Journal of the Marine Biological Association of the United Kingdom

cambridge.org/mbi

Review

Cite this article: Dando PR, Southward EC (2020). The history of the *Journal of the Marine Biological Association of the United Kingdom* and the influence of the publication on marine research. *Journal of the Marine Biological Association of the United Kingdom* **100**, 3–26. https://doi.org/10.1017/S0025315419001000

Received: 17 May 2019
Revised: 1 October 2019
Accepted: 17 October 2019
First published online: 19 December 2019

Key words:
Biodiversity; environmental change; marine chemistry; marine ecosystem; marine pollution; overfishing; physical oceanography; physiology; sampling methods

Author for correspondence:
Paul R. Dando, E-mail: pdando@MBA.ac.uk

The history of the *Journal of the Marine Biological Association of the United Kingdom* and the influence of the publication on marine research

Paul R. Dando and Eve C. Southward

Marine Biological Association of the United Kingdom, Plymouth, UK

Abstract

The origin and development of the *Journal of the Marine Biological Association of the United Kingdom* is described on the occasion of the publication of the 100th volume. Papers in the Journal demonstrate how the techniques and approaches to the study of the marine environment have evolved over the 120 years of publication. The early papers provided a baseline description of the marine environment and of marine communities that allowed the effects of later perturbations of the environment to be determined. Both the early papers and the long time series of records have proved to be particularly relevant as marine scientists try to predict the long-term results of climatic and anthropogenic effects on the marine ecosystem. The Journal has now become increasingly international, with most papers coming from outside Europe.

Introduction

A brief account of the history of the *Journal of the Marine Biological Association of the United Kingdom* (JMBA) was published to coincide with 100 years since the publication of the first issue (Spooner *et al.*, 1987). The present paper updates this account and reviews the influence that articles in the JMBA have had on disseminating the results of marine research. The selection of topics covered has had to be limited and the authors regret that it has not been possible to mention all the important papers published in the JMBA.

The Marine Biological Association of the United Kingdom (MBA) was conceived following debates, at the 1883 International Fisheries Exhibition in London, as to whether the major fisheries were inexhaustible or whether catches were already declining, in some areas, due to overfishing (Southward & Roberts, 1984). Prof. E. Ray Lankester, then at University College, London, appealed for the formation of a society to study marine life, including the habits and life-histories of food fishes. He organized an initial meeting at the Linnean Society in London to consider a proposal to establish a marine laboratory for the joint purpose of encouraging the study of marine zoology and making a scientific study of questions relating to sea fisheries (Lankester, 1887*a*, 1887*b*; Bourne, 1930). The MBA was formed at a meeting held at the Royal Society in London in March 1884. Construction of a laboratory in Plymouth commenced in February 1887, with the building opening the following year (Southward & Roberts, 1984).

Development of the journal

Remit and production of the JMBA

The JMBA was established in 1887, initially to inform members of the MBA of reports on the work of the Association and also of records of observations relating to the marine biology and fisheries of the coasts of the UK: fishermen and naturalists were invited to contribute (Lankester, 1887*a*). The first two numbers, of what is now called the 'Old Series' (OS), were published in August 1887 and August 1888. The first number contained a list of members of the MBA, an account of the formation of the Association and a description of the Laboratory, as well as an account of the local fishing grounds and fishing industry (see Figure 1; Heape, 1887).

G.C. Bourne, the first Director appointed, wrote that the JMBA was intended 'to supply scientific information in an easily comprehensible form to those who are interested in marine fisheries' as well as accounts of animal or vegetable morphology (Bourne, 1889). Bourne wrote 'the Journal will be issued from time to time, according to the amount of work ready for publication, and will contain, besides the memoirs alluded to, abstracts of the scientific work done by the naturalists hiring tables in the Laboratory, notes and correspondence from other fishery and marine stations, abstracts of the most important results obtained by the fisheries commissioners of various Governments, and any correspondence addressed to the editor for publication'.

Since the early years, papers in the JMBA showed an appreciation of how the biota differed according to the origin of the water mass (Cleve, 1897). Papers were encouraged on 'all aspects of marine biology and oceanography'. This broad remit continued until recent years when it

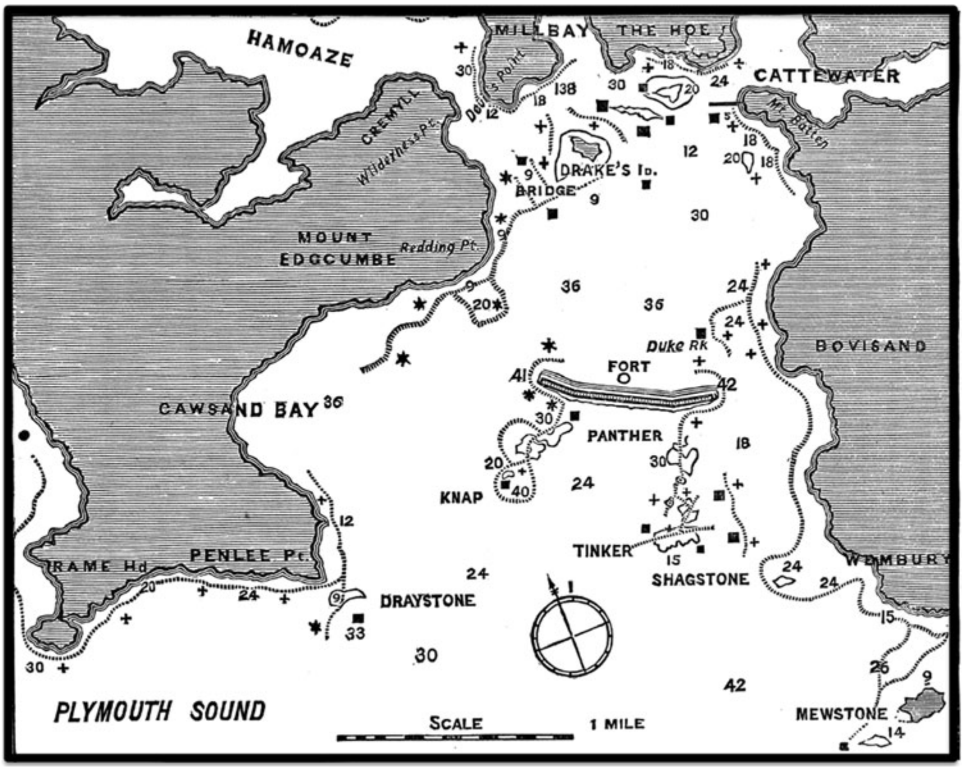

Fig. 1. From Heape (1887), original legend: 'Fishing Map of Plymouth Sound, after map published in G. and R. Books 'General Guide to Sea Fishing' No. 5. The depth is marked in feet thus 30. The best places to fish for pollock, bass and mackerel are shown by the dotted line. The crosses show places to fish in ebb tide. The stars show places to fish in flood tide.'

was stated, in 1996, that 'the primary topics covered are: (a) ecology, behaviour and fisheries; (b) physiology, ecotoxicology and biochemistry; (c) molecular, microbiology and genetics; (d) oceanography, satellite imagery and modelling'.

One of the duties of the Director under bye-law 14 was to 'prepare and edit the Journal' (Marine Biological Association, 1889). This duty was subsequently expanded in by-law 15 to 'prepare and edit the publications of the Association'. This wording was continued in the Memorandum and Articles of the Marine Biological Association of the United Kingdom from 1927 and subsequent revisions in 1945, 1971 and 1995. With the increasing number of papers published in the JMBA it became impractical for the Director to edit the JMBA along with the other required duties. The 2003 revision of the Memorandum and Articles, by the then Director and Secretary, S.J. Hawkins, therefore changed the wording to 'oversee the preparation and editing of the publications of the Association in liaison with the Editorial Board'. This wording is also used in the current Regulations and Rules of the Association, following the incorporation by Royal Charter in November 2017 (Marine Biological Association, 2017). As the editorial work increased, an Executive Editor was appointed to do a lot of the editorial work and subsequently the Director was replaced as Editor by an Editor-in-Chief who was responsible to the Director. A list of the editors, executive editors and Editors-in-Chief, with dates, is given in Table 1.

Illustrations

The early illustrations in JMBA were drawings that were engraved onto printing plates and published as plates inserted following the individual articles. For example, Cunningham (1889) made camera lucida drawings, of fish eggs and larvae, that were converted into printing plates by Glyptographie Silvestre et Cie, Paris. In this early period, commercial cameras and photographic materials were being improved rapidly, making photography simpler and quicker for the amateur as well as the professional. Half-tone photographs and simple drawings were inserted into the text pages (Browne, 1898) while more detailed drawings and collotype plates of photographs were inserted at the end of the paper as plates (e.g. Browne, 1898, 1907), as in other scientific publications of the period; an example is shown in Figure 2. Line drawings still remained the dominant mode of illustration. Marie Lebour, for example, published 67 papers on the planktonic larvae and biology of marine fishes and invertebrates in JMBA from 1916–1954 (available from the PLYMSEA repository), all beautifully illustrated with her own line drawings (e.g. Lebour, 1917, 1923, 1933, 1944). Her 1923 paper (Lebour, 1923) contains delicate drawings, within the text, of living medusae and *Sagitta* capturing fish larvae.

D.P. Wilson had been interested in photography from childhood. He took flash photos, using magnesium powder, of cuttlefish feeding in the aquarium (Wilson, 1946) and developed his own improved lighting systems for microphotography of living larvae and post-larvae, e.g. of the starfish *Luidia* (Wilson, 1978). From the mid 1950s papers using electron microscopy to describe microplankton and sub-cellular structures appeared in the JMBA. Parke and Manton started using the technique to study dinoflagellates (Parke *et al.*, 1955). Over the following 50 years more than 130 papers in the JMBA, on a variety of topics, used electron microscopy in the studies reported.

From 1957 until 1985 the MBA employed G.A.W. Battin as a cartographer and draftsman. He standardized and improved the presentation and lettering of many of the figures published in the JMBA over this period (e.g. Newell, 1967) and drew plans of the MBA Laboratory 1963 (Russell, 1963).

Hand-coloured illustrations were occasionally used in earlier years (e.g. Parke 1949) but colour photographs or computer diagrams were introduced regularly in the online version of papers from volume 82 (2002). Authors were given the option

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

Table 1. Editors, Editors-in-chief* and Executive Editors of the JMBA since its formation (** Acting Editor)

Editor/(*Editor-in-chief)	Dates
E. R. Lankester	1887–June 1888
G. C. Bourne	June 1888–August 1890
W. L. Calderwood	1890–January 1893
E. J. Bles	April 1893–October 1894
E. J. Allen	January 1895–September 1936
S. W. Kemp	October 1936–May 1945
F. S. Russell	August 1945–1965
J. E. Smith	1965–1974
E. J. Denton	1974–July 1987
J. V. Howarth	1972–March 1991
M. Whitfied	August 1977–March 1991
P. E. Gibbs*	February 2002–March 2009
P. E. Gibbs* & P. R. Dando*	April 2009–December 2009
P. R. Dando*	January 2010–June 2011
M. C. Thorndyke*	January 2013–May 2017
C. L. J. Frid**	June 2017–November 2017
J. Lewis*	December 2017 to date
Executive Editors	
F. S. Russell	1936–1939
G. M. Spooner	1945–1972
J. V. Howarth	1972–July 1977
P. E. Gibbs	August 1977–December 1978
J. V. Howarth	January 1979–February 1990
L. Maddock	March 1990–April 1995
A. L. Pulsford	May 1995–December 2015

of paying for them in the printed issue, although coloured illustrations in the online versions were free. One problem was that some colour figures were converted to grey-scale for the printed version without checking that differences in the shading were clear.

Printing and appearance of the JMBA

The JMBA has been published in all except two years since 1887. The number of pages of scientific papers printed each year has steadily increased, with the exception of the war years, from <300 prior to 1904 to >500 in 1926 and 1927 and to >1700 since 2008 (Figure 3A). Initially, only one or two issues each year were published, with the exception of 1902 and 1905, when no issues were published and 1906 and 1930 which each had 3 issues. With the post-WWII expansion of marine research the number of issues a year was increased to 3 from 1951 and increased again to 4 from 1969 and to 6 from 1999. Eight issues a year, the current number, were printed, starting in 2008. Similarly the number of scientific papers published each year has increased from 6 in 1900 to over 170 today (Figure 3B).

As the number of submissions increased, an editorial board was introduced to help in handling the submissions. By 1988 there was an editorial board of 12, drawn from eight countries. Currently the editorial board consists of eight individuals with an additional 34 associate editors drawn from 16 countries in total, reflecting the increased number of submissions and their broad international origin.

The journal was initially printed for the MBA by Adlard & Son, Bartholomew Close, London. This company continued printing the journal until 1897, volume 5, when the printing was transferred to William Brendon and Son, Mayflower Press, Plymouth. It was transferred again to Brook Crutchley, the printers for Cambridge University Press, in November 1937 (volume 22).

From the third number of the Journal, volume 1 of the New Series in 1889, the page size was increased to Royal Octavo to facilitate the preparation and appearance of illustrations. In November 1937 the page width was increased to allow for larger plates and figures. Following an increase in printing costs, the page margins were reduced to increase the amount of print on the page. The page width remained unchanged until February 2000, when the page size was increased to A4.

The Annual Council and Financial Reports for the MBA were published in the journal until 1992. From 1993 onwards they were issued as separate documents, freeing up more space in journal issues for scientific papers. The Annual Council Reports contained a summary of the work that scientists at the MBA had done during the year and contained advance publication of key results, as well as containing notes on observations on species and reports on scientific results that were not later published in the JMBA. For example, nearly all the neurophysiology studies conducted in the MBA Laboratory were published in the *Journal of Physiology* and elsewhere, although the key findings appeared in the Council Reports. In addition, abstracts of memoirs recording research carried out by researchers at the MBA Laboratory in Plymouth were printed in the JMBA from 1971 until 1980.

Changes in the appearance of the front cover of the journal over the years are illustrated in Figure 4. The original cover was pale blue, with an engraving of the MBA Laboratory, as seen from the sea (Figure 4A). In November 1937, with the transfer of publication to Cambridge University Press, the cover was revised and a new drawing of the MBA Laboratory was used on it. In June 1962, after enlargement of the Laboratory, a new engraving was used (Figure 4B). This continued to be used until 1989 when the cover changed to show a picture of waves breaking on a shore (Figure 4C). From 1999, volume 79, a picture of waves was inset into a black cover (Figure 4D). Coloured pictures were placed on the upper part of the front cover, first for special or themed issues, starting in February 2004 for an issue on 'Biodiversity and distribution of species' (Figure 4E) and from December 2005 onwards for every issue (Figure 4F).

Typesetting for the JMBA was carried out at the MBA from the beginning of 1990 and continued until this was taken over by Cambridge University Press.

Online publication, archiving of papers and online submission

In the 1980s the librarians of the Marine Biological Association scanned the JMBA volumes, from the first issue in August 1887 to volume 40 (1961). The papers were made freely available on the library website as pdf files and these are now available through the PLYMSEA open access repository (http://plymsea.ac.uk/). Subsequently, when Cambridge University Press took over as publisher of the JMBA, these issues were rescanned in early 2009, as were subsequent issues to volume 78 (1998) and made available as the JMBA Archive on the publisher's website (https://www.cambridge.org/core/journals/journal-of-the-marine-biological-association-of-the-united-kingdom/all-issues). The JMBA archive was launched in May 2009 and then comprised over 65,000 pages, 5900 articles and almost 100,000 linked references.

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

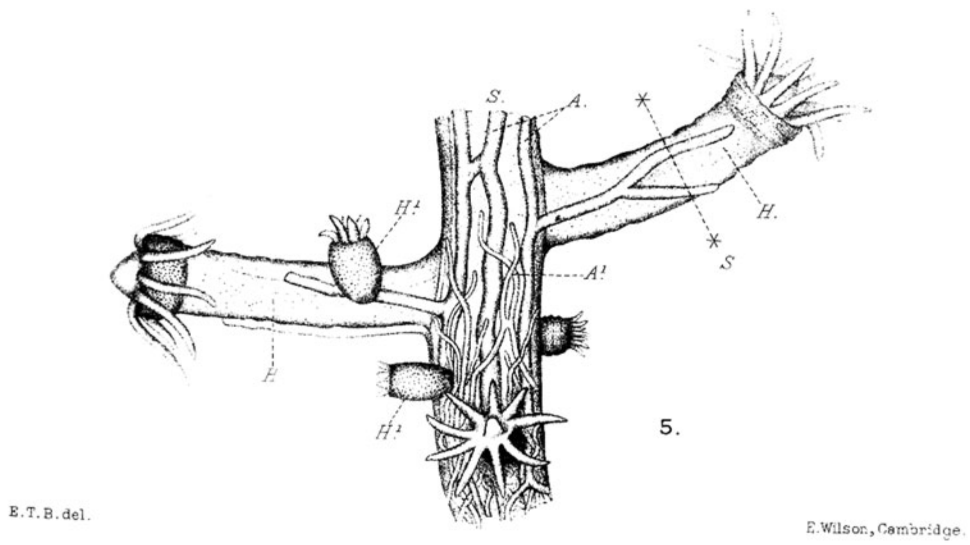

Fig. 2. Line drawing reproduced from Plate I in E.T. Browne (1907). *Bimeria biscayana* n. sp. Portion of a branch drawn to show the arrangement of the hydranths and the auxiliary tubes. [Renamed and re-described as: *Amphinema biscayana* (Browne 1907) by Schuchert (2000).]

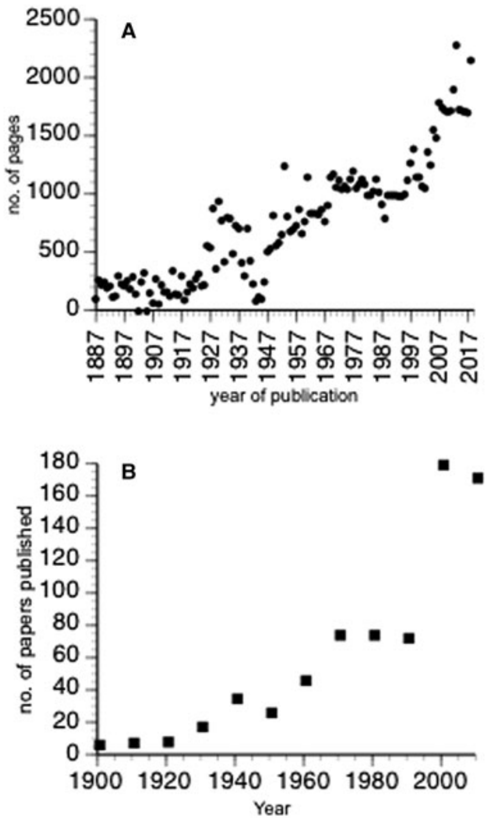

Fig. 3. (A) Number of pages printed in the JMBA in each year since 1887. (B) Number of scientific papers published in the JMBA in the first year of each decade.

In the first year over 9000 pdf files were downloaded from the archive. Whereas papers in the archive on PLYMSEA can be freely downloaded as pdf files, the papers in the Cambridge University Press archive are only freely available, without payment, as title, authors and abstracts for those published post-1990. Most papers published pre-1990 show an extract, usually the first part of the Introduction, in place of the abstract, even if there is an abstract in the full paper.

JMBA papers were made available online, in the same month that the printed publication was issued, starting in August 1999. In 2008 papers started to be put online first, before printed publication.

In October 2005 the MBA set up a new online journal, *JMBA 2 Biodiversity Records* in response to the changing marine and coastal environment and an increasing demand for the documentation of marine organisms in locations where they had not formerly been recorded, as well as of species loss from habitats. Papers were published on the JMBA section of the MBA website. In 2008, Cambridge University Press took over this new journal, renaming it *Marine Biodiversity Records* (MBR) and hosting it on the Press website, making access free for subscribers to the JMBA. In January 2016 it was re-launched as the MBA's first online Gold Open Access Journal with Biomed Central (Springer-Nature) as the new publisher. The launch of these journals allowed more space in the JMBA for longer papers.

Online submission, using the ScholarOne system, was introduced for the JMBA (as well as for MBR) by Cambridge University Press in February 2009. The start did not go well. Manuscripts were returned to authors who had not submitted them via the new system, but had followed the, still-existing, instructions on both the MBA and Cambridge University Press websites. These stated that manuscripts should be sent as email attachments or copied onto a CD and posted.

In 2013 it was decided to make JMBA a 'hybrid journal' providing authors, upon acceptance of their article, with the option to pay an article processing charge for Gold Open Access publication. In 2018, 4.5% (10 of 222) scientific articles were open access, excluding editorials, forewords and corrigenda.

