foreness Point reef to show area (red) where periwinkle grazing habitat has been lost between 1994 and 2002

Figure 3 shows the area where periwinkles dominated the mid and upper shore reefs in 1994 and the area in 2002 where algae have replaced the grazing molluscs. An estimated 20% of grazing habitat has been lost on this section of reef. This probably equates to the loss of several million periwinkles between 1994-2002.

Discussion

Since 1994, the frequency of harvesting by members of the public has not appeared to decrease. The concrete promenade provides easy access for cars to park beside the steps to the beach. The numbers of harvesters can be as many as to sixty at one time and usually of family groups (personal observation). The harvested shellfish are both eaten and cooked on the beach or taken away.

Most harvesters use the steps shown in plate 8 or an adjacent slipway to get on to the beach. It is likely that the greatest impact of harvesting will be near to these accesses until the local mollusc population in sufficiently depleted. This appears to already be the case at Foreness Point as there is a large area (Figure 2 – red area on map) that has been lost the high densities of periwinkles that were observed in 1994 and where algal cover has dramatically increased. *Fucus vesiculosus* (not usually abundant on the chalk reefs) and *Enteromorpha sp.* have covered most of the rock surface in this near shore zone. However, the further one moves to the north or east of this area, the greater the periwinkle population becomes. The area of rocks to the west did not have high densities of periwinkles in 1994 or 2002.

The importance of the grazing molluscs for the annual clearance of seasonal growths of green algae was demonstrated by the 1994 student project. Within two weeks of the complete removal of the numerically dominant grazing species (the periwinkles), opportunistic algal species quickly became established and formed a dense carpet several inches thick. However, intermediate levels of grazing allowed some algal growth. The creation of intermediate grazing areas was accidental and resulted from the harvesting of periwinkles by groups of people on a regular basis.

In 2002, when the site was revisited, the reef area that was used in 1994 for the experimental manipulation of periwinkle populations had dramatically altered. The once bare chalk reef was covered in dense growths of fucoid and green algae. Periwinkles that were in 1994 averaging 200 m^2 had largely disappeared from a significant area of the near-shore reef. This altered area was centered on the access steps from the concrete promenade. An adjacent chalk reef (to the east and not so readily accessible) looked identical to the situation observed in 1994 with periwinkles dominating the near and mid shore.

The area of reef shown in the photographs in Plates 8 - 10 (below) is virtually devoid of periwinkles and has established growths of fucoid algae. The remaining chalk surface is densely covered with *Enteromorpha* sp. This area radiates out from the steps for approximately 80 metres.

Plates 8 –10, area of chalk reef where periwinkles have largely disappeared and have been replaced by macroalgae

