Benthos
English Channel
Echinoderms
Dredging

Benthos
Manche
Échinodermes
Dragages

Fluctuations in the benthos of the western English Channel

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ABSTRACT

The most noticeable changes in benthos have been in the degree of penetration of species from the Celtic Sea into the western Channel. There may also have been an indirect effect on beds of *Ophiothrix fragilis* off Plymouth through fluctuations in populations of *Luidia ciliaris*, which preys on *Ophiothrix*. Other fluctuations in the benthos relating to sea temperature, exceptionally cold winters, immigrant species, dinoflagellate blooms, and oil pollution incidents have mainly affected the eastern Channel or inshore waters in the west, leaving offshore areas of the western Channel largely unaffected. There is now growing evidence of harmful effects of heavy fishing gear on the offshore benthos in parts of the western Channel.

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RÉSUMÉ

Fluctuations du benthos de la Manche occidentale

Les fluctuations du benthos les plus frappantes concernent la pénétration de quelques espèces de la Mer Celtique dans la partie occidentale de la Manche. Il est en outre possible que les variations dans les bancs d'*Ophiothrix fragilis*, au large de Plymouth, soient liées aux fluctuations d'abondance de *Luidia ciliaris*, prédateur d'*Ophiothrix*. D'autres fluctuations, en relation avec le climat marin, les hivers très froids, des espèces immigrantes, les « blooms » de dinoflagellés, la pollution par le mazout, ont principalement affecté la Manche orientale ou les eaux côtières de la Manche occidentale. Les effets sur le benthos d'engins de pêche lourds (dragues à coquilles Saint-Jacques, chaluts pour la pêche des soles) sont de plus en plus manifestes au large de Plymouth.

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INTRODUCTION

There is a long history of benthic investigation in the English Channel, dating from Allen's (1899) study of the Eddystone grounds and Pruvot's (1897) description of the fauna off the Brittany coast, and subsequent studies have largely been based on the Laboratories at Plymouth (Table) and Roscoff.

The western end of the Channel is well known as an important boundary to the distribution of species, particularly warm-water forms approaching their northern limits (Ekman, 1953). However limits to distribution are not due to temperature alone, nor is there any simple relation to temperature, and in fact there are a number of other important factors which change along the length of the Channel (Crisp, Southward, 1958; Holme, 1966; Cabioch, 1968). Conditions in the Channel are largely influenced by the strong tidal streams in its central and eastern parts, exceeding 2.5 knots at springs in the "narrows" between Portland and Cotentin, and in the Gulf of St Malo (golfe normanno-breton).

It is likely that the stronger tidal streams around the central Channel impose a relatively constant hydrographic regime in this sector. In the west however, particularly off the coasts of Devon and Cornwall, tidal streams are weaker, generally not exceeding one knot, and it is probable that wind and weather here

Table

Benthic surveys in the Plymouth area.

Author	Publication date	Survey date	Ground	Sampling gear	Notes
E. J. Allen	1899	1895-1898	Eddystone grounds	Dredge ; trawl	
L. R. Crawshay	1912	1906	Outside Eddystone	Dredge ; trawl	
E. Ford	1923	1922-1923	Plymouth area	Grab	Communities
G. A. Steven	1930	1928-1929	Inside Eddystone	Grab ; trawl	Food of fish
J. E. Smith	1932	1931	Eddystone gravels	Conical dredge	
M. F. Mare	1942	1939	Rame mud	Corer, grab	Microfauna
H. G. Vevers	1951 ; 1952	1949-1951	Plymouth area	Camera	*Ophiothrix* beds, etc.
N. A. Holme	1953	1950	Plymouth area	Grab	Biomass
N. A. Holme	1961 ; 1966	1958-1962	English Channel	Anchor-dredge	Distribution
N. A. Holme	1984	1970-1981	Western E. Channel	Dredge	*Ophiothrix, Ophiocomina*
N. A. Holme (*)	1977 ; 1980	1972-1982	Lizard-Start Point	TV sledge	Scallops, *Ophiocomina*

(*) Wilson *et al.* (1977) ; Franklin *et al.* (1980).

exert a relatively greater influence, so that seasonal and year-to-year variations are more marked. Thus seasonal patterns of water movements (Dietrich, 1950) and of plankton distributions (Southward, 1962) may have a greater influence, and the variable position of hydrographic " fronts " in this area (Pingree, 1978 ; 1979) contrasts with the more constant position of these features off Ushant and west Brittany.

