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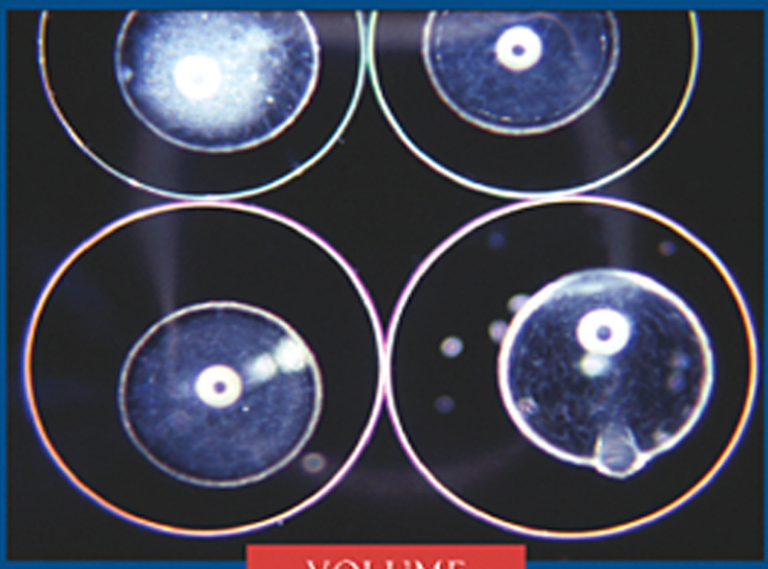
Advances in MARINE BIOLOGY



VOLUME
47

Series Editors
A J Southward, P A Tyler,
C M Young and L A Fuiman

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MARINE BIOLOGY

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Advances in MARINE BIOLOGY

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Long-Term Oceanographic and Ecological Research in the Western English Channel

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ADVANCES IN MARINE BIOLOGY VOL. 47
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Long-term research in the western English Channel, undertaken by the marine laboratories in Plymouth, is described and details of survey methods, sites, and time series given in this chapter. Major findings are summarized and their limitations outlined. Current research, with recent reestablishment and expansion of many sampling programmes, is presented, and possible future approaches are indicated. These unique long-term data sets provide an environmental baseline for predicting complex ecological responses to local, regional, and global environmental change.

Between 1888 and the present, investigations have been carried out into the physical, chemical, and biological components (ranging from plankton and fish to benthic and intertidal assemblages) of the western English Channel ecosystem. The Marine Biological Association of the United Kingdom has performed the main body of these observations. More recent contributions come from the Continuous Plankton Recorder Survey, now the Sir Alister Hardy Foundation for Ocean Science, dating from 1957; the Institute for Marine Environmental Research, from 1974 to 1987; and the Plymouth Marine Laboratory, which was formed by amalgamation of the Institute for Marine Environmental Research and part of the Marine Biological Association, from 1988. Together, these contributions constitute a unique data series—one of the longest and most comprehensive samplings of environmental and marine biological variables in the world. Since the termination of many of these time series in 1987–1988 during a reorganisation of UK marine research, there has been a resurgence of interest in long-term environmental change. Many programmes have been restarted and expanded with support from several agencies.

The observations span significant periods of warming (1921–1961; 1985–present) and cooling (1962–1980). During these periods of change, the abundance of key species underwent dramatic shifts. The first period of warming saw changes in zooplankton, pelagic fish, and larval fish, including the collapse of an important herring fishery. During later periods of change, shifts in species abundances have been reflected in other assemblages, such as the intertidal zone and the benthic fauna.

Many of these changes appear to be related to climate, manifested as temperature changes, acting directly or indirectly. The hypothesis that climate is a forcing factor is widely supported today and has been reinforced by recent studies that show responses of marine organisms to climatic attributes such as the strength of the North Atlantic Oscillation.

The long-term data also yield important insights into the effects of anthropogenic disturbances such as fisheries exploitation and pollution. Comparison of demersal fish hauls over time highlights fisheries effects not only on commercially important species but also on the entire demersal community. The effects of acute (''Torrey Canyon'' oil spill) and chronic (tributyltin [TBT] antifoulants) pollution are clearly seen in the intertidal records.

