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Hydrozoan people come together

Hydrozoa (Cnidaria) are common throughout the World Ocean, both in the benthos and in the plankton, with around ten thousand living species. Their basic life cycle comprises benthic modular polyp colonies that grow by budding and, in some cases, produce individual planktonic medusae by a process related to budding. Medusae reproduce sexually, with fertilization typically leading to a planula larva that settles on the bottom to form a polyp colony.

Many important biological phenomena have been discovered through the study of hydrozoans, from the possibility of tissue grafting, to sperm attraction by the egg, to transdifferentiation (the dedifferentiation and redifferentiation of cells) and to bioluminescence with its associated green fluorescent protein. The separate study of polyps and medusae, however, has plagued hydrozoan taxonomy since its outset, with the building of two separate classifications, one for medusae and one for polyps. Single species have many times been given two different names because medusae and polyps have been (and still are) studied by different specialists. This incongruency is so striking that Hennig[1] suggested it as a possible test for the efficacy of cladism. He argued that a cladistic-phylogenetic classification based just on medusae should match a similar one based only on polyps. This test has not yet been attempted; hydrozoan taxonomists have been working at building a single classification since the beginning of this century, but the task is still far from complete.

In 1985, several researchers founded the Hydrozoan Society. The main event that keeps the society alive is a workshop held every four years. This year, the fourth workshop of the Hydrozoan Society took place at the Bodega Marine Laboratory of the University of California at Davis (USA). The chance to spend two full weeks with ones scientific peers is rare today, and even two weeks is not enough time to pursue everything one would like; despite this, many new collaborations were forged.

The meeting opened with an analysis of the hydrozoan literature since the 1900s. Cinzia Gravili (University of Lecce, Italy) reported on a data set of more than ten thousand papers, originally compiled by Wim Vervoort[2] (National Museum of Natural History, Leiden, The Netherlands). She showed that taxonomic research on the group has nearly vanished in countries that once had the strongest tradition (UK, USA and France), whereas countries with almost no tradition in this field (such as Spain) are now among the few contributing to its advancement. Eric Hochberg (Santa Barbara Natural History Museum, CA, USA), Daphne Fautin (University of Kansas, Lawrence, USA) and Cliff Cunningham (Duke University, Durham, NC, USA) discussed the recent USA National Science Foundation (NSF) awareness that this trend is common to most animal groups, and that the USA scientific community has lost or is rapidly losing its taxonomic expertise. The NSF is now trying to revive taxonomy by supporting the training of new experts through special programmes.

Two lively discussions were dedicated to the possibility of new funding for taxonomic research on Hydrozoa, with suggestions about specific problems that the group hoped such new hydrozoan experts might tackle during their training. The unification of classification, including the use of molecular techniques, was still perceived as the main taxonomic problem. It was agreed, however, that knowledge of morphology and ecology are prerequisites to the use of molecular tools and that the organisms are as important as the molecules of which they are composed. How to merge morphological and molecular taxonomy and systematics was the subject of a discussion led by Bernd Shierwater (Freiberg University, Germany) and Diane Bridge (University of California, Irvine, USA). With very few exceptions, the molecular and the morphological approaches are presently so separate as to have different specialized journals, with practitioners who rarely interact. One result of this is that traditional taxonomists are often aware of problems but do not know how to solve them, whereas molecular taxonomists have the tools to solve problems they are not aware of.

A molecular approach, based on the complete small ribosomal subunit (18S) gene sequence, led Allen Collins (University of California, Berkeley, USA) to explore the phylogenetic history of the Hydrozoa, reviving a suggestion by Haeckel that the Siphonophora are nothing more than a group of Anthomedusae – something that is perceived by many specialists but that needs further support (like that provided by Collins) to become incorporated into zoology textbooks. Antonio Marques (Universidade de São Paulo, Brazil) provided morphological evidence that also supported this conclusion.

Textbook knowledge was challenged many times at Bodega Bay. Jack Costello (Providence College, Providence, RI, USA), for instance, showed convincing video footage demonstrating that flat-belled medusae do not actually use jet propulsion but simply flap their bells, swimming more like other gelatinous plankters, such as molluscs. Only streamlined medusae – round or tall forms with a narrow velar opening – actually proceed by jet propulsion. Ferdinando Boero (University of Lecce) continued to disrupt the certainties of zoology textbooks by further developing an argument that the bell cavity of hydromedusae is a true coelom, being closed during ontogeny and having a lining of striated muscle[3]. If this view is accepted, hydromedusae should be triploblastic and the whole scenario of metazoan phylogeny needs to be reassessed.

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Other surprises came from Hans Grüger (University of Basel, Switzerland), who reported on the occurrence of *PAX* (homeobox domain plus paired domain) genes in hydrozoans. Some *PAX* genes are responsible for the coding of eyes in vertebrates and some invertebrates; they have now even been found in hydrozoan species deprived of specialized sense organs, where they appear to be involved in nerve-cell differentiation. Given that cnidarians are considered to be diploblastic, their condition is ancestral compared with triploblasts. The occurrence of *PAX* genes from cnidarians to vertebrates might indicate that these genes have been co-opted for more specialized functions during metazoan evolution, while remaining rather conserved in structure.

