OCEANOLOGICA ACTA, 1983, N° SP

An estuarine mud flat re-surveyed after forty-five years

Estuary
Sediments
Macrofauna
Population density

Estuaire
Sédiments
Macrofaune
Densité de population

Christopher Mettam
Department of Zoology, University College, PO Box 78, Cardiff CF1 IXL Wales, UK.

ABSTRACT

The distribution of infauna across an estuarine mud flat, described by C. B. Rees in 1940, remains very similar more than 40 years later in spite of environmental changes that have occurred meanwhile. The apparent stability of the distribution and abundance of species is probably related to a constancy in the distribution of sediments on an eroding shoreline. Several species occur at greatest densities in restricted sections of the shore and lower densities elsewhere represent an outward spread of colonising individuals that do not survive to maturity.

Oceanol. Acta, **1983**. Proceedings 17th European Marine Biology Symposium, Brest, France, 27 September-1 October, 1982, 137-140.

RÉSUMÉ

Nouvelle observation d'un marais estuarien à 45 ans d'intervalle

La distribution des espèces animales dans un marais estuarien, décrite par C. B. Rees en 1940, demeure dans son ensemble peu modifiée au bout de 40 ans, malgré les changements écologiques intervenus pendant cette période. La stabilité apparente de cette distribution et l'abondance des espèces animales sont probablement en rapport avec la faible variation de la distribution des sédiments des rivages en voie d'érosion. Plusieurs espèces se trouvent en plus forte densité sur des zones restreintes. La plus faible densité de certaines populations qui se trouvent ailleurs, s'explique par la diffusion des individus colonisateurs qui se dispersent et ne survivent pas à maturité.

Oceanol. Acta, **1983**. Actes 17e Symposium Européen de Biologie Marine, Brest, 27 septembre-1er octobre 1982, 137-140.

INTRODUCTION

A quantitative description of the fauna of an estuarine mud flat near Cardiff, South Wales, carried out in August 1937 (Rees, 1940), provided an opportunity for comparison several decades later. The same transect was repeatedly sampled from August 1974 to April 1977 and again in July 1982, just prior to this symposium.

Rees (1940) observed that the transect crossed bands of different types of sediment. These were still present, with obvious differences in firmness and texture, representing zones of accretion on the generally eroding face of an earlier clay deposition (Fig. 1). Aerial photographs in which meandering drainage channels identify areas of soft mud (Fig. 1 *A*), show that the bands continue parallel with the shoreline. In places the shore has eroded by about 2 m since 1926 exposing an adjacent sewer pipe and its supporting pilings, laid down at

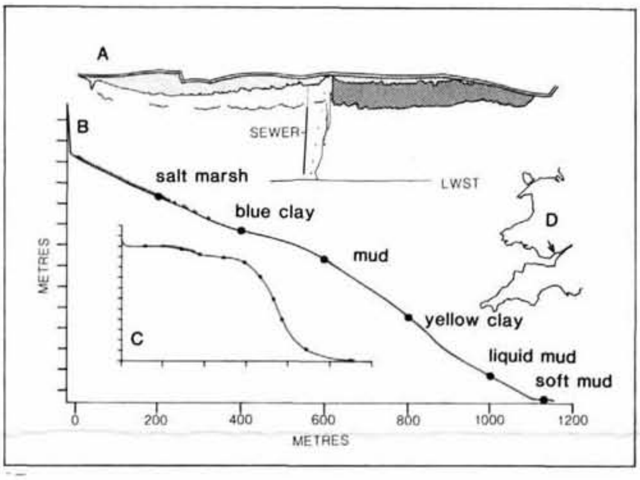

Figure 1

A, plan and B, profile of the transect sites for repeated samples are shown as dots ; C, profile after Rees (1940) drawn to half scale of B ; D, location of transect.

that time. Rees described an upper zone of bare mud with a *Salicornia* stand extending to a protruding peat bed (Fig. 1 *C*). In recent years this marsh has become thickly vegetated following plantings of *Spartina anglica* in the 1950s. The shore profile given by Rees (Fig. 1 *C*) cannot be reconciled with present conditions, nor with the surveyor's report when the sewage outfall was constructed, so his ten sampling sites cannot be located precisely.

METHODS

Rees (1940) collected macrofauna by sieving fresh mud cores through 200 µ perforations and small species were extracted alive from 18 mm diameter cores dispersed in water. No replicates were taken.