Reviews and special issues

Since the early years the JMBA has published occasional reviews. These were originally aimed at informing UK marine scientists of fishery practices, observations and research overseas, such as an account of the Newfoundland and Labrador fisheries (Grenfell, 1894), fishery research in the USA (Cunningham, 1894*b*), a report on flatfish research in Denmark (Stead, 1896) and studies on the Norwegian fisheries (Garstang, 1897). Subsequently many reviews have been aimed at an international readership, e.g. on the distribution of medusae species across the oceans (Kramp, 1961), the photon flux required for photolithotrophs (Raven *et al*., 2000), the worldwide migration of humpback whales (Rizzo & Schulle,

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

Fig. 4. JMBA covers. (A) First issue (old series) cover; (B) cover from June 1962 showing the enlarged laboratory; (C) cover from 1989; (D) cover from 1999; (E) first coloured cover (February 2004): (F) typical cover from December 2005.

2009) and the reproduction and dispersal of invertebrates at vents and cold seeps (Tyler & Young, 1999).

The JMBA has published a number of Special, or Themed issues and of issues, or issue sections, with Conference Papers (Table 2). Of particular note are the special issues, between 2007 and 2018, containing papers on cetaceans presented at annual meetings of the European Cetacean Society.

Three compilations have been published of all papers, including those in JMBA, of work that was done at the MBA. The first covered the years 1886–1913 (Anonymous, 1913), the second updated this to 1927 (Russell, 1928) and the third covered the period 1928–1950 (Russell, 1952).

The origin of published papers

Until about 1960, papers from the MBA staff and other scientists who carried out their research at the MBA, as well as members of the MBA, were prioritized for publication (Spooner *et al*., 1987). Since the 1960s the JMBA has been open to submissions globally and this is reflected in the increased numbers of papers (Figure 3B) as well as the change in the sources of published papers (Figure 5). Figure 5 allocates papers, published in the first year of each decade, as far as possible, to those carried out by MBA scientists, or by visiting scientists, at the MBA laboratories; those from the rest of the UK; those from Europe and those from other areas of the world. Papers were allocated to the region where most of the research was undertaken. Until the late 1960s, papers on work carried out at the MBA made up ~50% or more, of published papers. MBA scientists were then encouraged to publish in a wider range of journals and their submissions to JMBA sharply decreased. Subsequently, over 50% of papers published were from other UK laboratories until 2000 when papers from other European laboratories dominated publications in the journal. By 2010 the number of papers from South and Central America made up 30% of the total, reflecting the increase of marine laboratories and research activity in countries south of Mexico, with an increasing number also coming from Asia.

Although the JMBA has not one of the highest citation rates of marine biology journals, currently with an impact factor of 1.578, it is one of only four with a citation half-life of >10 years (Fuseler-McDowell, 1988) and has kept this long citation half-life since the Science Citation Index started in 1964. This underlines

Table 2. List of Special/Themed issues and issue sections with Conference Papers in the JMBA

Issue Title	Date(s)
Synopsis of the Medusae of the world	November 1991
R.R.S. Discovery Cruise 105	February 1992
Developmental biology of marine organisms	February 1994
The behaviour and natural history of cephalopods	May 1995
Marine biodiversity: causes and consequences	February 1996
Biodiversity and distribution of species	February 2004
Assemblages, biotopes and communities	June 2004
Feeding, breeding and distribution	August 2004
Alien and invasive species, Polychaetes	October 2004
Environment and climate change	December 2004
Xenobiotics, reproduction and development	February 2005
Gelatinous zooplankton	June 2005
Global biodiversity	August 2005
Sharks, rays and fishes	October 2005
	April 2006
Aquatic viruses	June 2006
Cetaceans	February 2007 & August 2009
Marine mammals	September 2008, December 2010, December 2012, September 2014, June 2016, August 2018
Hydrozoans	December 2008
In honour of Sir Frederick Stratten Russell, FRS	September 2010
Biodiversity and taxonomy	March 2011, August 2012
Fish ecology	September 2011
Coral reefs, the aquarium trade and the maritime industry	June 2012
Fish and fisheries	March. 2013
North Atlantic killer whale research	September 2014
Deep-sea sponges	November 2015
European Marine Biology Symposium	February 2015, December 2015, June 2016, May 2017, February 2018, December 2018
Oceans and human health	February 2016
Proceedings of the 9th World Sponge Conference	March 2016
Ascension Island	June 2017
Proceedings of the 12th International Polychaete Conference August	August 2017

the long-term value of so many of the publications in the JMBA. The 10 most cited papers in the JMBA during the first 60 years of publication are listed in Table 3 and the 10 most cited papers subsequently are listed in Table 4. In the first period, four of the 10 papers were on macroalgae whilst in the latter period four of the 10 were pollution-related.

The JMBA has been of particular use to the MBA Library (now the National Marine Biological Library) since copies have been exchanged for periodicals and annual reports from other institutions. This journal exchange was very important in the early years of the Library, but had declined to exchanges with 119 partners in 2014 and to 59 in 2019. The decrease being due to an increasing number of journals and reports becoming available online.

The influence of JMBA papers on marine research

Sampling methods and techniques

Studies on the distribution of marine organisms require reliable and repeatable sampling methods. Key equipment originally described in the JMBA included the improved plankton indicator (Hardy *et al.*, 1936) that developed into the continuous plankton recorder (Reid *et al.*, 2003). Plankton net tows at higher speed could be improved by fitting a front cone to reduce the entry area and improve filtration (Southward, 1970). Studies on the vertical distribution of plankton (Russell, 1926) required accurate depth-related sampling and stimulated the development of opening and closing mid-water nets (Russell, 1925; Baker *et al.*, 1973). A comparison of catches, made using nets of different mesh sizes, with those using a plankton pump were reported (Pyefinch, 1949), with the pump being considered best for quantitative sampling. Other net designs described included a neuston net (David, 1965) and mid-water trawls with lights to attract fish and cephalopods (Clarke & Pascoe, 1985, 1998). Mobile deep-sea benthic carnivores can also be effectively observed using baited camera landers, with baited traps used to recover fauna in depths of >9000 m (Jamieson *et al.*, 2012).

Early attempts at enumerating bacterial numbers in seawater samples relied on culture techniques (Lloyd, 1930). From 1970 onwards, epifluorescence techniques were used for direct counts, with acridine orange or DAPI as the fluorochrome (Turley & Hughes, 1994). Latterly, flow cytometry has been used to automate counts (Zubkov *et al.*, 2007).

For sampling benthos, new grabs were described for both gravel and mud bottoms (Smith & McIntyre, 1954; Hunter & Simpson, 1976). An adaptation of the Van Veen grab to fit a video camera allowed targeted sampling of the bottom (Mortensen *et al.*, 2000). New deep-sea benthic species were described from hauls taken by a modification of the early anchor dredge (Forster, 1953). This was later developed into a heavier instrument that could dig-in, whichever side landed up (Holme, 1961). Heavy, MBA-designed, anchor dredges were first used on the continental slope in the 1950s, resulting in the discovery of many new species, including Pogonophora, i.e. gutless frenulate siboglinid tube-worms (Southward & Southward, 1958*a*).

Collection and observation of sub-littoral organisms by divers dates back to 1893, when Boutan (1893) employed a diver to take underwater photographs. Lyle (1929) published, in the JMBA, an account of seaweed distribution on the vertical faces of wrecks in Scapa Flow, using a professional diver to collect samples. Kitching *et al.* (1934) described a diving helmet, supplied with air pumped from the surface, that allowed a team of naturalists to survey the fauna of a sub-littoral gulley with near-vertical walls. A lack of insulated suits limited dives to ∼15 minutes because of low water temperatures. Bainbridge (1952) observed the behaviour of zooplankton, using a facemask and regulating valve with air fed from a compressed air cylinder on the shore or on a boat.

After WWII, self-contained underwater breathing apparatus (scuba) became more available and studies made with their aid

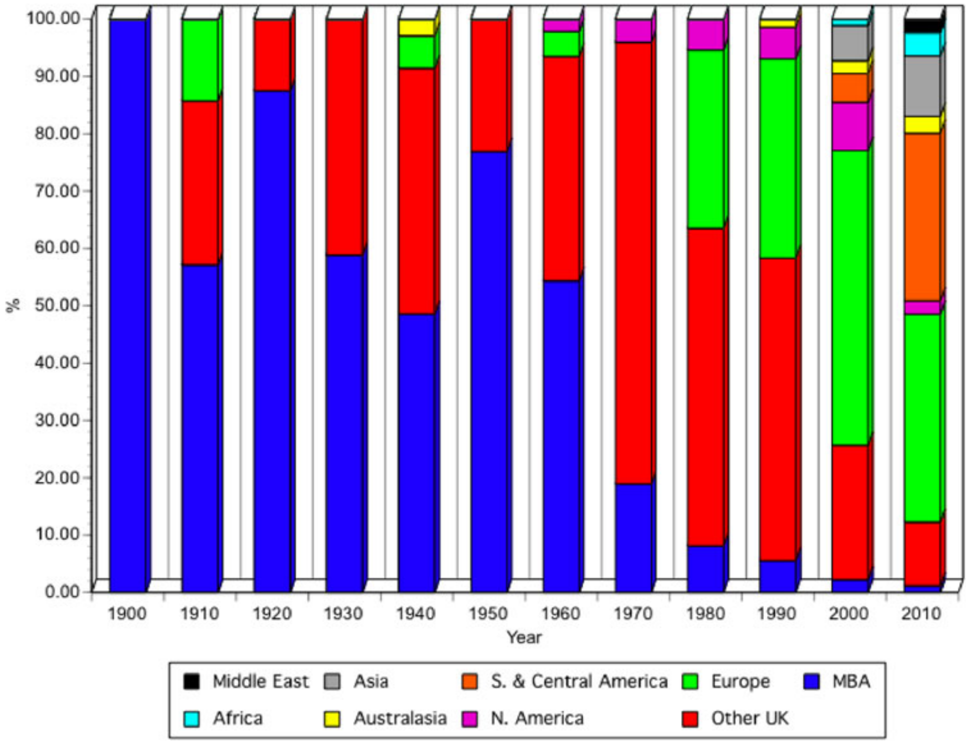

Fig. 5. Percentage of papers published in the JMBA, from the MBA, the rest of the UK or different regions of the world, in the first year of every decade, starting from 1900. North America includes Mexico.

started to be published in the JMBA in the 1950s. Forster (1954, 1959) used scuba to descend to 24 m to observe the biota of rock faces and to study grazing by *Echinus esculentus*. Papers, recording specimens observed and collected by scuba diving, were also published on the distribution of sub-littoral algae around the Isle of Man (Kain, 1960) and on the geology of the English Channel (Phillips, 1964).

Diver-operated equipment described include plankton nets (Potts, 1976) and a diver controlled epibenthic dredge (Kritzler & Eidemiller, 1972). The use of a still-camera lander to take pictures along a transect for estimating overall epifaunal density was described (Vevers, 1951) and a stereo-camera system for close-up photographs of the seabed on the continental slope was also developed (Southward *et al.*, 1976). McIntyre (1956) compared the efficiencies of the Agassiz trawl, Van Veen grab and still camera for estimating faunal densities on the same grounds. The use of towed video and still camera sleds (Holme & Barrett, 1977) allowed larger areas to be surveyed for epibenthos as well as by fitting a camera to the headline of a trawl (Dyer *et al.*, 1982). For surveys at higher speed, an off-bottom towed camera was described (Blacker & Woodhead, 2009). Cameras and data loggers have also been fitted to large marine organisms to observe feeding behaviour, e.g. turtles (Heithaus *et al.*, 2002).

In recent years, remotely operated vehicles (ROVs) have been used for both sampling (Ramirez-Llodra & Segonzac, 2006; Oliver *et al.*, 2015) and observations of organism behaviour e.g. in squid (Hunt *et al.*, 2000) and leptomedusae (Hidaka-Umetsu & Lindsay, 2018).

Biotope mapping on larger scales is now carried out acoustically, combined with ground-truthing by grabs, underwater video and/or still cameras and trawls (Brown *et al.*, 2004; Foster-Smith *et al.*, 2004). The development of this activity has become increasingly important with the establishment of networks of marine protected areas (MPAs) to ensure that they cover as much biodiversity as possible (Howell *et al.*, 2010). A comparison of modern mapping techniques in the English Channel with previous methods described in the JMBA showed good correspondence (Coggan & Diesing, 2008). For plankton blooms both airborne and satellite mapping techniques have been described (Garcia-Soto *et al.*, 1996).

Many of these sampling methods and survey techniques, first published in the JMBA, are recorded in manuals on benthic sampling (Eleftheriou, 2013), habitat mapping (Coggan *et al.*, 2007) and marine monitoring (Davies *et al.*, 2001).

Molecular approaches to determine genetically discrete populations and cryptic species started with the use of electrophoretic techniques to study protein differences from the 1970s onwards, e.g. in barnacles (Dando & Southward, 1980) and hydroids (Thorpe *et al.*, 1992). From the 1990s PCR techniques allowed nucleic acid differences to be studied alone (Karageorgopoulos & Lewis, 2008) or together with protein differences (Wilding *et al.*, 1999).

Papers in the JMBA suggest that we can improve our knowledge of the past distribution of many species by DNA analysis of historical samples. Methods are now available to identify species in formalin-preserved Continuous Plankton Recorder samples, using PCR of extracted DNA (Kirby & Reid, 2001). This approach has been used to identify the main species responsible for the rise in echinoderm larval numbers in the North Sea from the late 1980s onwards, following a rise in sea temperatures, when larvae of *Echinocardium cordatum* dominated the plankton (Kirby & Lindley, 2005).

Marking and tracking movements of marine fauna

Papers in the JMBA show the evolution of methods of marking marine animals to follow their movements. External tags, secured by ties through the muscle or skin of fish, or the epimeral suture of crabs (e.g. Hartley, 1947; Bennett & Brown, 1983), can be lost or loose tags can be placed on different specimens by fishermen wanting to claim the reward. Described methods to overcome this problem in fish include tattooing numbers on their opercula

Table 3. Top 10 citations in the *Journal of the Marine Biological Association of the United Kingdom* from 1887 to 1956

Year	Author(s)	Title	Citations
1949	Harding	The use of probability paper for the graphical analysis of polymodal frequency distributions.	392
1920	Orton	Sea-temperature, breeding and distribution in marine animals.	228
1929	Poole and Atkins	Photo-electric measurements of submarine illumination throughout the year.	217
1942	Mare	A study of a marine benthic community with special reference to the micro-organisms.	160
1926	Yonge	Structure and physiology of the organs of feeding and digestion in *Ostrea edulis*.	158
1948	Parke	Studies on British Laminariaceae. I. Growth in *Laminaria saccharina* (L.) Lamour.	144
1952	Black and Mitchell	Trace elements in the common brown algae and in seawater.	138
1950	Black	The seasonal variation in weight and chemical composition of the common British Laminariaceae.	138
1951	Gauld	The grazing rate of planktonic copepods.	137
1950	Knight and Parke	A biological study of *Fucus vesiculosus* L. and *F. serratus* L.	127

Table 4. Top 10 citations in the *Journal of the Marine Biological Association of the United Kingdom* from 1957 to present

Year	Author(s)	Title	Citations
1967	Wood *et al.*	Determination of nitrate in seawater by cadmium-copper reduction to nitrite.	689
1986	Bryan *et al.*	The decline of the gastropod *Nucella lapillus* around South-West England: evidence for the effect of tributyltin from antifouling paints.	521
1968	Droop	Vitamin B12 and marine ecology. IV. Kinetics of uptake, growth and inhibition in *Monochrysis lutheri.*	492
1974	Droop	The nutrient status of algal cells in continuous cultures.	398
1987	Gibbs *et al.*	The use of the dog-whelk, *Nucella lapillus*, as an indicator of tributyltin (TBT) contamination.	357
1981	Langdon and Waldock	TThe effect of algal and artificial diets on the growth and fatty acid composition of *Crassostrea gigas* spat.	287
1976	Parke and Dixon	Check-list of British marine algae – third revision.	254
1977	Boyden	Effect of size upon metal content of shellfish.	228
2005	Purcell	Climate effects on formation of jellyfish and ctenophore blooms: a review.	226
1988	Gibbs *et al.*	Sex change in the female dog-whelk, *Nucella lapillus*, induced by tributyltin from antifouling paints.	224

(Stevens, 1976) or by freeze-branding marks on their skin (Dando & Ling, 1980). Branding has also been used to mark starfish (Kurihara, 1998). Marking shelled molluscs by painting numbers or engraving marks on the shells has long been used. The technique has been applied to small juveniles using a code system of coloured dots (Gosselin, 1993). A comparison of methods for marking scallops, *Pecten maximus*, concluded that flexible plastic tags fixed with cyanoacrylate gel was the preferred method (Ross *et al.*, 2001).

The problem with all the above methods is that the animal has to be recaptured to gain information. An advance came with the use of ultrasonic pingers that allowed the tagged individual to be detected underwater using either a directional hydrophone or a fixed array of omnidirectional hydrophones (Green & Wroblewski, 2000; Giacalone *et al.*, 2006). Ultrasonic pingers were used with pressure-sensitive transmitters to study the depth of eels in the water column during migration (Parker & McCleave, 1997). External data storage tags, recording time, temperature and pressure, allowed movements to be calculated after recovery of the tag and showed that movements of thornback rays were much greater than determined from the use of conventional tags alone (Hunter *et al.*, 2005). An improvement was made by inserting the tags in the peritoneal cavity to prevent tag loss (Righton *et al.*, 2007).

Livestock ear tags have been used for marking blue sharks in mark–recapture studies (Stevens, 1976) but this method has now given way to geolocation tags for satellite tracking (Southall *et al.*, 2003), with the advantage that boats are not needed to recover or track the fish. Satellite tracking has also been used successfully for turtles (Hays *et al.*, 1991) and for following migrations and diving behaviour of cetaceans (Corkeron & Martin, 2004; Eskesen *et al.*, 2009).

Microchemical analysis of otoliths is being increasingly used to show the habitats occupied by individuals at different stages during their lives, particularly with anadromous species. A recent example demonstrates that the majority of European eels, *Anguilla anguilla*, spend most of their adult lives in a particular salinity environment, without migrations away from this home range (Arai *et al.*, 2019).

Describing the marine ecosystem

A first task for the MBA, on establishment, was to record the species of marine animals and plants present locally, although much had been done by local naturalists prior to this (Boalch, 1996). In the first issue of the JMBA, the laboratory superintendent described the local fishing industry and the species caught (Heape, 1887). Subsequently the fisheries for the main pelagic species, herring, pilchard and mackerel, were described (Ridge, 1889; Roach, 1890; Calderwood, 1891; Roach, 1891) and research into the spawning and nursery areas, growth rates and fecundity of these species was reported (Ford, 1933; Corbin, 1947; Steven, 1949).

An initial fauna list for Plymouth Sound and the nearby offshore area was produced (Heape, 1888). This formed the basis for assessing subsequent changes in the distribution of species.

Additional lists for species groups, including sublittoral algae (Johnson, 1890), tunicates (Garstang, 1891), oligochaetes (Beddard, 1889), turbellaria (Gamble, 1893) and nemertines (Riches, 1893) were published. A later publication described the meio- and micro-benthos and the methods of sampling these (Mare, 1925). Seasonal changes in micro-plankton (organisms passing through fine nets) were described by Lebour (1917). Baseline data on fish catches in South Devon bays (Garstang, 1903), a major study on the benthos and bottom deposits between Start Bay and the Eddystone (Allen, 1899) and descriptions of the fauna of local estuaries (Allen & Todd, 1900, 1902; Percival, 1929) were published. A detailed study of the distribution of the benthic fauna in the English Channel was undertaken by Holme (1966). Check-lists of British marine algae were published (Parke & Dixon, 1964, 1976) and a check-list of British marine diatoms was published in 1954 and updated in 1974 (Hendey, 1954, 1974). The latter list was later expanded to include freshwater and brackish water species (Hendey *et al.*, 1986). As information on the local fauna accumulated separate fauna lists for the area were published in 1904, 1931 and 1957 (Marine Biological Association, 1904, 1931, 1957).

The breeding seasons, in the Plymouth area, of invertebrate species with planktonic larvae, were studied by identifying the larvae of species and recording their seasonal distribution in the plankton. Similarly, the breeding seasons of fish were established by examining the seasonal distributions of fish eggs and larvae in plankton hauls (Russell, 1973). The papers in the JMBA on the identification of plankton have led to guides on the identification of species, e.g. Russell (1976) and Conway (2015).

