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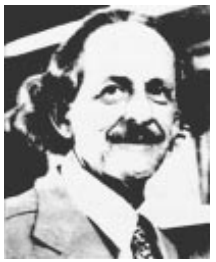

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Journal Citation Studies. 51. Down to the Sea Again: Probing the Depths of Marine Biology Literature

Go to reprint:"Documenting the literature of marine biology"

Number 19 May 8, 1989

Ten years ago I traveled to Khabarovsk in the USSR, to the Institute of Marine Biology, Far East Science Center, Academy of Sciences of the USSR. There I presented a paper on the literature of marine biology to the Pacific Scientific Conference. The article was subsequently published in *Biologiya Morya* (the *Soviet Journal of Marine Biology*) in 1980.[1] More recently, in a 1987 citation study, we examined oceanography journals.[2] In both papers, I had occasion to comment on the imprecise, often subjective distinctions between oceanography, marine biology, and their subfields.

Marine biology was excluded from our 1987 study of oceanography journals. As I noted at the time, the data for that study was compiled by Elizabeth Fuseler-McDowell, ISI®'s manager of bibliographic research, as part of a paper she delivered at the annual meeting of the International Association of Marine Science Libraries and Information Centers.[3] As it happened, Fuseler-McDowell gave another talk to the same group in 1988; her topic was the literature of marine biology.[4] We are pleased to present that paper in the following pages.

In the 1980 analysis of marine biology journals, we concluded that there is no literature of marine biology *per se*—that is, no distinct literature in the sense that there are literatures of physics, botany, cancer, and so on.[1] Citation patterns demonstrated considerable overlap and interaction with oceanography, freshwater biology, phycology, ecology, limnology, ichthyology, and other fields. It was, as noted at the time, difficult for the layperson to understand the distinctions underlying the practice of viewing such specialties as separate. The term "aquatic sciences" seemed more apt than did marine biology.

In a commentary in the same issue of *Biologiya Morya*, editor A.V. Zhirmunsky discussed my study and its indications that marine biology had not yet reached the status of a distinct science.[5] However, he disagreed with some of the selections and omissions in the list of core journals identified. Zhirmunsky pointed out that I had included journals dealing with freshwater biology as well as marine biology and had omitted journals that, in his view, are more specifically focused on marine biology. Zhirmunsky also offered some thoughts on the imprecise boundaries of marine biology, saying that "it is not so easy to confine a broad biological discipline...to hard-and-fast bounds."[5]

Needless to say, the literature of marine biology has changed in the decade since my study appeared. I am, therefore, especially pleased to feature Fuseler-McDowell's update. The list of core journals in her study is different from the one employed in the 1980 paper—although six of the journals she lists also appeared in my study. Furthermore, eight core journals from the 1987 study of oceanography literature can also be found in this study. As Elizabeth notes, this illustrates the very close links between the fields of oceanography and marine biology.

One notable difference between the core journals in Fuseler-McDowell's study and those in the 1980 paper is that one of the more significant journals she analyzed, *Marine Ecology—Progress Series* (*MEPS*), was not yet in existence when I was preparing my article. *MEPS*, as Elizabeth points out, has grown consistently in impact since beginning publication in 1979. The editor of *MEPS*, O. Kinne, Ecology Institute, Oldendorf, Federal Republic of Germany, mentioned our studies in an editorial marking the journal's 10th year of publication.[6]

Fuseler-McDowell has not been the only scholar at ISI examining the literature of marine biology. As she mentions, this winter we were fortunate to play host to a visiting research fellow from the USSR: Alexander Pudovkin, Institute of Marine Biology, Vladivostok. Pudovkin's work (as yet unpublished) involves a new method of clustering journals, based on a mathematical measure of journal relatedness. The resulting clusters can be mapped using multidimensional-scaling techniques. To develop and illustrate his methods, Pudovkin examined journals in marine biology. He identified a core of marine biology journals (including *MEPS*) and subjected them to mathematical measurement. As Pudovkin notes, the measurement was devised to "reflect an intuitive feeling of relatedness between a pair of journals, which one gets when browsing through them. This measure should reflect the relatedness of an average paper in journal 'A' to an average paper in journal 'B.' "[7]

Pudovkin also wrestled with the problem of fuzzy boundaries between the aquatic sciences. In mapping various clusters of journals, Pudovkin noted a clearer distinction between a "true core" of marine biology journals and other groups that, although related to marine biology, are devoted to such topics as aquaculture, fisheries, environmental toxicology, and phycology.

Pudovkin is continuing his work—in fact, he and Fuseler-McDowell are collaborating on a paper—and it is likely that we will have more to say about his methods in forthcoming essays. In the meantime, however, we present Fuseler-McDowell's study of the literature of marine biology.

* * * * *

My thanks to Christopher King for his help in the preparation of this essay.

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Presented at the annual meeting of the International Association of Marine Science Libraries and Information Centers, Miami, Florida, 4 October 1988.

Back to Introduction

Documenting the Literature of Marine Biology

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A bibliometric analysis of marine biology citations identifies the core journals and their impacts. Interjournal connections are revealed by ranking the journals most cited by the core. For each core journal, a most-cited article is listed.

