BOOKS: MARINE ECOLOGY

Frontline View of an Invasion

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The recent natural history of the Mediterranean Sea is filled with biological invasions. Many have been inferred from present-day species' distribution ranges, although their details remain poorly documented. After the waters of the Atlantic Ocean refilled the Mediterranean basin following the Messinian crisis (during which the basin nearly dried up, about 5 million years ago), there was a period of massive invasion by numerous taxa. That colonization and many subsequent invasions have always been regarded as the results of natural processes reflecting the species' life-history and dispersal strategies. For the past 200 years, however, humans have played major roles in the introduction of new species. The development of steamship travel brought species transported in the ballast waters. The opening of the Suez Canal in 1869 gave rise to "Lessepsian migrations" of Red Sea species, which are gradually changing the biodiversity of the eastern Mediterranean. These historical migrations, colonizations, and invasions have changed the marine ecosystems of the Mediterranean and have given rise to an underwater landscape that can be likened to a puzzle because of its high degree of heterogeneity.

Killer Algae tells the biological and political history of one recent invasion of the Mediterranean, the spread of the green alga *Caulerpa taxifolia*. This lush, bright green seaweed is a widespread but rare occupant of the tropical littoral from the Caribbean to Brazil, on the west and east coasts of Africa, from Pakistan to Indonesia, and from Australia to Japan to Polynesia. A clone able to live in colder water was discovered in a Stuttgart aquarium in 1980, and many public aquaria soon acquired cuttings. A square meter patch was observed in Monaco waters in 1984. Carried by yacht anchors and fishing gear, the alga spread east and west. By 1997, it had infested over 4600 hectares at 99 sites scattered between the Balearic Islands and the Adriatic Sea.

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Killer Algae
The True Tale of a Biological Invasion
by Alexandre Meinesz
translated by Daniel Simberloff

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Alexandre Meinesz, a professor of biology at the University of Nice in France, learned of the patch off the Oceanographic Museum of Monaco in early 1988. (By then, he had been studying algae of the order Caulerpales for two decades, and he had published on their advantages for aquarium decoration.) The following year, after finding that the patch had grown to cover a hectare, he warned of the potential invasion. His appeals to scientists and the French government went unheeded while the algae spread. So Meinesz accompanies his detailed account of the biology of the invasion with his perspectives on the bitter fighting among scientists and bureaucrats over divergent interpretations of the invasion and how best to respond to it.

The remarkable spread of *Caulerpa taxifolia* corroborates an alarming fact: biotic invasions are becoming more and more extreme and exerting greater effects on extant communities. As Meinesz rightly warns, we must be more vigilant than ever because we are exhausting the self-defense capabilities of the Mediterranean Sea, the cradle of modern Western culture. Today species such as *Asparagopsis armata*, an Australian alga that was inadvertently released in the first third of the 20th century, are common components of Mediterranean marine communities. In the spring, *A. armata* monopolizes large areas on rocky walls, but its thalli practically disappear in autumn and winter. Many other species cannot tolerate the annual temperature variations of more than 15°C in Mediterranean littoral waters, and this seasonality may be one factor that has helped the native communities withstand biological invaders. To date, *C. taxifolia* has seemed to be affected by such seasonality, and its spread has decelerated in recent years. The author's analysis, however, reveals an alarming aspect of the alga's biology: the species' ability to spread by fragmentation and transport during winter storms. This trait and a gradual warming trend in the Mediterranean suggest that *C. taxifolia* may be able to continue its frightening advance. As Meinesz rightly warns, we must be more vigilant than ever because the Mediterranean's ability to rebound from natural disasters seems to be failing.

Meinesz offers a wonderful tale of how one scientist's tenacity and enthusiasm may bring to light not only the degradation of natural systems but also weaknesses in our approaches to science. He found numerous obstacles to convincing the political and scientific authorities of the existence of a serious threat, and his account could affect the quality and success of ecological and environmental studies in France and other European countries. With the doubts expressed by colleagues and governmental authorities, the efforts of individuals and institutions to evade responsibility, and the more than two years that passed before the problem was recognized, Meinesz's elegant and courageous story resembles an epic feat rather than just a narrative. It shows how science survived because of the author's enthusiasm and love, for his work and for the biota he studies.

Meinesz details many factors that impeded an effective response to the alga's invasion. In his country, as elsewhere in Europe, the natural sciences face an excessive amount of red tape and a lack of interest by politicians. The importance of biodiversity is scorned by decision-makers, whose actions often make things worse (and exasperate scientists). The mass media is delighted at the chance to spread alarmist news but rarely serious about reporting less sensational facts.

Algal takeover. *Caulerpa taxifolia* and native gorgonians (red) on rocky substrates at 26 m off Cap Martin (5 km east of Monaco).

CREDIT: A. MEINESZ/FROM *KILLER ALGAE*

Besides recounting a major invasion, *Killer Algae* provides a natural history of life in the Mediterranean, a sea that is unfairly neglected in recent science books. I strongly recommend reading Meinesz's account, not only for the details of the biological phenomenon considered but also for its insights into the peculiarities and day-to-day realities of science in the Mediterranean countries.