In 1982, four replicate samples (0.025 m^2) were taken from the centre of each sediment type, shown in Figure 1 *B*. Samples, formalin preserved and Rose-Bengal stained, were sieved through a 210 µ mesh screen. In the long term study (1974-1977) sites were 200 m apart with one at extreme low water (Fig. 1 *A*, *B*). Sites at 800 and 1 000 m were transitional between mid-shore mud and yellow clay zones and between clay and liquid mud zones respectively. These samples were sieved through 500 µ mesh and all except the first series (August 1974) were fixed and stained before sieving.

RESULTS

Comparison of 1937 and 1982 results

Macrofaunal distributions were very similar in 1937 and 1982 ; compared in Figures 2 and 3. On both occasions *Macoma balthica* and *Hydrobia ulvae* were at similar densities and *H. ulvae*, at least, showed the same tenfold increase downshore, although also abundant in the salt marsh zone in 1982. *Corophium volutator* and *Nephtys hombergi* (the latter recorded as " present " by Rees) were confined to the lower shore. *Nereis diversicolor* showed a comparable pattern of distribution but densities were much higher in 1982, when larvae and juveniles were abundant. By sieving fresh mud, Rees probably missed these delicate, tiny individuals.

Mature animals were further limited within their species distributions in 1982. Breeding *C. volutator* were only present at the lowest site (1 100 m) where Rees had found them : high counts of *C. volutator* at 800 m were entirely small juveniles. More than 75 % of the total *M. balthica* sample were below 5 mm shell length and specimens with more than 2 growth rings only occurred at 1 000 m. Large *Scrobicularia plana* were present at the salt marsh level but no small specimens were seen : Rees (1940) noted the same phenomenon. Egg masses of *H. ulvae* occurred at all sites and juveniles predominated throughout the samples in 1982.

Rees (1940) recorded abundant oligochaetes on the upper shore and polychaetes on the lower shore but did not identify many. Further, his small samples,

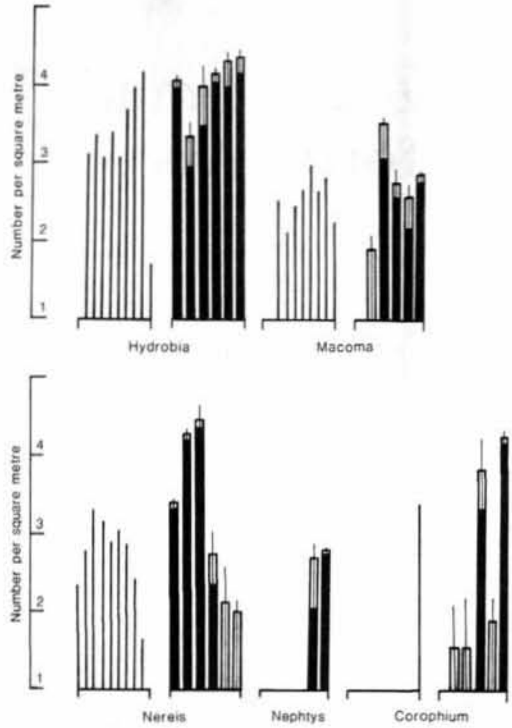

Figure 2

Densities of Macoma balthica, Hydrobia ulvae, Nereis diversicolor, Nephtys hombergi *and* Corophium volutator *in 1937 (narrow bars) and 1982 (histograms) across the transect to low water (right hand side). Densities are* log_{10} $N.m^{-2}$ *; fine lines on histograms indicate maximum and minimum counts.*

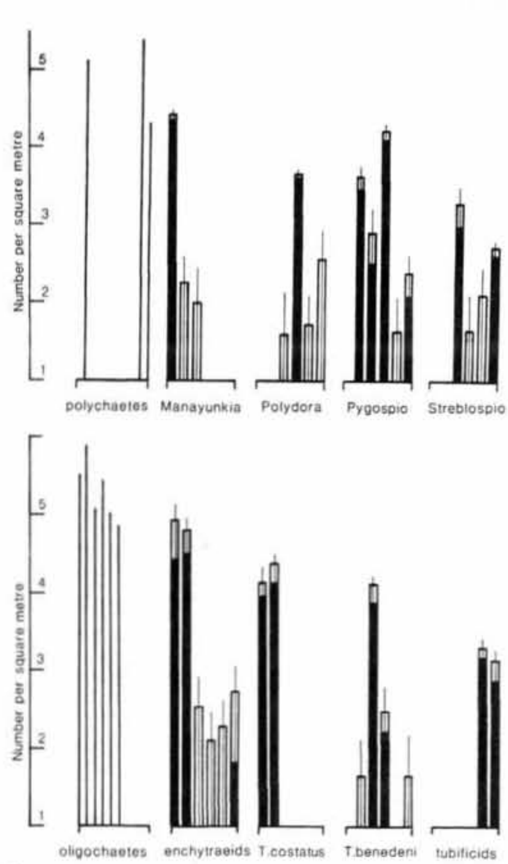

Figure 3

Upper figure, densities of Manayunkia aestuarina, Polydora *sp.*, Pygospio elegans *and* Streblospio shrubsolii *in 1982 (histograms) compared with total small polychaetes in 1937 (narrow bars). Lower figure, densities of enchytraeids,* Tubifex costatus, Tubificoides benedeni *and other tubificids in 1982 (histograms) compared with total oligochaetes in 1937 (narrow bars). Other conventions as in Figure 2.*