Last year (1987) at the International Association of Marine Science Libraries and Information Centers' (IAMSLIC) annual meeting in Halifax, Nova Scotia, Canada, I presented a study of the core journals in oceanography.[1] That study and this are

based on citation analysis of the data in the *Journal Citation Reports®* (*JCR®*). The *JCR* is a compilation of the citation links between the journals in the *Science Citation Index®* (*SCI®*). By analyzing these citation links it is possible to determine the important journals in a discipline through the journals the authors in that field reference. This is a good way to determine the key journals in specialized and/or closely linked fields. We have used those citation links in the 1987 *JCR* to show us about the literature of marine biology.

As I discussed in the oceanography journal study, oceanography and marine biology are closely linked fields. Oceanography is a multifaceted field of many overlapping subfields that attempt to describe and explain all the processes of the sea.[2] Often a distinction has been made between biological and physical/chemical oceanography. Looking at a list of the parent organizations of the membership of IAMSLIC, this division is the "working" separation of the field. These studies of the literature of both fields show the strong links between them.

Marine Biology Journals

The *JCR* classifies 33 journals in the category marine and freshwater biology. The journals that ISI® has selected for inclusion in the *JCR* marine and freshwater biology category are those that cover scientific studies on living organisms in fresh- and saltwater.

To determine the marine biology core, we first studied all citations received and references given out by all 33 journals in the marine and freshwater subject category indexed in the 1987 *JCR*. The 23 journals were selected on the basis of their citation data, impact factors, and also to give representation to the international scope of marine biology. We have used this method to determine the core journals of many subject fields and are confident that this method gives us the significant journals of a particular field.[3] Therefore, we can say that these 23 journals are the most significant of the 33 in the category.

Two of the oldest journals in Table 1 started publication before 1900, the *Journal of the Marine Biological Association of the United Kingdom* (1887) and *Biological Bulletin* (1898). *Marine Mammal Science* (1985) is the newest journal on the list. In 1980 the title of the *Journal of the Fisheries Research Board of Canada* changed to the *Canadian Journal of Fisheries and Aquatic Sciences*. We have not combined the data for the two titles because we thought it interesting to see how many authors continue to cite papers in the older title. It was cited over 580 times in 1987. If they had been combined, it would have ranked first on the list of journals highly cited by the core journals (Table 2).

US and British publishers account for 12 of the journals in this study. The Federal Republic of Germany publishes three. Denmark and The Netherlands account for two each. The USSR, Australia, Norway, and Canada each account for one.

Eighteen of these journals are published in English and 1 in Russian with an English translation edition available. Four of the journals are multilingual. English is common to the entire set. Two journals publish in English, French, and German. One publishes in English and German, and one, in English and French.

The journals of marine biology were studied by Eugene Garfield in 1980.[4] There are six journals common to the core journals in that study and this one—the *Australian Journal of Marine and Freshwater Research*, the *Journal du Conseil*, the *Journal of Experimental Marine Biology and Ecology*, the *Journal of the Marine Biological Association of the United Kingdom*, *Marine Biology*, and *Sarsia*. Dr. Alexander Pudovkin, Institute of Marine Biology, Vladivostok, USSR, is currently on sabbatical at ISI to work on updating Garfield's earlier study. Today I am presenting only the core of the marine biology literature. Dr. Pudovkin's study will be an overview of the entire literature and will include a mapping of the "universe" of the marine biology literature.

There are eight overlapping journals between this core and the core oceanography journals presented last year at the IAMSLIC meeting in Halifax. This reinforces the close interrelationship between the physical and biological aspects of oceanography.

Table 1: Core journals in marine biology indexed in the *SCI*® in 1987, with the year that each began publication, the publisher, and the editor(s).

Advances in Marine Biology (1963)
Academic Press, San Diego, CA
J.H.S. Blaxter & F.S. Russell, eds.

Australian Journal of Marine and Freshwater Research (1950)
CSIRO, Melbourne, Australia
A. Grant, ed.

Biological Bulletin (1898)
Marine Biological Laboratory, Woods Hole, MA
C.B. Metz, ed.

Biologiya Morya (1975)
Cover-to-cover English translation: Soviet Journal of Marine Biology, Consultant's Bureau, New York
Institute of Marine Biology, Vladivostok, USSR
A.V. Zhirmunsky, ed.

Bulletin of Marine Science (1950)
Rosenstiel School of Marine and Atmospheric Science, Miami, FL
W.J. Richards, ed.

Canadian Journal of Fisheries and Aquatic Sciences (1934)
Department of Fisheries and Oceans, Ottawa, Ontario, Canada
D.G. Cook, ed.

Estuarine, Coastal and Shelf Science (1973)
Academic Press, London, United Kingdom
Editorial Board

Helgolander Meeresuntersuchungen (1937)
Biologische Anstalt Helgoland, Hamburg, Federal Republic of Germany
H.P. Bulnheim, ed.

Journal du Conseil (1926)
International Council for the Exploration of the Sea, Copenhagen, Denmark
R.J.H. Beverton, ed.

Journal of Experimental Marine Biology and Ecology (1967)
Elsevier Science Publishers, Amsterdam, The Netherlands
H. Barnes, ed.

Journal of Fish Biology (1969)
Fisheries Society of the British Isles
Southampton, United Kingdom
A.R. Margetts, ed.

Journal of Plankton Research (1979)
IRL Press, Oxford, United Kingdom
D.H. Cushing, ed.

Journal of the Marine Biological Association of the United Kingdom (1887)
Cambridge University Press, Cambridge, United Kingdom
E.J. Denton, ed.

Limnology and Oceanography (1956)
American Society of Limnology and Oceanography, Lawrence, KS
P.A. Jumars, ed.

