

ODINAFRICA:

Marine Biodiversity Data Mobilisation Workshop on Molluscs

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1. Introduction

1.1 ODINAFRICA

The Ocean Data and Information Network for Africa (ODINAFRICA) brings together marine institutions from twenty-five Member States of the Intergovernmental Oceanographic Commission of UNESCO from Africa (Algeria, Angola, Benin, Cameroon, Comoros, Congo, Côte d'Ivoire, Egypt, Gabon, Ghana, Guinea, Kenya, Madagascar, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Senegal, Seychelles, South Africa, United Republic of Tanzania, Togo and Tunisia).

The earlier phases of ODINAFRICA enabled the participating Member States to get access to data available in other data centers worldwide, develop skills for manipulation of data and preparation of data and information products, and develop infrastructure for archival, analysis and dissemination of the data and information products.

The goal of the current phase of ODINAFRICA is to improve the management of coastal and marine resources and the environment in participating countries by: enhancing data flows into the national oceanographic data and information centre in the participating countries, strengthening the capacity of these centers to analyze and interpret the data so as to develop products required for integrated management of the coastal areas of Africa, and increase the delivery of services to end users.

The focus is on preparing data and information products to enable the Member States to address the key issues identified in the African Process: (i) coastal erosion, (ii) management of key ecosystems and habitats, (iii) pollution, (iv) sustainable use of living resources, and (v) tourism.

The government of Flanders, Belgium has provided US\$2.5 million to support the implementation of ODINAFRICA-III.

The following thematic work packages have been implemented to achieve the objectives of ODINAFRICA-III:

- Coastal Ocean Observing System: focuses on upgrading and expanding African network for in-situ measurements and monitoring of ocean variables (e.g. sea-level, temperature, salinity, currents, winds, etc), provision of near real-time observations of ocean variables, and building adequate capacity for collection, analysis and management of sea-state variables. About 15 tide stations will be installed or upgraded and some of them equipped with sensors for other meteorological and oceanographic parameters.
- Data and Information Management: focuses on further development and strengthening of National Oceanographic Data Centers (NODC) to manage data streams from the coastal ocean observing network, upgrading infrastructure in the NODC's (including internet access and computer systems), Integrating biogeographic and hydrological data streams into NODC systems, building capacity for data and information managers for new NODC's established as part of this project and rescue historical data (especially sea level data). The sub-Saharan Africa OBIS node (AfrOBIS; <http://afrobis.csir.co.za:8000/>) will collate marine biodiversity information from many sub-Saharan African countries. It will upload marine biodiversity data to the main OBIS portal, as well as provide a "local" portal for submission and servicing of data

requests. Data will be reformatted, loaded onto AfrOBIS and uploaded to the international OBIS portal at Rutgers.

- Product Development and end user communication and information delivery focuses on identification of end users of marine/coastal data/information products and their requirements, identification and development of a set of core products to be prepared by each NODC, development of Regional and National Marine Atlases, improvement of atmospheric and oceanic monitoring databases, promotion and dissemination of outputs of the project to all stakeholders, and assessment of the impacts of products on the end-user.

1.2 Biodiversity

Biodiversity or biological diversity is the diversity of life. This includes plants, animals, fungi and micro organisms, the genes they contain and the ecosystems they live in. Today, the total number of species on Earth is estimated at about 10 million. New species are often discovered and many of these newly discovered species have not been classified yet. The richest sources of biodiversity are found in rainforests and the oceans. 'Marine biodiversity' refers to this variety of life in molluscs, fishes, mammals, sea birds, sea turtles, sponges, corals reefs, etc..., and the variety of life in the different marine ecosystems such as mangroves, supra, intra and intertidal zones, continental shelf and slope, abyssal or deep ocean.

Biodiversity has contributed in many ways to the development of human culture, and, in turn, human communities have played a major role in shaping the diversity of nature at the genetic, species, and ecological levels. All species are an integral part of their ecosystem as they perform specific functions that are often essential to their ecosystem and human survival as well. Nevertheless the importance of marine biodiversity for ecological, economical and ethic reasons, there is still a lot of information lacking on the creatures living in this watery environment. In spite of this great lack of knowledge, marine biodiversity is already threatened by various activities. Next to an overexploitation of marine resources, pollution and introducing alien species, there is also a physical alteration of the seafloor through trawling and dredging which has its effect on the present marine fauna and flora.