Faunal studies on deep-sea species were first published on specimens collected in the Celtic Sea at depths down to 730 m (Bell, 1890; Bourne, 1890) and in northern Biscay at depths down to 810 m (Browne, 1907; Hickson, 1907; De Morgan, 1913). More frequent collections were made in these areas from the 1950s onwards, with the increasing availability of suitable vessels, leading to the discovery of several new species, including sponges and bryozoans (Hayward & Ryland, 1978), corals (Zibrowius, 1974), brachiopods (Atkins, 1959), polychaetes (Southward, 1963) and fish (Forster, 1967). In 2015 the JMBA published a special issue on the results of the International Workshop on Taxonomy of Atlanto-Mediterranean Deep-Sea Sponges (Xavier *et al.*, 2015).

Since the 1990s there has been an increasing number of papers in the JMBA on the distribution, ecology and nutrition of deep-sea hydrothermal vent and cold seep fauna from sites worldwide, including the Atlantic (Gebruk *et al.*, 2000*a*; Stöhr & Segonzac, 2005; Sitjà *et al.*, 2019), the Caribbean (Gracia *et al.*, 2012), the Gulf of Mexico (Maldonaldo & Young, 1998), the Indian Ocean (Herring, 2006), the South Pacific (Short & Metaxas, 2011), Japan (Yamaguchi *et al.*, 2004) and the North Pacific (Southward *et al.*, 1994).

Nutritional studies and the food web

Important early JMBA papers were on the results of studies on the food web. Lebour published papers on the diet of post-larval fish (Lebour, 1918, 1919*a*, 1919*b*) and on the food of planktonic invertebrates, both from the stomach contents of freshly collected organisms and from observations on those given mixed plankton in plunger jars (Lebour, 1922, 1923). Food selection by juvenile fish was observed in aquaria (Lebour, 1919*a*). Much later, integrated studies on the plankton communities revealed the complex temporal relationships between viruses, bacteria, phytoplankton and zooplankton (Rodríguez *et al.*, 2000). Viruses were found to be a major controlling factor on the structure of both bacterioplankton (Hewson & Fuhrman, 2006; Hewson *et al.*, 2006) and phytoplankton (Wilson *et al.*, 2002; Nagasaki *et al.*, 2006) communities.

Early studies off Plymouth were reported on the food of benthic invertebrates from local fishing grounds (Hunt, 1925) as well as on the selection of benthic species as food items by different species of fish in relation to the quantitative abundance of their prey (Steven, 1930). The latter study recognized the problems of organism avoidance of sampling gear and related the behaviour of both the bottom fauna and the fish to explain the observed species differences in diet. Both these publications used aquarium observations of the animals to help explain feeding differences between species. Observations on the behaviour of animals in aquaria were published both as collected notes, e.g. Wilson (1949*b*) and as separate papers on individual species, including angler fish (Wilson, 1937), brachyurans (Lebour, 1944) and holothurians (Fankboner, 1981).

The diets of the main pelagic fish in the area, herring, pilchard and mackerel, were described in JMBA papers. Bullen (1912) found the diet of mackerel changed from the filtration of plankton to sight hunting of larger zooplankton and small fish during the season. Euphausids were a major component of the diet of herrings offshore (Lebour, 1924). In the estuaries herring mainly fed on mysids (Ford, 1928*b*).

The identification of cephalopod species, using 'beaks' (Clarke, 1963) allowed the diets of apex predators to be described from stomach contents. The diets of large marine animals, described in JMBA papers, included those of giant squid (Lordan *et al.*, 1998), albatross species (Seco *et al.*, 2016), blue sharks (Stevens, 1973), otters (Heggberget, 1993), monk seals (Salman *et al.*, 2001) and whales (Lick & Piatkowski, 1998; Santos *et al.*, 2001). Some whales were found to eat a mixture of cephalopod prey or cephalopods and fish while others ate mainly a single cephalopod species (Clarke & Young, 1998). These studies led to a review of niche separation in beaked whale species (MacLeod *et al.*, 2003).

Since the beginning of this century there have been a number of papers in the JMBA on the use of stable isotope data to assess the trophic relationships of organisms including nematodes (Moens *et al.*, 2005), polychaetes (Nithart, 2000), gastropods (Korb, 2003), vent shrimps (Gebruk *et al.*, 2000*b*) and crabs (Tsuchida *et al.*, 2011), ophiuroids (Fourgon *et al.*, 2006), sharks (Estrada *et al.*, 2003), sea lions (Páez-Rosas & Aurioles-Gamboa, 2014) and whales (Mendes *et al.*, 2007). These food web studies also demonstrate the wide geographic coverage of marine biology studies published in the JMBA, covering all the oceans.

Culture of marine organisms

Many papers in the JMBA describe attempts to culture marine phytoplankton, zooplankton, invertebrates and fish larvae. Early attempts were made to rear the larvae of food fishes in order to describe their developmental stages (Cunningham, 1889, 1894*a*, 1894*b*; Garstang, 1900*b*; Jones, 1972), although for the more common species it was possible to follow development stages from observations of the ichthyofauna in the plankton (e.g. Lebour, 1919*c*; Ford, 1922; Demir, 1972; Demir *et al.*, 1985).

These papers, as well as many others, contributed to Russell's identification guide to the eggs and planktonic stages of British marine fishes (Russell, 1976).

A major advance was the development of the plunger jar system by E.T. Browne and the then MBA director, E.J. Allen (Browne, 1898). A glass disc was moved up and down in an inverted bell jar full of seawater, by means of a water-filled bucket, that emptied via a siphon when full. The gentle movement of the water in the bell jar prevented the plankton sinking to the bottom of the vessel. This system allowed medusae and planktonic crustaceans to be kept alive and their behaviour, feeding, food preferences and development studied (Lebour, 1922, 1923). Similar observations were made on echinoderm (MacBride, 1900), fish (Lebour, 1925) and gastropod larvae (Lebour, 1933). The use of plunger jars also allowed planktonic larvae to be reared through metamorphosis so that their species could be identified, e.g. Lebour (1934). These studies and others contributed to texts on embryology (MacBride, 1914; Young, 1990).

From the early issues, the JMBA has published papers on oyster cultivation, from accounts of it in Roman times (Günther, 1897) and descriptions of oyster fisheries (Fowler, 1890) to experiments on rearing larvae to settlement on different algal cultures (Bruce *et al*., 1940). Feeding adult oysters on algal cultures before spawning was found to increase larval numbers and their survival (Helm *et al*., 1973).

It was soon noted that phytoplankton required trace nutrients, such that artificial seawater media produced poor growth (Allen & Nelson, 1910; Allen, 1914). Several species were found to require organic compounds for growth, reviewed by Johnston (1955), including the haptophyte *Isochrysis galbana* Parke (Figure 6). Parke (1949) isolated the latter species from a fish pond. Subsequently high density culture techniques were developed for the species (Kain & Fogg, 1958), which required vitamin B12, as did the diatom *Skeletonema costatum* (Droop, 1955). *Isochrysis galbana* is now the most widely cultured species for rearing bivalve larvae in aquaculture (Helm *et al*., 2004) and *S. costatum* cultures are a good food for several bivalves and crustaceans including juvenile rock oysters (O'Connor *et al*., 1992) and shrimp post-larvae (Gleason & Wellington, 1988). Cultures have been fed to adult *Crassostea gigas* infected by *Alexandrium minutum*, to speed up detoxification (Gueguen *et al*., 2008).

The rotifer *Brachionus plicatilis* Müller was also shown to require vitamin B12 for growth (Scott, 1981). *Brachionus plicatilis* is a good first food for the post-larvae of the flatfish turbot and brill (Jones, 1972). Studies on the diet of post-larval and young juvenile marine fish were reported (Lebour, 1918, 1919*b*, 1920) and have been widely cited, since they provided a basis for deciding the size and type of food organisms that were suitable for different fish species and at different stages of development, e.g. brill and turbot (Jones, 1972) and pilchard (Blaxter, 1969).

Allen & Nelson (1910) described in detail methods for isolating single phytoplankton cells and keeping them in single species cultures. They listed 18 species of diatoms that they had in culture. Parke (1949) maintained six dinoflagellate species in culture at Plymouth, although two were lost as a result of wartime damage to the laboratory. These cultures formed the basis of the MBA Culture Collection, that now has ~400 strains (Marine Biological Association, 2018). Much of the MBA collection formed the basis of the Culture Collection of Algae and Protozoa when it was originally established in Cambridge, before being transferred to the Culture Collection of Algae and Protozoa at the Dunstaffnage Marine Laboratory. The MBA Culture Collection still holds strains of phytoplankton not in culture elsewhere and cultures, used for research and for larval food, are both supplied to, and deposited from, laboratories worldwide, e.g. Williams *et al*. (2016), Taylor & Cunliffe (2017) and Xu *et al*. (2018).

Recording anthropogenic and environmental change

Overfishing

The 130 years since the JMBA was first published have seen many changes in the marine environment and in the distribution of species. Even by 1887 sewage pollution had depleted the number of fish species within Plymouth Sound (Bourne, 1889) and shellfish fisheries in the local estuaries had been badly affected by mine and china clay wastes (Anonymous, 1856; Heape, 1887). One of the early papers considered the statistical evidence that overfishing had reduced stocks (Garstang, 1900*a*). The catch rates, of bottom fish, by vessels were compared, between 1875 and 1898, by converting the fishing power of steam trawlers to 'smack units', i.e. to the daily catch of a deep-sea sailing smack. Garstang concluded, 'that the rate at which sea fishes multiply and grow, even in favourable seasons, is exceeded by the rate of capture'. Unfortunately these words were not heeded and the same unit-effort approach to fisheries statistics has shown a still continuing decline of North Sea fish stocks (Thurstan *et al*., 2010).

Changes in temperature and other climate variables

The early JMBA publications, as well as many others, provided the initial basis from which the effects of both anthropogenic and climate change on the marine ecosystems in UK waters were subsequently detected. Both short-term changes, such as the effect on the benthos of the cold 1928–29 (Orton & Lewis, 1931) and 1962–63 winters (Holme, 1967), and longer-term climatic changes (Southward, 1960; Southward *et al*., 1995; Hawkins *et al*., 2003; Capasso *et al*., 2010; McHugh *et al*., 2010; Mieszkowska *et al*., 2014) have been described, based to a greater or lesser degree on earlier studies published in the JMBA.

It was Cunningham (1906), appointed in July 1887 as the first fisheries naturalist to the MBA, who first noted an alternation between warm-water species and cold-water species in the seas off south-west England, writing 'As the Cornish coasts form the northern limit of the range of the pilchard, it seems possible that in certain periods the drift of warm water from the south extends further to the north, and that the pilchard then extends its wandering – while in other periods the drift of warm water is weaker or takes another direction, and that for this reason the north coast is deserted by the pilchard and visited by the herring' (Cunningham, 1906). Orton (1920) noted that a minimum breeding temperature appeared to be a physiological constant for marine species and that this was one of the ways in which temperature controlled their distribution. Changes in mean seawater temperatures were shown to correlate well with an alternation between pilchard and herring fisheries (Southward *et al*., 1988). Related changes between water temperatures and the distribution of other fish species in the region were reported (Stebbing *et al*., 2002). In the late 1920s the local herring fishery supported 300 vessels working out of Plymouth (Ford, 1928*a*). This fishery collapsed shortly afterwards, during the 1930s (Southward *et al*., 1988), due to a regime shift in the ecosystem in the northern North Atlantic resulting in warmer sea temperatures, leading to colder water species migrating northwards (Drinkwater, 2006).

Similar changes in the distribution of fish post-larvae, a series started by Russell (1930) and followed for almost 50 years (Russell, 1973), showed long-term changes in species and species abundance that correlated with changing climate and water temperatures. Purcell (2005) reviewed the literature on the distribution and abundance of jellyfish and ctenophore species and concluded that ocean warming was a cause of changes in their distributions.

Changes in zooplankton composition, as well as in phytoplankton and zooplankton abundance (Russell, 1973; Robinson & Hunt, 1986) correlated with environmental variables and climatic changes. The observed inter-annual variations in sea surface and seabed temperatures were considered to be due to changes in the atmospheric circulation patterns brought about by changes in the amount of heat received by the Earth from the sun (Maddock & Swann, 1970). Movements of water masses could be tracked by 'indicator' species of zooplankton, such as species of *Parasagitta* and *Calanus* (Russell, 1935; Southward, 1962*a*). Changes in sea surface temperatures in a 150-year time series from the Bay of Biscay and adjacent areas, were correlated

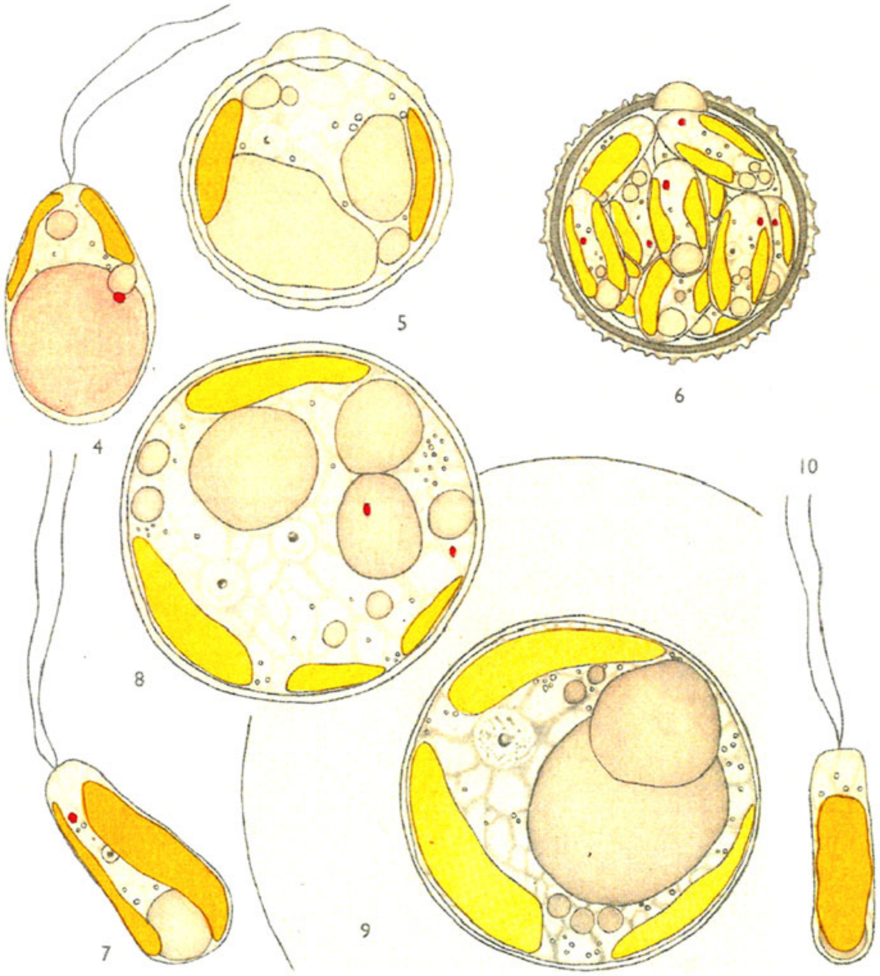

Fig. 6. *Isochrysis galbana* n.g. n.sp., reproduced from Plate 1 of Parke (1949), Figures 4–10, an example of an early hand-coloured illustration. 4, older motile stage; 5, immature cyst; 6, mature cyst; 7, young motile stage with lateral chromatophores; 8, reproduction in the palmelloid phase binucleate stage; 9, reproduction in the palmelloid phase, uninucleate stage; 10, young motile stage.

with the Atlantic Multidecadal Oscillation indices and to changes in the zooplankton in the western English Channel (Garcia-Soto & Pingree, 2012). Patterns in phytoplankton distribution were related to changes in weather patterns (Maddock *et al.*, 1989).

Examinations of the distribution of plankton, benthic invertebrates and fish species require boats, nets and corers, grabs, or cameras, to assess species' occurrence and abundance. A less costly approach to study the effects of physical and chemical environmental changes on the distribution of marine species is to study the distribution of intertidal rocky shore organisms.

A classic, much-cited, early paper describing intertidal zonation at Wembury details the zonation of barnacles and macroalgae on rocks (Colman, 1933). Moore (1936) subsequently examined the zonation distribution of the northern barnacle species *Semibalanus balanoides* and the southern barnacle *Chthamalus stellatus* around Plymouth, in relation to food supply and suspended matter in the water. This distribution study was extended to the British Isles and northern France (Moore & Kitching, 1939). Subsequently, Crisp & Southward (1958) showed that changes in the relative distributions of the two species were correlated with their temperature tolerances (Southward, 1958) and the environmental temperatures that influenced the beat rate of their cirri (Southward, 1957, 1962*b*). A longer-term, 40-year study showed that fluctuations in the relative numbers of *Chthamalus* and *Semibalanus* followed sea temperatures, with a 2-year lag, in a cyclical manner that was close to the 10–11 year sunspot cycle (Southward, 1991). This pattern diverged from the solar cycle after 1975, probably related to major climatic changes (Southward, 1991).

Distribution studies considering other intertidal species were reported by Crisp & Southward (1958). The southern barnacle species *Balanus perforatus* was displaced from many sites by the exceptionally cold winter of 1962–63 but subsequently recovered and colonized sites as much as 100 km east of previous records for the English Channel (Herbert *et al.*, 2003). Studies of these distributional changes in the density and range of intertidal organisms were later expanded to cover the south-west peninsula and subsequently the whole British Isles and nearby Continental European shores. Fifty years of observations on the distribution and densities of intertidal fauna enabled links to be established between faunal changes in the eastern Atlantic intertidal zone and changes in the Atlantic Multidecadal Oscillation (AMO) (Mieszkowska *et al.*, 2014). Historical datasets are proving vital for attempts to predict future changes in littoral ecosystems (Hawkins *et al.*, 2015).

Changes in other environmental conditions

Papers in the JMBA describe the effects of a wide range of natural and anthropogenic effects on the marine ecosystem, including the effects of increased footfall over a rocky shore (Boalch *et al.*, 1974), changes in the benthos resulting from the discharge of china clay wastes (Probert, 1975, 1981) and the effects of eutrophication on infauna and fish (Quillien *et al.*, 2017). Both pre-effect and post-effect surveys have been used to study sites and comparisons of fauna changes along effect gradients used to evaluate impacts. One particularly interesting case was the impact of the infection of seagrasses, *Zostera* species, by a slime mould (Muehlstein *et al.*, 1991).

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

The fauna of the Salcombe estuary were first described by Allen & Todd (1900), including the species inhabiting the *Zostera* beds inside the harbour entrance. In the early 1930s *Zostera* beds started dying on both sides of the Atlantic (Graham & Atkins, 1938). Wilson (1949*a*) examined the dead and dying *Zostera marina* beds near Salcombe that had been surveyed 50 years previously and found a marked decline in both the number of individuals and the numbers of macroinfaunal species, as well as marked changes in sand deposition due to the death of the *Zostera*. In the Tamar estuary, at Plymouth, Hartley (1940), who studied the estuarine fish population in 1936 and 1937, wrote 'in days gone by some of the Saltash men made a living all the year round by catching 'smelts' (*Atherina presbyter*). Now this fish has become so rare that its capture excites comment: I have myself seen only nine specimens in two years' work.' This species spawns in *Zostera* beds (Kennedy & FitzMaurice, 1969), attaching its eggs with long filaments to vegetation and its loss occurred at the time the *Zostera* beds died out. These studies have contributed to our knowledge of the role of *Zostera* beds in the marine ecosystem (Fonseca & Fisher, 1986).

Other major factors affecting the distribution of marine fauna include earthquakes. Although the 2016 Kaikoura quake is perhaps best known for its effects on marine life, no studies on the marine effects of this have been published to date in the JMBA, although changes in the zonation of intertidal biota following the 2011, Mw 9.0, earthquake in east Japan have been described (Noda *et al*., 2016).

Marine chemistry

It was early appreciated that different water masses contained different plankton communities (Cleve, 1897). The chemical composition of seawater, not just the salinity, was related to the species composition, particularly of the phytoplankton (Atkins, 1923*a*, 1923*b*). Harvey (1926), who devised a more accurate method for determining nitrate in seawater, by reduction to nitrite and colorimetric measurement of the nitrite after diazotization, using a Duboscq colorimeter, showed that uptake by phytoplankton removed all nitrate from the upper layers of the sea in summer. Nitrate was thought to be regenerated by vertical mixing with deeper water in winter but Pingree & Pennycuick (1975) showed that significant transfer also occurred through the thermocline. The analytical method for nitrate was refined by several authors but was always difficult to undertake at sea. Finally a more sensitive method was developed, passing water through copperized cadmium filings to convert the nitrate to nitrite (Wood *et al*., 1967). This technique was subsequently adapted for automation, using AutoAnalyzer and submersible FIA systems (Oudot & Montel, 1988; Daniel *et al*., 1995; Zhang, 2000).