Marine Biology (1980)
Springer International, New York, NY
O. Kinne, ed.

Marine Ecology—Progress Series (1979)
Inter-Research, Amelinghausen, Federal Republic of Germany
O. Kinne, ed.

Marine Ecology. Pubblicazioni della Stazione Zoologica di Napoli (1929)
Paul Parey, Berlin, Federal Republic of Germany
R. Riedl & J. Ott, eds.

Marine Environmental Research (1978)
Elsevier Applied Science, Essex, United Kingdom
G. Roesijadi & R.B. Spies, eds.

Marine Mammal Science (1985)
Society for Marine Mammology, Lawrence, KS
D. Wartzok, ed.

Netherlands Journal of Sea Research (1961)
Netherlands Institute for Sea Research, Texel, The Netherlands
J.J. Beukema, ed.

Oceanography and Marine Biology. An Annual Review (1963)
Taylor-Carlisle, New York, NY
H. Barnes, ed.

Ophelia (1964)
Marine Biological Laboratory, University of Copenhagen, Helsingor, Denmark
K. Muus, ed.

Sarsia (1969)
University of Bergen, Department of Marine Biology, Blomsterdalen, Norway
T. Brattegard, ed.

In our journal studies we consider the journals in the field we are studying as if they composed a single "Macrojournal of Discipline X." Data were taken from the 1987 *JCR* to determine which journals this macrojournal cited and which journals cited *into* the macrojournal.

Journal Statistics

In 1987 the 23 "core" marine biology journals published 1,945 articles. This represents slightly over 0.5 percent of the 410,806 research articles covered in the 1987 *JCR*. The articles in these 23 journals

Table 2: The 49 journals most cited by the core marine biology journals in the 1987 *SCI®*. Asterisks (*) indicate core journals. A=citations from core journals. B=citations from all journals. C=self-citations. D=percent of total citations that are core-journal citations (A/B). E=percent of total citations that are self-citations (self-cited rate, C/B). F=percent of core-journal citations that are self-citations (C/A). G=1987 impact factor. H=1987 immediacy index. I=1987 total source items.

	A	B	C	D	E	F	G	H	I
*Mar. Biol.	2,663	5,454	726	48.83	13.31	27.26	1.484	0.239	226
*Limnol. Oceanogr.	2,566	6,859	623	37.41	9.08	24.28	3.286	0.432	132
*J. Exp. Mar. Biol. Ecol.	1,550	2,839	474	54.60	16.70	30.58	1.274	0.311	183
*Mar. Ecol.—Progr. Ser.	1,516	2,530	547	59.92	21.62	36.08	1.867	0.300	220
*Can. J. Fisheries Aquat. Sci.	1,153	3,018	674	38.20	22.33	58.46	1.507	0.394	203
J. Fish. Res. Board Can.	1,102	3,912	—	28.17	—	—	—	—	0
*J. Mar. Biol. Assn. UK	969	2,162	182	44.82	8.42	18.78	1.036	0.259	58
Science	798	97,700	—	0.82	—	—	14.304	3.491	813
Ecology	788	9,825	—	8.02	—	—	2.784	0.333	216
Nature	680	155,736	—	0.44	—	—	14.999	3.903	1,210
*Biol. Bull.	597	2,645	129	22.57	4.88	21.61	1.196	0.167	60
*Estuar. Coast. Shelf Sci.	596	1,409	156	42.30	11.07	26.17	1.127	0.108	111
Deep-Sea Res. Pt. A—Oceanogr. Res.	586	3,242	—	18.08	—	—	2.077	0.448	125
*J. Fish Biol.	560	1,858	381	30.14	20.51	68.04	0.695	0.139	187
Oecologia	507	5,547	—	9.14	—	—	1.614	0.230	331
Appl. Environ. Microbiol.	454	9,999	—	4.54	—	—	2.105	0.318	557
Fish. Bull.—NOAA	441	1,040	—	42.40	—	—	0.576	0.051	59
J. Mar. Res.	425	1,781	—	23.86	—	—	2.354	0.205	39
*Bull. Mar. Sci.	422	853	123	49.47	14.42	29.15	0.607	0.208	96
*J. Plankton Res.	422	767	117	55.02	15.25	27.73	1.348	0.144	90
J. Phycol.	394	1,683	—	23.41	—	—	1.323	0.284	88
*Aust. J. Mar. Freshwater Res.	376	767	156	49.02	20.34	41.49	0.805	0.755	49
Can. J. Zool.	361	4,992	—	7.23	—	—	0.869	0.205	425
Hydrobiologia	324	2,216	—	14.62	—	—	0.641	0.094	352
Amer. Naturalist	319	6,914	—	4.61	—	—	2.607	0.422	128
*Neth. J. Sea Res.	319	601	72	53.08	11.98	22.57	0.924	0.000	27
Ecol. Monogr.	307	2,447	—	12.55	—	—	4.231	0.563	16
Trans. Amer. Fish. Soc.	305	1,591	—	19.17	—	—	0.897	0.000	83
*J. Conseil	296	497	45	59.56	9.05	15.20	0.677	0.158	38
*Helgolander Meeresunters.	279	605	59	46.12	9.75	21.15	0.580	0.375	24
Geochim. Cosmochim. Acta	272	10,450	—	2.60	—	—	3.217	0.485	26
*Oceanogr. Mar. Biol.	253	544	18	46.51	3.31	7.11	2.647	0.667	9
Arch. Hydrobiol.	250	1,670	—	14.97	—	—	0.961	0.207	121
J. Anim. Ecol.	223	3,327	—	6.70	—	—	2.293	0.613	75
Aquaculture	221	1,838	—	12.02	—	—	0.752	0.414	249
Comp. Biochem. Physiol. Pt. A	213	3,632	—	5.86	—	—	0.826	0.102	432
J. Exp. Biol.	208	5,256	—	3.96	—	—	1.954	0.392	186
*Ophelia	196	435	23	45.06	5.29	11.73	0.431	0.091	22
*Sarsia	187	337	84	55.49	24.93	44.92	0.741	0.583	48
Bull. Fish. Res. Board Can.	180	468	—	38.46	—	—	—	—	—
Mar. Pollut. Bull.	179	1,507	—	16.93	—	—	1.421	0.234	107
Crustaceana	167	506	—	33.00	—	—	0.236	0.064	78
J. Geophys. Res.—Oceans	162	33,381	—	0.49	—	—	6.839	1.467	478
Int. Rev. Gesamten. Hydrobiol.	161	730	—	22.05	—	—	0.490	0.162	37
Estuaries	158	341	—	46.33	—	—	0.802	0.000	22
Amer. Zool.	157	2,593	—	6.05	—	—	1.778	1.143	70
Environ. Biol. Fish.	156	601	—	25.96	—	—	0.670	0.176	91
Ver. Int. Ver. A Limnol.	150	806	—	18.61	—	—	—	—	0
Aquat. Bot.	147	856	—	17.17	—	—	1.006	0.225	80