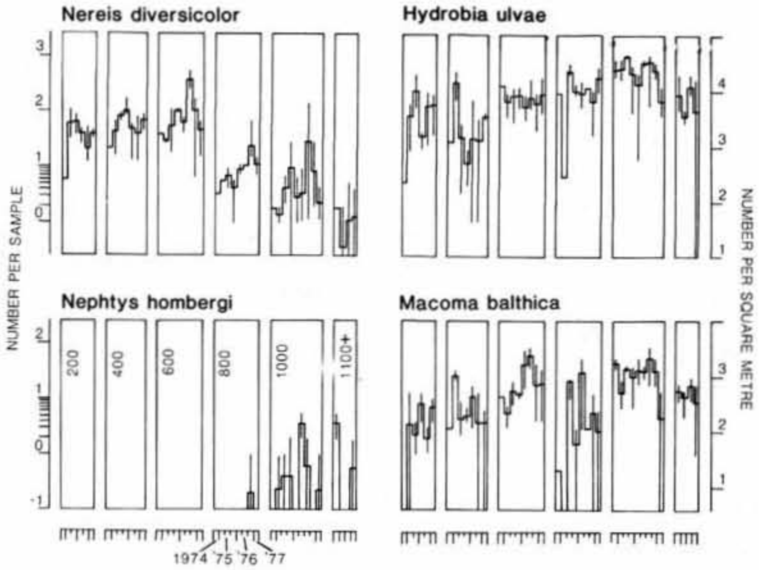

Figure 4

Densities of Nereis diversicolor, Nephtys hombergi, Hydrobia ulvae *and* Macoma balthica *across the transect to low water (right hand side). Each block represents one sampling site, repeatedly sampled from 1974-1977 : large divisions on the time scale indicate years, subdivided when sampling was repeated in any year (sample times are detailed in the Table). Densities are* $\log_{10}$ *number per sample (left axis), converted to* $\log_{10}$ *number per* m^2 *(right axis). Mean densities shown by continous line with maximum and minimum counts (vertical bars) where available.*

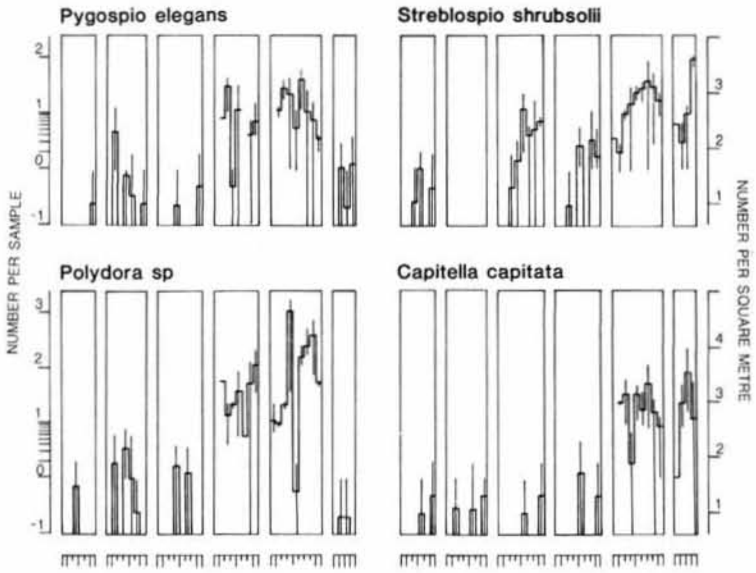

Figure 5

Densities of Pygospio elegans, Streblospio shrubsolii, Polydora *sp. and* Capitella capitata. *Conventions as for Figure 4.*

multiplied up, give minimum densities of 10^4 m^{-2} so comparison with 1982 findings cannot be made in detail. Polychaetes in bare mud on the upper shore, identified as *Polydora ciliata* by Rees (1940) have gone with the development of marsh vegetation.