Papers in the JMBA also show developments in the measurement of dissolved phosphate in seawater. Early methods required large volumes of water and concentration of phosphate by precipitation, before colorimetric determination as phosphomolybdate (Matthew, 1916). The method was later refined and made more sensitive with a newly designed colorimeter (Harvey, 1948) and a single solution reagent for phosphate determination was subsequently introduced (Murphy & Riley, 1958). A comparative study of the methods of seawater inorganic phosphate analyses was made (Jones & Spencer, 1963). Atkins (1923*a*) used the loss of phosphate from the water column during the year and the phosphate content of phytoplankton, to estimate the annual primary production of the English Channel as 1.4 kg phytoplankton m^{-2} over a water depth of 70 m. A similar production figure was obtained from the change in alkalinity of seawater due to photosynthesis (Atkins, 1922).

The complexity of seawater nutrient studies was revealed by the development of a method for determining total dissolved nitrogen and phosphorus by irradiating seawater with UV from a mercury arc lamp before analysis (Armstrong & Tibbitts, 1968). Analysis over an 11-year period showed that, unlike inorganic nitrogen and phosphate, total N and P changed little over the year (Butler *et al*., 1979). Thus the lost inorganic nutrients were replaced by equivalent organic nutrients that could be utilized by phytoplankton (Harvey, 1940; Antia *et al*., 1975).

Other significant analytical methods published in the JMBA include those for ammonia (Newell, 1967), amino acids (Riley & Segar, 1970), iron (Armstrong, 1957) and silicate (Liss & Spencer, 1969). All the above, as well as other JMBA publications, helped to develop the methods described in later manuals of seawater analysis (e.g. Strickland & Parsons, 1972; Grasshoff *et al*., 1999).

Physical oceanography

In order to understand the movement of pelagic fish eggs it was necessary to understand the drift of surface water. Drift bottles, described by Nelson (1922), that were weighted to make them almost completely submerged just below the surface or to float close to the bottom, were used to follow water movements throughout the year. Surface drift was measured in the English Channel. North Sea and Irish Sea (Garstang, 1898; Carruthers, 1925). In subsequent studies surface and bottom drift bottles were deployed together (Carruthers, 1927). Studies on water temperatures and salinities showed that episodic movements of surface water from the Atlantic into the English Channel occurred (Harvey, 1925). Carruthers *et al.* (1951) examined continuous current meter data from the Seven Stones Light Vessel, situated between Land's End and the Isles of Scilly, for 1939–1941 and found an ESE residual flow of 2.5 miles day^{-1}. Deployment of a satellite-tracked ARGOS float, drogued at 10 m, south of the Isle of Scilly, revealed a residual clockwise current around the islands with a mean speed of 1 m s^{-1} in one circumnavigation (Pingree & Maddock, 1985). Cooper (1952*a*, 1952*b*) studied the effect of winds causing mixing of deep and surface water on the continental slope and the effect of canyons in channelling nutrient-enriched water into the English Channel by means of internal oceanic waves. He explained how similar conditions carried shoals of boar fish, *Capros aper*, well into the English Channel (Cooper, 1952*a*). In 1888 this deep-sea fish was filling the nets of trawlers working off Plymouth (Cunningham, 1888).

Drogued ARGOS floats and neutrally buoyant ALACE floats, that rose to the surface at intervals to allow a satellite fix, were used to follow the path of a 'meddy' (an eddy with a core of high salinity Mediterranean outflow water) starting off the continental slope west of Lisbon (Pingree, 1995). The meddy was followed for 204 days with a mean westward track and had a rotational time of 2.5 days.

A compilation of oceanographic data from the above, and other, studies of the NE Atlantic (Pingree, 2002) revealed the complexities of the circulation system. A number of eddy systems were identified and followed, some of which had wave-like properties. The ARGOS and ALACE floats, together with current meter and shipboard measurements, allowed a correlation with satellite altimeter data of sea level anomalies, such that the altimeter data interpretation of eddies, internal wave and current systems could be verified. Long-term changes from 1992 to 2002 in the North Atlantic Current and the Subtropical Gyre transport were correlated with the winter NAO Index.

On a smaller scale, a study of wave-induced water circulation in sands (Webb & Theodor, 1972) described how dissolved and finely particulate organic matter would be supplied to interstitial

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

microbiota (Meadows & Anderson, 1968) and affect the small-scale distribution of epibenthic organisms.

Physiology and biochemistry

Although studies on the giant nerve axon of cephalopods are the best known of the physiological studies undertaken at the MBA (Sims, 2014), the results were not published in the JMBA, but in journals including *Nature* and the *Journal of Physiology*. A summary of the history of this research was published in the JMBA (Hill, 1950).

A theme of many physiology papers in the JMBA is how marine organisms can sense and respond to changes in the environment, such as temperature, pressure/sound/vibrations, salinity and light. A number of early papers describe the use of conditioned responses of fish to determine their ability to detect changes in temperature, to as little as 0.03°C (Bull, 1936), salinity, vibrations (Bull, 1928) and light wavelengths (Bull, 1935). A mesopelagic deep-sea fish was shown to have different pigments in the part of the retina receiving light from above to the part receiving light from below (Denton & Locket, 1989). Pioneering studies on bioluminescence and fish eyes were published in JMBA by J.A.C. Nicol in the 1950s. He first investigated the light-producing glands of the polychaete *Chaetopterus* (Nicol, 1952) and then luminescence in other marine species, with a much-cited joint paper with G.L. Clarke, on comparative studies on luminous pelagic animals, in JMBA (Clarke *et al*., 1962).

In a series of papers on clupeids, the linked swimbladder-inner ear-lateral line system was described as the set of organs that could respond to vibrational pressures and allow the fish to estimate the direction and distance of the source (Allen *et al*., 1976). The frequency responses of this system were described (Denton *et al*., 1979; Gray & Denton, 1979) as were the startle response of herring shoals (Blaxter & Hoss, 1981). The response was most sensitive in smaller fish with a threshold of 2–18 Pa (Blaxter & Hoss, 1981). Herring larvae only responded when the otic bulla contained gas, but showed a tactile response soon after hatching (Blaxter & Batty, 1985).

Papers also describe how many marine organisms achieve neutral buoyancy in seawater. Many phytoplankton cells reduce their density, after sinking into dark nutrient-rich waters, so that they can ascend again into the photic zone for photosynthesis after acquiring more nutrients (Steele & Yentsch, 1960). Pelagic eggs of teleostean fish achieve buoyancy by having a water content with a reduced salinity (Craik & Harvey, 1987). Lipid contributes only a minor component to the buoyancy.

Sodium and potassium ions were replaced by lighter ammonium ions in some squids to increase buoyancy (Clarke, 1979) and also in the chaeotognath *Sagitta elegans* (Bone *et al*., 1987). In some mesopelagic fish, neutral buoyancy was achieved by reducing skeletal density and protein mass (Denton & Marshall, 1958) and such fish are probably only capable of short burst swimming (Blaxter *et al*., 1971). In contrast, most elasmobranchs reduce their density by depositing large amounts of oil in their livers (Bone & Roberts, 1969). The cephalopod *Nautilus* achieves buoyancy by replacing seawater in the shell chambers by gas and by water with a lower density (Denton & Gilpin-Brown, 1966). Similarly *Sepia* achieves neutral buoyancy by displacing water with gas in the chambers of the cuttle bone (Denton & Gilpin-Brown, 1961).

Clarke (1978*a*, 1978*b*, 1978*c*), in three substantial papers in JMBA, provided evidence for the hypothesis that, because of the physical properties of spermaceti oil, sperm whales are able to achieve neutral buoyancy over their geographic range, when they dive below 200 m, by lowering the temperature of the oil in the spermaceti organ in their head by about 3°C. Clarke proposed that this was mainly done by cooling the blood, passing it through the skin in the head, before circulating around the organ.

A number of papers have reported mechanisms of camouflage in marine organisms, including the ways in which pelagic fish, such as silvery teleosts and hatchet fish, reduce their visibility to predators (Denton & Nicol, 1966; Janssen *et al*., 1986). The processes that create the silvery appearance during smoltification of salmon were also described (Denton & Saunders, 1972). An unusual elongated eye in the octopus *Vitreledonella richardi* was considered to minimize the silhouette and reduce predation (Land, 1992). Some sponges use an external sediment crust as camouflage (Schönberg, 2016).

These adaptations of marine organisms to their environment now form part of the text of books on marine biology, marine ecology and the physiology of marine organisms (Newell, 1976; Barnes & Hughes, 1999; Kaiser *et al*., 2011).

The discovery of species of small, gutless, frenulate tubeworms (Southward & Southward, 1958*b*; Southward, 1978) led to investigations on their uptake of dissolved organic compounds from the sediment as a nutritional source (Southward & Southward, 1980). Following the discovery of symbiotic, chemoautotrophic bacteria in their larger vestimentiferan relatives from hydrothermal vents (Cavanaugh *et al*., 1981), it was discovered that similar bacteria also occurred in frenulates (Southward, 1982; Southward *et al*., 1986). Further investigations showed that some thyasirid and lucinid bivalves (Dando & Southward, 1986; Southward, 1986) and nematodes (Austen *et al*., 1993) also obtained nutrition from endosymbiotic chemosynthetic bacteria. Stable isotope studies revealed different nutritional sources for three chemosynthetic bivalve species at the Logatchev hydrothermal site (Southward *et al*., 2001). Other species at vents can harvest chemosynthetic epibiotic bacteria from their surfaces (Suzuki *et al*., 2009; Tsuchida *et al*., 2011).

These papers on bacterial symbionts in nematodes, siboglinid tubeworms, bivalves, crustaceans and other species have been cited in reviews of these fields (Kiel, 2010; Hilário *et al*., 2011; Duperron *et al*., 2013).

Pollution studies

Oil spills

The massive oil spill resulting from the grounding of the Torrey Canyon oil tanker on the Seven Stones Reef, between Cornwall and the Isles of Scilly in 1967 led to a major investigation by the MBA into the effects of crude oil and of the oil dispersants used at that time on marine life. Publications showing the effects of oil and dispersants on organisms started appearing in the JMBA the following year (Corner *et al*., 1968; Wilson, 1968; Bryan, 1969). These and other studies by scientists at the MBA resulted in the rapid publication of the book "Torrey Canyon' Pollution and Marine Life: A Report by the Plymouth Laboratory of the Marine Biological Association of the United Kingdom' (Smith, 1968) that concluded that the oil dispersants used at the time were more damaging than the oil itself. This led to the JMBA becoming a popular journal for publishing studies on observations on the results of oil spills elsewhere, including the Amoco Cadiz spill off Brittany (Brule, 1987), the Erika spill off Pays de la Loire (Pavillon *et al*., 2002), the Sea Empress spill off Wales (Reynolds *et al*., 2003), the Prestige oil spill off Spain (Bustamante *et al*., 2010) and the Volgoneft-248 spill off Turkey (Tas *et al*., 2011).

Follow-up studies, on the recovery of the intertidal fauna in particular, were published, e.g. Southward & Southward (1978). Fifty years after the Torrey-Canyon spill the Industry Technical Advisory Committee (ITAC) annual meeting, organized by Oil

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

Spill Response Ltd, was held in Plymouth, at which the problems of defining the long-term changes resulting from oil spills and dispersant use were summarized. A session was also included on the ecological and sociological long-term effects of the Torrey Canyon oil spill citing the early studies published in JMBA (Hawkins *et al.*, 2017*b*). The inter-tidal and low sub-tidal flora and fauna on some sheltered shores had taken 15 years to return to their pre-spill conditions and the value of long-term monitoring was emphasized. Oil spill dispersants have continued to be used in the marine environment, but the dispersant industry has modified the ingredients and now gives more attention to the 'net environmental benefit' of their use (Lessard & Demarco, 2000).

Heavy metal pollution

Metal mining for lead, silver, tin and copper has an ancient history in Devon and Cornwall. Tin smelting dates back to the early Bronze Age (Miles, 1975; Hausten *et al.*, 2010), although large-scale mining did not become established until Roman times (Mehang *et al.*, 2012). Effluent from these mines and the leachates from the mine spoil heaps entered rivers and estuaries and affected marine life (Garnacho *et al.*, 2001; Daka & Hawkins, 2004). Seasonal variation in the copper content of coastal seawater was measured (Atkins, 1953) and probably reflected periods of increased river flow. Drainage waters from coal mines were also shown to have adverse effects on estuarine fauna (Woolsey & Wilkinson, 2007).

Several papers describe the adaptation of invertebrates to living in sediments containing high concentrations of heavy metals, including lead (Daka & Hawkins, 2004), manganese (Bryan & Hummerstone, 1973a), mercury (Clark & Topping, 1989) and zinc (Daka & Hawkins, 2004). Common estuarine organisms were studied as indicator species to be analysed for metal contamination in estuaries. These included the brown seaweed *Fucus vesiculosus* (Bryan & Hummerstone, 1973*b*), the barnacle *Balanus improvisus* (Rainbow *et al.*, 2002), the bivalve *Scrobicularia plana* (Bryan & Hummerstone, 1978) and the gastropod *Littorina littorea* (Bryan *et al.*, 1983; Mason & Simkiss, 1983).

Papers have described the physiological and behavioural effects of copper (Blaxter, 1977; Manley, 1983; Garnacho *et al.*, 2001) and its effects on larval development (Ruiz *et al.*, 1996). Concentrations of copper and zinc, just above the respective maxima of 25 and 138 nM, found in seawater from the English Channel, were shown to inhibit carbon fixation rates in phytoplankton (Davies & Sleep, 1979, 1980) and low concentrations of mercury (5 µM) inhibited algal cell division (Davies, 1976).

Some of the above studies led to separate MBA publications on biological indicator species for heavy metal contamination in estuaries (Bryan *et al.*, 1980) and on the history of heavy metal pollution of the Fal estuary due to mining activity (Bryan & Gibbs, 1980). The papers published in the JMBA made an important contribution to a review of the effect of trace metals on organisms in the British Isles (Rainbow, 2018).

Tributyl tin (TBT)

Following the introduction of marine anti-fouling paints containing tributyl tin (TBT) compounds, populations of the dogwhelk, *Nucella lapillus*, showed marked declines in numbers in the vicinity of harbours and marinas (Bryan *et al.*, 1986, 1987, 1993). The cause of the decline was found to be the development of a penis and vas deferens on the female, in response to TBT exposure. The vas deferens overgrowing the vulva prevented the release of egg capsules and thus rendered the female sterile (Bryan *et al.*, 1986, 1987). Other gastropods were similarly affected (Gibbs *et al.*, 1991; Kohn & Almasi, 1993; Averbuj & Penchaszadeh, 2010). The accumulating evidence of the damage caused by these antifouling paints led to the UK banning the use of the antifouling agent on vessels <25 m length overall in 1986, although larger vessels could still use it. An EU ban on the presence of TBT-based antifouling coatings on ship hulls in EU ports was introduced in January 2008 and a global ban on both the application and presence on ship hulls of TBT-based antifoulants the following September. The recovery of gastropod populations in affected areas in Watermouth Cove, an area affected by leaching from the hulls of pleasure craft, was described (Crothers, 2003): even outside the cove, it took 13 years for the population of *Nucella lapillus* to recover. In areas where there were no nearby unaffected populations and scarce natural habitat, artificial hard substrata provided stepping-stones that facilitated the migration of *Nucella* (Bray *et al.*, 2012).

The early reports regarding the effects of TBT pollution formed the basis for longer-term recovery studies. At a site near a shipyard in Falmouth, Cornwall, the population of the gastropod *Ocenebra erinacea* was still severely affected 20 years after initial exposure (Gibbs, 2009). The TBT concentration in sediments off Southampton had only halved after 33 years (Langston *et al.*, 2015). Reviews in other recent papers on stress in intertidal communities and the global impacts of TBT also cite early studies published in the JMBA (Crowe *et al.*, 2000; Sousa *et al.*, 2014).

Discussion

Papers published in the JMBA, since 1887, reveal the development of collection, measurement and survey techniques, as well as our understanding of the marine ecosystem and the interrelationships of different organisms from viruses to cetaceans. These papers are now cited in modern texts on marine ecology (Barnes & Hughes, 1999; Kaiser *et al.*, 2011) and fisheries ecology (Jennings *et al.*, 2001) as well as in manuals on sampling methods in the marine environment, e.g. Eleftheriou (2013).

The long series of records of changes in the distributions and densities of species, together with corresponding data on the physical and chemical environment, has allowed the development of models to forecast future ecosystem changes in different areas of the oceans (Zacharias *et al.*, 1999; Huang & Brooke, 2011; Hattab *et al.*, 2013).

Since the earliest records, marine organisms have been affected by both cyclical climatic changes and anthropogenic discharges and pollutants. Disentangling the causes of ecosystem changes resulting from multiple stressors is complicated. A recent analysis (Hawkins *et al.*, 2017*a*) stresses the need for continued long-term observations and reveals the value of the early ecosystem studies published in the JMBA. The records published in the JMBA have been especially useful in describing the changes in the English Channel ecosystem through periods of warming and cooling, as well as describing the effects of and the recovery from pollution events (Southward *et al.*, 2005).

The JMBA started as a 'house journal' for the members of the Marine Biological Association of the United Kingdom, publishing work carried out at the Plymouth Laboratory by members, staff and visiting scientists. It has evolved, by the 100th volume, to become a truly international journal for marine science, publishing papers from around the world dealing with the marine environment and marine biota, from the intertidal to the hadal zone. The JMBA continues to contribute to our knowledge on how changing climates may affect our oceans in future. One uncertainty, at the time of writing, is how the proposals, by major funding agencies, that all future scientific publications resulting from their grants must be in fully open access journals (McNutt, 2019), will affect the JMBA.

Acknowledgements. We thank Barbara Bultman, the National Marine Biological Library and Jane Lewis for assistance during the writing of this review. Steve Hawkins gave us helpful comments on an earlier version of the manuscript. We thank the reviewers for their helpful comments.

Financial support. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

References

Allen EJ (1899) On the fauna and bottom-deposits near the thirty-fathom line from the Eddystone Grounds to Start Point. *Journal of the Marine Biological Association of the United Kingdom* **5**, 365–542.

Allen EJ (1914) On the culture of the plankton diatom *Thalassiosira gravida* Cleve, in artificial sea-water. *Journal of the Marine Biological Association of the United Kingdom* **10**, 417–439.

Allen EJ and Nelson EW (1910) On the artificial culture of marine plankton organisms. *Journal of the Marine Biological Association of the United Kingdom* **8**, 421–474.

Allen EJ and Todd RA (1900) The fauna of the Salcombe Estuary. *Journal of the Marine Biological Association of the United Kingdom* **6**, 151–207.

Allen EJ and Todd RA (1902) The fauna of the Exe Estuary. *Journal of the Marine Biological Association of the United Kingdom* **6**, 295–335.

Allen JM, Blaxter JHS and Denton EJ (1976) The functional anatomy and development of the swimbladder-inner ear-lateral line system in herring and sprat. *Journal of the Marine Biological Association of the United Kingdom* **56**, 471–486.

Anonymous (1856) *Post Office Directory of Cornwall 1856*. London: Kelly and Co. Ltd.

Anonymous (1913) List of publications recording the results of researches carried out under the auspices of the Marine Biological Association of the United Kingdom in their Laboratory at Plymouth or on the North Sea Coast from 1886–1913. *Journal of the Marine Biological Association of the United Kingdom* **10**, 143–178.

Antia NJ, Berland BR, Bonin DJ and Maestrini SY (1975) Comparative evaluation of certain organic and inorganic sources of nitrogen for phototrophic growth of marine microalgae. *Journal of the Marine Biological Association of the United Kingdom* **55**, 519–539.

Arai T, Kotake A, Harrod C, Morrissey M and McCarthy TK (2019) Ecological plasticity of the European eel *Anguilla anguilla* in a tidal Atlantic lake system in Ireland. *Journal of the Marine Biological Association of the United Kingdom* **99**, 1189–1195.

Armstrong FAJ (1957) The iron content of sea water. *Journal of the Marine Biological Association of the United Kingdom* **36**, 509–5176.

Armstrong FAJ and Tibbitts S (1968) Photochemical combustion of organic matter in sea water for nitrogen, phosphorus and carbon determination. *Journal of the Marine Biological Association of the United Kingdom* **48**, 143–152.

Atkins WRG (1922) The hydrogen ion concentration of sea water and its biological relations. *Journal of the Marine Biological Association of the United Kingdom* **12**, 717–771.

Atkins WRG (1923*a*) The phosphate content of fresh and salt waters in its relationship to the growth of the algal plankton. *Journal of the Marine Biological Association of the United Kingdom* **13**, 119–150.