gave out 62,410 references, which is about 0.7 percent of the over 9,464,000 references processed to create the *JCR* last year.

Articles from the 23 marine biology journals received a total of 38,515 citations in 1987 from all journals, or 0.4 percent of the almost 9.5 million *JCR* citations. Seven journals account for over 75 percent of the citations received: the *Canadian Journal of Fisheries and Aquatic Sciences*, including the *Journal of the Fisheries Research Board of Canada* (6,930); *Limnology and*

Table 3: The 51 journals that most frequently cited core marine biology journals in the 1987 *SCI*®. Asterisks (*) indicate core journals. A=citations to core journals. B=citations to all journals. C=self-citations. D=percent of total citations that are core-journal citations (A/B). E=percent of total citations that are self-citations (self-citing rate, C/B). F=percent of core-journal citations that are self-citations (C/A). G=1987 impact factor. H=1987 immediacy index. I=1987 total source items.

	A	B	C	D	E	F	G	H	I
*Mar. Ecol.—Progr. Ser.	2,653	7,800	547	34.01	7.01	20.62	1.867	0.300	220
*Mar. Biol.	2,375	7,333	726	32.39	9.90	30.57	1.484	0.239	226
*J. Exp. Mar. Biol. Ecol.	1,911	6,005	474	31.82	7.89	24.80	1.274	0.311	183
*Can. J. Fisheries Aquat. Sci.	1,231	6,416	674	19.19	10.50	54.75	1.507	0.394	203
*Limnol. Oceanogr.	1,221	4,159	623	29.36	14.98	51.02	3.286	0.432	132
*J. Plankton Res.	936	2,852	117	32.82	4.10	12.50	1.348	0.144	90
*Estuar. Coast. Shelf Sci.	798	3,275	156	24.37	4.76	19.55	1.127	0.108	111
Hydrobiologia	690	9,250	—	7.46	—	—	0.641	0.094	352
*J. Fish Biol.	653	4,094	381	15.95	9.31	58.35	0.695	0.139	187
Deep-Sea Res. Pt. A—Oceanogr. Res.	555	3,853	—	14.40	—	—	2.077	0.448	125
*Bull. Mar. Sci.	538	2,938	123	18.31	4.19	22.86	0.607	0.208	96
Comp. Biochem. Physiol. Pt. A	455	11,228	—	4.05	—	—	0.826	0.102	432
Can. J. Zool.	452	11,798	—	3.83	—	—	0.869	0.205	425
Aquaculture	440	5,127	—	8.58	—	—	0.752	0.414	249
*J. Mar. Biol. Assn. UK	436	1,350	182	32.30	13.48	41.74	1.036	0.259	58
*Biol. Bull.	402	1,976	129	20.30	6.53	32.09	1.196	0.167	60
Ecology	369	8,687	—	4.25	—	—	2.784	0.333	216
J. Phycol.	355	2,727	—	13.02	—	—	1.323	0.284	88
Appl. Environ. Microbiol.	354	13,801	—	2.57	—	—	2.105	0.318	557
J. Water Pollut. Contr. Fed.	352	6,738	—	5.22	—	—	0.949	0.151	146
Freshwater Biol.	350	3,028	—	11.56	—	—	1.077	0.333	96
*Oceanogr. Mar. Biol.	323	1,839	18	17.56	0.98	5.57	2.647	0.667	9
Oecologia	321	10,370	—	3.10	—	—	1.614	0.230	331
Cont. Shelf Res.	320	2,065	—	15.50	—	—	0.636	0.133	98
*Sarsia	315	1,199	84	26.27	7.01	26.67	0.741	0.583	48
*Aust. J. Mar. Freshwater Res.	308	1,141	156	26.99	13.67	50.65	0.805	0.755	49
*Neth. J. Sea Res.	295	809	72	36.46	8.90	24.41	0.924	0.000	27
Arch. Hydrobiol.	280	3,197	—	8.76	—	—	0.961	0.207	121
Environ. Biol. Fish.	279	2,826	—	9.87	—	—	0.670	0.176	91
J. Mar. Res.	265	1,436	—	18.45	—	—	2.354	0.205	39
Geochim. Cosmochim. Acta	257	11,369	—	2.26	—	—	3.217	0.485	268
Polar Biol.	248	1,801	—	13.77	—	—	1.224	0.414	58
Rev. Geophys.	245	26,491	—	0.92	—	—	3.109	0.406	143
Aquat. Bot.	236	2,179	—	10.83	—	—	1.006	0.225	80
*Mar. Environ. Res.	218	1,112	—	19.60	—	—	1.231	0.024	42
Fish. Bull.—NOAA	211	1,592	—	13.25	—	—	0.576	0.051	59
*Helgolander Meeresunters.	202	845	59	23.90	6.98	29.21	0.590	0.375	24
J. Crustacean Biol.	200	1,658	—	12.06	—	—	0.559	0.177	62
Comp. Biochem. Physiol. Pt. B	196	13,652	—	1.44	—	—	0.846	0.102	472
Nippon Suisan Gakk.	193	3,601	—	5.36	—	—	0.336	0.016	316
Bot. Mar.	192	1,679	—	11.44	—	—	0.903	0.045	66
*Ophelia	190	714	23	26.61	3.22	12.11	0.431	0.091	22
Mar. Pollut. Bull.	182	1,873	—	9.72	—	—	1.421	0.234	107
J. Geophys. Res.—Oceans	165	7,509	—	2.20	—	—	0.440	0.624	290
Mar. Chem.	164	1,936	—	8.47	—	—	1.836	0.209	67
Oceanol. Acta	160	1,024	—	15.63	—	—	0.873	0.135	37
Coral Reef.	158	638	—	24.76	—	—	0.960	0.182	22
*J. Conseil	153	713	45	21.46	6.31	29.41	0.677	0.158	38
*Biol. Morya	151	1,247	52	12.11	4.17	34.43	0.173	0.026	76
Sci. Total Environ.	149	5,147	—	2.89	—	—	0.571	0.165	267
Water Res.	149	4,020	—	3.71	—	—	1.181	0.075	199
*Mar. Ecol. Publ. Stat. Zool. Napoli[1]	126	627	5	20.10	0.80	3.97	0.522	0.000	17

