Universiteit Antwerpen

VLIZ

Contribution to finalizing the World Register of Marine Species (WoRMS)

Conservation internship report

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INTRODUCTION - WoRMS

The World Register of Marine Species (WoRMS) is an open-access online database created by an editorial board of 270 taxonomists from 146 institutions in 32 countries (Costello et al., 2013). It grew out of the European Register of Marine Species (ERMS) and in combination with several other species registers is maintained at the Flanders Marine Institute (VLIZ). The core platform that underpins the World Register of Marine Species is called Aphia. This platform, established by Flanders Marine Institute, not only allows the storage of accepted and unaccepted species names, but also the linking of different pieces of information through scientific names, both within the Aphia platform and in relation to externally hosted database (Vandepitte et al., 2015). WoRMS aims to combine the information from Aphia and other authoritative marine species list (such as: AlgaeBase, FishBase, Hexacorallia) to provide the most comprehensive list of all known marine species.
This list is now accepted as a standard for marine taxonomic information and as such is embedded in many European and international initiatives (Worms Editorial Board, 2016).

The first aim of WoRMS has been to compile a list of all taxonomically accepted marine species, original description names and commonly used synonyms. WoRMS database enabled the following set of marine biodiversity metrics to be assembled for the first time: the number of nominal species, i.e., all species named, including those now recognized as synonyms due to multiple descriptions of the same species and the number of taxonomically accepted species, i.e., recognized species, excluding names that have been recognized as synonyms (Appeltans et al., 2012). This way any confusion about the species identities should be minimised and a register could serve as a guide to interpret taxonomic literature.

Besides species names, synonyms and vernacular names, WoRMS also contains taxonomic classification for every species, which takes into account both previously established systems and recent changes. Proposals for modification of classification are not implemented until they have been discussed with taxonomic community and this is normally done in 5 year intervals in order to avoid confusion by new classification and terminology (Costello et al., 2013).

In addition to taxonomy, the ultimate aim is to include more detailed information for as many species as possible, such as: pictures, key literature sources (including original descriptions, new combination references, basis of records), distribution, habitat, morphology, dimensions, reproduction, holotype, type locality, IUCN red list category, economic importance, feeding types, predators, parasites, known introductions and links to other authoritative databases (e.g. Encyclopedia of life, Barcode of life, IUCN Red List, Marine species identification portal...). Therefore, beyond complete taxonomic coverage, the long-term objective is to provide the data on species biology, ecology and guides to their identification.

The content of WoRMS is controlled by taxonomic experts, where each taxonomic group is represented by an expert who has the authority over the content and is responsible to control the quality of the information. In addition, the main taxonomic editors can invite several specialists of smaller groups within their area of responsibility (Worms Editorial Board, 2016). Since the database is centralized, standardization, online publication and communication within and beyond the taxonomic community are now facilitated potentially leading to increased rates of discovery of species and synonyms and a reduced rate of creation of new synonyms (and homonyms).

Therefore, WoRMS, as the most completes list of all known marine organisms, has a potential for becoming an invaluable tool for scientist working in different aspects of marine biology including conservation and management of marine species and habitats.

INTERNSHIP OUTLINE

The internship was conducted at the Flanders Marine Institute (VLaams Instituut voor de Zee – VLIZ) in Oostende in the period between July the 1st until July the 31st, 2015. Within this one month period, the work was carried out every working day for 8 hours.

Description of activities

1st July

- Getting familiar with the Flanders Marine Institute facilities and equipment, previous and on-going research, monitoring, educational activities, etc.
- Getting familiar with data management system in VLIZ, especially Aphia – a platform behind the World register of Marine species.

2nd July – 31st July

The main task of the internship was to use available information for certain marine parasitic species (e.g. accepted species names or synonyms) as a starting point to obtain more specific information, that was then entered in WoRMS database.

More specifically the tasks included:

- Relating the name of species with its original description source
- Relating the accepted name of species to its original name based on the new combination reference (in the cases where the original name was changed)
- Relating the species to other important sources where it was investigated (for instance, source that provided new insights in classification of particular species)
- Editing the information about the sources in the database
- Linking species to all the known hosts based on original description (type host) and other available sources
- Editing the details of host-parasite interaction (e.g. endoparasite, ectoparasite), details about larval stages etc.
- Pointing to the missing data in the database and to some errors as determined by investigating available sources

Achieved results and insights

During the internship, more than 1800 marine parasitic worm species names were processed and the acquired information (as noted above) was entered in the database. This included about 660 species from the class Trematoda (subclass Digenea), 600 species form the class Monogenea and 540 species from the class Cestoda. These three classes of parasitic worms belong to phylum Plathelminthes (flatworms) which is characterised by simple bliateralian, unsegmented body with no coelom and no specialised circulatory and respiratory organs (Carranza, 1997).

This internship provided a good insight into how a big, comprehensive dataset that includes the names of all known marine species can be created while taking into account the ever-present changes in taxonomy and relations between different species (such as: host-parasite interaction). Secondly, it was an excellent opportunity to learn how to interpret scientific literature related to taxonomy of species and how to use the combination of different sources and databases to obtain the necessary information. Finally, it provided a better understanding of importance of taxonomy and species' lists such as this one for conservation purposes. This will be discussed in the following section, with a particular emphasis on the importance of parasite diversity for conservation of marine ecosystems.