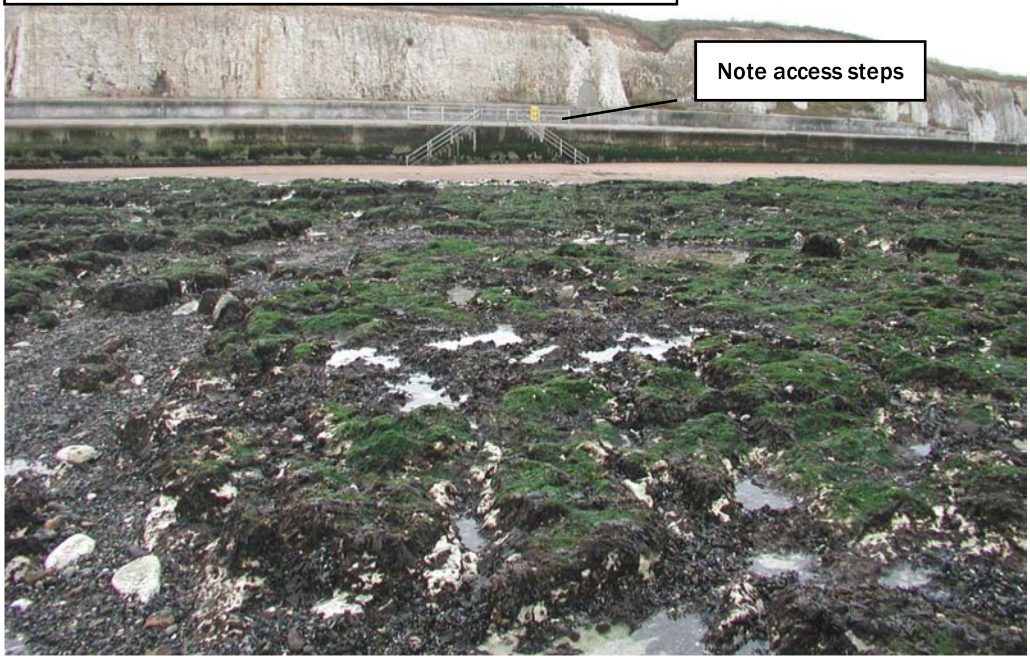

Plate 9

Plate 10

Conclusion

This evidence strongly suggests that the continual harvesting of periwinkles from the chalk reef has shifted the equilibrium from a grazing community to an algal dominated one. The change might (in the medium to short term at least) be permanent and has affected a large area of chalk reef. If the harvesting were to continue at the present rate, the impacted area would become larger because the periwinkles appear be unable to recolonise the reef once fucoid algae have become established. The estimated loss of several million periwinkles from the intertidal area at Foreness Point and the potential loss of several million more could have important consequences for bird feeding. If there are bird species that depend upon the periwinkles at these sites then a significant loss of feeding ground is possible.

The importance of Ostracoda and their relationship with the marine near shore environment of Thanet

Alasdair Bruce

Introduction

The Isle of Thanet is surrounded on three sides by water. A wide range of littoral to sub-littoral environments exists around the island. Principally these can be divided into chalk reef systems, muddy/sandy open beaches and estuarine/salt marsh. All these environments support a rich and varied assemblage of micro-organisms including ostracods.

Ostracoda

The use of ostracods as an environmental interpretation tool has been a relatively recent application, and to date has not been applied on Thanet. The following comments do not constitute a survey of any kind of this group's distribution in and around Thanet, rather they are merely a loose collection of observations spread over an unspecific time period. As such they give a poor guide as to what ostracods might be expected in certain locations.

Ostracods offer a powerful tool in assessing the current and past condition of certain aquatic environments. They are small crustaceans (average 1mm) enclosed in a carapace made up of two hinged calcitic valves (see Figure 1). They inhabit a wide variety of aquatic environmental niches, with well-known taxonomy and ecology. During the life cycle an ostracod will pass through up to eight growth stages or instars. In common with other crustaceans, an ostracod grows by shedding its carapace up to eight times before reaching adult size. Thus, during its life it leaves behind a large number of potentially identifiable fossil indicators for each individual (see Figure 2).

Ostracods are sensitive to environmental factors such as salinity, temperature, water chemistry, substrate and pollution. As such, many ostracod species are very niche specific and are excellent indicators of the health of an ecosystem.

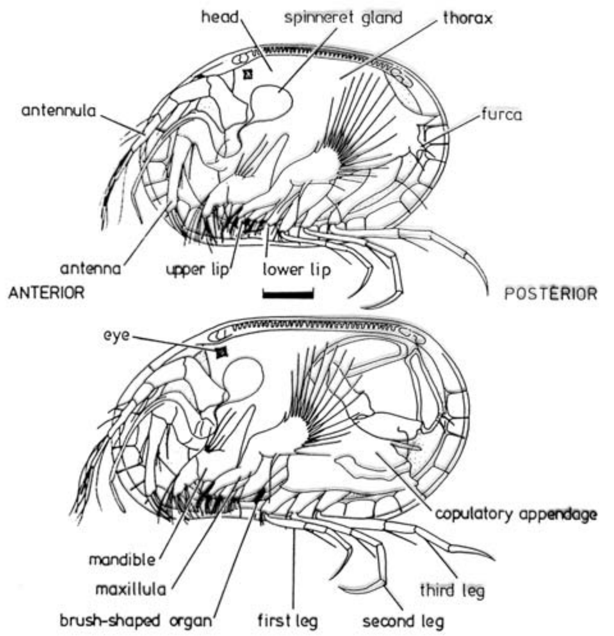

Fig. 1. *Loxoconcha elliptica*, adult female (above) and adult male (below), seen from the left side with left valves removed, to show the general arrangement of the appendages in a typical cytheracean podocopid ostracod (only one of each pair of appendages shown for clarity). Scale bar = 100 µm.

