In the United States, by contrast, projects easily fall prey to annual budget reviews made in the light of cost increases and changes in the priorities of the administration and incoming presidents. This was particularly the case in the Reagan era, when the United States more or less unilaterally canceled its share of a joint Solar-Polar mission. In the authors' view, the same attitudes have tended to prevail over the space station where "the rule of the *fait accompli* was the basic management practice" in the dealings of the United States with her partners (p. 111). The authors are emphatic that unless this attitude changes—and there are encouraging signs that it will—Europe will be less and less inclined to collaborate with the United States in large-scale technical cooperative projects.

Bonnet and Manno have written a timely and important book. On occasion they may be faulted for being overhasty in their presentation of material—but this is only to be expected of a work written in their vanishingly small "spare time." It is a pity, too, that they did not build a full description of the Horizon 2000 program into the body of their text. At the same time they are to be commended for their courage in raising contentious issues and, in particular, in alerting all those involved in international collaboration in space as to how their European partners expect to be treated in the future.

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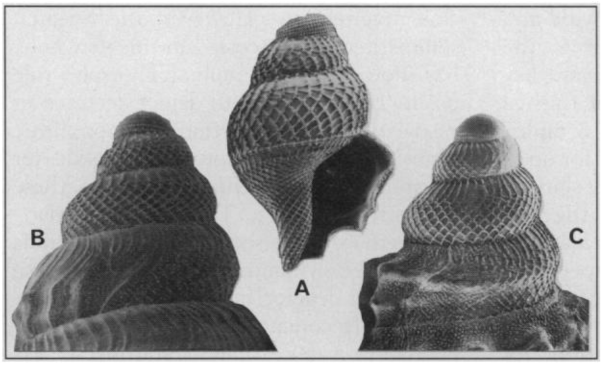
Offspring in the Sea

The Bio-Physics of Marine Larval Dispersal. P. W. SAMMARCO and M. L. HERON, Eds. American Geophysical Union, Washington, DC, 1994. xiv, 352 pp., illus. $42; to AGU members, $29.40. Coastal and Estuarine Studies, 45. From a conference, Thredbo, New South Wales, Feb. 1990.

Reproduction, Larval Biology, and Recruitment of the Deep-Sea Benthos. CRAIG M. YOUNG and KEVIN J. ECKELBARGER, Eds. Columbia University Press, New York, 1994. xvi, 336 pp., illus. $95 or £60. From a symposium, Atlanta, GA, Dec. 1991.

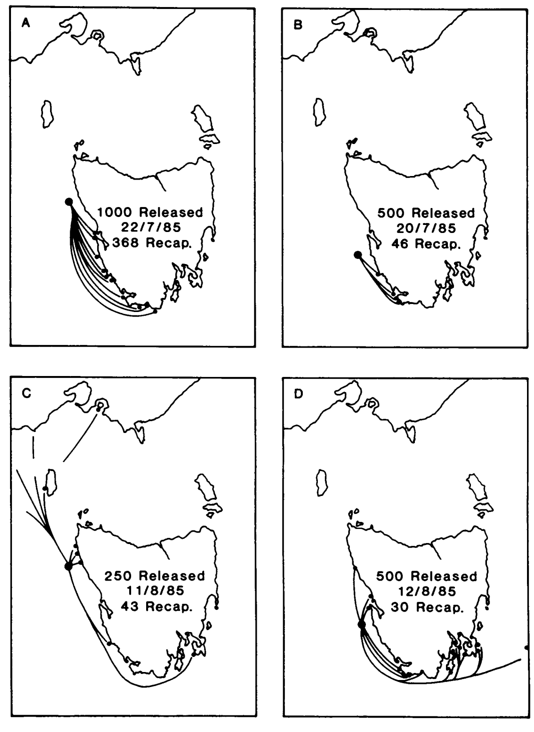
One of the most striking contrasts between marine and terrestrial animals is in processes of reproduction and recruitment. Many marine species—thousands of vertebrates and invertebrates—shed eggs, sperm, or larvae into the sea, where they develop in the plankton before assuming the adult habit.



"Daphnelline veliger and protoconchs. This type of protoconch sculpture occurs in hundreds of shallow- and deep-water turrids. A: Larva from surface plankton, SW Pacific 24°46′S, 177°13′E; water depth 4150 m; height 910 μm. B: Protoconch of *Pleurotomella bureaui*, a bathyal species from the Azores; height 745 μm. C: Protoconch of *Philbertia linearis*, Swedish west coast, shallow water; height 650 μm." [From P. Bouchet and A. Warén's paper in *Reproduction, Larval Biology, and Recruitment of the Deep-Sea Benthos*]

The array of reproductive strategies in marine organisms has intrigued and confounded biologists and ecologists for over a century, and the evolutionary forces that give rise to such strategies are still hotly debated (even by paleobiologists, who can infer modes of development for some groups on the basis of preserved morphology of larval hard-parts). The two books reviewed here are important contributions to our understanding of marine larval biology, made especially valuable by emphasis on a single problem or theme, rather than being the usual diffuse collection of papers linked only by their focus on the pre-adult stage.