A number of plants and animals living in the oceans are already being used as a food resource, while sponges for example are now a handy tool in our bathrooms. Not only sponges, but also mangroves have useful applications: they provide tannin for the leather industry and wood for the construction industry. Seaweeds on the other hand do not only naturally temper the beating of the waves during storms, they can also be used as an agricultural soil conditioner or fertilizer. Next to food resources, coastal protection and industrial or agricultural uses, ocean life is also used in biomedical research. Coral reefs for example form a home for thousands of species that may be developed into pharmaceuticals which can help to maintain our health and maybe even treat and cure diseases, but corals can also maintain the sustainability of fisheries resources. Another biomedical example is the exploration of some poisonous snails from the Indo-Pacific for their potential to help produce new painkillers. Scientists however fear that many of these little or unexplored resources may disappear before they had the change to tap their potential.

In order to better understand the ecosystem functioning and the maintenance of biodiversity in our seas and oceans, it is of great importance to map the present diversity in sea life, as the oceans are a very important resource for humanity.

1.3 Importance of databases

In the old days – before the computer and internet era – all information was written down in books and information was sometimes hard to find. Now, since we have access to computers and the World Wide Web, exchanging information has become a lot easier. However, scientists still do not find it easy to exploit this information because of the variety in for example data formats and interfaces. Therefore, it is very important that data is not just made available, but that it is also managed in a proper way, thus becoming easily accessible and understandable for the user. Databases form the ideal tools to structure information on for example the distribution and taxonomy of species. As a database is not limited to one specific aspect of a species, one can make the available information as broad as possible. One can, for example, include information on taxonomy and distribution, but also on ecological aspects such as life history traits (type of larvae, feeding types ...). A single database can capture all this information, without becoming too complex for its users.

One can however not forget that a good biodiversity or taxonomic database needs the input of many internationally respected specialists. Although managing and coordinating these networks and related databases and assisting the participating scientists is very time consuming, it is certainly worthwhile to invest in.

1.4 Taxonomy

During this first ODINAFRICA Marine Biodiversity Data Mobilisation Workshop on Molluscs, a variety of taxonomic problems was encountered. These problems occurred on all taxonomic levels but were most significant at genus or species level or they were related to the cited authority.

The most common difficulties were the following:

- The same species being placed under different genera
- Spelling variations in the names of species, genera and families
- Large variation in authorities: different sources give a same authority, but the year of publication varies; authorities placed between brackets in one source, but not in another ...
- Genera placed in different families or sub-families, depending on the used source

How we dealt with these and other problems will be discussed further on in this report.

1.5 Introduction to the represented institutes during the workshop

Kenya Marine and Fisheries Research Institute - KMFRI

Kenya Marine and Fisheries Research Institute (KMFRI) is a State Corporation in the Ministry of Livestock and Fisheries Development of the Government of Kenya. It is mandated to conduct aquatic research covering all the Kenyan waters and the corresponding riparian areas. The Institute was established by an Act of Parliament (Science and Technology Act, Cap 250 of the Laws of Kenya) in 1979. Its vision is to be a centre of excellence for aquatic research and promotion of wise and sustainable use of marine and freshwater resources in Kenya in order to meet the national challenges for food security, poverty alleviation and economic growth. Its mission is to conduct multidisciplinary research in the aquatic systems in both marine and fresh waters in order to generate information for the sustainable management and optimal exploitation of aquatic resources and thus alleviate poverty and enhance employment creation. It is engaged in six programs, namely: fisheries,

environment and ecology, information and data management, aquaculture, socio-economics and natural products.

KMFRI is divided into two main research divisions, namely the Inland Waters Research Division based at Kisumu and Marine and Coastal Waters Research Division based at Mombasa. The research center at Kisumu coordinates the following research stations: Kegati, Sangoro, Naivasha, Turkana, Baringo and Nairobi. The research center at Mombasa coordinates the research substations at Gazi and Lamu.

Contact: Kenya Marine and Fisheries Research Institute
P.O. Box 81651
80100 – Mombasa, Kenya.
Phone: 254 41 475151-4, 475157
Fax: 254 41 475157
Email: kmfri@kmfri.co.ke
Website: <http://www.kmfri.co.ke/>

L'institut Mauritanien de Recherches Océanographiques et des Pêches - IMROP

The Mauritanian Institute of Oceanographic and Fisheries Research (IMROP) has been founded in 1978. Its main objective is to analyse the pressure, the biological, physical, socio-economical determinants and fishing techniques of the fishing industry. This is done by evaluating the state of the resources, following exploitation systems and studying the applied management techniques. The institute is also responsible for the approval of fishing establishments and fishing boats, controlling the health standards of fishery related products and the conservation of the marine environment by combating pollution.

