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EDITORIAL

Marine Ecology Progress Series: celebrating 40 years of global impact

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INTRODUCTION

The first issue of *Marine Ecology Progress Series* (MEPS) was published on July 30th, 1979. By the end of that year the first volume (Issues 1 to 4) included an impressive 46 papers authored by scientists representing nations from Europe, North America, Asia and Africa. Although German and US scientists led the majority (61%) of articles in Vol. 1, MEPS quickly grew into a global journal (Fig. 1). This diversity of authorship is matched by the wide breadth of topics embraced in each and every volume (from bacteria and foraminifera to jellyfish and sharks, from single-species studies in the laboratory and the wild to extensive community-level field research, sometimes over decades). To help celebrate MEPS' auspicious 40th birthday in 2019 and look back on the broad impact of MEPS on the field of marine ecology, we briefly present and describe the unique contributions by MEPS' 40 most highly-cited studies — the 'MEPS Top 40 at 40' (Table 1).

EXPERIMENTAL DESIGN AND ANALYSIS

Some of the most highly-cited studies within MEPS introduced statistical techniques that are now commonplace when designing field studies and/or analyzing ecological data. These techniques include sampling designs appropriate for testing differences among field locations (Clarke & Green 1988) and the use of multi-dimensional scaling in revealing patterns in distribution among field stations to help identify environmental drivers or indicator species (Field et al. 1982, Clarke & Ainsworth 1993). Other well-cited studies introduced biodiversity indices (e.g. Delta, Delta* or variation in taxonomical distinctness) (Warwick & Clarke 1995, Clarke & Warwick 2001), which have become mainstays in research examining ecosystem change along environmental gradients.

NEW MEASUREMENT TECHNIQUES

Papers unveiling powerful measurement techniques that greatly advanced marine ecology are also among some of the most highly-cited papers in MEPS. In order to advance studies of nutrient cycling, Hoppe (1983) introduced a technique to measure *in situ* enzymatic degradation of macromolecules, a key step controlling the rate of production of dissolved organic carbon. Several studies reported improvements in the chemical measurement of algal pigments (Wright et al. 1991, Mackey et al. 1996, Zapata et al. 2000), paving the way for more precise estimates of standing stocks of different phytoplankton groups. In order to enhance understanding of food web structure, Hobson & Welch (1992) used measurements of stable-carbon and -nitrogen isotope ratios in the Arctic to create a novel isotopic food web model. A few years later, by summarizing and com-

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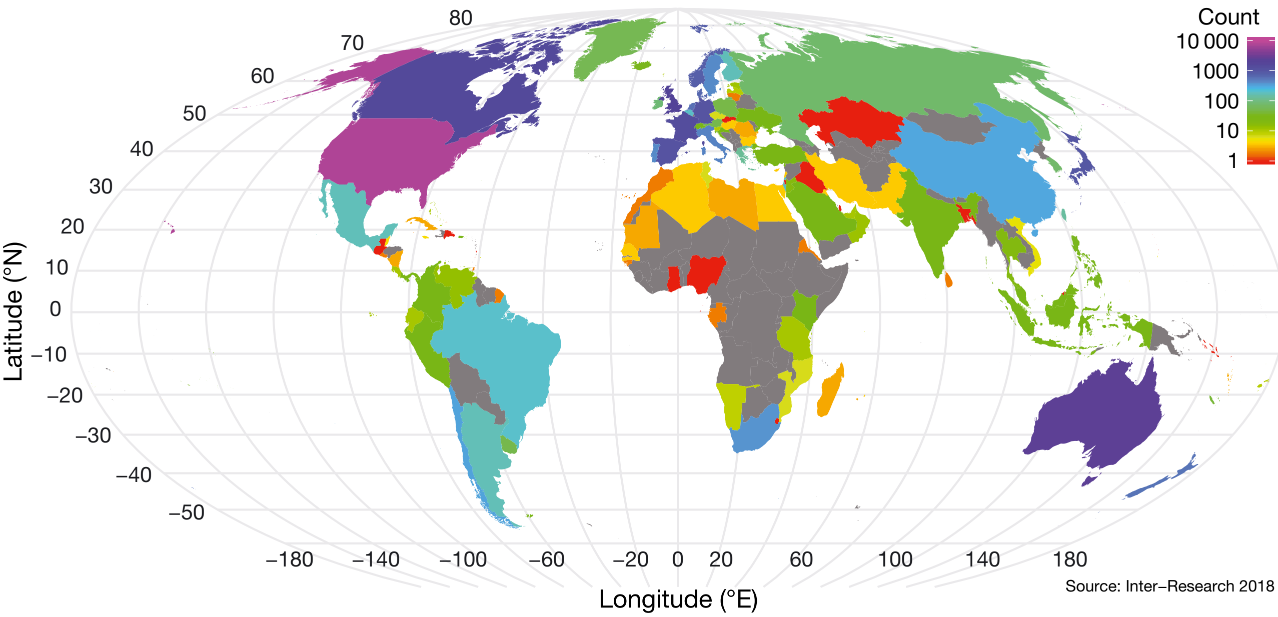

