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Taxonomic editors plan a World Register of Marine Species (WoRMS)

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Why WoRMS?

An authoritative register of all marine species is urgently required to facilitate biological data exchange and management, integration of biological with other ocean data, and to allow taxonomists to focus on describing new species instead of overlooking recently described species and correcting past nomenclatural confusion (Costello *et al.*, 2006). Its production has added benefits in fostering collaboration between experts at a global scale. Easy access to the register allows ecologists and local experts to correct their use of taxonomic names, and encourages submissions of overlooked species to the list. In turn, this stimulates biogeographic and evolutionary research.

Local and regional species checklists are also in demand for conservation and fisheries management, ecological surveys, and training in marine ecology and environmental management. However, these lists are inevitably compromised by either not being updated by experts, inheriting past misuse of names, using the same name for different species in different locations, using different names for the same species in different regions, or combinations of these problems.

The solution is a single authoritative world register, freely accessible on the World Wide Web, that is routinely updated by experts. The absence of such a world register partly reflects the local and regional focus of marine biology in the past. It also reflects the fact that the diversity of species, and hundreds of publications that they are described in, makes collating a checklist beyond the capability of even a modest group of scientists. Now, biodiversity informatics enables international collaboration and data management to be fast at low cost (Bisby 2000; Wilson 2000; Costello *et al.*, 2005; Costello & Vanden Berghe, 2006). Such a register is an essential requirement, if not a prerequisite, for taxonomy to be available on the internet (Pennisi, 2000; Godfray, 2002, 2007; Mallett & Willmott, 2003; Wilson, 2003; Knapp *et al.*, 2007; Wheeler & Krell, 2007).

How?

There are practical limitations to what a group of scientists can achieve with limited resources. Providing a full, web-based taxonomy, including expert validated species' nomenclatures and information on all species, is beyond the scope of a few scientists. However, clusters of scientists working in synergy with others can contribute parts of the ultimate resource, just as the marine science community achieved with the European Register of Marine Species (ERMS). To this end, over 130 taxonomists are now collaborating together to produce a World Register of Marine Species coordinated by an international Steering Committee representative of a range of related initiatives and taxonomic expertise. This builds directly on the success of ERMS in terms of experts collaborating to validate the content, an intellectual property rights agreement between editors and the Society for the Management of Electronic Biodiversity Data (www.smebd.eu), and the Flanders Marine Institute (VLIZ) providing the database infrastructure and a permanent host institution (Costello, 2000, 2004; Cuvelier *et al.*, 2006).

WoRMS will be a taxonomically authoritative register of marine species names. Some will be

hosted in a database (called Aphia) at VLIZ, and others would be elsewhere but interoperable with WoRMS. It will build on authoritative registers of marine species names that exist at regional levels (e.g. ERMS, New Zealand's Species 2000 inventory, Codes for Australian Aquatic Biota, Fondo *et al.*, 2004, Vanden Berghe, 2004), and for particular taxa at global levels (e.g. *Hexacorallia*, AlgaeBase, Fautin 2000, Nic Donnacha and Guiry 2002, Deprez *et al.*, 2002). Species 2000 is a federation of Global Species Databases (GSD) providing authoritative species names, but is incomplete at present, and does not distinguish which species are marine. uBio uses intelligent taxonomic software tools to capture and store many more names than occur in Species 2000 (Patterson *et al.*, 2006), but it does not add taxonomic or nomenclatural value to these like authoritative registers do. Thus, tools like uBio are valuable for finding information associated with species names, but authoritative registers like ERMS, Species 2000 and ITIS tell users which are the correct names to use, and which names mean the same species.

We estimated that at least half of the estimated 230,000 described marine species (Bouchet 2006) are not included in existing registers of marine species and GSD. WoRMS will collaborate with and contribute to Species 2000's Catalogue of Life (CoL), presently including almost 60% of all world species, and used by OBIS and GBIF as their master list of species names. Already, WoRMS comprises 14 global species databases and six all-taxon regional species databases.