DISCUSSION

Linking taxonomy and conservation

Conservation is a discipline that relies to a great extent on taxonomy (Costello et al., 2015). Shortage of taxonomic information and skills, and confusion produced by different species concepts and unstandardized taxonomy can cause big problems for conservationists (Mace, 2004). Indeed, it is not feasible to conserve organisms that cannot be properly identified and our attempts to understand the consequences of environmental threats are very much compromised if we cannot recognize and describe the interacting components of natural ecosystems. Since we remain continually unaware of the vast number of species that comprise global biodiversity, it is plausible that many of them will become extinct before they are described. These knowledge gaps in our taxonomic system, the shortage of trained taxonomists and curators, and the impact these deficiencies have on our ability to conserve, use and share the benefits of our biological diversity are acknowledged by the Convention of Biological Diversity as a "taxonomic impediment" (CBD, 2016).

In addition, it is not possible to develop necessary plans and mechanisms for species conservation without adequate knowledge and description (Samper, 2004). Without doubt, species need to be named and identified formally if they are to benefit from the conservation policies which provide legal protection.

These are all key factors that have to be improved in order to obtain solid bases for conservation activities. Therefore, WoRMS model of structured building of taxonomic knowledge is recognized as essential for improvement of conservation activities, which is why it deserves to be replicated in other areas of taxonomy (Costello et al. 2015).

Importance of marine biodiversity

Oceans encompass about 72% of the planet's surface and more than 90% of habitats occupied by life forms (Goulletquer, at., 2014). These heterogeneous habitats hold a great portion of Earths biodiversity. Eventhough the number of new marine species described per decade has never been greater (Appeltans, et al., 2012), it is estimated that tens of thousands of marine species are yet to be discovered; many of which may already be in specimen collection (Parsons, et al., 2014). Thus, our knowledge about marine species diversity is still fairly limited.
Based on the information from WoRMS database, Appeltans, et al. determined that there are approximately 226,000 eukaryotic marine species described. In addition, they report that there are around 170,000 synonyms, 58,000–72,000 species are collected but not yet described and 482,000–741,000 more species have yet to be sampled (Appeltans, et al. 2012). There is still much debate on how many marine organisms exist in total and the estimates range from 300 000 to 10 million (Poore & Wilson, 1993; Mora, et al., 2011; Costello, et al., 2012; Appeltans, et al., 2012).

Marine biodiversity has enormous importance in several different aspects: it strengthens resistance and resilience of ecosystems to altering environmental conditions, it is important in disturbance prevention, nutrient cycling, gas and climate regulation and it has a provisioning importance for humans (food, different types of raw material, etc.) (Norse, 1993; Goulletquer et al., 2014). That is why the role of biodiversity is essential subjects when addressing problems like climate change and sustainable use of natural resources (Goulletquer, 2014).

However, biodiversity in the oceans has decreased dramatically since industrialisation began in the 19th century. The primary causes for the losses include the destruction of habitats by overharvesting, acidification, pollution and eutrophication of the ocean, as well as the steady progress of climate change (IUCN, Marine Species; World Ocean Review). Therefore, it is essential to develop conservation and management strategies which will enable us to minimise human impact on marine ecosystems (A Research Agenda for the Nation, 1994).

Bearing in mind previously described association between taxonomy and conservation, it is clear that we cannot address the issues of accelerated loss of marine biodiversity without the integrated knowledge about the species that are currently known to the science. Therein lies the huge importance of taxonomic list such as WoRMS, that provide comprehensive and up-to-date overview of all the known species that can be found in the oceans.

Importance of parasites for conservation of marine ecosystems

Estimating marine parasite diversity is very difficult for numerous reasons: species numbers of many host groups (especially the deep sea hosts) are not known; most host groups have not been thoroughly examined for parasites or not at all; in most cases latitudinal, longitudinal and depth gradients in species richness are only poorly understood or not known at all, there are few studies using techniques of molecular biology to distinguish sibling species (Rohde, 2002). However, on the basis of a conservative estimate of an average of 3 to 4 fish parasites in each existing fish species alone and a current number of 31,400 described fish species, it has been estimates that number of fish parasites goes up to 120,000 species (Palm, 2011). With so many different species (only related to fish), marine parasites clearly comprise a major part of marine biodiversity.

Marine parasites can be important from the conservation point of view for several reasons: they can serve as biological indicators for pollution, eutrophication and even climate change (Palm, 2011); within fisheries they can serve as natural tags for tracking fish migrations and separation of fish stocks (MacKenzie & Hemmingsen, 2015); they pose an important component of marine food webs (Dunne & al, 2013), they can have an influence on the establishment of introduced host species or be the invaders themselves (Volodymyr, et al., 2015) etc.

First major importance of marine parasites is related to their crucial role in fish biology. Parasites can have an influence on individual survival and reproduction in fish, they can alter fish behaviour and migration patterns, affect fish community structure and ultimately regulate fish populations (Luque & Poulin, 2008). So, from the economic and conservation aspect parasites are thought to have a negative impact on ecosystem since many of them are serious pathogens which can cause a decline in host populations (Poulin & Chappeli, 2002).