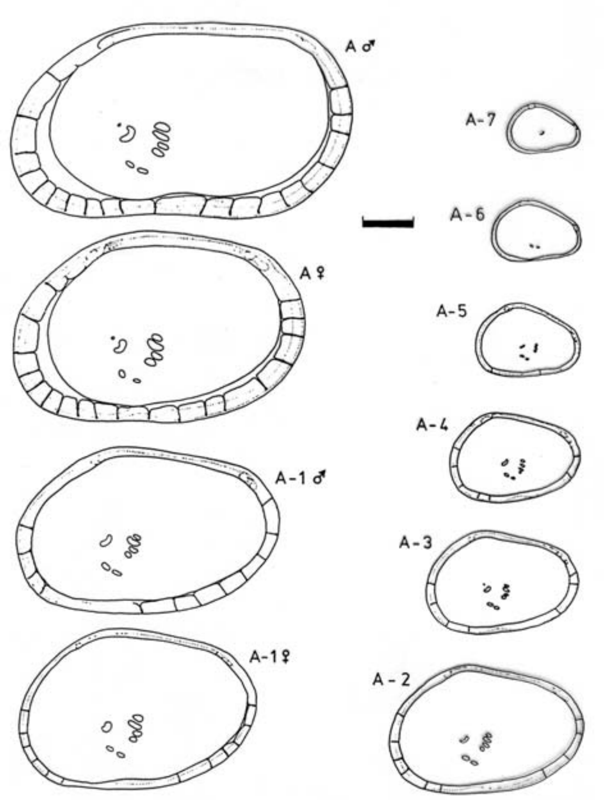

Fig. 2. Ontogeny of a cytheracean podocopid ostracod, *Loxoconcha elliptica*. All external lateral views of left valves, seen in transmitted light (anterior to the left). Scale bar = 100 µm.

Figures 1 and 2 amended after Athersuch *et al.*, 1989

Case study

A six-year environmental project on the Fleet lagoon in Dorset used ostracods as the interpretation tool to reconstruct the evolution of the lagoon through the Holocene to the present day. Below is a brief summary of the findings and their implications.

The linear-shaped Fleet lagoon in Dorset is Britain's largest macrotidal lagoon, and has a unique environment brought about by a very restricted link to the sea. The Holocene evolution of this lagoon is not fully understood. This project allowed the acquisition of material to assist in addressing that fact. A number of mechanically collected Holocene sediment cores from the Fleet lagoon, Dorset were analysed for their Ostracoda and Foraminifera content. In addition, nine hand-recovered cores were collected along the length of the lagoon and a year -long study of the living ostracods of the Fleet was completed. The palaeo-environmental analyses of these three different types of material indicate that significant environmental changes have occurred to the Fleet lagoon over the last *circa* 5000 years. The earliest sampled sediments in the cores are of a sandy nature and contain a faunal assemblage indicative of a shallow marine embayment. Thesegrade upwards into silts and clays with a progressively more lagoonal faunal assemblage. Increasing evidence of salt marsh culminates in the presence of a peat bed. The top of the peat bed shows evidence of a rapid incursion of the sea with an associated shell bed, followed by a return to lagoonal silts. These contain a fauna that indicates the west and east Fleet had similar environments until quite recently. Occasional sand beds within these silts contain deeper water marine ostracod taxa indicative of catastrophic storm events and seawater overtopping of Chesil Beach. The impact of storm events and man-made alteration to the Fleet during the last 500 years are discussed. The year- long live ostracod survey confirms that there is seasonal migration of certain ostracods within the Fleet. This, compared to a similar survey taken thirty years ago, shows there have been a number of major changes in the ostracod distribution of the Fleet lagoon. Implications for a sustainable management strategy for the Fleet lagoon are discussed in Bruce *et al.* (in press).

The Ostracod environments of Thanet

The only known studies of Thanet's ostracod populations have been undertaken by the present author during the last five years. This has consisted of sampling for ostracod assemblages around the island at selected locations. The locations were chosen for their differing environments in order to ascertain whether the known ostracod assemblages from other similar environments in Britain would be found here. The study of marine and brackish water ostracods undertaken by Athersuch *et al.* (1982) indicated what should be expected and in many cases this was true. However, there were a number of anomalies which will be mentioned later.

Again, It must be noted that what is written below in no way constitutes a full and detailed survey of the ostracods of Thanet. To my mind there is a great need to fill this gap in our knowledge of this group and its local distribution in Thanet. This is made all the more necessary by the unusual presence/absence of certain ostracods from particular assemblages. Plate 1 shows some of the more common ostracods to be observed around Thanet.

Chalk reefs

The large chalk reef platforms support a wide range of marine ostracods. Most species are phytal, living on and around the root anchorages of *Laminaria* sp and in the tufts of *Corallina offinalis*. These two structures are the most often sampled sites on these reefs; however, there is evidence from observations in other parts of Britain that certain ostracods may prefer to dwell in the old borings of piddock shells. This is but one example of the niche specific nature of certain species of ostracod. Those species so far recorded are listed below:

Leptocythere tenera
Semicytherura nigrescens
Paradoxostoma ensiforme
Paradoxostoma sp
Heterocythereis albomaculata
Hemicythere villosa
Hirschmannia viridis
Cythere lutea
Loxoconcha rhomboidea
Hemicytherura cellulosa
Aurila convexa.