The minimum requirement for WoRMS is the accepted full species name (i.e. accepted combination of genus, specific epithet, author, year, parentheses) placed in an accepted higher taxon group (at least family) and environment (e.g. marine, brackish, and/or freshwater). Desirable additional information is original combination of species name, alternative combinations, important junior synonyms, key literature, distribution, location of type material, and type locality. However, some species pages include considerable additional information, from biology to distribution and images, and WoRMS would continue to provide this service for the Taxonomic Editors and users.

What is WoRMS not?

WoRMS is not a register of all species names because that is the role of CoL and GBIF's Global Names Architecture. WoRMS is not a full Species Information System. That is the function of specialist systems such as FishBase, SeaLifeBase, SpeciesBase and the Encyclopedia of Life (EoL). However, these information systems demand taxonomically authoritative species names, so WoRMS will directly and indirectly (e.g. through CoL) provide a service to those that need it. Thus, WoRMS will contribute to the Global Species Information System proposed by the G8 Environment Ministers (2007). Neither is WoRMS a system for the formal registration of species names. However, as part of the new Pan-European Species-directories Infrastructure project (PESI), it will directly contribute to the development of ICZN ZooBank, which will register names. WoRMS will collaborate with other initiatives to ensure that a comprehensive infrastructure of primary species data, information, maps, images and publications is available online through interoperable portals.

Who wants WoRMS?

Several initiatives have an interest in a WoRMS and would benefit from its availability. The Census of Marine Life (CoML) would find it an invaluable metric of how many and what species are known in the oceans. The CoML's Ocean Biogeographic Information System (OBIS) needs WoRMS for quality control of species names, and as a metric of how complete its distribution data are. Like OBIS, the Global Biodiversity Information Facility (GBIF needs to know the currently correct names for all species (Edwards *et al.*, 2000), and being able to distinguish marine species would enable enhanced data exploration and exchange facilities on its web portal. The International Association of Biological Oceanography (IABO), a member of IUBS, would find WoRMS a valuable focal point and networking mechanism for marine biologists. The Catalogue of Life (CoL), and its partners Species 2000 and the Integrated Taxonomic Information System (ITIS), seek to have an authoritative inventory of all species on Earth (Bisby 2000), but they lack the resources and personal contacts for all marine taxa and have major challenges in the species-rich, non-marine taxa (Bisby & Ruggiero, pers. comm.). The International Code of Zoological Nomenclature's (ICZN) ZooBank needs a register of valid names to begin an online registration system for animal names (Polaszek *et al.*, 2005; Wheeler & Krell, 2007). This already exists for fungi in MycoBank (Hawksworth 2005) and for bacteria (Lapage *et al.*, 1992; Euzéby, 2007).

WoRMS is a freely available scientific service. In addition to individual scientists, students, naturalists, ecological consultants and environmental managers who will use the website to access information on species names, there will be major data systems benefiting from WoRMS. Such beneficiaries will be Species 2000 and CoL, GBIF, OBIS, ZooBank, ITIS, Universal Biological Index and Organizer (uBio), and the planned GBIF Global Names Architecture (GNA). As is the case with ERMS, we expect a range of additional users such as regional environmental and nature conservation agencies and major institutional databases. For example, copies of ERMS have been licensed out at no charge for the use of some individual researchers and the following organisations: the European Environment Agency, International Council for the Exploration of the Sea, Rijkswaterstaat (Netherlands), Nature Protection Directorate (Italy), L'Inventaire national du Patrimoine naturel (France), IFREMER, Federal Environmental Agency (Germany), Akvaplan-NIVA (Norway), National Cancer Institute, Hellenic Centre for Marine Research (Greece), Stazione Zoologica Napoli (Italy), Joint Nature Conservation Committee (UK) (full list at www.smebd.eu).

Progress

So far, there are over 128,000 species from the anticipated 230,000 species estimated to have been described. Associated information includes about 234,000 names, 122,000 literature sources, 7,500 pictures and information on 2,900 specimens. The number of taxonomic editors is over 130 and grows steadily, first to cover all taxa, and then within taxa to share the workload and benefit from collaboration.

Comments from users, including suggestions for new content and services; and anomalies omissions, and errors in the data; are welcomed. The database will only be as good as we make it. The success and future of WoRMS depends on the scientific community providing their time to edit the system, use and promote it, and assist in funding applications that will make it as good quality and comprehensive as possible.

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