In 1982, the small annelids showed clearly the tendency for species to attain consistently high densities within restricted parts of the transect, *e.g. Manayunkia aestuarina* in the marsh zone, *Polydora* sp. in the yellow clay (Fig. 3). *Pygospio elegans* and *Streblospio shrubsolii* were more widely distributed, the former associated with firm substrata and the latter with soft mud. Enchytraeids were abundant in salt marsh and blue clay zones but mature specimens were only common in the latter habitat. Of several species not shown in Figures 2 and 3, only *Limapontia depressa* was at all common (exceeding 2 000 m^{-2} in the marsh zone).

Long term studies 1974-1977

For many species, the distribution patterns were remarkably persistent (Fig. 4, 5 and 6) with clear differences

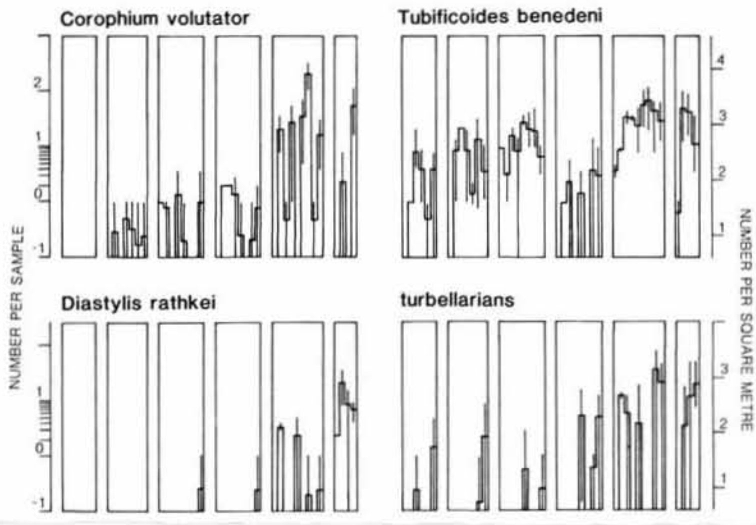

Figure 6

Densities of Corophium volutator, Diastylis rathkei, Tubificoides benedeni *and turbellarians. Conventions as for Figure 4.*

in density between sites on the transect. *H. ulvae* showed surprising consistency of numbers at 600 m where the range of mean densities was less than the range of variation between replicate samples. Recruitment produced peaks for *M. balthica* (*e.g.* March 1975 at 400 m) which exhibited greatest numerical stability at 1 000 m, where old specimens were regularly found. The peak of *N. diversicolor* in July 1976 comprised 85 % group O^+ juveniles and the migration of these worms onto lower shore sites was evident in the following months. Extreme variations were shown by *C. volutator* (Fig. 6) fluctuating with its population cycle. *Diastylis rathkei* was generally present and recorded by Rees (1940) although not found in 1982 samples.

The longer time series confirms the localised distribution of the small polychaetes (Fig. 5). The association of *P. elegans* with firm mud is now more obvious. *Streblospio shrubsolii* is the only species showing an apparent trend towards increasing numbers over these years. The classic opportunist, *Capitella capitata* was present at the edge of the fluid mud zone (1 000 m) and only one specimen was recorded in 1982 when this narrow transition zone was not sampled. An apparent seasonality occurred in an unidentified turbellarian which was common in springtime samples.

Table

Sampling dates shown on Figures 4-6 for sites along transect.

Date	Distance (m)					
	200	400	600	800	1 000	1 100 +
1974 August	+	+	+	+	+	+
1975 March		+	+	+	+	+
June	+	+	+	+	+	
August	+	+	+	+	+	
1976 May	+	+	+	+	+	+
July			+	+	+	
August					+	
October	+	+	+	+	+	
1977 April	+	+	+	+	+	+

DISCUSSION

The distribution of infaunal species appears to conform to the underlying zonation of sediment characteristics which, on the eroding face of an earlier, probably Flandrian, deposit has been a stable feature over many years. Fluctuations in population densities *within* sites do not obscure the consistent differences *between* sites. *Corophium volutator* on the lower shore, considered by Rees (1940) to be a temporary feature but subsequently noted by Purchon (1948), is a persistent population although having large seasonal variations. In most other species, recruitment and losses give more stable populations.

Acknowledgements

Part of this work was undertaken during tenure of grant GR3/2401 from the Natural Environment Research Council. The Job Creation Programme of the Manpower Services Scheme funded staff to sort and count samples collected in 1974-1977.

REFERENCES

Purchon R. D., 1948. Studies of the Bristol Channel XVII. The littoral and sublittoral fauna of the northern shores near Cardiff. *Proc. Bristol. Nat. Soc.*, **27**, 285-310.

Rees C. B., 1940. A preliminary study of the ecology of a mud-flat. *J. Mar. Biol. Assoc. UK*, **24**, 185-199.