Atkins WRG (1923*b*) The silica content of some natural waters and of culture media. *Journal of the Marine Biological Association of the United Kingdom* **13**, 151–159.

Atkins WRG (1953) The seasonal variation in the copper content of seawater. *Journal of the Marine Biological Association of the United Kingdom* **31**, 493–494.

Atkins D (1959) A new species of *Platidia* (Brachiopoda) from the La Chapelle Bank region. *Journal of the Marine Biological Association of the United Kingdom* **38**, 133–142.

Austen MC, Warwick RM and Ryan KP (1993) *Astomonema southwardorum* sp. nov., a gutless nematode dominant in a methane seep area in the North Sea. *Journal of the Marine Biological Association of the United Kingdom* **73**, 627–634.

Averbuj A and Penchaszadeh PE (2010) On the reproductive biology and impact of imposex in a population of *Buccinanops monilifer* from Mar del Plata, Argentina. *Journal of the Marine Biological Association of the United Kingdom* **90**, 729–734.

Bainbridge R (1952) Underwater observations on the swimming of marine zooplankton. *Journal of the Marine Biological Association of the United Kingdom* **31**, 107–112.

Baker ADC, Clarke MR and Harris MJ (1973) The N.I.O. combination net (RMT 1 + 8) and further developments of rectangular midwater trawls. *Journal of the Marine Biological Association of the United Kingdom* **53**, 167–184.

Barnes RSK and Hughes RN (1999) *An Introduction to Marine Ecology*. Oxford: Blackwell Science.

Beddard FE (1889) Notes on the marine Oligochaeta of Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **1**, 69.

Bell EJ (1890) Notes on the echinoderms collected by Mr. Bourne in deep water off the south-west of Ireland in H.M.S. 'Research'. *Journal of the Marine Biological Association of the United Kingdom* **1**, 324–327.

Bennett DB and Brown CG (1983) Crab (*Cancer pagurus*) migrations in the English Channel. *Journal of the Marine Biological Association of the United Kingdom* **63**, 371–398.

Black WAP (1950) The seasonal variation in weight and chemical composition of the common British Laminariaceae. *Journal of the Marine Biological Association of the United Kingdom* **29**, 45–72.

Black WAP and Mitchell RL (1952) Trace elements in the common brown algae and in sea water. *Journal of the Marine Biological Association of the United Kingdom* **30**, 575–584.

Blacker RW and Woodhead PMJ (2009) A towed underwater camera. *Journal of the Marine Biological Association of the United Kingdom* **45**, 593–597.

Blaxter JHS (1969) Experimental rearing of pilchard larvae, *Sardina pilchardus*. *Journal of the Marine Biological Association of the United Kingdom* **49**, 557–575.

Blaxter JHS (1977) The effect of copper on the eggs and larvae of plaice and herring. *Journal of the Marine Biological Association of the United Kingdom* **57**, 849–858.

Blaxter JHS and Batty RS (1985) The development of startle responses in herring larvae. *Journal of the Marine Biological Association of the United Kingdom* **65**, 737–750.

Blaxter JHS and Hoss DE (1981) Startle response in herring: the effect of sound stimulus frequency, size of fish and selective interference with the acoustico-lateralis system. *Journal of the Marine Biological Association of the United Kingdom* **61**, 871–879.

Blaxter JHS, Wardle CS and Roberts BL (1971) Aspects of the circulatory physiology and muscle systems of deep-sea fish. *Journal of the Marine Biological Association of the United Kingdom* **51**, 991–1006.

Boalch GT (1996) Some aspects of the history of the study of marine biology in Devon. *Transactions of the Devonshire Association for the Advancement of Science* **128**, 1–16.

Boalch GT, Holme NA, Jephson NA and Sidwell JMC (1974) A resurvey of Colman's intertidal traverses at Wembury, South Devon. *Journal of the Marine Biological Association of the United Kingdom* **54**, 551–553.

Bone Q and Roberts BL (1969) The density of elasmobranchs. *Journal of the Marine Biological Association of the United Kingdom* **49**, 913–917.

Bone Q, Brownlee C, Bryan GW, Burt GR, Dando PR, Liddicoat MI, Pulsford AL and Ryan KP (1987) On the differences between the two 'indicator' species of chaetognath, *Sagitta setosa* and *S. elegans*. *Journal of the Marine Biological Association of the United Kingdom* **67**, 545–560.

Bourne GC (1889) The Directors Report No. 1. *Journal of the Marine Biological Association of the United Kingdom* **1(NS)**, 1–9.

Bourne GC (1890) Report of a Trawling cruise in H.M.S. ' Research ' off the south-west Coast of Ireland. *Journal of the Marine Biological Association of the United Kingdom* **1(NS)**, 306–323.

Bourne GC (1930) Edwin Ray Lankester, 1847–1929. *Journal of the Marine Biological Association of the United Kingdom* **16**, 365–371.

Boutan L (1893) Mémoire sur la photographie sous-marine. *Archives de zoologie expérimentale et générale* **1**, 281–232.

Boyden CR (1977) Effect of size upon metal content of shellfish. *Journal of the Marine Biological Association of the United Kingdom* **57**, 675–714.

Bray S, McVean EC, Nelson A, Herbert RJH, Hawkins SJ and Hudson MD (2012) The regional recovery of *Nucella lapillus* populations from marine pollution, facilitated by man-made structures. *Journal of the Marine Biological Association of the UK* **92**, 1585–1594.

Brown CJ, Hewer AJ, Meadows WJ, Limpenny DS, Cooper KM and Rees HL (2004) Mapping seabed biotopes at Hastings Shingle Bank, eastern English Channel. Part 1. Assessment using sidescan sonar. *Journal of the Marine Biological Association of the United Kingdom* **84**, 481–488.

Browne ET (1898) On keeping medusae alive in an aquarium. *Journal of the Marine Biological Association of the United Kingdom* **5**, 176–180.

Browne ET (1907) The hydroids collected by the 'Huxley' from the north side of the Bay of Biscay in August, 1906. *Journal of the Marine Biological Association of the United Kingdom* **8**, 15–36.

Bruce JR, Knight M and Parke MW (1940) The rearing of oyster larvae on an algal diet. *Journal of the Marine Biological Association of the United Kingdom* **24**, 337–374.

Brule T (1987) The reproductive biology and the pathological changes of the plaice *Pleuronectes platessa* (L.) after the 'Amoco Cadiz' oil spill along the north-west coast of Brittany. *Journal of the Marine Biological Association of the United Kingdom* **67**, 237–247.

Bryan GW (1969) The effects of oil-spill removers ('detergents') on the gastropod *Nucella lapillus* on a rocky shore and in the laboratory. *Journal of the Marine Biological Association of the United Kingdom* **49**, 1067–1092.

Bryan GW and Gibbs PE (1980) *Heavy Metals in the Fal Estuary, Cornwall: A Study of Long Term Contamination by Mining Waste and its Effects on Estuarine Organisms*. Plymouth: Marine Biological Association of the United Kingdom, 112 pp.

Bryan GW and Hummerstone LG (1973*a*) Adaptation of the polychaete *Nereis diversicolor* to manganese in estuarine sediment. *Journal of the Marine Biological Association of the United Kingdom* **53**, 859–872.

Bryan GW and Hummerstone LG (1973*b*) Brown seaweed as an indicator of heavy metals in estuaries in South-West England. *Journal of the Marine Biological Association of the United Kingdom* **53**, 705–720.

Bryan GW and Hummerstone LG (1978) Heavy metals in the burrowing bivalve *Scrobicularia plana* from contaminated and uncontaminated estuaries. *Journal of the Marine Biological Association of the United Kingdom* **58**, 401–419.

Bryan GW, Langston WJ and Hummerstone LG (1980) *The Use of Biological Indicators of Heavy Metal Contamination in Estuaries*. Plymouth: Marine Biological Association of the United Kingdom, 97 pp.

Bryan GW, Langston WJ, Hummerstone LG, Burt GR and Ho YB (1983) An assessment of the gastropod, *Littorina littorea*, as an indicator of heavy-metal contamination in United Kingdom estuaries. *Journal of the Marine Biological Association of the United Kingdom* **63**, 327–345.

Bryan GW, Gibbs PE and Hummerstone LG (1986) The decline of the gastropod *Nucella lapillus* around South-West England: evidence for the effect of tributyltin from antifouling paints. *Journal of the Marine Biological Association of the United Kingdom* **66**, 611–640.

Bryan GW, Gibbs PE, Burt GR and Hummerstone LG (1987) The effects of tributyltin (TBT) accumulation on adult dog-whelks, *Nucella lapillus*: long-term field and laboratory experiments. *Journal of the Marine Biological Association of the United Kingdom* **67**, 525–544.

Bryan GW, Bright DA, Hummerstone LG and Burt GR (1993) Uptake, tissue distribution and metabolism of ^{14}C-labelled tributyltin (TBT) in the dog-whelk, *Nucella lapillus*. *Journal of the Marine Biological Association of the UK* **73**, 889–912.

Bull HO (1928) Studies on conditioned responses in fishes. Part I. *Journal of the Marine Biological Association of the United Kingdom* **15**, 485–533.

Bull HO (1935) Studies on conditioned responses in fishes. Part III. Wave-length discrimination in *Blennius pholis* L. *Journal of the Marine Biological Association of the United Kingdom* **20**, 347–364.

Bull HO (1936) Studies on conditioned responses in fishes. Part VII. Temperature perception in teleosts. *Journal of the Marine Biological Association of the United Kingdom* **21**, 1–27.

Bullen GE (1912) Some notes upon the feeding habits of mackerel and certain clupeoids in the English Channel. *Journal of the Marine Biological Association of the United Kingdom* **9**, 394–403.

Bustamante M, Tajadura-Martin FJ and Saiz-Salinas JI (2010) Temporal and spatial variability on rocky intertidal macrofaunal assemblages affected by an oil spill (Basque coast, northern Spain). *Journal of the Marine Biological Association of the United Kingdom* **90**, 1305–1317.

Butler EI, Knox S and Liddicoat MI (1979) The relationship between inorganic and organic nutrients in seawater. *Journal of the Marine Biological Association of the United Kingdom* **59**, 239–250.

Calderwood WL (1891) The Plymouth mackerel fishery of 1889–90. From data collected by Mr. Wm. Roach, Associate Member M.B.A. *Journal of the Marine Biological Association of the United Kingdom* **2**, 4–14.

Capasso E, Jenkins SR, Frost M and Hinz H (2010) Investigation of benthic community change over a century-wide scale in the western English Channel. *Journal of the Marine Biological Association of the United Kingdom* **90**, 1161–1172.

Carruthers JN (1925) The water movements in the neighbourhood of the English Channel – North Sea Junction. Drift bottle experiments. *Journal of the Marine Biological Association of the United Kingdom* **13**, 665–669.

Carruthers JN (1927) Investigations upon the water movements in the English Channel. Summer, 1924. *Journal of the Marine Biological Association of the United Kingdom* **14**, 685–721.

Carruthers JN, Lawford AL, Veley VFC and Gruning JF (1951) Studies of water movements and winds at various lightvessels. II. At the Seven Stones Lightvessel near the Scilly Isles. *Journal of the Marine Biological Association of the United Kingdom* **29**, 587–608.

Cavanaugh CM, Gardiner SL, Jones ML, Jannasch HW and Waterbury JB (1981) Prokaryotic cells in the hydrothermal vent tube worm *Riftia pachyptila* Jones: possible chemoautotrophic symbionts. *Science* **213**, 340–342.

Clark G and Topping G (1989) Mercury concentrations in fish from contaminated areas in Scottish waters. *Journal of the Marine Biological Association of the United Kingdom* **69**, 437–445.

Clarke MR (1963) The identification of cephalopod "beaks" and the relationship between beak size and total body weight. *Bulletin of the British Museum (Natural History) – Zoology* **8**, 419–489.

Clarke MR (1978a) Structure and proportions of the spermaceti organ in the sperm whale. *Journal of the Marine Biological Association of the United Kingdom* **59**, 1–17.

Clarke MR (1978b) Physical properties of spermaceti oil in the sperm whale. *Journal of the Marine Biological Association of the United Kingdom* **58**, 15–28.

Clarke MR (1978c) Buoyancy control as a function of the spermaceti organ in the sperm whale. *Journal of the Marine Biological Association of the United Kingdom* **58**, 27–71.

Clarke MR (1979) On the use of ammonium for buoyancy in squids. *Journal of the Marine Biological Association of the United Kingdom* **59**, 259–276.

Clarke MR and Pascoe PL (1985) The influence of an electric light on the capture of deep-sea animals by a midwater trawl. *Journal of the Marine Biological Association of the United Kingdom* **65**, 373–393.

Clarke MR and Pascoe PL (1998) The influence of an electric light on the capture of oceanic cephalopods by a midwater trawl. *Journal of the Marine Biological Association of the United Kingdom* **78**, 561–575.

Clarke M and Young R (1998) Description and analysis of cephalopod beaks from stomachs of six species of odontocete cetaceans stranded on Hawaiian shores. *Journal of the Marine Biological Association of the United Kingdom* **78**, 623–641.

Clarke GL, Coer R, David CN and Nicol JAC (1962) Comparative studies of luminescence in copepods and other pelagic marine animals. *Journal of the Marine Biological Association of the United Kingdom* **42**, 541–564.

Cleve PT (1897) Microscopic marine organisms in the service of hydrography. *Journal of the Marine Biological Association of the United Kingdom* **4**, 381–385.

Coggan R and Diesing M (2008) The seabed habitats of the central English Channel: a generation on from Holme and Cabioch, how do their interpretations match-up to modern mapping techniques? *Continental Shelf Research* **31**, S132–S150.

Coggan R, Populus J, White J, Sheehan K, Fitzpatrick F and Piel S (2007) Review of standards and protocols for seabed habitat mapping, *MESH Project document*. Available at http://www.searchmesh.net/Default.aspx?page=1442. (Accessed 2 February 2019).

Colman J (1933) The nature of the intertidal zonation of plants and animals. *Journal of the Marine Biological Association of the United Kingdom* **18**, 435–476.

Conway DVP (2015) *Marine Zooplankton of Southern Britain. Part 3: Ostracoda, Stomatopoda, Nebaliacea, Mysida, Amphipoda, Isopoda, Cumacea, Euphausiacea, Decapoda, Annelida, Tardigrada, Nematoda, Phoronida, Bryozoa, Entoprocta, Brachiopoda, Echinodermata, Chaetognatha, Hemichordata and Chordata*. Plymouth: Marine Biological Association, 271 pp.

Cooper LHN (1952*a*) The boar fish, *Capros aper* (L.), as a possible biological indicator of water movement. *Journal of the Marine Biological Association of the United Kingdom* **31**, 351–362.

Cooper LHN (1952*b*) Processes of enrichment of surface water with nutrients due to strong winds blowing on to a continental slope. *Journal of the Marine Biological Association of the United Kingdom* **30**, 453–464.

Corbin PG (1947) The spawning of mackerel, *Scomber scombrus* L., and pilchard, *Clupea pilchardus* Walbaum, in the Celtic Sea in 1937–39. *Journal of the Marine Biological Association of the United Kingdom* **27**, 65–132.

Corkeron PJ and Martin AR (2004) Ranging and diving behaviour of two 'offshore' bottlenose dolphins, *Tursiops* sp., off eastern Australia.

Journal of the Marine Biological Association of the United Kingdom **84**, 465–468.

Corner EDS, Southward AJ and Southward EC (1968) Toxicity of oil-spill removers ('detergents') to marine life: an assessment using the intertidal barnacle *Elminius modestus*. *Journal of the Marine Biological Association of the United Kingdom* **48**, 29–47.

Craik JCA and Harvey SM (1987) The causes of buoyancy in eggs of marine teleosts. *Journal of the Marine Biological Association of the United Kingdom* **67**, 169–182.

Crisp DJ and Southward AJ (1958) The distribution of intertidal organisms along the coasts of the English Channel. *Journal of the Marine Biological Association of the United Kingdom* **37**, 157–208.

Crothers JH (2003) Further observations on a population of dog-whelks, *Nucella lapillus* (L.) recolonizing a site polluted by tributyltin (TBT) in antifouling paint. *Journal of the Marine Biological Association of the United Kingdom* **83**, 1023–1027.

Crowe TP, Thompson RC, Bray S and Hawkins SJ (2000) Impacts of anthropogenic stress on rocky intertidal communities. *Journal of Aquatic Ecosystem Research and Recovery* **7**, 273–297.

Cunningham JT (1888) Notes and memoranda. Some notes on Plymouth fishes. *Journal of the Marine Biological Association of the United Kingdom* **1**, 243–250.

Cunningham JT (1889) Studies of the reproduction and development of teleostean fishes occurring in the neighbourhood of Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **1**(NS), 10–54.

Cunningham JT (1894*a*) Experiments on the rearing of fish larvae in the season of 1894. *Journal of the Marine Biological Association of the United Kingdom* **3**, 206–207.

Cunningham JT (1894*b*) Fishery publications of the United States. *Journal of the Marine Biological Association of the United Kingdom* **3**, 236–245.

Cunningham JT (1906) Fishes. In Page W (ed.), *The Victoria County History of the County of Cornwall*, vol. **1**. London: Constable & Co. Ltd, pp. 291–306.

Daka ER and Hawkins SJ (2004) Tolerance to heavy metals in *Littorina saxatilis* from a metal contaminated estuary in the Isle of Man. *Journal of the Marine Biological Association of the United Kingdom* **84**, 393–400.

Dando PR and Ling R (1980) Freeze-branding of flatfish: flounder, *Platichthys flesus*, and plaice, *Pleuronectes platessa*. *Journal of the Marine Biological Association of the United Kingdom* **60**, 741–748.

Dando PR and Southward AJ (1980) A new species of *Chthamalus* (Crustacea: Cirripedia) characterized by enzyme electrophoresis and shell morphology: with a revision of other species of *Chthamalus* from the western shores of the Atlantic Ocean. *Journal of the Marine Biological Association of the United Kingdom* **60**, 787–831.

Dando PR and Southward AJ (1986) Chemoautotrophy in bivalve molluscs of the genus *Thyasira*. *Journal of the Marine Biological Association of the United Kingdom* **66**, 915–929.

Daniel A, Birot D, Blain S, Tréguer P, Leïldé B and Menut E (1995) A submersible flow-injection analyser for the in-situ determination of nitrite and nitrate in coastal waters. *Marine Chemistry* **51**, 67–77.

David PM (1965) The neuston net: a device for sampling the surface fauna of the ocean. *Journal of the Marine Biological Association of the United Kingdom* **45**, 313–320.

Davies AG (1976) An assessment of the basis of mercury tolerance in *Dunaliella tertiolecta*. *Journal of the Marine Biological Association of the United Kingdom* **56**, 39–57.

Davies AG and Sleep JA (1979) Inhibition of carbon fixation as a function of zinc uptake in natural phytoplankton assemblages. *Journal of the Marine Biological Association of the United Kingdom* **59**, 937–949.

Davies AG and Sleep JA (1980) Copper inhibition of carbon fixation in coastal phytoplankton assemblages. *Journal of the Marine Biological Association of the United Kingdom* **60**, 841–850.

Davies J, Baxter J, Bradley M, Connor D, Khan J, Murray E, Sanderson W, Turnbull C and Vincent M (2001) *Marine Monitoring Handbook*. Peterborough: Joint Nature Conservation Committee.

De Morgan W (1913) The echinoderms collected by the 'Huxley' from the north side of the Bay of Biscay in August, 1906. *Journal of the Marine Biological Association of the United Kingdom* **9**, 530–541.

Demir N (1972) The abundance and distribution of the eggs and larvae of some teleost fishes off Plymouth in 1969 and 1970. II. The postlarvae of *Callionymus*. *Journal of the Marine Biological Association of the United Kingdom* **52**, 997–1010.

Demir N, Southward AJ and Dando PR (1985) Comparative notes on postlarvae and pelagic juveniles of the rocklings *Gaidropsaurus mediterraneus*, *Rhinonemus cimbrius*, *Ciliata mustela* and *C. septentrionalis*. *Journal of the Marine Biological Association of the United Kingdom* **65**, 801–839.

Denton EJ and Gilpin-Brown JB (1961) The buoyancy of the cuttlefish, *Sepia officinalis* (L.). *Journal of the Marine Biological Association of the United Kingdom* **41**, 319–342.

Denton EJ and Gilpin-Brown JB (1966) On the buoyancy of the pearly nautilus. *Journal of the Marine Biological Association of the United Kingdom* **46**, 723–759.

Denton EJ and Locket NA (1989) Possible wavelength discrimination by multibank retinae in deep-sea fishes. *Journal of the Marine Biological Association of the United Kingdom* **69**, 409–435.