Stefano Piraino (Istituto Talassografico del CNR, Taranto, Italy) addressed the question of how medusae grow. Most of the jellyfish body is made up of extracellular matrix (the jelly), and it is still not completely understood how acellular living matter can grow at places that are very far from the tissues that distribute nutrients. One important idea that coalesced during the meeting is Project Hydrozoa, suggested by Bernd Schierwater. This comprehensive project will allow scientists from all over the world to contribute to a scheme in which 50–100 selected species, widely distributed throughout the Hydrozoa, would form one axis of a grand data availability matrix (DAM). The matrix will include columns with life history characteristics, molecular sequences for several genes, nematocyst complement, polyp and medusa morphologies, development, literature citations and other data. Most scientists at the meeting committed themselves to making a special effort to fill in parts of the matrix, thus building an unprecedented web-accessible database from which to answer phylogenetic and evolutionary questions.

Adam Benović (Institute for Oceanography and Fisheries Laboratory, Dubrovnik, Croatia), and John Rees (California State University, Hayward, USA) reported on nonindigenous hydrozoan species in marine ecosystems, providing examples from both Europe and America. They stressed the role of ballast water in ships as a transport vector for alien species. Hydrozoa are top predators in the marine environment, feeding on the eggs and larvae of almost all animals, including fish[4]. When abundant populations establish, they can exert strong pressures on species of commercial importance, decimating recruitment. Fisheries can thus be sharply affected by both medusan and hydroid predation; the importance of gelatinous zooplankton is generally underestimated in ecological studies. Larval mortality is usually the main constraint to recruitment, so the most devastating predators of species that reach large adult sizes are not necessarily big themselves. On the contrary, small and efficient predators can cause the demise of fish populations, as happened in the early 1990s in the Black Sea with the establishment of the non-indigenous ctenophore *Mnemiopsis leidyi*.

The report by Patrizia Pagliara (University of Lecce), on a species of *Clytia* able to produce floating colonies that can eventually settle on the bottom, reconfirmed that polyps, as well as medusae, can lead a planktonic life. Sometimes, species travel across geographic barriers on unexpected vehicles. Giorgio Bavestrello (University of Genova, Italy) reported on a mysterious hydroid that inverts its polarity during fission. A similar or identical hydroid was studied briefly 40 years ago in San Francisco Bay[5] but was never found again. It seems to have reappeared recently as a pest in the jellyfish tank of the Aquarium of Genova. Bavestrello's study of its life cycle showed that these polyps form cysts, and one explanation of their presence in the aquarium is linked to the use of *Artemia* (a classic food for captive marine animals) imported as cysts from San Francisco Bay. It is possible that this and other encysted forms are being dispersed throughout the world along with *Artemia* eggs (resting cysts).

Jellyfish are now very popular in public as well as at-home aquarium displays, and Danielle Richardi (Aquarium of the Americas, New Orleans, LA, USA) reported on how she maintains such delicate creatures. Many species in her display were purchased at pet stores – there is a flourishing commerce of exotic jellyfish in the USA. The many ways a species can be dispersed, from ballast waters to pet stores and pet food caused much concern to researchers working on introduced species; bored home aquarists might simply liberate their pets in the sea and introduce alien species in any country.

Other conservation issues were highlighted by Jeanette Watson (Museum of Victoria, Australia), who outlined the hydroid fauna of recently discovered (and already heavily exploited) seamounts off Australia, and Claudia Mills (University of Washington, USA), who discussed declines in populations of large semibenthic polyorchid medusae that have been used for decades as research animals on both sides of the North Pacific. Emmanuelle Buecher (University of the Western Cape, Cape Town, South Africa) and Hermes Mianzan (Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata, Argentina) reported on changes in jellyfish populations important for fisheries and tourism in South Atlantic regions.

Ecological contributions included that of Sergi Rossi (Institut de Ciències del Mar, Barcelona, Spain), who discussed trophic strategies of hydroids under different environmental conditions. A parallel approach came from Maria Pia Miglietta (University of Lecce), who described several behavioural patterns of both hydroids and medusae, revealing an unexpected diversity in the way these simple animals react to different kinds of stimulus. The Hydrozoa are rich in strange animals. Yayoi Hirano (Kominato Marine Laboratory, Amatsu-Kominato, Japan) dealt with the tiny crawling medusae of *Staurocladia* that live on tide pool algae; Shin Kubota (Seto Marine Laboratory, Shirahama, Japan) sketched the evolution of the hydroids living only in the mantle cavity of bivalve molluscs; and Heike Hadrys (Goethe University, Frankfurt, Germany) explored the genetic diversity of the marsupial medusa *Eleutheria*, which forms clones of benthic, hermaphroditic medusae.

In spite of having almost abandoned taxonomy, the US scientific community is very strong in ecology, and talks by Dawn Murray and Kevin Raskoff (both from the Monterey Bay Aquarium Research Institute, Moss Landing, CA, USA) revealed unexpected gelatinous worlds that can be appreciated only by those with access to diving submersibles in the depths of marine canyons. Research performed during the workshop led to the discovery of species previously unreported from the Pacific Coast of the USA, with information on their life cycles. Just two weeks of work can improve knowledge of the biodiversity of even well studied areas.

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