

Meiofauna in closed coastal saline lagoons in the United Kingdom: Structure and biodiversity of the nematode assemblage

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ARTICLE INFO

Article history:

Received 9 October 2007

Accepted 24 March 2008

Available online 1 April 2008

Keywords:

lagoon
brackish
saline
coastal
subtidal
benthos
meiofauna
nematode
biodiversity
species turnover

ABSTRACT

Coastal saline lagoons are rare in North West Europe and tend to be closed, brackish water systems. In the United Kingdom they are small and isolated, each exhibiting extremely variable habitat conditions, both spatially and temporally. This paper represents the first species-level study of lagoonal nematode assemblages in the UK. Samples were taken from seven ponds in a saline lagoon system on the south coast of England in order to describe the nematode assemblage in relation to habitat type and to assess the possibility of lagoonal specialisation. At each site samples were also taken, or data were already available, for salinity, sediment granulometry, sediment organic carbon content, photosynthetic pigments and lagoon topography.

A lagoonal specialist nematode fauna was not identified, but it was found that the nematode communities strongly reflected the differences between environmental conditions in the lagoons. Sample and site diversity were found to be relatively similar, but the importance of habitat networks was indicated by the relatively high system diversity, species turnover being highest between lagoons with different salinity and/or granulometry regimes. Salinity was the principal factor correlated with assemblage structure and species diversity was highest at the higher salinity sites. Median salinity (averaged from weekly records over the previous 4 months) correlated more clearly with nematode assemblage structure than salinity at the time of sampling. This shows the importance of considering historical as well as contemporaneous data when undertaking ecological studies: Contemporary conditions may influence species fecundity, and therefore relative abundances, whilst historic conditions may influence species occurrence through the effects of recruitment and survival.

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1. Introduction

Coastal saline lagoons tend to be shallow and isolated, with low water renewal rates, and exhibit spatial and seasonal variation of salinity and water temperature, both of which may be significantly different from ambient seawater (Barnes, 1980). Though they are commonly grouped with other brackish water habitats and classified by salinity (Remane, 1971), it is generally agreed that salinity *per se* does not structure brackish water macrofaunal assemblages (Guelorget and Perthuisot, 1992; Barnes, 1999) and isolation, or confinement, has been proposed as an alternative classification system (Guelorget and Perthuisot, 1992). However, the definitions of confinement and paralic assemblages are controversial (Barnes, 1994a; Elliott and McLusky, 2002) and when comparing small isolated lagoons (i.e. closed systems), salinity and macrofaunal

assemblages may be correlated (Barnes, 1994b). Therefore, in this paper the lagoons are defined by salinity, but using the closed system amendment to the “Venice System” (Dahl, 1956) (Fig. 1).

In North West Europe, lagoons are rare. In the UK they tend to be meso- or poly-haline and may freeze over in winter; they may also exhibit pH stratification and tend towards high sediment organic content and nutrient levels (Bamber et al., 1992). UK lagoons usually support both estuarine and lagoonal [brackish-water] specialist macrofauna and flora (Bamber et al., 1992) characteristic of the closed lagoons found in NW Europe (Barnes, 1994b) and which may be equated to the V–VI confinement zone as defined by Guelorget and Perthuisot (1984). However, similar macrofaunal assemblages may not occur in adjacent lagoons and habitat type cannot be relied upon to denote the presence of specialist lagoonal macrofauna (Barnes, 1988). It is likely this reflects both stochastic exchange between systems and local extinctions (Pearson et al., 2002; Jolly et al., 2003).

In these habitats it may be more appropriate to study the meiofauna, and specifically the Nematoda: Nematode assemblages persist during environmental perturbations which may reduce or

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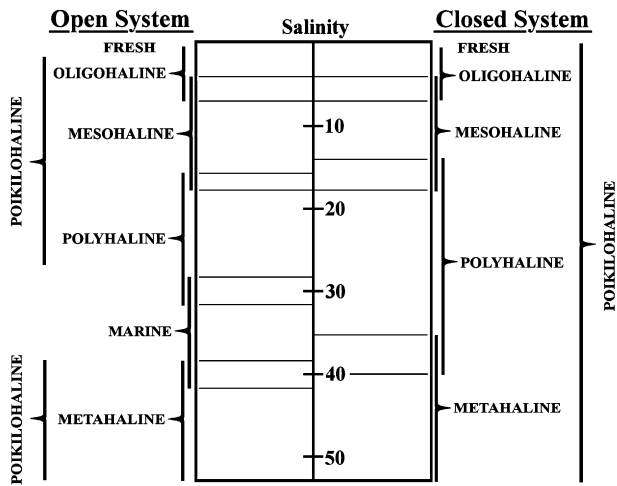


Fig. 1. A classification of brackish water in open and closed systems. Redrawn from Dahl, 1956 (salinity is defined according to the Practical Salinity Scale).

eliminate macrofaunal populations (Lorenzen et al., 1987; Hendelberg and Jensen, 1993), and are sensitive indicators of change in salinity (Forster, 1998), sediment organic content (Schratzberger and Warwick, 1998), and sediment granulometry (Vanaverbeke et al., 2000). Also, despite direct benthic development and negative rheotactic behaviour, successful nematode dispersal has been noted in a number of re-colonisation experiments, although it may differ between habitats and species (see data in Sherman and Coull, 1980; Chandler and Fleeger, 1983; Schratzberger et al., 2004). Nematodes may be passively suspended in the water column (Commito and Tita, 2002) and disperse by a number of mechanisms (Palmer, 1984; Platonova and Gal'tsova, 1985; Arroyo et al., 2006).