Many of the more noticeable fluctuations in benthic species off Plymouth are related to variations in penetration into the Channel of species whose normal habitat is in the Celtic Sea. These are likely to be cold-water, stenothermal, species unable to tolerate the greater extremes and range of temperature up-Channel. In the Celtic Sea the annual variation in bottom temperature is no more than a degree or two, off Plymouth it is about 5°, while in the eastern Channel and Gulf of St Malo it is 8-9°. It is not clear whether the observed fluctuations in " western " species are due to changes in sea temperature, more favourable conditions for breeding and growth off Plymouth, or to variations in currents carrying larvae into the Channel from breeding stock in the Celtic Sea.

Amongst " western " species known to have fluctuated in abundance off Plymouth are :

The anomuran crustacean *Munida bamffica*. Not taken in Allen's surveys of the Eddystone grounds in the 1890's, and there were only a few records in the early part of this century. Common off Plymouth through the 1930's, but only a few taken since the last war (Marine Biological Association, 1957, *see* also Wilson, 1951).

The sea-urchin *Echinus acutus* was moderately common in deeper water in the early part of the century, but has not been recorded since about 1930. It still occurs in the Celtic Sea.

The scaphopod mollusc *Dentalium entalis* was widespread around the Eddystone in the 1890's, but appears to no longer occur off Plymouth. It is still present at the mouth of the Channel (Holme, 1961), as well as in the Celtic Sea.

The return of the starfish *Luidia sarsi* after an absence of some years was noted in the late 1960's. The larva of this species is known to be associated with *Sagitta elegans* water (Russell, 1939 ; Southward, 1962 ; *see* also Ursin, 1960). Following a long period from the early 1930's when the plankton off Plymouth was characterised by *Sagitta setosa*, a reversion to conditions similar to those of the 1920's, with a *Sagitta elegans* community, occurred about 1968 (Southward, 1980). *Luidia sarsi* was absent or very rare off Plymouth in the 1950's and early 1960's (Holme, 1961, and unpublished observations), the first sign of a return being in April 1968, after which further records showed that it had become established in the area.

A more indirect link with the occurrence of " western " species may account for fluctuations in the abundance of beds of the brittle-star *Ophiothrix fragilis*. Dense beds of this species were recorded from the Eddystone grounds by Allen (1899), and fifty years later Vevers (1951 ; 1952) photographed beds of *Ophiothrix* here and elsewhere in the Plymouth area. However there is evidence that these beds had not persisted unchanged during this period, and it is likely that they were rare or absent during the 1920's. Ford's (1923) grab samples revealed only low densities of this species, and although the Petersen grab is not an ideal instrument for sampling *Ophiothrix* beds, it is surprising that none of his many grab samples took *Ophiothrix* in appreciable numbers. Similarly Smith's survey (Smith, 1932) of the Eddystone gravels revealed only small numbers of *Ophiothrix*.

Ophiothrix beds were again common in the 1950's and early 1960's, after which the offshore beds disappeared completely. Today, small individuals occur singly among shells, bryozoan colonies, etc., but that is all. Off the French coast (east Channel, Gulf of St Malo, off Roscoff) beds still persist, and there is no evidence of a decline comparable to that off Plymouth (personal observations, and information from L. Cabioch).