[1]Mar. Ecol. Publ. Stat. Zool. Napoli was the 59th ranked journal by citations to the core marine biology journals. It is given here for the purposes of comparison to other core journals

Oceanography (6,859); *Marine Biology* (5,454); the *Journal of Experimental Marine Biology and Ecology* (2,839); *Marine Ecology—Progress Series* (2,530); *Biological Bulletin* (2,645); and the *Journal of the Marine Biological Association of the United Kingdom* (2,162).

Table 2 shows the data for the 49 journals most frequently cited by the core. It includes 18 of the core journals, which are marked with an asterisk (*). They are listed in decreasing order by the number of citations they received from the core that year. The table also provides total citations from all journals (B), self-citations for each journal (C), the 1987 impact factors (G) and immediacy indexes (H), and the number of 1987 source items (I). The impact factor is a measure of the frequency with which the "average article" of a journal has been cited in a given year, while the immediacy index is a measure of how quickly the "average article" in a particular field gets cited. Seven of the top 10 highly cited journals, including the *Journal of the Fisheries Research Board of Canada*, are core marine biology journals. Also in the top 10 are *Science* and *Nature*. This occurs because, in addition to citing journals in their specialties, researchers cite a common set of basic research journals. These basic journals are cited by scientists in numerous specialties and serve to link the fields of science.[5]

Table 4: Half-lives. The 1987 *SCI*® cited and citing half-lives of core marine biology journals listed in alphabetic order. A=cited half-life. B=citing half-life.

	A	B
Advan. Mar. Biol.	>10.0	—
Aust. J. Mar. Freshwater Res.	7.0	8.6
Biol. Bull.	>10.0	8.0
Biol. Morya	6.5	>10.0
Bull. Mar. Sci.	7.3	>10.0
Can. J. Fisheries Aquat. Sci.	4.4	8.1
Estuar. Coast. Shelf Sci.	6.0	8.5
Helgolander Meeresunters.	9.6	>10.0
J. Conseil	>10.0	9.5
J. Exp. Mar. Biol. Ecol.	5.8	8.5
J. Fish Biol.	7.3	9.0
J. Mar. Biol. Assn. UK	>10.0	>10.0
J. Plankton Res.	4.0	8.2
Limnol. Oceanogr.	9.0	7.5
Mar. Biol.	7.4	8.5
Mar. Ecol.—Progr. Ser.	3.8	7.0
Mar. Ecol. Publ. Stat. Zool. Napoli	—	9.2
Mar. Environ. Res.	3.4	7.6
Neth. J. Sea Res.	8.2	7.6
Oceanogr. Mar. Biol.	8.8	>10.0
Ophelia	9.2	>10.0
Sarsia	7.2	8.7

Table 5: Core journal impact factors. The 1978-1987 *JCR*® impact factors of core journals.