However, marine parasites can in many cases be important for the conservation of other marine species and marine habitats in general.

One example of the importance of marine parasites is that they can be used as natural biological tags of different species of fish in order to gain a better understanding of their subpopulation structure, feeding and migratory characteristics (Sindermann, 1983; Palm, 2011). Many studies investigating the potential of marine parasites as natural tags were conducted on economically important species such as herring (*Clupea harengus*) which is host to 9 species of parasites and Atlantic cod (*Gadhus morhua*) which is host to 25 different parasite species (according to WoRMS database). For instance, the recruitment of the herring migrations in the North Sea was traced using two species of digenean metacercariae of the genus Renicola and the plerocercoid of the cestode *Lacistorhynchus tenuis* (MacKenzie, 1985). Another study focused on the cod populations proposed that migratory patterns and stock identification could be investigated using metacercariae of the digenean *Prosorhynchoides borealis* and plerocercoids of the cestode *Diphyllobothrium phocarum* (which are long-lived in cod) while short-lived adult digeneans *Hemiurus communis* and *Hemiurus levinseni* could be used to follow seasonal migrations (MacKenzie & Hemmingsen, 2015). Bearing in mind that cod is indicated as vulnerable in IUCN red list, benefits for conservation and species management that could arise from using the parasites as natural tags is more than evident.

Apart for the aforementioned species, other groups of organisms that were successfully tracked using parasites as natural tags include redfish, flatfish, tunas, anadromous fish, elasmobranchs and some marine mammals and invertebrates (MacKenzie & Hemmingsen, 2015). Considering all the threats to marine biodiversity, especially overharvesting and pollution, tracking populations of different marine organisms using parasites as tags could prove to be invaluable tool which could help us to shed light on ecology of populations of many different marine species.

In addition, parasites can serve as indicators of different pollutants (such as heavy metal concentrations, industrial and sewage pollution, eutrophication) since their metrics have been connected to specific environmental conditions (Palm, 2011). Moreover, Palm states that in many cases parasite infections have been connected to anthropogenic impact and environmental change in marine habitats.

Finally, since some parasites are highly host specific, they can potentially be used as biological indicators for host identification and phylogeny and its systematic position (Rokicki, 1983). For example, it was recently estimated that the original hosts of two primary parasite lineages in the cestode order Trypanorhyncha are alternatively rajiform batoids and carcharhiniform sharks which provided independent proof for the theory that sharks and rays belong to separate lineages, and supported the most recent molecular phylogenies of the Neoselachii (Olson et al., 2010; Palm, 2011).

So far, parasites in general have largely been neglected from conservation aspect for numerous reasons: they are difficult to study due to their small size and complex life cycles, their taxonomy is still not clarified and because it is thought that they have little influence on ecosystem organisation and functioning (Gómez et al., 2012). However, as discussed before, a growing body of evidence demonstrates that parasites are extremely diverse, have key roles in ecological and evolutionary processes, they are fundamental components of food web (Dunne et al., 2013) and that infection may paradoxically result in ecosystem services of direct human relevance (Gómez & Nichols, 2013).
This leads to a conclusion that getting better insight in the species diversity, life cycle biology and ecological characteristics of marine parasite species is not to be neglected from the conservation point of view. On the contrary, the knowledge about parasitic species can serve as a basis for further research into marine biodiversity which could inform conservation actions. A database of all known marine parasites and the host they are related to, without doubt, serves as a vital tool for all future studies in this field that could ultimately provide a better ecological understanding of whole marine ecosystems.

SUMMARY

It is clear that good conservation practices are tightly linked to the proper taxonomic knowledge about the species we want to conserve. Without standardised names for species, the management and use of biodiversity is compromised due to confusions and misinterpretations that could arise as a consequence of differing nomenclatures. Conservation is also hampered by the absence of information on what kind of species exist, their ecology, biogeography, and trends in abundance.

Despite the productivity of taxonomic research, the boost in additional research has never been so urgently needed because of the threat of species extinctions (Costello et al., 2015). One way to accelearte the taxonomic productivity could be to combine the efforts of conservation scientists, managers, organization, journals and funding agencies.
A good example of this kind of approach that integrates and connects different types of scientists, but also general public and legislation organs, is a worldwide standardised list of species such as WoRMS. By providing easy access to expert-validated content, WoRMS improves quality control in the use of species

names, with consequent benefits to taxonomy, ecology, conservation and marine biodiversity research and management.

In this report special emphasis was put on marine parasites which comprise a great part of marine biodiversity. These organisms, which are often unjustly neglected from conservation point of view, have their own place in ecosystem functioning with both negative and positive effects on the overall marine biodiversity. Since marine biodiversity is important for many global processes, it is also important to understand the diversity and role of parasites in marine ecosystems. It is therefore clear that list of marine parasites together with the information about their distribution, invasion success, the host they are related to, etc. can be used as a basis for many types of research which can inform people involved in conservation and restoration of marine biodiversity.

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