The Institute manages multiple biological databases. For example databases concerning pelagic and demersal species, juvenile species and data concerning scientific marine observations. It also manages oceanographic databases (cf. Odinafrica metadata) and also a system that allows to statistically monitor the artisanal fisheries of the country, which proves to be of great importance. IMROP focuses on different fields of study, for example stock evaluation, ecology and biology of species, monitoring of the environment ...

Contact: L'Institut Mauritanien de Recherches Océanographiques et des Pêches
Mauritanian Institute of Oceanographic and Fisheries Research
BP 22
Nouadhibou – Mauritania
Phone: 222-5 749 035
Fax: 222-5 745 081
Email: secretariat@imrop.mr
Website: <http://www.imrop.mr>

Mauritius Oceanography Institute - MOI

The Mauritius Oceanography Institute (MOI), was established in January 2000. MOI is responsible for the formulation, implementation and coordination of scientific programmes

relating to the protection, exploration and development of marine living and non-living resources in the Maritime Zones of the Republic of Mauritius. MOI is an autonomous research organization involved in scientific research and modelling to characterize coastal and oceanic processes within the maritime jurisdiction of the Republic of Mauritius and the Indian Ocean.

Contact: Mauritius Oceanography Institute
France Centre, Victoria Avenue
Quatre-Bornes, Mauritius
Tel: (230) 427 4428 31 32 34
Fax: (230) 427 4433
Email: moi@intnet.mu
Website: <http://moi.gov.mu/>

National Institute of Fisheries Research - INIP

The National Institute of Fisheries Research (INIP) is a public institution of scientific marine research and fisheries technology. It carries out studies on biological aquatic resources and their respective ecosystems (marine, brackish and fresh water ecosystems) and it also involves in quality control of different fisheries products. The National Institute consists of three departments which are Aquatic resources, Aquatic ecosystems and Fisheries technology. Each department possesses a technical laboratory which in total makes three laboratories. There are also two new laboratories dealing with environmental impacts.

The INIP is involved in different regional as well as international programmes such as BENEFIT (Benguela Environment and Fisheries Interaction and Training Programme), BCLME (Benguela Large Marine Currents and Ecosystems), GCLME (Guinea Large Marine Currents and Ecosystems), FAO and ODINAFRICA in biodiversity and ecosystem.

Contact: Instituto Nacional de Investigaçãa Pesqueira
National Institute of Fisheries Research
Email: iim@angola-minpescas.com
Website: <http://www.angola-minpescas.com/IIM/index.aspx>

National Institute of Marine Sciences and Technologies

The National Institute of Marine Sciences and Technologies (INSTM) is actually a research public institution. The mission of INSTM consists of:

- Conducting contractual research programs related directly or indirectly to the sea and its resources: fishing, agriculture, marine environment, sea technologies, oceanography, etc.
- Participating in different national, regional and international networks related to the sea.
- Contributing to the resolution of problems related to the development of urban and economic activities on the coast as well as in territorial waters.

- Transferring its know-how and the results of its research to decision makers, professionals of the sea and scientists.
- Helping with decision making processes in issues relating to the sustainable management of the sea and its resources.
- Contributing to the diffusion of knowledge and education about marine issues and to raising the public's consciousness for the protection and preservation of the sea and its biodiversity.

The INSTM organization is made up of a board of directors, an academic advisory board (Scientific council), a director-general and a secretary-general. At the scientific level, INSTM consists of four laboratories and seven specialized units.

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2. Materials

2.1 Aphia

Reference: www.vliz.be/vmdcdata/aphia

VLIZ is currently doing several projects involving taxonomic names and biogeographical information. To make sure taxonomy used in these different projects is consistent, a separate database supporting these different activities was developed. Aphia, the resulting species register, is complemented with extra information like distribution records, vernacular names and photographs.

Detailed sources of taxonomic information are an integral part of the database, and are listed in the web interface with the information on individual taxa. For the classification, a number of standard works have been chosen, and these choices are also documented in the database. It should be noted that the classification used is, by necessity in a database with such wide taxonomic scope, a 'compromise' classification, and that it is very difficult to be completely up-to-date for all taxonomic groups.