Previous meiofaunal studies in lagoons have been mainly at the higher taxon level (e.g. McArthur et al., 2000; Dye and Barros, 2005), with only a few species-level identifications in studies of enclosed water bodies with high sediment organic loadings (Mahmoudi et al., 2003; Hendelberg and Jensen, 1993) and none in the UK. Lagoonal nematode assemblages may be similar to those of estuarine habitats, structuring along salinity gradients (Warwick, 1971; Soetaert et al., 1995), with diversity and abundance tending to reduce with decreasing salinity and increasing salinity range (Attrill, 2002). However, absolute tolerance of individual populations is likely to relate to the degree and duration of deviation from the average salinity to which the population is accustomed and the rate of change in salinity (Forster, 1998), factors which differ between closed lagoons and open estuaries. Sediment parameters also differ between lagoons and estuaries, reflecting different hydrodynamic regimes, and are expected to have a significant influence on the abundance, diversity and species composition of nematode assemblages (see Heip et al., 1985 for review).

We aim here to investigate whether nematode assemblages in UK lagoons comprise novel lagoonal specialists and to test the null hypothesis that nematode assemblages in lagoons are not correlated with habitat type.

2. Materials and methods

2.1. Sites

The study focused on shallow saline lagoons in the Keyhaven–Pennington Marshes (Fig. 2), a 2 km² area within the Solent and Southampton Water RAMSAR site/Special Protection Area (SPA) and the Solent and Isle of Wight Lagoons Special Area of Conservation (SAC) on the south coast of England. They are comparatively small (<5 ha), shallow (<0.5 m), brackish (7.5–26.5 salinity on

average) ponds enclosed by a sea wall, with macrofaunal assemblages comprising lagoonal specialist, estuarine and marine species (Bamber et al., 1992). They are therefore principally of ecological interest, supporting rare/lagoonal specialist flora and fauna and migratory birds.

Six lagoons were studied: Butts (B), Pennington (P), Oxy South (OS), Salterns (S), Eight Acre Pond (EAP), and Normandy Farm (NF) with an additional sampling site in a drainage ditch, Normandy Farm Ditch (NFD), which has been found to support lagoonal specialist macrofauna (Barnes, personal observation). Pennington, Oxy South, Salterns, and Normandy Farm lagoons and Normandy Farm ditch are directly connected to the Solent by sluice gates, whilst additional sluices connect Pennington and Oxy South lagoons, Salterns and Eight Acre Pond lagoons, and Normandy Farm ditch and Normandy Farm lagoon. The sluices were designed to allow drainage from the lagoons and prevent marine water inflow, but in practice, inflow has been noted at Normandy Farm Ditch (Barnes, personal observation). Butts lagoon did not have an open connection with the Solent at the time of sampling and was also isolated from the other lagoons.

The system has been subject to intensive surveys commissioned by the local county council and consequently hydrological information is available (Marcus Hodges Environment Ltd., unpublished data): Groundwater percolation from the Solent is the main source of saline water to the lagoons, but although the estuary is macrotidal there is little tidal influence and changes in water level are seasonal not tidal. Sources of freshwater, including land run-off (as catchment size), rainfall and small point sources differ between the lagoons and due to different surface area/volume ratios, rates of evaporation are also expected to vary. As a result, ambient surface water salinity regimes differ widely between the lagoons, generally being less than the 34.4 recorded in the Solent (Dixon and Moore, 1987). Fortnightly salinity records are available from the lagoon sites for the four months prior to sampling (Marcus Hodges Environment Ltd., unpublished data).

Data on sediment granulometry and organic content (as loss on ignition at 540 °C) were also available from consultancy studies (Bamber, unpublished data). Granulometry is described in terms of the Wentworth Scale. No hydrological or granulometry data were available for Normandy Farm Ditch, which has not been officially recognised as a lagoon habitat and has therefore not been included in the above surveys. Owing to restricted saline water exchange, most or all sedimentation is expected to be of lagoonal or terrestrial origin.

The sites also exhibited different edge topography and exposure (Table 1). They were either gently sloping, shallow and potentially exposed to wind-driven disturbance (wave formation was observed in Pennington lagoon), or more basin-like with stepped sides that may experience [more prolonged] hypoxic events owing to reduced disturbance. Additionally, the sites differed in terms of fringing macroflora, which directly correlated with topography (see Table 1). Three sites (Pennington lagoons, Eight Acre Pond and Normandy Farm) were gently sloping and bare, whilst the remaining four sites (Butts, Oxy South and Salterns Lagoons and Normandy Farm Ditch) were stepped with fringing macroflora. Eight Acre Pond is used for dinghy sailing, whilst all the lagoons are visited by cattle from adjacent coastal grazing marsh.

A summary of these data is shown in Table 1 with other environmental data (see Section 3).

2.2. Sampling

On 26 April 2000, sediment core samples were collected from the seven sites using modified disposable 50 ml plastic syringes (2.65 cm internal diameter). At each site, samples were taken approximately 30 cm below average water depth to account for variation in edge topography and site exposure. Three sediment

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