As its title suggests, *The Bio-Physics of Marine Larval Dispersal* is emphatically interdisciplinary. A daunting obstacle to understanding larval biology is our extreme ignorance of what happens to the gametes and larvae between release and settlement. Mortality and dispersal clearly occur, but the details are crucial here—for many species, recolonization following natural or anthropogenic disturbance depends on the ability of larvae to reach a locality in sufficient numbers to maintain a population. This volume brings together physical oceanographers and biologists to tackle the dispersal problem with considerable success. Hydrodynamics is just the beginning, including rates and patterns of diffusion, lateral and vertical transport, and how coasts and seafloor impinge on these. Added to this is biology: the patchiness of larval input imposed by distribution and timing of spawning parents, for example, and the vertical movements of the larvae, which can shift among water layers moving at different rates or in different directions. A variety of quantitative models are presented in this book for the complex interaction of physical processes and organismic behavior, relative to patterns of transport or retention of larvae in estuaries, around reefs or headlands, and across or along the continental shelf. Models are tested against field data for corals, crustaceans, scallops, fishes, and the crown-of-thorns starfish (all from Australian coasts). The result is of course not the final synthesis, but a much-improved appreciation of the important variables—and the realization that local meteorological and hydrodynamic conditions can indeed have enormous impact on larval survival or recruitment, from 99% mortality to 99% recruitment according to one analysis. Gay and Andrews's study of coral recruitment to Helix Reef off Queensland is just one concrete example: positively buoyant larvae at the



"Release and recovery points of surface drift cards deployed during the midst of the 1985 [*Macronurus*] *novaezelandiae* spawning season. The drift cards were released just inshore of the shelf-edge and at points immediately to the north and south of the apparent spawning area. (Very large numbers of newly hatched larvae were caught at both sites at the time of drift card deployment.)" [From V. D. Lyne and R. E. Thresher's paper in *The Bio-Physics of Marine Larval Dispersal*] surface were moved primarily by wind and were flushed away from the reef to the north within a day; neutrally buoyant larvae were carried by currents that flushed them to the south, but owing to complex eddies near the reef were retained for up to six days; and negatively buoyant larvae, which stay within 0.5 meter of the seafloor, were retained near the reef indefinitely. Clearly, variation among species or individuals can send larvae of co-occurring adults onto strongly divergent trajectories, with far-reaching implications for gene flow and the maintenance or recovery of local communities.

Reproduction, Larval Biology, and Recruitment of the Deep-Sea Benthos deals with a suite of habitats that seem particularly hostile to free-swimming larvae: the deep sea and, in a few chapters, polar seas. Until recently, most have assumed that these settings, with scarce or highly seasonal phytoplankton food sources and with low temperatures that slow development, would constrain marine organisms to brood their larvae rather than release them. This view was codified as Thorson's rule, which as recently as 1986 was described by a prominent marine biologist as "the one valid generalization" about life-history patterns in marine invertebrates. However, the research summarized and discussed in this new book has thoroughly undermined Thorson's rule or any other attempt to depict deep-sea or high-latitude reproduction in monolithic terms. All the major reproductive modes for marine macroinvertebrates occur in these habitats; contrary to Thorson's rule, many and perhaps most species in both habitats release free-swimming larvae, and feeding larvae that develop from yolk-poor eggs are surprisingly common. John Pearse's survey of shallow-water Antarctic starfish, for example, shows only two brooders, nine with non-feeding but mobile larvae, and three species—in fact the most abundant as adults—with feeding, free-swimming larvae. Similar counts have been obtained for deep-sea sites as distinct as the soft-bottom Rockall Trough and the Galapagos Rift hydrothermal vents.