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Advan. Mar. Biol.	—	1.800	1.778	2.444	5.000	—	—	0.500	1.167	1.857
Aust. J. Mar. Freshwater Res.	0.563	0.547	0.661	0.701	0.599	0.909	0.766	0.941	0.879	0.805
Biol. Bull.	1.203	1.352	1.346	1.357	2.014	1.762	1.844	1.710	1.738	1.196
Biol. Morya	—	—	0.196	0.244	0.122	0.138	0.113	0.164	0.192	0.173
Bull. Mar. Sci.	1.140	0.826	0.427	0.529	0.908	0.582	0.768	0.608	0.794	0.607
Can. J. Fisheries Aquat. Sci.	1.401	—	1.530	1.836	1.359	1.727	1.375	1.473	1.790	1.507
Estuar. Coast. Shelf Sci.	1.385	1.401	1.134	1.132	1.373	1.306	0.962	1.341	1.079	1.127
Helgolander Meeresunters.	0.862	1.083	0.912	0.620	1.030	0.759	0.968	0.616	1.112	0.580
J. Conseil	0.604	0.333	0.452	0.343	0.657	0.465	0.652	0.432	0.513	0.677
J. Exp. Mar. Biol. Ecol.	0.900	1.296	1.318	1.420	1.510	1.118	1.478	1.331	1.482	1.274
J. Fish Biol.	0.811	1.053	0.979	0.706	0.996	1.114	0.848	0.950	0.833	0.695
J. Mar. Biol. Assn. UK	1.340	1.373	1.325	1.177	1.119	1.052	1.120	1.190	1.124	1.036
J. Plankton Res.	—	—	—	—	—	—	1.202	1.543	1.688	1.348
Limnol. Oceanogr.	2.155	2.487	2.404	2.492	3.029	2.535	2.628	2.852	3.120	3.286
Mar. Biol.	1.382	1.506	1.681	1.453	1.945	1.664	1.811	1.667	1.892	1.484
Mar. Ecol.—Progr. Ser.	—	—	0.652	0.866	1.431	1.974	2.189	2.041	2.172	1.867
Mar. Ecol. Publ. Stat. Zool. Napoli	—	—	—	—	—	—	—	—	0.667	0.522
Mar. Environ. Res.	—	—	—	—	—	0.962	0.859	0.798	0.802	1.231
Neth. J. Sea Res.	0.630	0.563	0.274	0.684	1.433	0.726	0.877	0.673	0.743	0.924
Oceanogr. Mar. Biol.	—	—	—	—	—	2.000	—	2.526	1.571	2.647
Ophelia	0.452	0.724	0.893	0.424	1.317	1.097	0.839	1.379	1.034	0.431
Sarsia	0.677	0.800	0.810	0.556	0.538	0.575	0.500	0.645	0.482	0.741

The journals in Table 2 received almost 16,000 citations from the 23 core journals, which is 27.9 percent of the total citations they received. This is 41.5 percent of the references given out by the core journals in 1987. *Limnology and Oceanography* (3.286) is the highest impact journal in the core. This is often the case with review journals.

The immediacy index measures how often a journal's articles were cited in the same year that they were published. Marine biology, as a whole, is a field that ranks high in immediacy as compared to the *JCR* as a whole. Ten of the core journals rank in the top one-quarter of the *JCR* ranked by immediacy factor.

Table 3 shows the 51 journals that most frequently cited the core marine biology journals in 1987. *Marine Ecology—Progress Series*, the journal that most frequently cited the core, was not in existence when Garfield did his earlier study. *Marine Biology* and the *Journal of Experimental Marine Biology and Ecology*, which rank second and third in this study, ranked first and second, respectively, in the Garfield study. Eight of the top 10 journals ranked by the number of citations to core journals are themselves core journals. The core journals in Table 3 provided over 57,000 references that year. Over 15,000, or slightly over 26 percent of these, were to core journals. The remainder were

Table 6: The 1987 *SCI*® source data listing. S = source items. R = reference items. R/S = ratio of reference items to source items.

Journal Name	Nonreview Articles			Review Articles			Combined Total Nonreview & Review		
	S	R	R/S	S	R	R/S	S	R	R/S
Aust. J. Mar. Freshwater Res.	48	1,213	25.2	1	46	46.0	49	1,259	25.6
Biol. Bull.	58	1,823	31.4	2	195	97.5	60	2,018	33.6
Biol. Morya	76	1,282	16.8	0	0	0	76	1,282	16.8
Bull. Mar. Sci.	95	3,112	32.7	1	15	15.0	96	3,127	32.5
Can. J. Fisheries Aquat. Sci.	202	6,836	33.8	1	163	163.0	203	6,999	34.4
Estuar. Coast. Shelf Sci.	111	3,510	31.6	0	0	0	111	3,510	31.6
Helgolander Meeresunters.	23	722	31.3	1	142	142.0	24	864	36.0
J. Conseil	36	599	16.6	2	153	76.5	38	752	19.7
J. Exp. Mar. Biol. Ecol.	183	6,329	34.5	0	0	0	183	6,329	34.5
J. Fish Biol.	187	4,280	22.8	0	0	0	187	4,280	22.8
J. Mar. Biol. Assn. UK	57	1,315	23.0	1	99	99.0	58	1,414	24.3
J. Plankton Res.	90	2,965	32.9	0	0	0	90	2,965	32.9
Limnol. Oceanogr.	132	4,285	32.4	0	0	0	132	4,285	32.4
Mar. Biol.	226	7,661	33.8	0	0	0	226	7,661	33.8
Mar. Ecol.—Progr. Ser.	214	7,882	36.8	6	395	65.8	220	8,277	37.6
Mar. Ecol. Publ. Stat. Zool. Napoli	17	662	38.9	0	0	0	17	662	38.9
Mar. Environ. Res.	42	1,197	28.5	0	0	0	42	1,197	28.5
Mar. Mammal Sci.	25	463	18.5	2	234	117.0	27	697	25.8
Neth. J. Sea Res.	27	857	31.7	0	0	0	27	857	31.7
Oceanogr. Mar. Biol.	3	249	83.0	6	1,737	289.5	9	1,986	220.6
Ophelia	22	740	33.6	0	0	0	22	740	33.6
Sarsia	46	1,066	23.1	2	183	91.5	48	1,249	26.0
Totals	1,920	59,048	31.5	25	3,362	134.8	1,945	62,410	32.1
SCI JCR® Totals	400,436	8,470,613	21.1	10,370	993,841	95.8	410,806	9,464,454	23.0
Marine Biology % of *JCR* Totals	0.5	0.7	149.3	0.2	0.3	57.1	0.5	0.7	139.6