Fig. 1. A global view of MEPS' authorship based on the country affiliation of authors of published manuscripts. The cumulative number is shown for papers published between 1997 and 2018 (Vol. 156 to 604)

paring 876 values of Carbon-13, France (1995) documented differences between marine and freshwater taxa and between phytoplankton and benthic algae in marine habitats. In reviewing chemical measurements on fish otoliths, calcium carbonate ear bone structures containing growth rings, Campana (1999) demonstrated the wealth of information that these structures could provide on the life history of individuals, including stage-specific habitat utilization. This approach played a central role in launching a wide range of studies on population connectivity, a major research challenge in basic marine ecology and in fisheries management.

FUNDAMENTAL ECOLOGY OF ORGANISMS AND COMMUNITIES

The field of marine ecology requires fundamental understanding of the trophodynamic structure and function of marine ecosystems, nowadays a prevalent research theme in studies published in MEPS. In MEPS' most highly-cited article, Azam et al. (1983) described the roles of water-column bacteria and microplankton such as heterotrophic flagellates in the 'microbial loop'. Subsequent work described specific aspects of the 'microbial loop' such as bacterial protein synthesis (Simon & Azam 1989) and generated relationships for predicting bacterial production in the water column and sediments in different marine and freshwater systems (Cole et al. 1988). Fundamental MEPS studies also advanced knowledge on the growth physiology and life-cycle dynamics of key groups of planktonic and benthic organisms that helped set future research directions. This includes research on (1) phytoplankton nutrient requirements (Dortch 1990, Egge & Aksnes 1992), (2) the metabolic and lipid dynamics of zooplankton (Kiørboe et al. 1985, Lee et al. 2006), and (3) larval dynamics and the process of settlement and recruitment in benthic invertebrates (Gosselin & Qian 1997, Hunt & Scheibling 1997, Pechenik 1999). Three well-cited papers revealed fundamental aspects of coral ecology including how (1) reef-building corals reproduce using fragmentation (Highsmith 1982), (2) healthy corals have a rich, species-specific bacterial community (Rohwer et al. 2002) and (3) the mucus of corals contains antibiotic protection against invasive microbes (Ritchie 2006). Fish ecological research documented species-specific patterns of trophic niche breadth and size-based feeding strategies (Scharf et al. 2000). Other papers provided novel comments and syntheses on key processes such as epibiosis (Wahl 1989), top-down control (Verity & Smetacek 1996), and the nursery function of ecosystem engineers such as seagrasses (Heck et al. 2003).

MARINE ECOLOGY IN THE ANTHROPOCENE

Across 4 decades marked by increasing anthropogenic pressures, MEPS documented impacts of

Table 1. The 40 most-cited articles published in MEPS. Numbers of citations are based on a search performed on 25th October 2018 using CrossRef data. This dataset underestimates full citation numbers, typically by a factor of about 2 (only citation counts of participating publishing outlets are included), but was selected over other data sources such as Google Scholar because of its reliability for comparison purposes