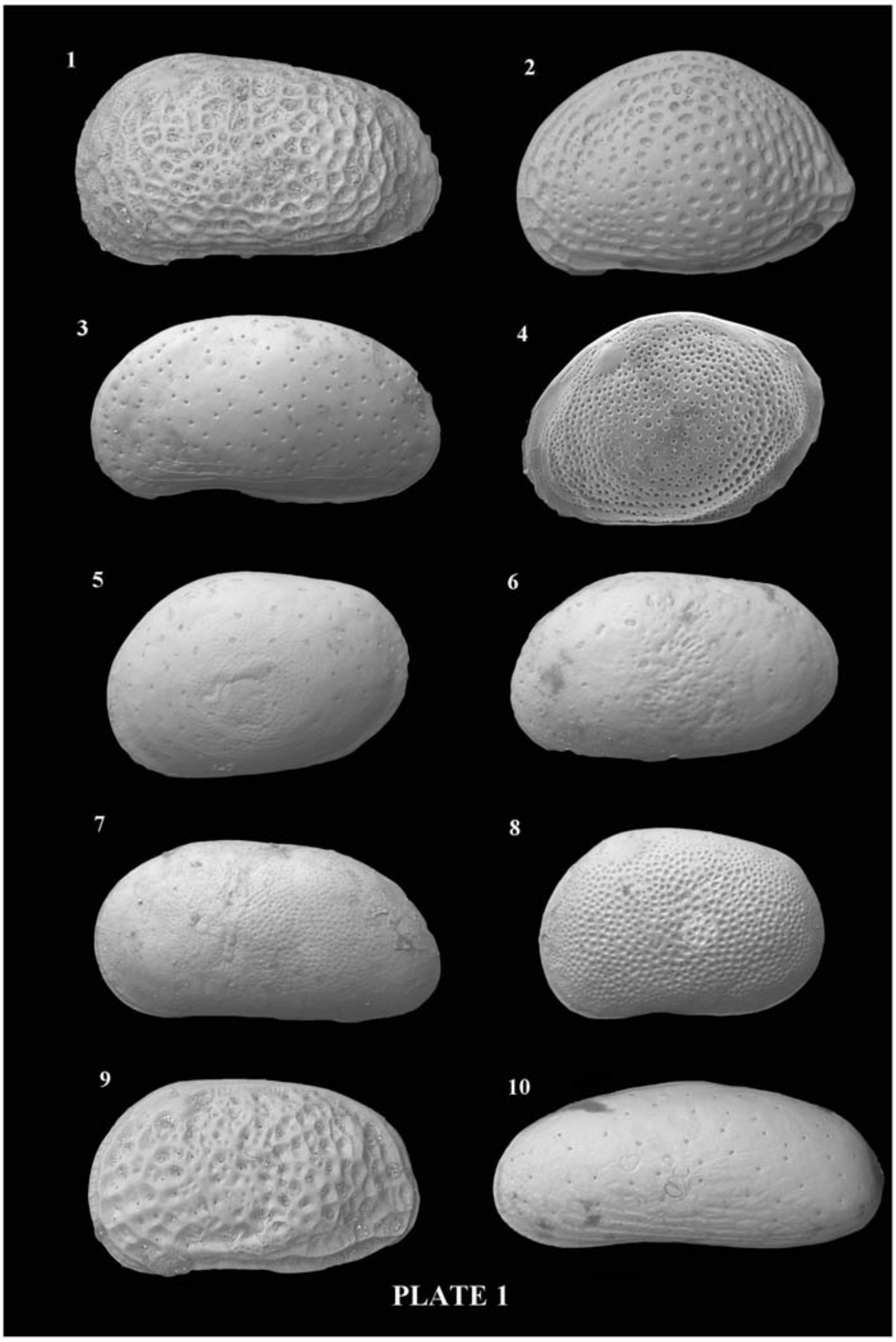

Plate 1 Ostracods from the Thanet coast

1 *Hemicythere rubida* (Brady), male (?) left valve. Foreness reef, Thanet, Kent. Specimen size 680 µm, x95.
2 *Aurila convexa* (Baird), female (?) left valve. Foreness reef, Thanet, Kent. Specimen size 760 µm, x79.
3 *Heterocythereis albomaculata* (Baird), female left valve. Foreness reef, Thanet, Kent. Specimen size 830 µm, x77.
4 *Loxoconcha rhomboidea* (Fischer), female left valve. Foreness reef, Thanet, Kent. Specimen size 625 µm, x90.
5 *Loxoconcha elliptica* Brady, female left valve. Minnis Bay, Thanet, Kent. Specimen size 600 µm, x90.
6 *Elofsonia baltica* (Hirschmann), female (?) left valve. Pegwell Bay, Thanet, Kent. Specimen size 490 µm, x120.
7 *Cyprideis torosa* (Jones), male left valve. Pegwell Bay, Thanet, Kent. Specimen size 1000 µm, x65.
8 *Hirschmannia viridis* (O.F. Müller) female right valve. Foreness reef, Thanet, Kent. Specimen size 525 µm, x105.
9 *Hemicythere villosa* (Sars), female left valve. Foreness reef, Thanet, Kent. Specimen size 740 µm, x88.
10 *Pontocythere elongata* (Brady), female left valve. Foreness reef, Thanet, Kent. Specimen size 980 µm, x70.

Beach

The open storm beaches of Thanet support a limited assemblage of ostracods that are dominated by the benthonic forms listed below. There are certain species which are also found on the reef systems. Among the species noted below are a number which appear to exist in close relationship with the sand tubes of the marine worm *Sabellaria alveolata*; in some cases I have witnessed their gruesome incorporation in these tubes whilst still alive. This is particularly true of *Pontocythere elongata.* Species of ostracod recorded are:

Leptocythere tenera
Aurila convexa
Pontocythere elongata.

Estuarine salt-marsh

Pegwell Bay is the best-developed example of this environment in Thanet, although parts of the foreshore around Minnis Bay might be considered estuarine in nature. In Pegwell Bay three areas have been studied in particular. These are:

1. The salt ponds between the old Hoverport site and the petrol station.
2. The drainage channels feeding the River Stour by the bird reserve.
3. The root areas of sea grass in the north of the bay.

The salt ponds were sampled as part of my recent work on establishing more precisely the environmental parameters of two very common British brackish water ostracods. *Cyprideis torosa* and *Loxoconcha elliptica* are found all around Britain in marsh and estuarine environments (Horne & Boomer, 2000). What is not yet fully understood is whether they both flourish in the same space within these extreme environments or simply overlap here. The salt ponds at Pegwell Bay are perhaps the