Denton EJ and Marshall NB (1958) The buoyancy of bathypelagic fishes without a gas-filled swimbladder. *Journal of the Marine Biological Association of the United Kingdom* **37**, 753–767.

Denton EJ and Nicol JAC (1966) A survey of reflectivity in silvery teleosts. *Journal of the Marine Biological Association of the United Kingdom* **46**, 685–722.

Denton EJ and Saunders RL (1972) On the organization of silvery layers in the skin of the Atlantic salmon (*Salmo salar*) during smoltification and on the regeneration of these layers under abnormal lighting conditions. *Journal of the Marine Biological Association of the United Kingdom* **52**, 889–898.

Denton EJ, Gray JAB and Blaxter JHS (1979) The mechanics of the clupeid acoustico-lateralis system: frequency responses. *Journal of the Marine Biological Association of the United Kingdom* **59**, 27–47.

Drinkwater KF (2006) The regime shift of the 1920s and 1930s in the North Atlantic. *Progress in Oceanography* **68**, 134–151.

Droop M (1955) A pelagic marine diatom requiring cobalamin. *Journal of the Marine Biological Association of the United Kingdom* **34**, 229–231.

Droop M (1968) Vitamin B12 and marine ecology. IV. Kinetics of uptake, growth and inhibition in *Monochrysis lutheri*. *Journal of the Marine Biological Association of the United Kingdom* **48**, 689–733.

Droop M (1974) The nutrient status of algal cells in continuous cultures. *Journal of the Marine Biological Association of the United Kingdom* **54**, 825–855.

Duperron S, Gaudron SM, Rodrigues CF, Cunha MR, Decker C and Olu K (2013) An overview of chemosynthetic symbioses in bivalves from the North Atlantic and Mediterranean Sea. *Biogeosciences (Online)* **10**, 3241–3267.

Dyer MF, Fry WG, Fry PD and Cranmer GJ (1982) A series of North Sea benthos surveys with trawl and headline camera. *Journal of the Marine Biological Association of the United Kingdom* **62**, 297–313.

Eleftheriou A (ed.) (2013) *Methods for the Study of Marine Benthos*. Oxford: Wiley.

Eskesen IG, Teilmann J, Geertsen BM, Desportes G, Riget F, Dietz R, Larsen F and Siebert U (2009) Stress level in wild harbour porpoises (*Phocoena phocoena*) during satellite tagging measured by respiration, heart rate and cortisol. *Journal of the Marine Biological Association of the United Kingdom* **89**, 885–892.

Estrada JA, Rice AN, Lutcavage ME and Skomal GB (2003) Predicting trophic position in sharks of the north-west Atlantic Ocean using stable isotope analysis. *Journal of the Marine Biological Association of the United Kingdom* **83**, 1347–1350.

Fankboner PV (1981) A re-examination of mucus feeding by the sea cucumber *Leptopentacta* (= *Cucumaria*) *elongata*. *Journal of the Marine Biological Association of the United Kingdom* **6**, 679–683.

Fonseca MS and Fisher JS (1986) A comparison of canopy friction and sediment movement between four species of seagrass with reference to their ecology and restoration. *Marine Ecology Progress Series* **29**, 15–22.

Ford E (1922) On the young stages of *Blennius ocellaris* L., *Blennius pholis* L., and *Blennius gattorugine* L. *Journal of the Marine Biological Association of the United Kingdom* **12**, 688–692.

Ford E (1928*a*) Herring investigations at Plymouth. III. The Plymouth Winter Fishery during the seasons 1924–25, 1925–26, and 1926–27. *Journal of the Marine Biological Association of the United Kingdom* **15**, 279–304.

Ford E (1928*b*) Herring investigations at Plymouth. IV. The growth of young herrings in the neighbourhood of Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **15**, 305–319.

Ford E (1933) An account of the herring investigations conducted at Plymouth during the years from 1924 to 1933. *Journal of the Marine Biological Association of the United Kingdom* **19**, 305–384.

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

Forster GR (1953) A new dredge for collecting burrowing animals. *Journal of the Marine Biological Association of the United Kingdom* **32**, 193–198.
Forster GR (1954) Preliminary note on a survey of Stoke Point rocks with self-contained diving apparatus. *Journal of the Marine Biological Association of the United Kingdom* **33**, 341–344.
Forster GR (1959) The ecology of *Echinus esculentus* L. Quantitative distribution and rate of feeding. *Journal of the Marine Biological Association of the United Kingdom* **38**, 361–367.
Forster GR (1967) A new deep-sea ray from the Bay of Biscay. *Journal of the Marine Biological Association of the United Kingdom* **47**, 281–286.
Foster-Smith RL, Brown CJ, Meadows WJ and White WH (2004) Mapping seabed biotopes at two spatial scales in the eastern English Channel. Part 2. Comparison of two acoustic ground discrimination systems. *Journal of the Marine Biological Association of the United Kingdom* **84**, 489–500.
Fourgon D, Lepoint G and Eeckhaut I (2006) Assessment of trophic relationships between symbiotic tropical ophiuroids using C and N stable isotope analysis. *Journal of the Marine Biological Association of the United Kingdom* **86**, 1443–1447.
Fowler GH (1890) Notes on oyster culture. *Journal of the Marine Biological Association of the United Kingdom* **1**, 257–267.
Fuseler-McDowell E (1988) *Documenting the Literature of Marine Biology*. Proceedings of the 14th Annual Conference of the International Association of Aquatic and Marine Science Libraries and Information Centers, Miami. International Association of Aquatic and Marine Science Libraries and Information Centers, pp. 45–60.
Gamble FL (1893) The Turbellaria of Plymouth Sound and the neighbourhood. *Journal of the Marine Biological Association of the United Kingdom* **3**, 30–47.
Garcia-Soto C and Pingree RD (2012) Atlantic multidecadal oscillation (AMO) and sea surface temperature in the Bay of Biscay and adjacent regions. *Journal of the Marine Biological Association of the United Kingdom* **92**, 213–234.
Garcia-Soto C, Sinha B and Pingree RD (1996) Mapping a bloom of the coccolithophorid *Emiliania huxleyi* from airborne thematic mapper (ATM) data. *Journal of the Marine Biological Association of the United Kingdom* **76**, 839–849.
Garnacho E, Tyler PA and Peck LS (2001) Reproduction, seasonality, and copper toxicity in the coastal mysid *Praunus flexuosus*. *Journal of the Marine Biological Association of the United Kingdom* **81**, 433–440.
Garstang W (1891) Report on the Tunicata of Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **2**, 47–57.
Garstang W (1897) Hjort's hydrographic-biological studies of the Norwegian fisheries: a review. *Journal of the Marine Biological Association of the United Kingdom* **5**, 56–71.
Garstang W (1898) Report on the surface drift of the English Channel and neighbouring seas during 1897. *Journal of the Marine Biological Association of the United Kingdom* **5**, 199–231.
Garstang W (1900*a*) The impoverishment of the sea. A critical summary of the experimental and statistical evidence bearing upon the alleged depletion of the trawling grounds. *Journal of the Marine Biological Association of the United Kingdom* **6**, 1–69.
Garstang W (1900*b*) Preliminary experiments on the rearing of sea-fish larvæ. *Journal of the Marine Biological Association of the United Kingdom* **6**, 70–93.
Garstang W (1903) Report on trawling and other investigations carried out in the bays on the south-east coast of Devon during 1901 and 1902. *Journal of the Marine Biological Association of the United Kingdom* **6**, 435–527.
Gauld DT (1951) The grazing rate of planktonic copepods. *Journal of the Marine Biological Association of the United Kingdom* **29**, 695–706.
Gebruk AV, Chevaldonné P, Shank T, Lutz RA and Vrijenhoek RC (2000*a*) Deep-sea hydrothermal vent communities of the Logatchev area (14°45′N, Mid-Atlantic Ridge): diverse biotopes and high biomass. *Journal of the Marine Biological Association of the United Kingdom* **80**, 383–393.
Gebruk AV, Southward EC, Kennedy H and Southward AJ (2000*b*) Food sources, behaviour, and distribution of hydrothermal vent shrimps at the Mid-Atlantic Ridge. *Journal of the Marine Biological Association of the United Kingdom* **80**, 485–499.
Giacalone VM, D'Anna G, Pipitone C and Badalamenti F (2006) Movements and residence time of spiny lobsters, *Palinurus elephas* released in a marine protected area: an investigation by ultrasonic telemetry. *Journal of the Marine Biological Association of the United Kingdom* **86**, 1101–1106.
Gibbs PE (2009) Long-term tributyltin (TBT)-induced sterilization of neogastropods: persistence of effects in *Ocenebra erinacea* over 20 years in the vicinity of Falmouth (Cornwall, UK). *Journal of the Marine Biological Association of the United Kingdom* **89**, 135–138.
Gibbs PE, Bryan GW, Pascoe PL and Burt GR (1987) The use of the dog-whelk, *Nucella lapillus*, as an indicator of tributyltin (TBT) contamination. *Journal of the Marine Biological Association of the United Kingdom* **67**, 507–523.
Gibbs PE, Bryan GW, Pascoe PL and Burt GR (1991) Reproductive abnormalities in female *Ocenebra erinacea* (Gastropoda) resulting from tributyltin-induced imposex. *Journal of the Marine Biological Association of the United Kingdom* **70**, 639–656.
Gleason DF and Wellington GM (1988) Food resources of postlarval brown shrimp (*Penaeus aztecus*) in a Texas salt marsh. *Marine Biology* **97**, 329–337.
Gosselin LA (1993) A method for marking small juvenile gastropods. *Journal of the Marine Biological Association of the United Kingdom* **73**, 963–966.
Gracia A, Rangel-Buitrago N and Sellanes J (2012) Methane seep molluscs from the Sinú–San Jacinto fold belt in the Caribbean Sea of Colombia. *Journal of the Marine Biological Association of the United Kingdom* **92**, 1367–1377.
Graham M and Atkins WRG (1938) The disappearance of *Zostera marina*. *Journal of the Marine Biological Association of the United Kingdom* **23**, 207–210.
Grasshoff K, Kremling K and Ehrhardt M (1999) *Methods of Seawater Analysis*. Weinheim: Wiley–VCH.
Gray JAB and Denton EJ (1979) The mechanics of the clupeid acoustico-lateralis system: low frequency measurements. *Journal of the Marine Biological Association of the United Kingdom* **59**, 11–26.
Grenfell WT (1894) Letter from W. T. Grenfell Esq. *Journal of the Marine Biological Association of the United Kingdom* **3**, 143–147.
Green JM and Wroblewski JS (2000) Movement patterns of Atlantic cod in Gilbert Bay, Labrador: evidence for bay residency and spawning site fidelity. *Journal of the Marine Biological Association of the United Kingdom* **80**, 1077–1085.
Gueguen M, Bardouil M, Baron R, Lassus P, Truquet P, Massardier J and Amzil Z (2008) Detoxification of Pacific oyster *Crassostrea gigas* fed on diets of *Skeletonema costatum* with and without silt, following PSP contamination by *Alexandrium minutum*. *Aquatic Living Resources* **21**, 13–20.
Günther ET (1897) The oyster culture of the Ancient Romans. *Journal of the Marine Biological Association of the United Kingdom* **4**, 360–365.
Harding JP (1949) The use of probability paper for the graphical analysis of polymodal frequency distributions. *Journal of the Marine Biological Association of the United Kingdom* **28**, 141–153.
Hardy AC, Lucas CE, Henderson GTD and Fraser JH (1936) The ecological associations between the herring and the plankton investigated with the plankton indicator. Pt I, II, III & IV. *Journal of the Marine Biological Association of the United Kingdom* **21**, 147–291.
Hartley PHT (1940) The Saltash tuck-net fishery and the ecology of some estuarine fishes. *Journal of the Marine Biological Association of the United Kingdom* **24**, 1–68.
Hartley PHT (1947) Observations on flounders *Pleuronectes flesus* L. marked in the estuaries of the Tamar and Lynher. *Journal of the Marine Biological Association of the United Kingdom* **27**, 53–64.
Harvey HW (1925) Water movement and sea temperature in the English Channel. *Journal of the Marine Biological Association of the United Kingdom* **13**, 659–664.
Harvey HW (1926) Nitrate in the sea. *Journal of the Marine Biological Association of the United Kingdom* **14**, 71–88.
Harvey HW (1940) Nitrogen and phosphorus required for the growth of phytoplankton. *Journal of the Marine Biological Association of the United Kingdom* **24**, 115–123.
Harvey HW (1948) The estimation of phosphate and of total phosphorus in seawaters. *Journal of the Marine Biological Association of the United Kingdom* **27**, 337–359.
Hattab T, Lasram FBR, Albouy C, Sammari C, Romdhane MS, Cury P, Leprieur F and Le Loçh F (2013) The use of a predictive habitat model and a fuzzy logic approach for marine management and planning. *PLoS ONE* **8**, e76430.
Hausten M, Gillis C and Pernicka E (2010) Tin isotopy – a new method for solving old questions. *Archaeometry* **52**, 816–832.

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

Hawkins SJ, Southward AJ and Genner MJ (2003) Detection of environmental change in a marine ecosystem – evidence from the western English Channel. *Science of the total environment* **310**, 245–256.

Hawkins SJ, Mieszkowska N, Firth LB, Bohn K, Burrows MT, MacLean MA, Thompson RC, Chan BKK, Little CT and Williams GA (2015) Looking backwards to look forwards: the role of natural history in temperate reef ecology. *Marine and Freshwater Research* **67**, 1–13.

Hawkins SJ, Evans AJ, Mieszkowska N, Adams LC, Bray S, Burrows MT, Firth LB, Genner MJ, Leung KMY, Moore PJ, Pack K, Schuster H, Sim DW, Whittington M and Southward EC (2017*a*) Distinguishing globally-driven changes from regional- and local-scale impacts: the case for long-term and broad-scale studies of recovery from pollution. *Marine Pollution Bulletin* **124**, 573–586.

Hawkins SJ, Evans AJ, Moore J, Whittington M, Pack K, Firth LB, Adams LC, Moore PJ, Masterson-Algar P, Mieszkowska N and Southward EC (2017*b*) *From the Torrey Canyon to today: a 50 year retrospective of recovery from the oil spill and interaction with climate-driven fluctuations on Cornish rocky shores*. International Oil Spill conference, Plymouth, International Oil Spill conference, Washington, pp. 74–103.

Hays GC, Webb PI, Hayes JP, Priede IG and French J (1991) Satellite tracking of a loggerhead turtle (*Caretta caretta*) in the Mediterranean. *Journal of the Marine Biological Association of the United Kingdom* **71**, 743–746.

Hayward PJ and Ryland JS (1978) Bryozoa from the Bay of Biscay and Western Approaches. *Journal of the Marine Biological Association of the United Kingdom* **58**, 143–159.

Heape W (1887) Notes on the fishing industry of Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **1**, 45–95.

Heape W (1888) The fauna of Plymouth Sound. *Journal of the Marine Biological Association of the United Kingdom* **1**, 153–193.

Heggberget TM (1993) Marine-feeding otters (*Lutra lutra*) in Norway: seasonal variation in prey and reproductive timing. *Journal of the Marine Biological Association of the United Kingdom* **73**, 297–392.

Heithaus MR, McLash JJ, Frid A, Dill LM and Marshall GJ (2002) Novel insights into green sea turtle behaviour using animal-borne video cameras. *Journal of the Marine Biological Association of the United Kingdom* **82**, 1049–1050.

Helm MM, Holland DL and Stephenson RR (1973) The effect of supplementary algal feeding of a hatchery breeding stock of *Ostrea edulis* L. on larval vigour. *Journal of the Marine Biological Association of the United Kingdom* **53**, 673–684.

Helm MM, Bourne N and Lovatelli A (2004) *Hatchery Culture of Bivalves. A Practical Manual*. Rome: Food and Agriculture Organization of the United Nations.

Hendey NI (1954) A preliminary check-list of British marine diatoms. *Journal of the Marine Biological Association of the United Kingdom* **33**, 537–560.

Hendey NI (1974) A revised check-list of British marine diatoms. *Journal of the Marine Biological Association of the United Kingdom* **54**, 277–300.

Hendey NI, Ross R and Willims DM (1986) A check-list of the freshwater, brackish and marine diatoms of the British Isles and adjoining coastal waters. *Journal of the Marine Biological Association of the United Kingdom* **66**, 531–610.

Herbert RJH, Hawkins SJ, Sheader M and Southward AJ (2003) Range extension and reproduction of the barnacle *Balanus perforatus* in the eastern English Channel. *Journal of the Marine Biological Association of the United Kingdom* **83**, 73–82.

Herring PJ (2006) Presence of postlarval alvinocaridid shrimps over southwest Indian Ocean hydrothermal vents, with comparisons of the pelagic biomass at different vent sites. *Journal of the Marine Biological Association of the United Kingdom* **86**, 125–128.

Hewson I and Fuhrman JA (2006) Viral impacts upon marine bacterioplankton assemblage structure. *Journal of the Marine Biological Association of the United Kingdom* **86**, 577–589.

Hewson I, Winget DM, Williamson KE, Fuhrman JA and Wommack KE (2006) Viral and bacterial assemblage covariance in oligotrophic waters of the West Florida Shelf (Gulf of Mexico). *Journal of the Marine Biological Association of the United Kingdom* **86**, 591–603.

Hickson SJ (1907) The Alcyonaria, Antipatharia, and Madreporaria collected by the 'Huxley' from the north side of the Bay of Biscay in August, 1906. *Journal of the Marine Biological Association of the United Kingdom* **8**, 6–14.

Hidaka-Umetsu M and Lindsay D-J (2018) Comparative ROV surveys reveal jellyfish blooming in a deep-sea caldera: the first report of *Earleria bruuni* from the Pacific Ocean. *Journal of the Marine Biological Association of the United Kingdom* **98**, 2075–2085.

Hilário A, Capa M, Dahlgren TG, Halanych KM, Little CTS, Thornhill DJ, Verna C and Glover AG (2011) New perspectives on the ecology and evolution of siboglinid tubeworms. *PLoS ONE* **6**, e16309.

Hill DK (1950) Advances in the physiology of the peripheral nerve. *Journal of the Marine Biological Association of the United Kingdom* **29**, 241–246.

Holme NA (1961) The bottom fauna of the English Channel. *Journal of the Marine Biological Association of the United Kingdom* **41**, 397–461.

Holme NA (1966) The bottom fauna of the English Channel. Part II. *Journal of the Marine Biological Association of the United Kingdom* **46**, 401–493.

Holme NA (1967) Changes in the bottom fauna off Weymouth Bay and Poole Bay following the severe winter of 1962–63. *Journal of the Marine Biological Association of the United Kingdom* **47**, 397–405.

Holme NA and Barrett RL (1977) A sledge with television and photographic cameras for quantitative investigation of the epifauna on the continental shelf. *Journal of the Marine Biological Association of the United Kingdom* **57**, 391–403.

Howell KL, Davies JS and Narayanaswamy BE (2010) Identifying deep-sea megafaunal epibenthic assemblages for use in habitat mapping and marine protected area network design. *Journal of the Marine Biological Association of the United Kingdom* **90**, 33–68.

Huang Z and Brooke B (2011) Performance of predictive models in marine benthic environments based on predictions of sponge distribution on the Australian continental shelf. *Ecological Informatics* **6**, 205–216.

Hunt OD (1925) The food of the bottom fauna of the Plymouth Fishing Grounds. *Journal of the Marine Biological Association of the United Kingdom* **13**, 560–599.

Hunt JC, Zeidberg LD, Hamner WM and Robison BH (2000) The behaviour of *Loligo opalescens* as observed by a remotely operated vehicle (ROV). *Journal of the Marine Biological Association of the United Kingdom* **80**, 873–883.

Hunter B and Simpson AE (1976) A benthic grab designed for easy operation and durability. *Journal of the Marine Biological Association of the United Kingdom* **56**, 951–957.

Hunter E, Buckley AA, Stewart C and Metcalfe JD (2005) Migratory behaviour of the thornback ray, *Raja clavata*, in the southern North Sea. *Journal of the Marine Biological Association of the United Kingdom* **85**, 1095–1105.

Jamieson AJ, Lörz A-N, Fujii T and Priede IG (2012) *In situ* observations of trophic behaviour and locomotion of *Princaxelia* amphipods (Crustacea: Pardaliscidae) at hadal depths in four West Pacific Trenches. *Journal of the Marine Biological Association of the United Kingdom* **92**, 143–150.

Janssen J, Harbison GR and Craddock JE (1986) Hatchetfishes hold horizontal attitudes during diagonal descents. *Journal of the Marine Biological Association of the United Kingdom* **66**, 825–833.

Jennings S, Kaiser M and Reynolds JD (2001) *Marine Fisheries Ecology*. Oxford: Blackwell Science.