A possible cause of the decline is predation by the large starfish *Luidia ciliaris*. This is known to feed upon *Ophiothrix*. Surprisingly, *L. ciliaris* was not taken on the Eddystone grounds in Allen's (1899) survey, although it was recorded, from deeper water, a few years later by Crawshay (1912). However there is evidence that it was reasonably common in the 1920's, since Hunt (1925)

was able to obtain a total of 108 specimens from 20 trawl hauls off Plymouth. *Luidia ciliaris* was relatively common off Plymouth in the 1970's, and a sample off Bolt Tail taken in 1971 contained 20 large specimens together with large numbers of *Ophiothrix* (Holme, 1984). We do not know whether predation by *Luidia* would be sufficient to cause beds of *Ophiothrix* to disintegrate and disappear, but if this were so this brittle-star would be expected to persist where this predator were absent. *Luidia ciliaris* has a " western " type of distribution both in the English Channel and North Sea (Ursin, 1960). Its main area of occurrence since 1968 corresponding with that formerly occupied by the *Ophiothrix* beds off Plymouth (Figure).

The effects of the physical and chemical conditions with which *Sagitta elegans* may be associated is shown not only in the occurrence of certain " western " species, but in the success of spatfall of other benthic species. Ford's grab surveys of 1922-23 were made when there was a strong *elegans* influence, and his samples were remarkable not only for the number of species they contained, but for the densities of young, particularly of bivalve molluscs. It was fortunate that Ford carried out his surveys at that time as they enabled him better to describe the communities of the area, at the same time painting what in hindsight can be seen as a rosy picture of the richness and diversity of the communities.

Other faunistic changes have included :

1) Fluctuations in the range of " Sarnian " species which are centred in the Gulf of St Malo, showing a penetration into other parts of the Channel which may be related to the effects of temperature. Examples include the common octopus (Rees, Lumby, 1954), and *Venus verrucosa* and *Dentalium vulgare* (Holme, 1966).

2) Mortalities during exceptionally cold winters, such as 1962-63 (Crisp, 1964 ; Holme, 1967), which mainly affected the eastern Channel.

3) Immigrant species, such as *Crepidula fornicata*, which spread into the western Channel in the late 1940's (Marine Biological Association, 1957).

4) Dinoflagellate blooms, which in 1978 caused mortalities among inshore benthos along the Cornish coast (Forster, 1979).

5) Oil pollution. Effects of toxic detergent used for clearing *Torrey Canyon* oil caused mortalities on the shore, and locally offshore where very heavy detergent spraying had occurred (Smith, 1968), and the more toxic oil from *Amoco Cadiz*, when sunk to the bottom caused mortalities at least as far east as the Rade de Morlaix (Cabioch *et al.*, 1980).

These trends have affected either the central and eastern Channel or have been confined to coastal waters in the western Channel. It might appear that fluctuations in the western Channel offshore benthos are still related, as in the past, to hydrographic and biological conditions at the mouth of the channel and are still largely unrelated to man's activities.

However there is one further factor, which may be having an increasing effect on the benthos in the western Channel, as elsewhere. This is the effect of heavy fishing gear (heavy chains on trawls used for catching soles, toothed scallop dredges) on the sea bed. Apart from fish or shellfish captured, or damaged without being caught, the bottom is disturbed so that invertebrates are brought to the surface of the sediment where they are promptly devoured by predators of all kinds, so diminishing sources of future fish food. In addition hydroid and bryozoan colonies rooted in the sand are dislodged. These form an important nursery area for small crustaceans etc., and are the surfaces to which young queens (*Chlamys opercularis*) attach themselves. It seems that man-made influences could in time become paramount in determining the nature of the bottom fauna in the more heavily fished parts of the western Channel.

Figure

Map of the western English Channel. ▨ *; areas within which* Ophiothrix *beds have been recorded over the past 90 years.* • *; location of statistical rectangles (6' longitude × 3' latitude) in which* Luidia ciliaris *has been recorded since 1968.*

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