Significant advances in diverse scientific disciplines have been generated from research undertaken alongside the long-term data series. Many concepts in marine biological textbooks have originated in part from this work (e.g. the seasonal cycle of plankton, the cycling of nutrients, the pelagic food web trophic interactions, and the influence of hydrography on pelagic communities). Associated projects currently range from studies of marine viruses and bacterial ecology to zooplankton feeding dynamics and validation of ocean colour satellite sensors.

Recent advances in technology mean these long-term programmes are more valuable than ever before. New technology collects data on finer temporal and spatial scales and can be used to capture processes that operate on multiple scales and help determine their influence in the marine environment. The MBA has been in the forefront of environmental modelling of shelf seas since the early 1970s. Future directions being pursued include the continued development of coupled physical-ecosystem models using western English Channel time-series data. These models will include both the recent high-resolution data and the long-term time-series information to predict effects of future climate change scenarios. It would be beneficial to provide more spatial and high-resolution temporal context to these data, which are fundamental for capturing processes that operate at multiple scales and understanding how they operate within the marine environment. This is being achieved through employment of technologies such as satellite-derived information and advanced telemetry instruments that provide real-time in situ profile data from the water column.

1. INTRODUCTION AND HISTORICAL BACKGROUND

The western English Channel is in a boundary region between oceanic and neritic waters. It also straddles biogeographical provinces, with both boreal/cold temperate and warm temperate organisms present. Thus it is not surprising that there has been considerable fluctuation of the flora and fauna in the area since formal scientific work began in the late nineteenth century. This review outlines the long-term research that has been conducted