Citations	Authors	Year	Title
2108	Azam et al.	1983	The ecological role of water-column microbes in the sea
1390	Cloern	2001	Our evolving conceptual model of the coastal eutrophication problem
1076	Clarke & Ainsworth	1993	A method of linking multivariate community structure to environmental variables
964	Campana	1999	Chemistry and composition of fish otoliths: pathways, mechanisms and applications
920	Clarke & Green	1988	Statistical design and analysis for a 'biological effects' study
833	Field et al.	1982	A practical strategy for analysing multispecies distribution patterns
760	Simon & Azam	1989	Protein content and protein synthesis rates of planktonic bacteria
641	Kemp et al.	2005	Eutrophication of Chesapeake Bay: historical trends and ecological interactions
613	Hobson & Welch	1992	Determination of trophic relationships within a high Arctic marine food web using $\delta^{13}C$ and $\delta^{15}N$ analysis
599	Wright et al.	1991	Improved HPLC method for the analysis of chlorophylls and carotenoids from marine phytoplankton
598	Rogers	1990	Reponses of coral reefs and reef organisms to sedimentation
596	Mackey et al.	1996	CHEMTAX – a program for estimating class abundances from chemical markers: application to HPLC measurements of phytoplankton
582	Cole et al.	1988	Bacterial production in fresh and saltwater ecosystems: a cross-system overview
581	Lester et al.	2009	Biological effects within no-take marine reserves: a global synthesis
553	Wahl	1989	Marine epibiosis. I. Fouling and antifouling: some basic aspects
497	Rohwer et al.	2002	Diversity and distribution of coral-associated bacteria
480	Gray et al.	2002	Effects of hypoxia and organic enrichment on the coastal marine environment
457	France	1995	Carbon-13 enrichment in benthic compared to planktonic algae: foodweb implications
441	Zapata et al.	2000	Separation of chlorophylls and carotenoids from marine phytoplankton: a new HPLC method using a reversed phase C_8 column and pyridine-containing mobile phases
413	Clarke & Warwick	2001	A further biodiversity index applicable to species lists: variation in taxonomic distinctness
412	Pörtner	2008	Ecosystem effects of ocean acidification in times of ocean warming: a physiologist's view
404	Ritchie	2006	Regulation of microbial populations by coral surface mucus and mucus-associated bacteria
395	Hoppe	1983	Significance of exoenzymatic activities in the ecology of brackish water: measurements by means of methylumbelliferyl-substrates
392	Warwick & Clarke	1995	New 'biodiversity' measures reveal a decrease in taxonomic distinctness with increasing stress
390	Purcell et al.	2007	Anthropogenic causes of jellyfish blooms and their direct consequences for humans: a review
379	Heck et al.	2003	Critical evaluation of the nursery role hypothesis for seagrass meadows
377	Scharf et al.	2000	Predator size-prey size relationships of marine fish predators: interspecific variation and effects of ontogeny and body size on trophic-niche breadth
355	Lee et al.	2006	Lipid storage in marine zooplankton
346	Egge & Aksnes	1992	Silicate as regulating nutrient in phytoplankton competition
345	Gosselin & Qian	1997	Juvenile mortality in benthic marine invertebrates
338	Dortch	1990	The interaction between ammonium and nitrate uptake in phytoplankton
322	Kurihara	2008	Effects of CO_2-driven ocean acidification on the early developmental stages of invertebrates
319	Michaelidis et al.	2005	Effects of long-term moderate hypercapnia on acid–base balance and growth rate in marine mussels *Mytilus galloprovincialis*
318	Pechenik	1999	On the advantages and disadvantages of larval stages in benthic marine invertebrate life cycles
316	Hunt & Scheibling	1997	Role of early post-settlement mortality in recruitment of benthic marine invertebrates
311	Friedlander & DeMartini	2002	Contrasts in density, size, and biomass of reef fishes between the northwestern and the main Hawaiian islands: the effects of fishing down apex predators
306	Kiørboe et al.	1985	Bioenergetics of the planktonic copepod *Acartia tonsa*: relation between feeding, egg production and respiration, and composition of specific dynamic action
305	Highsmith	1982	Reproduction by fragmentation in corals
304	Verity & Smetacek	1996	Organism life cycles, predation, and the structure of marine pelagic ecosystems
292	Kaiser et al.	2006	Global analysis of response and recovery of benthic biota to fishing

human activities on marine species, communities, and ecosystems. The first volume of MEPS contained several studies documenting impacts of environmental stressors (e.g. hypoxia, oil, metals) on the vital rates of marine fauna. Not surprisingly, therefore, our Top 40 contain seminal research efforts documenting aspects of the human footprint on marine habitats. For example, studies highlighted the deleterious impacts of (1) eutrophication on coastal habitats (Cloern 2001, Gray et al. 2002, Kemp et al. 2005), (2) sedimentation and the destruction of coral habitats (Rogers 1990), and (3) fishing on benthic and pelagic invertebrate and fish communities (Friedlander & DeMartini 2002, Kaiser et al. 2006, Lester et al. 2009). Three studies discussed impacts of ongoing ocean acidification on invertebrates and/or fish (Michaelidis et al. 2005, Kurihara 2008, Pörtner 2008), while another study reflected on how interaction of various anthropogenic stressors may have increased jellyfish populations world-wide with substantial economic costs to human communities (Purcell et al. 2007).

HORIZONS IN MARINE ECOLOGY

Against this backdrop of highly-cited research on such a wide range of subjects, we are pleased to announce that, to celebrate its 40^{th} anniversary, MEPS plans to publish a number of perspective articles written by recognized leaders in different fields of marine ecology. Each Ecological Memoir will cover a specific topic (from marine microbes to marine management), chronicling how the field has advanced and providing an outlook on the most exciting developments and future avenues of research in that area. We hope that our readers will find these articles interesting and inspiring, especially the students and early career researchers who will produce the next 40 years of outstanding marine ecological research.

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