Note: Advan. Mar. Biology was not received in 1987.

to a variety of journals, many in other marine science fields. The percentages in column D of Table 3—the percent of citations that are core-journal citations—are sometimes referred to as specialty factors. For example, *Marine Ecology—Progress Series* and the *Netherlands Journal of Sea Research* cite the core literature more than one-third of the time, thereby having the highest citing specialty rate.

A journal's half-life figures give us more information about the nature of that journal. Half-life is the median age of a journal's cit*ed* or cit*ing* literature. Table 4 lists the cit*ed* and cit*ing* half-lives for 22 of the core journals. Because *Advances in Marine Biology* was not received in time for processing in the 1987 *SCI*, we cannot determine the current citing half-life for it.

Cit*ed* half-life is the median age of the articles from each journal that were cited in 1987. The average cit*ed* half-life for marine biology journals is over seven. In other words, on the average, half of the 1987 citations to core marine biology journals were to articles published within the past seven years. Four journals had cited half-lives of over 10 years—*Advances in Marine Biology,*

Table 7: The most-cited article from each core marine biology journal cited at least 50 times in the *SCI®*, *1955-1987*, listed in alphabetic order by first author. A = 1955-1987 citations. B = number of papers from that journal cited at least 50 times.

A	Bibliographic Data	B
260	**Anderson J W, Neff J M, Cox B A, Tatem H E & Hightower G M.** Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish. *Mar. Biol.* 27:75-88, 1974.	125
159	**Azam F, Fenchel T, Field J G, Gray J S, Meyer-Reil L A & Thingstad F.** The ecological role of water column microbes in the sea. *Mar. Ecol.—Progr. Ser.* 10:257-64, 1983.	14
71	**Bayly I A E & Williams W D.** Chemical and biological studies on some saline lakes of southeast Australia. *Aust. J. Mar. Freshwater Res.* 17:177-228, 1966.	6
74	**Berland B.** Nematodes from some Norwegian marine fishes. *Sarsia* 2:1-50, 1961.	1
76	**Duursma E K.** Dissolved organic carbon, nitrogen and phosphorus in the sea. *Neth. J. Sea Res.* 1:1-85, 1961.	9
104	**Ellis A E.** Leukocytes of fish. *J. Fish Biol.* 11:453-91, 1977.	14
191	**Eppley R W, Holmes R W & Strickland J D H.** Sinking rates of marine phytoplankton measured with a fluorometer. *J. Exp. Mar. Biol. Ecol.* 1:191-208, 1967.	32
240	**Fenchel T.** The ecology of marine microbenthos. IV. Structure and function of the benthic ecosystem, its chemical and physical factors and the microfauna communities with special reference to the ciliated protozoa. *Ophelia* 6:1-182, 1969.	12
429	**Harding J P.** The use of probability paper for the graphical analysis of polymodal frequency distributions. *J. Mar. Biol. Assn. UK* 28:141-53, 1949.	149
414	**Holm-Hansen O, Lorenzen C J, Holmes R W & Strickland J D H.** Fluorometric determination of chlorophyll. *J. Conseil* 30:3-15, 1965.	16
127	**Lang J.** Interspecific aggression by scleractinian corals. 2. Why the race is not always to the swift. *Bull. Mar. Sci.* 23:260-79, 1973.	12
224	**Loosanoff V L & Davis H C.** Rearing of bivalve mollusks. *Advan. Mar. Biol.* 1:1-136, 1963.	26
197	**Mantoura R F C, Dickson A & Riley J P.** The complexation of metals with humic materials in natural waters. *Estuar. Coast. Shelf Sci.* 6:387-408, 1978.	10
774	**Mazia D, Brewer P A & Alfert M.** The cytochemical staining and measurement of protein with mercuric bromphenol Blue. *Biol. Bull.* 104:57-67, 1953.	204
103	**Paffenhofer G-A.** Cultivation of *Calanus helgolandicus* under controlled conditions. *Helgolander Meeresunters.* 20:346-59, 1970.	13
436	**Ricker W E.** Linear regressions in fishery research. *J. Fish. Res. Board Can.* 30:409-34, 1973.	231
129	**Rowland S J & Volkman J K.** Biogenic and pollutant aliphatic hydrocarbons in *Mytilus edulis* from the North Sea. *Mar. Environ. Res.* 7:117-30, 1982.	1
269	**Smayda T J.** The suspension and sinking of phytoplankton in the sea. *Oceanogr. Mar. Biol.* 8:353-414, 1970.	30
868	**Solorzano L.** Determination of ammonia in natural waters by the phenolhypochlorite method. *Limnol. Oceanogr.* 14:799-801, 1969.	360
53	**Urrere M A & Knauer G A.** Zooplankton fecal pellet fluxes and vertical transport of particulate organic material in the pelagic environment. *J. Plankton Res.* 3:369-88, 1981.	1
101	**Young J Z.** The preparation of isotonic solutions for use in experiments with fish. *Mar. Ecol. Publ. Stat. Zool. Napoli* 12:425-31, 1933.	6

