17. Marine biodiversity: what is there still to discover?

Philippe Bouchet

In propelling biodiversity into the realm of political concerns, the Rio Convention generated a flood of reviews, summary reports and forecasts of the number of species known on Earth. Unlike entomologists, marine biologists have a tool for measuring the magnitude of marine biodiversity, the World Register of Marine Species (WoRMS). Working with a network of 50 taxonomic editors, WoRMS maintains an up-to-date global inventory of known marine species and their valid names. The primary reason for assigning names, to which biologists and non-biologists attach traits and characteristics, is so that all branches of knowledge can communicate with each other using universal terminology. As of April 2016, WoRMS had identified 239,165 valid species, across all taxa. This level of precision may well raise a smile, but it reflects both the comprehensiveness of the catalogue and the progress of discoveries. Indeed, far from being complete, the rate of discovery of marine flora and fauna shows no sign of slowing, and today, in the early 21st century, scientists are still discovering new species at a pace faster than during the historic expeditions of the 19th century. Since 2010, no fewer than 1,930 new marine species have been described each year!

From discovery to description

Often, many years elapse between discovery and description; for marine species, the average is 16 years (compared with 30 years for plants and 21 for all biodiversity). There are good reasons for this delay. When a specialist has in their possession a single specimen of a species that they believe is new, more often than not they will want to base their description on several specimens. Their discovery is therefore shelved until such time as another expedition collects one or more additional specimens. There are also bad reasons, however. There are entire taxonomic groups (both marine and terrestrial) with no active specialists anywhere in the world: this is the case for many small invertebrates (*e.g.*, crustaceans, molluscs, annelids, nematodes...), while the more emblematic groups (*e.g.*, fish and reef-building corals) are the focus of much attention. For these 'neglected' groups, the road from discovery to description starts on the shelves of the major museums, whose collections offer a considerable resource for research.

Fig. 1 – ***Dinochelus ausubeli*, or Ausubel's Mighty Claws Lobster, a blind lobster discovered at a depth of 320 m off the Philippines and named in honour of the Sloan Foundation's programme officer, who supported the Census of Marine Life from 2000 to 2010. © T.-Y. CHAN. ■**

Location of unknown species

Newly discovered species come from all over the world. It is true that Europe's seas have been the focus of naturalists' attention for more than two centuries, and on the whole their marine macroflora and macrofauna are well inventoried. Nevertheless, meiofauna (small organisms living between sand grains), single-celled eukaryotes and parasites remain under-researched everywhere, including in the imme-

diate surroundings of marine biological stations. However, the major sources of unknown species are the tropics (Fig. 1), specifically the 'Coral Triangle' which stretches from the Philippines to Papua New Guinea and is home to an astounding accumulation of species: one square kilometre of coastal ecosystems in the Coral Triangle is home to more species than the whole of the 2.5 million km^2 of the Mediterranean. Habitats that are difficult to access are obvious sources of discoveries, whether in the mesophotic 'twilight' zone with its low levels of light penetration, in caves, at bathyal depths in 200 to 2,000 metres or at abyssal depths in 2,000 to 6,000 metres. In contrast, and contrary to conventional wisdom, the polar regions and deep-water chemosynthetic ecosystems, which are the focus of numerous research cruises, are comparatively (very) species-poor, with fewer than 1,000 new species having been described since hydrothermal vents were discovered 40 years ago.

Obstacles to the discovery of new species

How many species are really present in the oceans? What still remains to be discovered? With 240,000 species described and a further 2,000 new species being added each year, there is much speculation on the real magnitude of marine biodiversity, with projections ranging from 0.4 to 2.2 million species. The low-case scenario (fewer than 0.5 million species) appears too conservative, and figures of 1.5 to 2 million marine species seem to be a better fit with the pace and number of contemporary discoveries (Fig. 2). Even based on an 'average' hypothesis of 1 million species, it would take 350 years at the current rate of discovery and description for all these species to be assigned a name.

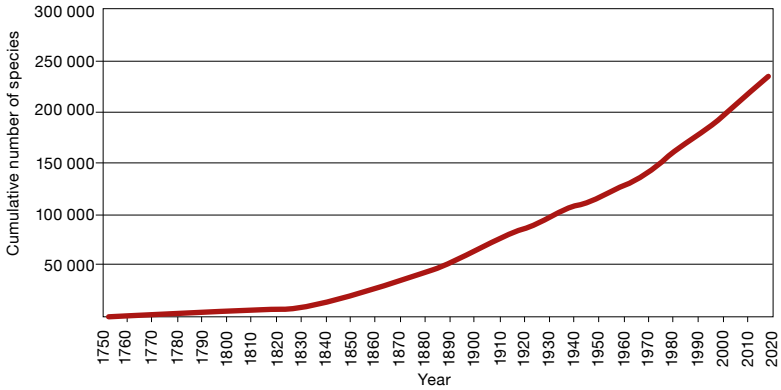

Fig. 2 – Growth in the number of known marine species from the mid-18th century to the present day. There has been no tailing off in the curve and most authors speculate that there may be 1.5 to 2 million species in the world's oceans. To date, just 240,000 species have been described and named. Source: http://www.marinespecies.org. ■

The obstacles to increasing the speed of discovery are primarily scientific and technological. For example, 15 years after the emergence of the 'barcoding of life' concept and the launch of major sequencing programmes (Marine Barcoding of Life and International Barcoding of Life), it must be acknowledged that the objectives announced with such initial enthusiasm have not been achieved: to date, barely 10% of known marine species have a sequence in the major molecular databases and the percentage is hardly any higher for newly described species. Furthermore, there are also sociological obstacles. Indeed, when a group of marine (or terrestrial) organisms for which no critical monograph has been produced for decades and is in need of revision, more often than not there is no backing for it from funding agencies, on the grounds that exploration and discovery are not sufficiently hypothesis-driven. As a result, there is often no one specialist for the most challenging families of organisms, which are also the major reservoirs of unknown species, and they become what are referred to as 'orphan groups'. Lastly, there is a final, regulatory obstacle, in the form of the Convention on Biological Diversity (1994) and the Nagoya protocol (2014): the collection of scientific samples and their permitted uses are subject to regulation and licencing – which is ethically essential in regulating research for commercial purposes (such as pharmacology, cosmetics or aquaculture), but presents a formidable obstacle in terms of academic exploration.

References

• W. APPELTANS *et al.* – *The Magnitude of Global Marine Species Diversity*, Current Biology, 2012.

• P. BOUCHET – *The magnitude of marine biodiversity*, *In:* C. M. DUARTE (ed.), *The exploration of marine biodiversity*, Scientific and technological challenges, Fundacion BBVA, 2006.

• P. BOUCHET – *L'insaisissable inventaire des espèces*, Les Dossiers de La Recherche, 2007.

• C. MORA, D. P. TITTENSOR, S. ADL, A. G. B. SIMPSON and B. WORM – *How Many Species Are There on Earth and in the Ocean?* PLoS Biology, 2011.