Johnson T (1890) Flora of Plymouth Sound and adjacent waters. Preliminary paper. *Journal of the Marine Biological Association of the United Kingdom* **1**, 286–305.

Johnston R (1955) Biologically active compounds in the sea. *Journal of the Marine Biological Association of the United Kingdom* **34**, 185–195.

Jones A (1972) Studies on egg development and larval rearing of turbot, *Scophthalmus maximus* L., and brill, *Scophthalmus rhombus* L., in the laboratory. *Journal of the Marine Biological Association of the United Kingdom* **52**, 965–986.

Jones PGW and Spencer CP (1963) Comparison of several methods of determining inorganic phosphate in sea water. *Journal of the Marine Biological Association of the United Kingdom* **43**, 251–273.

Kain JM (1960) Direct observations on some Manx sublittoral algae. *Journal of the Marine Biological Association of the United Kingdom* **39**, 609–630.

Kain JM and Fogg GE (1958) Studies on the growth of marine phytoplankton II *Isochrysis galbana* Parke. *Journal of the Marine Biological Association of the United Kingdom* **37**, 781–788.

Kaiser MJ, Attrill MJ, Jennings S, Thomas DN, Barnes DKA, Brierley AS, Hiddink JG, Kaartokallio H, Polunin NVC and Raffaelli DG (2011) *Marine Ecology: Processes, Systems, and Impacts*. Oxford: Oxford University Press.

Karageorgopoulos P and Lewis C (2008) A new species of *Marphysa* (Eunicidae) from the western Cape of South Africa. *Journal of the Marine Biological Association of the United Kingdom* **88**, 277–287.

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

Kennedy M and FitzMaurice P (1969) Pelagic eggs and young stages of fishes taken on the south coast of Ireland in 1967. *Irish Fisheries Investigations Series B (Marine)* **5**, 5–36.

Kiel S (ed.) (2010) *The Vent and Seep Biota. Aspects From Microbes to Ecosystems*. Topics in Geobiology. Dordrecht: Springer.

Kirby RR and Lindley JA (2005) Molecular analysis of continuous plankton recorder samples, an examination of echinoderm larvae in the North Sea. *Journal of the Marine Biological Association of the United Kingdom* **85**, 451–459.

Kirby RR and Reid PC (2001) PCR from the CPR offers a historical perspective on marine population ecology. *Journal of the Marine Biological Association of the United Kingdom* **81**, 539–540.

Kitching JA, Macan TT and Gilson HC (1934) Studies in sublittoral ecology. I. A submarine gully in Wembury Bay, South Devon. *Journal of the Marine Biological Association of the United Kingdom* **19**, 677–705.

Knight M and Parke M (1950) A biological study of *Fucus vesiculosus* L. and *F. serratus*. l. *Journal of the Marine Biological Association of the United Kingdom* **29**, 439–514.

Kohn AJ and Almasi KN (1993) Imposex in Australian *Conus*. *Journal of the Marine Biological Association of the United Kingdom* **73**, 241–244.

Korb R (2003) Lack of dietary specialization in adult *Aplysia californica*: evidence from stable carbon isotope composition. *Journal of the Marine Biological Association of the United Kingdom* **83**, 501–505.

Kramp PL (1961) Synopsis of the Medusae of the world. *Journal of the Marine Biological Association of the United Kingdom* **40**, 7–382.

Kritzler H and Eidemiller A (1972) A diver-monitored dredge for sampling motile epibenthos. *Journal of the Marine Biological Association of the United Kingdom* **52**, 553–556.

Kurihara T (1998) Brand marks on the starfish, *Asterina pectinifera*. *Journal of the Marine Biological Association of the United Kingdom* **78**, 677–680.

Land MF (1992) A note on the elongated eye of the octopus *Vitreledonella richardi*. *Journal of the Marine Biological Association of the United Kingdom* **72**, 89–92.

Langdon CJ and Waldock MJ (1981) The effect of algal and artificial diets on the growth and fatty acid composition of *Crassostrea gigas* spat. *Journal of the Marine Biological Association of the United Kingdom* **61**, 431–448.

Langston WJ, Pope ND, Davey M, Langston KM, O'Hara SCM, Gibbs PE and Pascoe PL (2015) Recovery from TBT pollution in English Channel environments: a problem solved? *Marine Pollution Bulletin* **95**, 551–564.

Lankester ER (1887*a*) Preface to the Journal of the Marine Biological Association. *Journal of the Marine Biological Association of the United Kingdom* **1(OS)**, 1–2.

Lankester ER (1887*b*) Report of the Foundation Meeting of the Marine Biological Association. *Journal of the Marine Biological Association of the United Kingdom* **1(OS)**, 22–39.

Lebour MV (1917) The microplankton of Plymouth Sound from the region beyond the breakwater. *Journal of the Marine Biological Association of the United Kingdom* **11**, 133–182.

Lebour MV (1918) The food of post-larval fish. *Journal of the Marine Biological Association of the United Kingdom* **11**, 433–469.

Lebour MV (1919*a*) Feeding habits of some young fish. *Journal of the Marine Biological Association of the United Kingdom* **12**, 9–21.

Lebour MV (1919*b*) The food of post-larval fish. No. II (1918). *Journal of the Marine Biological Association of the United Kingdom* **12**, 22–47.

Lebour MV (1919*c*) The young of the Gobiidae from the neighbourhood of Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **12**, 48–80.

Lebour MV (1920) The food of young fish. No. III (1919). *Journal of the Marine Biological Association of the United Kingdom* **12**, 261–264.

Lebour MV (1922) The food of plankton organisms. *Journal of the Marine Biological Association of the United Kingdom* **12**, 644–677.

Lebour MV (1923) The food of plankton organisms. II. *Journal of the Marine Biological Association of the United Kingdom* **13**, 70–92.

Lebour MV (1924) The Euphausiidæ in the neighbourhood of Plymouth and their importance as herring food. *Journal of the Marine Biological Association of the United Kingdom* **13**, 402–421.

Lebour MV (1925) Young anglers in captivity and some of their enemies: a study in a plunger jar. *Journal of the Marine Biological Association of the United Kingdom* **13**, 721–734.

Lebour MV (1933) The eggs and larvae of *Turritella communis* and *Aporrhais pespelecani* (L.). *Journal of the Marine Biological Association of the United Kingdom* **18**, 499–506.

Lebour MV (1934) Rissoid larvae as food of the young herring. The eggs and larvae of the Plymouth Rissoidae. *Journal of the Marine Biological Association of the United Kingdom* **19**, 523–539.

Lebour MV (1944) Studies of the Plymouth Brachyura. I. The rearing of crabs in captivity, with a description of the larval stages of *Inachus dorsettensis*, *Macropodia longirostris* and *Maia squinado*. *Journal of the Marine Biological Association of the United Kingdom* **26**, 7–15.

Lessard RR and Demarco G (2000) The significance of oil dispersants. *Spill Science and Technology Bulletin* **6**, 59–68.

Lick R and Piatkowski U (1998) Stomach contents of a northern bottlenose whale (*Hyperoodon ampullatus*) stranded at Hiddensee, Baltic Sea. *Journal of the Marine Biological Association of the United Kingdom* **78**, 643–650.

Liss PS and Spencer CP (1969) An investigation of some methods used for the determination of silicate in sea water. *Journal of the Marine Biological Association of the United Kingdom* **49**, 569–601.

Lloyd B (1930) Bacteria of the Clyde Sea Area: a quantitative investigation. *Journal of the Marine Biological Association of the United Kingdom* **16**, 879–907.

Lordan C, Colins MA and Perales-Raya C (1998) Observations on morphology, age and diet of three *Architeuthis* caught off the west coast of Ireland in 1995. *Journal of the Marine Biological Association of the United Kingdom* **78**, 903–917.

Lyle L (1929) Marine algae of some German warships in Scapa Flow and of the neighbouring shores. *Botanical Journal of the Linnean Society* **48**, 231–257.

MacBride EW (1900) Notes on the rearing of echinoid larvae. *Journal of the Marine Biological Association of the United Kingdom* **6**, 94–97.

MacBride EW (1914) *Text-Book of Embryology: Volume 1. Invertebrates*. London: McMillan & Co. Ltd.

MacLeod CD, Santos MB and Pierce GJ (2003) Review of data on diets of beaked whales: evidence of niche separation and geographic segregation. *Journal of the Marine Biological Association of the United Kingdom* **83**, 651–665.

Maddock L and Swann CL (1970) A statistical analysis of some trends in sea temperature and climate in the Plymouth area in the last 70 years. *Journal of the Marine Biological Association of the United Kingdom* **57**, 317–358.

Maddock L, Harbour DS and Boalch GT (1989) Seasonal and year-to-year changes in the phytoplankton from the Plymouth area, 1963–1986. *Journal of the Marine Biological Association of the United Kingdom* **69**, 229–244.

Maldonaldo M and Young CM (1998) A new species of poecilosclerid sponge (Porifera) from bathyal methane seeps in the Gulf of Mexico. *Journal of the Marine Biological Association of the United Kingdom* **79**, 795–806.

Manley AR (1983) The effects of copper on the behaviour, respiration, filtration and ventilation activity of *Mytilus edulis*. *Journal of the Marine Biological Association of the United Kingdom* **63**, 205–222.

Mare MF (1925) A study of a marine benthic community with special reference to the micro-organisms. *Journal of the Marine Biological Association of the United Kingdom* **25**, 517–552.

Marine Biological Association (1889) Bye-laws. *Journal of the Marine Biological Association of the United Kingdom* **1(NS)**, xiii–xv.

Marine Biological Association (1904) Plymouth marine invertebrate fauna. *Journal of the Marine Biological Association of the United Kingdom* **7**, 155–298.

Marine Biological Association (1931) *Plymouth Marine Fauna*. Plymouth: Marine Biological Association of the United Kingdom.

Marine Biological Association (1957) *Plymouth Marine Fauna*. Plymouth: Marine Biological Association of the United Kingdom.

Marine Biological Association (2017) Regulations and Rules, *Marine Biological Association*. Available at https://www.mba.ac.uk/sites/default/files/alexa/Regulations%20November%202017_0.pdf (Accessed 12 March 2019).

Marine Biological Association (2018) Culture collection. Available at https://www.mba.ac.uk/facilities/culture-collection#b7 (Accessed 12 March 2019).

Mason AZ and Simkiss K (1983) Interactions between metals and their distribution in tissues of *Littorina littorea* (L.) collected from clean and polluted sites. *Journal of the Marine Biological Association of the United Kingdom* **63**, 661–672.

Matthew DJ (1916) On the amount of phosphoric acid in the sea-water off Plymouth Sound. *Journal of the Marine Biological Association of the United Kingdom* **11**, 122–130.

McHugh M, Sims DW, Partridge JC and Genner MJ (2010) A century later: long-term change of an inshore temperate marine fish assemblage. *Journal of Sea Research* **65**, 187–194.

McIntyre AD (1956) The use of trawl, grab and camera in estimating benthos. *Journal of the Marine Biological Association of the United Kingdom* **35**, 419–429.
McNutt M (2019) "Plan S" falls short for society publishers – and for the researchers they serve. *Proceedings of the National Academy of Sciences USA* **116**, 2400–2403.
Meadows PS and Anderson HG (1968) Micro-organisms attached to marine sand grains. *Journal of the Marine Biological Association of the United Kingdom* **48**, 161–175.
Mehang AA, Edwards KJ, Schofield JE, Raab A, Feldmann J, Moran A, Bryant CL, Thornton B and Dawson JJC (2012) First comprehensive peat depositional records for tin, lead and copper associated with the antiquity of Europe's largest cassiterite deposits. *Journal of Archaeological Science* **39**, 717–727.
Mendes S, Newton J, Reid RJ and Frantzis A (2007) Stable isotope profiles in sperm whale teeth: variations between areas and sexes. *Journal of the Marine Biological Association of the United Kingdom* **87**, 621–627.
Mieszkowska N, Sugden H, Firth LB and Hawkins SJ (2014) The role of sustained observations in tracking impacts of environmental change on marine biodiversity and ecosystems. *Philosophical Transactions of the Royal Society A* **A375** (2025), 20130339. doi: 10_1098/rsta.2013.0339 (Accessed 4 January 2019).
Miles H (1975) Barrows on the St. Austell Granite, Cornwall. *Cornish Archaeology* **14**, 35–38.
Moens T, Bouillon S and Gallucci F (2005) Dual stable isotope abundances unravel trophic position of estuarine nematodes. *Journal of the Marine Biological Association of the United Kingdom* **85**, 1401–1407.
Moore HB (1936) The biology of *Balanus balanoides*. V. Distribution in the Plymouth Area. *Journal of the Marine Biological Association of the United Kingdom* **20**, 701–716.
Moore HB and Kitching JA (1939) The biology of *Chthamalus stellatus* (Poli). *Journal of the Marine Biological Association of the United Kingdom* **23**, 521–541.
Mortensen PB, Roberts M and Sundt RC (2000) Video-assisted grabbing: a minimally destructive method of sampling azooxanthellate coral banks. *Journal of the Marine Biological Association of the United Kingdom* **80**, 365–366.
Muehlstein LK, Porter D and Short FT (1991) *Labyrinthula zosterae* sp. nov., the causative agent of wasting disease of eelgrass, *Zostera marina*. *Mycologia* **83**, 180–191.
Murphy J and Riley JP (1958) A single-solution method for the determination of soluble phosphate in seawater. *Journal of the Marine Biological Association of the United Kingdom* **37**, 9–14.
Nagasaki K, Tomaru Y, Shirai Y, Takao Y and Mizumoto H (2006) Dinoflagellate-infecting viruses. *Journal of the Marine Biological Association of the United Kingdom* **86**, 469–474.
Nelson EW (1922) On the manufacture of drift bottles. *Journal of the Marine Biological Association of the United Kingdom* **12**, 700–716.
Newell BS (1967) The determination of ammonia in seawater. *Journal of the Marine Biological Association of the United Kingdom* **47**, 322–325.
Newell RC (ed.) (1976) *Adaptation to Environment: Essays on the Physiology of Marine Animals*. London: Butterworths.
Nicol JAC (1952) Studies on *Chaetopterus variopedatus* (Renier). I. The light-producing glands. *Journal of the Marine Biological Association of the United Kingdom* **30**, 417–433.
Nithart M (2000) Comparison of stable carbon and nitrogen isotope signatures of the polychaete *Nereis diversicolor* from different estuarine sites. *Journal of the Marine Biological Association of the United Kingdom* **80**, 763–765.
Noda T, Twasaki A and Fukaya K (2016) Recovery of rocky intertidal zonation: two years after the 2011 Great East Japan Earthquake. *Journal of the Marine Biological Association of the United Kingdom* **96**, 1549–1555.
O'Connor WA, Nell JA and Diemar JA (1992) The evaluation of twelve algal species as food for juvenile Sydney rock oysters *Saccostrea commercialis* (Iredale & Roughley). *Aquaculture* **108**, 277–283.
Oliver PG, Vestheim H, Antunes A and Kaartvedt S (2015) Systematics, functional morphology and distribution of a bivalve (*Apachecorbula muriatica* gen. et sp. nov.) from the rim of the 'Valdivia Deep' brine pool in the Red Sea. *Journal of the Marine Biological Association of the United Kingdom* **95**, 523–535.
Orton HN (1920) Sea-temperature, breeding and distribution in marine animals. *Journal of the Marine Biological Association of the United Kingdom* **12**, 339–366.
Orton JH and Lewis HM (1931) On the effect of the severe winter of 1928–1929 on the oyster drills (with a record of five years' observations on sea-temperature on the oyster-beds) of the Blackwater Estuary. *Journal of the Marine Biological Association of the United Kingdom* **17**, 301–313.
Oudot C and Montel Y (1988) A high sensitivity method for the determination of nanomolar concentrations of nitrate and nitrite in seawater with a Technicon Autoanalyzer II. *Marine Chemistry* **24**, 239–252.
Páez-Rosas D and Aurioles-Gamboa D (2014) Spatial variation in the foraging behaviour of the Galapagos sea lions (*Zalophus wollebaeki*) assessed using scat collections and stable isotope analysis. *Journal of the Marine Biological Association of the United Kingdom* **94**, 1099–1107.
Parke M (1948) Studies on British Laminariaceae. I. Growth in *Laminaria saccharina* (L.) Lamour. *Journal of the Marine Biological Association of the United Kingdom* **27**, 651–709.
Parke M (1949) Studies on marine flagellates. *Journal of the Marine Biological Association of the United Kingdom* **28**, 255–285.
Parke M and Dixon PS (1964) A revised check-list of British marine algae. *Journal of the Marine Biological Association of the United Kingdom* **44**, 499–542.
Parke M and Dixon PS (1976) Checklist of British marine algae – third revision. *Journal of the Marine Biological Association of the United Kingdom* **56**, 527–594.
Parke M, Manton I and Clarke B (1955) Studies on marine flagellates II. Three new species of *Chrysochromulina*. *Journal of the Marine Biological Association of the United Kingdom* **34**, 579–609.
Parker SJ and McCleave JD (1997) Selective tidal stream transport by American eels during homing movements and estuarine migration. *Journal of the Marine Biological Association of the United Kingdom* **77**, 871–889.
Pavillon J-F, Oudot J, Dlugon A and Roger E (2002) Impact of the 'Erika' oil spill on the *Tigriopus brevicornis* ecosystem at the Le Croisic headland (France): preliminary observations. *Journal of the Marine Biological Association of the United Kingdom* **82**, 409–413.
Percival E (1929) A report on the fauna of the River Tamar and the River Lynher. *Journal of the Marine Biological Association of the United Kingdom* **16**, 81–108.
Phillips FP (1964) Metamorphic rocks of the sea floor between Start Point and Dodman Point, S.W. England. *Journal of the Marine Biological Association of the United Kingdom* **44**, 655–663.
Pingree RD (1995) The droguing of meddy Pinball and seeding with ALACE floats. *Journal of the Marine Biological Association of the United Kingdom* **75**, 235–252.
Pingree RD (2002) Ocean structure and climate (Eastern North Atlantic): *in situ* measurement and remote sensing (altimeter). *Journal of the Marine Biological Association of the United Kingdom* **82**, 681–707.
Pingree RD and Maddock L (1985) Stokes, Euler and Lagrange aspects of residual tidal transports in the English Channel and the Southern Bight of the North Sea. *Journal of the Marine Biological Association of the United Kingdom* **65**, 969–982.
Pingree RD and Pennycuick L (1975) Transfer of heat, fresh water and nutrients through the seasonal thermocline. *Journal of the Marine Biological Association of the United Kingdom* **55**, 261–274.
Poole HH and Atkins WRG (1929) Photo-electric measurements of submarine illumination throughout the year. *Journal of the Marine Biological Association of the United Kingdom* **16**, 297–324.
Potts GW (1976) A diver-controlled plankton net. *Journal of the Marine Biological Association of the United Kingdom* **56**, 959–962.
Probert PK (1975) The bottom fauna of china clay waste deposits in Mevagissey Bay. *Journal of the Marine Biological Association of the United Kingdom* **55**, 19–44.
Probert PK (1981) Changes in the benthic community of china clay waste deposits in Mevagissey Bay following a reduction of discharges. *Journal of the Marine Biological Association of the United Kingdom* **61**, 789–804.
Purcell JE (2005) Climate effects on formation of jellyfish and ctenophore blooms: a review. *Journal of the Marine Biological Association of the United Kingdom* **85**, 461–476.
Pyefinch KA (1949) Short-period fluctuations in the numbers of barnacle larvae, with notes on comparisons between pump and net plankton hauls. *Journal of the Marine Biological Association of the United Kingdom* **28**, 353–369.
Quillien N, Nordström MC, Le Bris H, Bonsdorff E and Grall J (2017) Green tides on inter- and subtidal sandy shores: differential impacts on

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

infauna and flatfish. *Journal of the Marine Biological Association of the United Kingdom* **98**, 699–712.

Rainbow PS (2018) *Trace Metals in the Environment and Living Organisms: The British Isles as a Case Study*. Cambridge: Cambridge University Press.

Rainbow PS, Smith BD and Lau SSS (2002) Biomonitoring of trace metal availabilities in the Thames estuary using a suite of littoral biomonitors. *Journal of the Marine Biological Association of the United Kingdom* **82**, 65–72.

Ramirez-Llodra E and Segonzac M (2006) Reproductive biology of *Alvinocaris muricola* (Decapoda: Caridea: Alvinocarididae) from cold seeps in the Congo Basin. *Journal of the Marine Biological Association of the United Kingdom* **86**, 1347–1356.

Raven JA, Kübler JE and Beardall J (2000) Put out the light, and then put out the light. *Journal of the Marine Biological Association of the United Kingdom* **80**, 1–25.