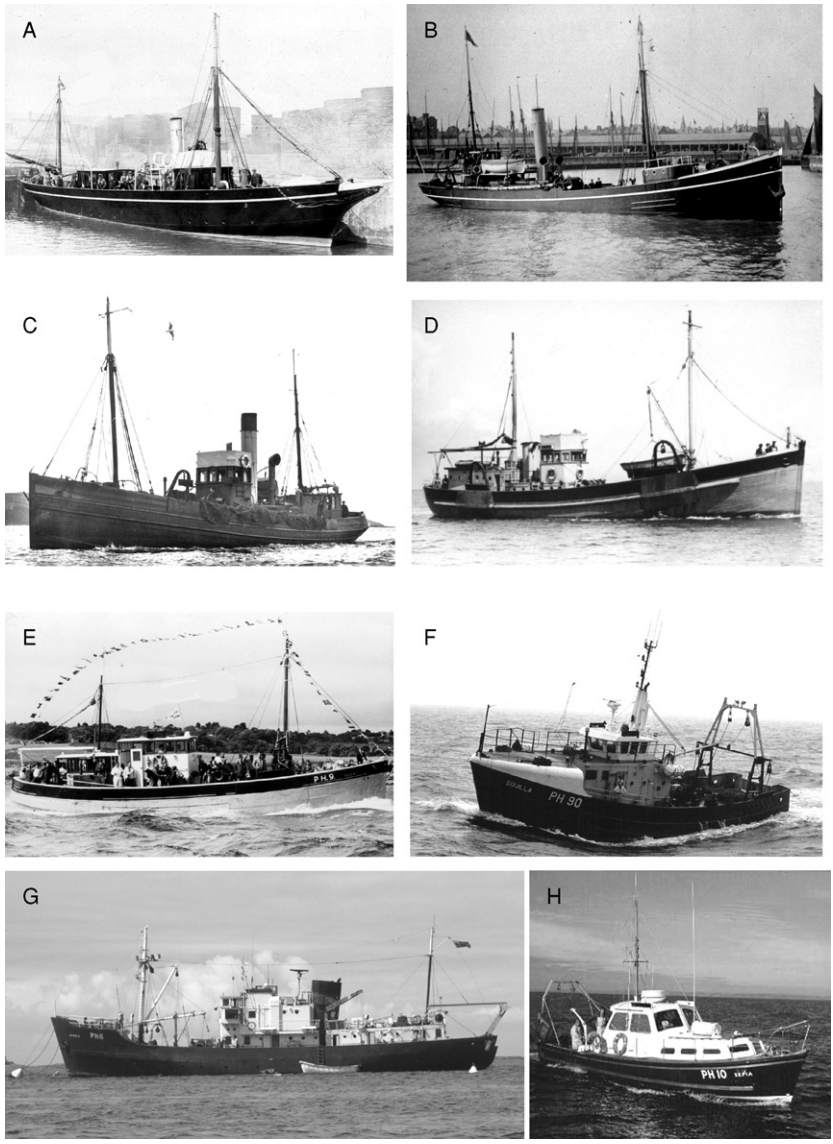

Figure 1 The Plymouth research vessels that have carried out chemical and physical work in the western English Channel and sampled plankton, fish, and benthos for the long-term studies. (A) the ocean-going steam yacht *Oithona*, 83 ft (26 m) long, undergoing conversion in Millbay Docks in 1901, sampling from 1902 to 1921; (B) the 115-ft (36-m) North Sea steam trawler *Huxley* that sampled from 1903 to 1909; (C) the 88-ft (27-m) ex-Naval steam drifter/trawler *Salpa*, that sampled from 1921 to 1939; (D) the 90-ft (28-m) motor fishing vessel *Sabella*, leased from the Navy,

in the western English Channel by the laboratories in Plymouth, the Marine Biological Association of the United Kingdom (MBA), the Institute for Marine Environmental Research (IMER), the Plymouth Marine Laboratory (PML), and the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), whose efforts complement one another. After the historical background is summarized, data held at Plymouth are described, and details of survey methods, sites, and time series are given. Major findings from long-term studies are summarized, and their limitations are outlined. Current research, with the recent resurgence and expansion of many sampling programmes, is presented, along with future approaches, illustrating how these important and unique data can aid in understanding and predicting complex ecological responses to a changing environment. The review outlines the historical development of ideas and techniques and also charts the vagaries of research funding priorities that have fluctuated as much as the ecosystem itself.

Investigation of the western English Channel began when the Plymouth Laboratory of the MBA was opened in 1888. A condition attached by the U.K. Government to substantial financial aid given in the foundation years of the MBA stated that researchers should "aim at practical results with regard to the breeding and management of food fishes" (Southward, 1996). Hence, even before the MBA laboratory building was completed, studies were initiated on the eggs and larval stages of many fish species (Cunningham, 1892a,b,c,d,e,f; Lankester *et al*., 1900; Garstang, 1903), and there was a study of mackerel that involved bringing over fresh Boston mackerel, in the fast transatlantic passenger ships that then called at Plymouth, for comparison of their meristic characters with the various European races that were also assessed (Garstang, 1898). Although much preliminary work was carried out with the 60-ft (19-m) "Busy Bee" from 1895 to 1901, systematic collection of data on zooplankton, including fish eggs and larvae, became easier when the MBA obtained reliable vessels capable of venturing into open waters (Figure 1): first *Oithona* in 1902, then *Huxley* in 1903 (Garstang, 1903; Southward, 1996). These vessels were used to carry out exploratory surveys of the southern North Sea, the English Channel, and the continental shelf

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that sampled from 1946 to 1953; (E) the 60-ft (19-m) ex-Naval motor fishing vessel *Sula* that sampled from 1948 to 1972, seen here winning her class at the Brixham trawler race in 1971; (F) the 60-ft (19-m) trawler *Squilla* that sampled from 1973 to 2003, seen here from *Sarsia* on a joint fishing operation in October 1979; (G) the specially designed 128-ft (39-m) *Sarsia* that sampled from 1953 to 1981, seen here on a visit to the Roscoff Laboratory in Brittany in 1978; (H) the 42-ft (13-m) fast motor launch *Sepia* that sampled plankton from 1968 to 2004, seen in 1979. There was a converted trawler, *Frederick Russell*, 143 ft (44 m), in use by the Marine Biological Association from 1981 to 1982, as a replacement for *Sarsia*, but it was converted to general oceanographic research in 1982 and was not available for time series work off Plymouth afterward. Photos from Marine Biological Association archives.