Table 8: The 1987 *SCI®/SSCI®* research fronts that include at least 50 citing documents published in the core marine biology journals. A = number of articles from core journals citing into the core of each front. B = total number of citing documents. C = total number of core documents.

Number	Name	A	B	C
87-0213	Evolutionary aspects of reproduction and sexual variations in populations	52	346	26
87-1438	Bacterial biomass productivity in the marine environment	72	253	17
87-1649	Early life history, growth, and survival of larval fish, including vulnerability to predation	66	123	15
87-2223	Photosynthesis and growth of marine phytoplankton	73	136	8
87-2632	Echinoderm larval biology	53	79	6
87-3546	Distribution, settlement, and recruitment of marine invertebrate larvae	58	89	10
87-4337	Disturbance, competition, and predation in intertidal algal communities	70	560	20
87-5117	Marine phytoplankton growth and development	73	136	8
87-5810	Growth, mortality, and secondary production of marine crustaceans	57	87	9

Biological Bulletin, the *Journal du Conseil*, and the *Journal of the Marine Biological Association of the United Kingdom*. This shows the longevity of highly cited articles in the field. Six journals had citing half-lives of over 10 years. The average citing half-life was over nine years. This shows the "durability" of the classic articles in the field.

Table 5 contains data for the core journals that show how their impacts have varied over the 10 years. Most of the journals have been remarkably consistent. The exception is *Marine Ecology—Progress Series*, which has continued to grow in impact on the field since it began publication in 1979.

Table 6 presents data for two types of articles—nonreview and review—published by each of the core journals in 1987 and the number of reference items for each type. *Advances in Marine Biology* was again omitted because it was not received by us in time for inclusion in the 1987 data set. The combined total number of references per nonreview and review article in marine biology (32.1) is about one-third higher than the average number of references per nonreview and review article in the *JCR* (23.0). Nonreview marine biology articles had on the average almost one and one-half times (31.5) the references of the average for the *JCR* (21.1).

Most-Cited Papers

In addition to examining the journals, we looked at the individual papers published in the core journals. Table 7 lists the most-cited article from each core marine biology journal as determined by citations in the *SCI*, 1955-1987, if a journal had an article cited at least 50 times. Two journals (*Biologiya Morya* and *Marine Mammal Science*) are not represented in this table because they did not meet that selection criterion. This occurs in many small fields. The figures in column B give the total number of papers each journal published that were cited at least 50 times. These articles contribute to the high-impact long-term cumulative citation counts to these journals.

There is often a relationship between the age of a journal and the number of articles from it cited 50 times or more. In most of our studies, older journals have the greatest number of published articles cited 50 times or more. *Biological Bulletin* and the *Journal of the Marine Biological Association of the United Kingdom* have the third and fourth highest number of published articles in this category. *Marine Mammal Science*, the newest journal in the core (only three years old), has not had much time to accumulate highly cited articles.

The most-cited paper in this study was published in *Limnology and Oceanography* by Lucia Solórzano of the Institute of Marine Resources, Scripps Institution of Oceanography, University of California, San Diego. This paper discusses a method for determining ammonia in seawater. If you look at the most-cited lists in other areas of science you will find that many of the more highly cited papers are methodology papers. While this paper is not marine biology in the strictest sense, it presents a technique that is often

used in marine biological studies. It was also the most-cited paper in the oceanography journal study.

Daniel Mazia, Philip A. Brewer, and Max Alfert, then of the Department of Zoology, University of California, Berkeley, coauthored the second most-cited paper. Also a methods paper, it presents a staining technique that is widely used in cytochemical studies.

The third most-cited paper, by William E. Ricker, of the Fisheries Research Board of Canada, is a methods paper on the use of linear regression in fisheries research. Over one-third of the 21 articles on this table are methods papers.

Looking at the titles in Tables 7 and 8 you can see how often articles dealing with plankton are cited by the marine biology journals. This lends more support to the idea that all of the marine sciences are closely interrelated.

Summary

When we compare the data for the core journals in Tables 2 and 3, we find that 4 of the 23 core journals (*Marine Biology*, the *Journal of Experimental Marine Biology and Ecology*, the *Canadian Journal of Fisheries and Aquatic Sciences*, and *Marine Ecology—Progress Series*) appear among the top 10 journals in both tables. These journals rank among the top nine core journals when ranked by impact factor. The same 4 journals rank among the top 10 core journals when ranked by immediacy factor. *Limnology and Oceanography* and the *Canadian Journal of Fisheries and Aquatic Sciences* provide a bridge to the literature of the other aquatic sciences—limnology, oceanography, and fisheries. Clearly these four journals are the most influential in marine biology and would be of importance to anyone looking at the history of marine biology research.

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