Rees HL, Waldock R, Mathiessen P and Pendle MA (1987) Surveys of the epibenthos of the Crouch Estuary (UK) in relation to TBT contamination. *Journal of the Marine Biological Association of the United Kingdom* **79**, 209–223.

Reid PC, Colebrook JM, Matthews JBL and Aiken J (2003) The continuous plankton recorder: concepts and history, from plankton indicator to undulating recorders. *Progress in Oceanography* **58**, 117–173.

Reynolds WJ, Lancaster JE and Pawson MG (2003) Patterns of spawning and recruitment of sea bass to Bristol Channel nurseries in relation to the 1996 'Sea Empress' oil spill. *Journal of the Marine Biological Association of the United Kingdom* **83**, 1163–1170.

Riches TH (1893) A list of the nemertines of Plymouth Sound. *Journal of the Marine Biological Association of the United Kingdom* **3**, 1–29.

Ridge RJ (1889) The mackerel fishery in the West of England. *Journal of the Marine Biological Association of the United Kingdom* **1(NS)**, 72–73.

Righton D, Quayle VA, Hetherington S and Burt GR (2007) Movements and distribution of cod (*Gadus morhua*) in the southern North Sea and English Channel: results from conventional and electronic tagging experiments. *Journal of the Marine Biological Association of the United Kingdom* **87**, 599–613.

Riley JP and Segar DA (1970) The seasonal variation of the free and combined dissolved amino acids in the Irish Sea. *Journal of the Marine Biological Association of the United Kingdom* **50**, 713–720.

Rizzo LY and Schulle D (2009) A review of humpback whales' migration patterns worldwide and their consequences to gene flow. *Journal of the Marine Biological Association of the United Kingdom* **89**, 995–1002.

Roach W (1890) Notes on the herring, long-line, and pilchard fisheries of Plymouth during the Winter 1889–90. *Journal of the Marine Biological Association of the United Kingdom* **1**, 382–390.

Roach W (1891) Notes on the herring, long-line, and pilchard fisheries of Plymouth (continued). *Journal of the Marine Biological Association of the United Kingdom* **2**, 180–188.

Robinson GA and Hunt HG (1986) Continuous plankton records: annual fluctuations of the plankton in the Western English Channel, 1958–83. *Journal of the Marine Biological Association of the United Kingdom* **66**, 791–802.

Rodríguez F, Fernández E, Head RN and Harbour DS (2000) Temporal variability of viruses, bacteria, phytoplankton and zooplankton in the western English Channel off Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **80**, 575–586.

Ross KA, Thorpe JP, Norton TA and Brand AR (2001) An assessment of some methods for tagging the great scallop, *Pecten maximus*. *Journal of the Marine Biological Association of the United Kingdom* **81**, 975–977.

Ruiz JM, Bryan GW, Wigham JM and Gibbs PE (1996) Effects of copper on the 48-h embryonic development of the bivalve *Scrobicularia plana*. *Journal of the Marine Biological Association of the United Kingdom* **76**, 829–832.

Russell FS (1925) A releasing apparatus for horizontally towed plankton nets. *Journal of the Marine Biological Association of the United Kingdom* **13**, 673–677.

Russell FS (1926) The vertical distribution of marine macroplankton. II. The pelagic young of teleostean fishes in the day-time in the Plymouth Area, with a note on the eggs of certain species. *Journal of the Marine Biological Association of the United Kingdom* **14**, 101–159.

Russell FS (1928) List of publications recording the results of researches carried out under the auspices of the Marine Biological Association of the United Kingdom in their Laboratory at Plymouth or on the North Sea Coast from 1886–1927. *Journal of the Marine Biological Association of the United Kingdom* **15**, 753–828.

Russell FS (1930) The seasonal abundance and distribution of the pelagic young of teleostean fishes caught in the ring-trawl in offshore waters in the Plymouth Area. *Journal of the Marine Biological Association of the United Kingdom* **16**, 707–722.

Russell FS (1935) On the value of certain plankton animals as indicators of water movements in the English Channel and North Sea. *Journal of the Marine Biological Association of the United Kingdom* **20**, 309–331.

Russell FS (1952) Classified list of publications. Volumes XVI to XXIX of the Journal of the Marine Biological Association and other publications recording the results of researches carried out at the Plymouth Laboratory from 1928 to 1950. *Journal of the Marine Biological Association of the United Kingdom* **30**, 589–673.

Russell FS (1963) The Plymouth Laboratory of the Marine Biological Association of the United Kingdom, 1963. *Journal of the Marine Biological Association of the United Kingdom* **43**, 281–290.

Russell FS (1973) A summary of the observations on the occurrence of planktonic stages of fish off Plymouth 1924–1972. *Journal of the Marine Biological Association of the United Kingdom* **68**, 423–455.

Russell FS (1976) *The Eggs and Planktonic Stages of British Marine Fishes*. New York, NY: Academic Press.

Salman A, Bilecenoglu M and Güçlüsoy H (2001) Stomach contents of two Mediterranean monk seals (*Monachus monachus*) from the Aegean Sea, Turkey. *Journal of the Marine Biological Association of the United Kingdom* **81**, 719–720.

Santos MB, Pierce GJ, Herman J, Lopez A, Guerra A, Mente E and Clarke MR (2001) Feeding ecology of Cuvier's beaked whale (*Ziphius cavirostris*): a review with new information on the diet of this species. *Journal of the Marine Biological Association of the United Kingdom* **81**, 687–694.

Schönberg CHL (2016) Happy relationships between marine sponges and sediments – a review and some observations from Australia. *Journal of the Marine Biological Association of the United Kingdom* **96**, 493–514.

Scott JM (1981) The vitamin B12 requirement of the marine rotifer *Brachionus plicatilis*. *Journal of the Marine Biological Association of the United Kingdom* **61**, 983–999.

Seco J, Daneri GL, Ceia FR, Vieira RPS, Hill SL and Xavier JC (2016) Distribution of short-finned squid *Illex argentinus* (Cephalopoda: Ommastrephidae) inferred from the diets of Southern Ocean albatrosses using stable isotope analyses. *Journal of the Marine Biological Association of the United Kingdom* **98**, 1211–1215.

Short J and Metaxas A (2011) Gregarious settlement of tubeworms at deep-sea hydrothermal vents on the Tonga–Kermadec arc, South Pacific. *Journal of the Marine Biological Association of the United Kingdom* **91**, 15–22.

Sims DW (2014) Inside the squid giant axon. *Marine Biologist* **3**, 28.

Sitjà C, Maldonaldo M, Farias C and Rueda JL (2019) Deep-water sponge fauna from the mud volcanoes of the Gulf of Cadiz (North Atlantic, Spain). *Journal of the Marine Biological Association of the United Kingdom* **99**, 807–831.

Smith JE (1968) *'Torrey Canyon' Pollution and Marine Life*. Cambridge: Cambridge University Press.

Smith W and McIntyre AD (1954) A spring-loaded bottom sampler. *Journal of the Marine Biological Association of the United Kingdom* **33**, 257–264.

Sousa AC, Takahashi S and Pastorhino MR (2014) History on organotin compounds, from snails to humans. *Environmental Chemistry Letters* **12**, 117–137.

Southall EJ, Sims DW, Metcalfe JD, Doyle JL, Fanshawe S, Lacey C, Shrimpton J, Solandt J-L and Speedie CD (2003) Spatial distribution patterns of basking sharks on the European shelf: preliminary comparison of satellite-tag geolocation, survey and public sightings data. *Journal of the Marine Biological Association of the United Kingdom* **85**, 1083–1088.

Southward AJ (1957) On the behaviour of barnacles III. Further observations on the influence of temperature and age on cirral activity. *Journal of the Marine Biological Association of the United Kingdom* **36**, 323–334.

Southward AJ (1958) Note on the temperature tolerances of some intertidal animals in relation to environmental temperatures and geographical distribution. *Journal of the Marine Biological Association of the United Kingdom* **37**, 49–66.

Southward AJ (1960) On the changes of sea temperature in the English Channel. *Journal of the Marine Biological Association of the United Kingdom* **39**, 449–458.

https://doi.org/10.1017/S0025315419001000 Published online by Cambridge University Press

Southward AJ (1962*a*) The distribution of some plankton animals in the English Channel and Approaches. ii. Surveys with the Gulf. iii. High-speed sampler, 1958–60. *Journal of the Marine Biological Association of the United Kingdom* **42**, 275–375.

Southward AJ (1962*b*) On the behaviour of barnacles. IV: the influence of temperature on cirral activity and survival of some warm-water species. *Journal of the Marine Biological Association of the UK* **42**, 163–177.

Southward AJ (1970) Improved methods of sampling post-larval young fish and macroplankton. *Journal of the Marine Biological Association of the United Kingdom* **50**, 689–712.

Southward AJ (1991) Forty years of changes in species composition and population density of barnacles on a rocky shore near Plymouth. *Journal of the Marine Biological Association of the United Kingdom* **71**, 495–513.

Southward AJ and Roberts EA (1984) The Marine Biological Association 1884–1984: one hundred years of marine research. *Reports and Transactions of the Devonshire Association* **116**, 155–199.

Southward AJ and Southward EC (1958*a*) Pogonophora from the Atlantic. *Journal of the Marine Biological Association of the United Kingdom* **181**, 1607.

Southward AJ and Southward EC (1978) Recolonization of rocky shores in Cornwall after use of toxic dispersants to clean up the *Torrey Canyon* spill. *Journal of the Fisheries Research Board of Canada* **35**, 682–706.

Southward AJ and Southward EC (1980) The significance of dissolved organic compounds in the nutrition of *Siboglinum ekmani* and other small species of Pogonophora. *Journal of the Marine Biological Association of the United Kingdom* **60**, 1005–1034.

Southward AJ, Robinson SG, Nicholson D and Perry TJ (1976) An improved stereocamera and control system for close-up photography of the fauna of the continental slope and outer shelf. *Journal of the Marine Biological Association of the United Kingdom* **56**, 247–257.

Southward AJ, Southward EC, Dando PR, Barrett RL and Ling R (1986) Chemoautotrophic function of bacterial symbionts in small Pogonophora. *Journal of the Marine Biological Association of the United Kingdom* **66**, 415–437.

Southward AJ, Boalch GT and Maddock L (1988) Fluctuations in the herring and pilchard fisheries of Devon and Cornwall linked to change in climate since the 16th century. *Journal of the Marine Biological Association of the United Kingdom* **68**, 423–445.

Southward AJ, Southward EC, Spiro B, Rau GH and Tunnicliffe V (1994) Select 13C/12C of organisms from Juan de Fuca Ridge hydrothermal vents: a guide to carbon and food sources. *Journal of the Marine Biological Association of the United Kingdom* **74**, 265–278.

Southward AJ, Hawkins SJ and Burrows MT (1995) Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. *Journal of Thermal Biology* **20**, 127–155.

Southward AJ, Langmead O, Hardman-Mountford NJ, Aiken J, Boalch GT, Dando PR, Genner MJ, Joint I, Kendall MA, Halliday NC, Harris RP, Leaper R, Mieszkowska N, Pingree RD, Richardson AJ, Sims DW, Smith T, Walne AW and Hawkins SJ (2005) Long-term oceanographic and ecological research in the Western English Channel. *Advances in Marine Biology* **47**, 1–105.

Southward EC (1963) Some new and little known serpulid polychaetes from the Continental Slope. *Journal of the Marine Biological Association of the United Kingdom* **43**, 573–587.

Southward EC (1978) A new species of Lamellisabella (Pogonophora) from the North Atlantic. *Journal of the Marine Biological Association of the United Kingdom* **58**, 713–718.

Southward EC (1982) Bacterial symbionts in Pogonophora. *Journal of the Marine Biological Association of the United Kingdom* **62**, 889–906.

Southward EC (1986) Gill symbionts in thyasirids and other bivalve molluscs. *Journal of the Marine Biological Association of the United Kingdom* **66**, 889–914.

Southward EC and Southward AJ (1958b) On some Pogonophora from the north-east Atlantic, including two new species. *Journal of the Marine Biological Association of the United Kingdom* **37**, 627–632.

Southward EC, Gebruk A, Kennedy H, Southward AJ and Chevaldonné P (2001) Different energy sources for three symbiont-dependent bivalve molluscs at the Logatchev hydrothermal site (Mid-Atlantic Ridge). *Journal of the Marine Biological Association of the United Kingdom* **81**, 485–499.

Spooner GM, Howarth JV, Southward AJ and Roberts EA (1987) Centenary of the Journal. *Journal of the Marine Biological Association of the United Kingdom* **67**, 463–464.

Stead FB (1896) The fourth report of the Danish Biological Station. *Journal of the Marine Biological Association of the United Kingdom* **4**, 213–218.

Stebbing ARD, Turk SMT, Wheeler A and Clarke KR (2002) Immigration of southern fish species to south-west England linked to warming of the North Atlantic (1960–2001). *Journal of the Marine Biological Association of the United Kingdom* **82**, 177–180.

Steele JH and Yentsch CS (1960) The vertical distribution of chlorophyll. *Journal of the Marine Biological Association of the United Kingdom* **39**, 217–226.

Steven GA (1930) Bottom fauna and the food of fishes. *Journal of the Marine Biological Association of the United Kingdom* **16**, 677–706.

Steven GA (1949) Contributions to the biology of the mackerel *Scomber scombrus* L. II. A study of the fishery in the South-West of England, with special reference to spawning, feeding, and 'fishermen's signs'. *Journal of the Marine Biological Association of the United Kingdom* **28**, 555–581.

Stevens JD (1973) Stomach contents of the blue shark (*Prionace glauca* L.) off South-West England. *Journal of the Marine Biological Association of the United Kingdom* **53**, 357–361.

Stevens JD (1976) First results of shark tagging in the north-east Atlantic, 1972–1975. *Journal of the Marine Biological Association of the United Kingdom* **56**, 929–937.

Stöhr S and Segonzac M (2005) Deep-sea ophiuroids (Echinodermata) from reducing and non-reducing environments in the North Atlantic Ocean. *Journal of the Marine Biological Association of the United Kingdom* **85**, 382–402.

Strickland JDH and Parsons TR (1972) *A Practical Handbook of Seawater Analysis*. Ottawa: Fisheries Research Board of Canada.

Suzuki Y, Suzuki M, Tsuchida S, Takai KKH, Southward AJ, Newman WA and Yamaguchi T (2009) Molecular investigations of the stalked barnacle *Vulcanolepas osheai* and the epibiotic bacteria from the Brothers Caldera, Kermadec Arc, New Zealand. *Journal of the Marine Biological Association of the United Kingdom* **89**, 727–733.

Tas S, Okus E, Ünlu S and Altiok H (2011) A study on phytoplankton following 'Volgoneft-248' oil spill on the north-eastern coast of the Sea of Marmara. *Journal of the Marine Biological Association of the United Kingdom* **91**, 715–725.

Taylor JD and Cunliffe M (2017) Coastal bacterioplankton community response to diatom-derived polysaccharide microgels. *Environmental Microbiology Reports* **2**, 151–157.

Thorpe JP, Ryland JS, Cornelius PFS and Beardmore PA (1992) Genetic divergence between branched and unbranched forms of the thecate hydroid *Aglaophenia pluma*. *Journal of the Marine Biological Association of the United Kingdom* **72**, 887–894.

Thurstan RH, Brockington S and Roberts CM (2010) The effects of 118 years of industrial fishing on UK bottom trawl fisheries. *Nature Communications* **1**, 1–15.

Tsuchida S, Suzuki Y, Fujiwara Y, Kawato M, Uematsu K, Yamanaka T, Mizots C and Yamamoto H (2011) Epibiotic association between filamentous bacteria and the vent-associated galatheid crab, *Shinkaia crosnieri* (Decapoda: Anomura). *Journal of the Marine Biological Association of the United Kingdom* **91**, 23–32.

Turley CM and Hughes J (1994) The effect of storage temperature on the enumeration of epifluorescence-detectable bacterial cells in preserved sea-water samples. *Journal of the Marine Biological Association of the United Kingdom* **74**, 259–262.

Tyler PA and Young CM (1999) Reproduction and dispersal at vents and cold seeps. *Journal of the Marine Biological Association of the United Kingdom* **79**, 193–208.

Vevers HG (1951) Photography of the sea floor. *Journal of the Marine Biological Association of the United Kingdom* **30**, 101–112.

Webb JE and Theodor JL (1972) Wave-induced circulation in submerged sands. *Journal of the Marine Biological Association of the United Kingdom* **52**, 903–914.

Wilding CS, Beaumont AR and Latchford JW (1999) Are *Pecten maximus* and *Pecten jacobaeus* different species? *Journal of the Marine Biological Association of the United Kingdom* **79**, 949–952.

Williams OJ, Beckett RE and Maxwell D (2016) Marine phytoplankton preservation with Lugol's: a comparison of solutions. *Journal of Applied Phycology* **28**, 1705–1712. doi: 10.1007/s10811-015-0704-4

Wilson DP (1937) The habits of the angler-fish, *Lophius piscatorius* L., in the Plymouth Aquarium. *Journal of the Marine Biological Association of the United Kingdom* **21**, 477–496.

Wilson DP (1946) A note on the capture of prey by *Sepia officinalis* L. *Journal of the Marine Biological Association of the United Kingdom* **26**, 421–425.

Wilson DP (1949*a*) The decline of *Zostera marina* L. at Salcombe and its effects on the shore. *Journal of the Marine Biological Association of the United Kingdom* **28**, 395–412.

Wilson DP (1949*b*) Notes from the Plymouth Aquarium. *Journal of the Marine Biological Association of the United Kingdom* **28**, 345–351.

Wilson DP (1968) Long-term effects of low concentrations of an oil-spill remover ('detergent'): studies with the larvae of *Sabellaria spinulosa*. *Journal of the Marine Biological Association of the United Kingdom* **48**, 177–182.

Wilson DP (1978) Some observations on bipinnariae and juveniles of the starfish genus *Luidia*. *Journal of the Marine Biological Association of the United Kingdom* **58**, 467–478.

Wilson WH, Tarran GA, Schroeder D, Cox M, Oke J and Malin G (2002) Isolation of viruses responsible for the demise of an *Emiliania huxleyi* bloom in the English Channel. *Journal of the Marine Biological Association of the United Kingdom* **82**, 369–377.

Wood ED, Armstrong FAJ and Richards FA (1967) Determination of nitrate in sea water by cadmium-copper reduction to nitrite. *Journal of the Marine Biological Association of the United Kingdom* **47**, 23–31.

Woolsey S and Wilkinson M (2007) Localized field effects of drainage water from abandoned coal mines on intertidal rocky shore seaweeds at St Monans, Scotland. *Journal of the Marine Biological Association of the United Kingdom* **87**, 659–665.

Xavier JR, Cárdenas P, Cristobo J, Van Soest R and Rapp HT (2015) Systematics and biodiversity of deep-sea sponges of the Atlanto-Mediterranean region. *Journal of the Marine Biological Association of the United Kingdom* **95**, 1285–1286.

Xu Y, Ibrahim IM, Wosu CI, Ben-Amotz A and Harvey PJ (2018) Potential of new isolates of *Dunaliella salina* for natural-carotene production. *Biology* **7**, 14. doi: 10.3390/biology7010014

Yamaguchi T, Newman WA and Hashimoto J (2004) A cold seep barnacle (Cirripedia: Neolepadinae) from Japan and the age of the vent/seep fauna. *Journal of the Marine Biological Association of the United Kingdom* **84**, 111–120.

Yonge CM (1926) Structure and physiology of the organs of feeding and digestion in *Ostrea edulis*. *Journal of the Marine Biological Association of the United Kingdom* **14**, 295–386.

Young CM (1990) Larval ecology of marine invertebrates: a sesquicentennial history. *Ophelia* **32**, 1–48.

Zacharias MA, Morris MC and Howes DF (1999) Large scale characterization of intertidal communities using a predictive model. *Journal of Experimental Marine Biology and Ecology* **239**, 223–242.

Zhang J-Z (2000) Shipboard automated determination of trace concentrations of nitrite and nitrate in oligotrophic water by gas-segmented continuous flow analysis with a liquid waveguide capillary flow cell. *Deep Sea Research Part I* **47**, 1157–1171.

Zibrowius H (1974) *Caryophyllia sarsiae* n. sp. and other recent deep-water *Caryophyllia* (Scleractini) previously referred to little-known fossil species (*C. arcuata*, *C. cylindracea*). *Journal of the Marine Biological Association of the United Kingdom* **54**, 769–784.

Zubkov MV, Allen JI and Fuchs BM (2007) Coexistence of dominant groups in marine bacterioplankton community – a combination of experimental and modelling approaches. *Journal of the Marine Biological Association of the United Kingdom* **84**, 519–529.