This startling range of reproductive styles is attributed by some authors partly to phylogenetic constraints: the snail groups that predominate at hydrothermal vent sites, for example, are drawn from lineages that almost always release free-swimming, non-feeding larvae regardless of latitude or depth and thus appear to be locked into that strategy. But this cannot be the whole story: mytilid bivalves and turrid gastropods are demonstrably capable of evolving a wide array of reproductive modes but contrary to all expectations tend to release free-swimming, feeding larvae in the deep sea, both at vents and in less unusual settings. How do these larvae obtain sufficient food to grow and develop? Do they migrate several kilometers to surface waters, or feed on detritus near the bottom? The cold temperatures may actually help, by slowing development to improve chances of encountering suitable food patches or settlement sites (which in turn would imply that predation on larvae is low per unit time so that protracted development carries a relatively low mortality risk). More generally, several authors point out that the high frequency of non-feeding, free-swimming larvae bears on long-standing debates regarding the chief role of the larval stage in marine invertebrates. Forceful arguments, some bolstered by quantitative models, have pressed the claim that other factors than dispersal must select for free-swimming larvae, such as the ability to shift some costs of reproduction to the plankton by releasing small, inexpensive eggs that develop through a feeding larval stage. The prevalence of free-swimming larvae that develop from expensive, yolk-rich eggs in so much of the world's ocean, however, shows that larvae that travel some distance from the parent are advantageous in many situations and suggests that dispersal may be their chief role. (See also Alan J. Kohn and Frank E. Perron's 1994 monograph *Life History and Biogeography: Patterns in Conus* [Clarendon Press; 114 pp., $56] for a demonstration that geographic range within a single well-studied snail genus is significantly correlated with mode of larval development and with length of planktonic larval period.) Finally, in yet another shock to our preconceptions about the supposedly monotonous deep-sea environment, reproductive cycles in many abyssal species have proven to be decidedly seasonal, apparently being cued by variations in detritus from surface-water productivity. As with larval modes, the most intriguing fact is the within-site variability: co-occurring taxa may or may not show seasonal cycles, presumably owing to details of their nutritional biology that deserve much additional study.

Perhaps the only glaring lack in these volumes is in genetics, which receives only passing mention but could cast much light on the evolutionary consequences of alternative reproductive modes, hydrodynamical patterns, and larval behaviors. For example, which of the many details of hydrography that shape short-term dispersal patterns have sufficient stability to influence genetic population structures? Do the non-feeding larvae of the deep sea yield rates of gene flow sufficient to homogenize populations to the degree often maintained in species in shallow-water species having prolonged, feeding larval stages? These books are valuable not only as summary statements of our new understanding of these important aspects of larval biology but as a platform for the next generation of exciting questions in these fields.

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Adapted Wavelet Analysis from Theory to Software. Mladen Victor Wickerhauser. Peters, Wellesley, MA, 1994. xii, 486 pp., illus. $59.95.

Bioelectrochemistry IV. Nerve Muscle Function—Bioelectrochemistry, Mechanisms, Bioenergetics, and Control. Bruno Andrea Melandri, Giulio Milazzo, and Martin Blank, Eds. Plenum, New York, 1994. x, 376 pp., illus. $115. NATO ASI Series A, vol. 267. From an institute, Erice, Italy, Oct.-Nov. 1991.

Combustion Science. Principles and Practice. J. C. Jones. Dwyer, Newtown, Australia, 1994 (U. S. distributor, Seven Hills, Cincinnati, OH). xii, 306 pp., illus. Paper, $29.95. Reprint, 1993 ed.

Deterministic Explanation of Quantum Mechanics. Based on a New Trajectory-Wave Ordering Interaction. Billie Jack Dalton. North Star Press of St. Cloud, St. Cloud, MN, 1994. viii, 79 pp. Paper, $29.95.

The Environmental Protection Agency. Asking the Wrong Questions. From Nixon to Clinton. 2nd ed. Mark K. Landy, Marc J. Roberts, and Stephen R. Thomas. Oxford University Press, New York, 1994. xiv, 341 pp. Paper, $17.95.

Fundamentals of Cosmic Electrodynamics. Boris V. Somov. Kluwer, Norwell, MA, 1994. xii, 364 pp., illus. $144 or £96 or Dfl. 240. Astrophysics and Space Science Library, vol. 191.

Gaskinetic Theory. Tamas I. Gombosi. Cambridge University Press, New York, 1994. xiv, 297 pp., illus. $59.95; paper, $29.95. Cambridge Atmospheric and Space Science Series.

History of Life. Richard Cowen. 2nd ed. Blackwell Scientific, Cambridge, MA, 1994. xviii, 462 pp., illus. Paper, $34.95.

Immunochemistry. Carel J. van Oss and Marc H. V. van Regenmortel, Eds. Dekker, New York, 1994. xii, 1069 pp., illus. $195.

Korovkin-type Approximation Theory and Its Applications. Francesco Altomare and Michele Campiti. De Gruyter, Hawthorne, NY, 1994. xii, 627 pp. $148.95 or DM 248. De Gruyter Studies in Mathematics, 17.

Labor and Politics in the U.S. Postal Service. Vern K. Baxter. Plenum, New York, 1994. xii, 275 pp. $39.50.

Ornithology. Frank B. Gill. 2nd ed. Freeman, New York, 1994. xxviii, 763 pp., illus. $55.95.

Parallel Computing Using the Prefix Problem. S. Lakshmivarahan and Sudarshan K. Dhall. Oxford University Press, New York, 1994. xvii, 294 pp., illus. $59.95.

Remote Sensing for Geologists. A Guide to Image Interpretation. Gary L. Prost. Gordon and Breach, Langhorne, PA, 1994. (distributor, International Publishers Distributor, Brooklyn, NY). xviii, 326 pp., illus., + plates. $115 or £75 or ECU96.