most extreme environments to be found in the bay. For long periods during the summer they dry out and during the winter they are often full of freshwater. In between they are prone to flooding during sea storm events. It therefore comes as no surprise to discover that only one or two very robust and euryhaline species dominate here. One species (*C. torosa*) at least has been proved to have the ability to withstand desiccation events.

Loxoconcha elliptica has, surprisingly, not been found in association with *C. torosa* at this location. Another location behind Minnis Bay between the shingle and the sea wall also only contains *C. torosa*. Other similar locations around Britain have been found to contain both species. *Loxoconcha elliptica* has been collected around Thanet, but not in locations where it would be expected. These observations are not expanded on here as they are the subject of continued study and any statements would be premature. However, these observations illustrate the need for further research into the relationship of these two common and environmentally important species. Plate 1 shows a number of the more common ostracods encountered around the shores of Thanet.

Species seen in the salt ponds, creeks and drainage channels are:

Cyprideis torosa
Leptocythere castanea
Elofsonia baltica.

Additional species observed out on the main part of the bay were:

Pontocythere elongata
Loxoconcha rhomboidea
Hirschmannia viridis.

Conclusion

A wide range of environments is available for exploitation by ostracods around Thanet. The above lists are a rough and ready look at some of these, but do hint at the future potential of understanding ostracod distribution. This is particularly true of those that rely on algae. The distribution of algae on the reef systems of Thanet is well known, but it has been noted (personal observations) that in certain places the controlling factor on distribution is strongly affected by the type and hardness of the chalk substrate rather than tidal position on the shore. Ostracods are affected by substrate, salinity temperature and, to a lesser extent, exposure time within the tidal cycle (Whittaker, 1972). It is important to understand how these parameters alter the distribution of ostracods in differing circumstances such as the chalk reefs of Thanet. Ostracods as a food source is not well understood. Studies from the Fleet lagoon show that bass will feed on certain species of ostracod up to a particular size, when they shift their attention to other foods, but little else is known. A better understanding of the role ostracods play in the diet of fish and possibly birds is long overdue.

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