The database structure includes fields for the following information:

- Taxon name, rank and parent (required fields)
- Source used to create record (required field); can be person (expert), database or publication.
- Authority of the taxonomic name (optional); including authority for new combination for botany; including any 'non', 'ex', ... clauses as needed
- Original publication (optional); publication in which the taxonomic description was originally published
- Type taxon (optional); for families and genera
- Currently accepted taxon (required field); by default points at the taxon itself
- Actual (required for taxa placed in synonymy) and primary source (optional) for the synonymy

There is a provision to make annotations - these are dated and attributed to one of the possible information sources (expert, database or publication). Other tables allow storing vernacular names (in several languages), and distribution records.

Since Aphia is a single database supporting different projects and web sites, there has to be a mechanism to assign information to these contexts. The database should, in fact, be seen as a collection of overlapping subsets of data, where each piece of information can be selectively shown in one or several contexts. Thus, a sponge species occurring in Europe will be visible to a visitor to the European Register of Marine Species, but the same record will be shown to a visitor of Porifera, a web site with a world-wide list of sponges. The most important projects incorporated in Aphia are

- European Register of Marine Species (ERMS)
- Porifera
- Cumacea
- Register of Antarctic Marine Species (RAMS)
- North West Atlantic Register of Marine Species (NWARMS)

Most importantly, it is used to standardise all taxonomic names of the biogeographical records. The two main collections of biogeographical records are the European node of the Ocean Biogeographical Information System (EurOBIS – now also including the Taxonomic

Information System on the Belgian coastal area, TISBE), and the Antarctic node of OBIS, SCAR-MarBIN.

2.2 VLIMAR Gazetteer (Pieter Deckers & Simon Claus)

Reference: www.vliz.be/vmdcdata/vlimar

The VLIMAR gazetteer is a hierarchical list of geographical place names. As it is a marine gazetteer, it is focused on names of sandbanks, bays, gulfs, seas, islands, seamounts, coastal regions, ridges, bays and standard sampling stations used in marine research. The geographic cover of the gazetteer is global, however the gazetteer is focused on the Belgian North Sea Region, the Scheldt estuary and the Southern Bight of the North Sea. The purpose of the gazetteer is to improve access and clarity of the different geographic, mainly marine names used in marine research. The gazetteer is consultable through a web interface (<http://www.vliz.be/vmdcdata/vlimar>) where one can search and browse through the database. Each geographical place name has a certain place type and can be linked with a certain relation type ('part of', 'adjacent to', ...) to one or more other place types. Angola, for example, has a place type 'Nation' and is part of Africa. Bay of Mussulo has a place type 'Bay' and is part of the South Atlantic Ocean. Furthermore, it is linked with Luanda, a region that is part of Angola, with the 'adjacent to'-relation.

Place names can also be linked with geo-units of other databases like APHIA. This link, in combination with the relations between the place names, makes it possible to do some complex biogeographical queries. This way, species that were found in the Bay of Mussulo can be included in the species list of Luanda, the species list of Angola, the species list of Africa, the species list of the South Atlantic Ocean, etc.

Place names are also linked with geographical locations. This can be centroid coordinates of the place name but it can also be polygons or polylines that describe the shape of the place name. This makes it possible to show the exact location of place names on an interactive map.

2.3 Sources used to enter data into the database

The following sources (books, articles and internet) were used to enter species into the database and/or to check if the taxonomy was correct.

All these sources are seen as reliable sources for taxonomic information. If there was any doubt about the taxonomy or if there were differences among sources, priority was given to the book 'Molluscan classification' of Vaught and the book 'Malacologia'.

Molluscan Classification

Full reference: Vaught, K.C., 1989. A classification of the living Mollusca. American Malacologists: Melbourne, FL (USA). ISBN 0-915826-22-4. XII, 195 pp.

This book gives an overview of all mollusc classification. Continued research in the field of molluscs has led to new taxa being discovered and the general classification developing due to changes and additions. It is a book that has collected literature on changes made in light of new methods of identification and classification in various scientific journals and periodicals and reconciled them with the previously accepted works. An index listing all known supraspecific scientific names arranged in as logical an order as possible was created therefore

providing a tool for the advanced amateur, the student and the professional malacologist. It has all the family and generic names and abbreviations.

Malacologia

Full reference: Bouchet, P. & Rocroi, J.-P. (ed.) (2005). Classification and nomenclator of gastropod families. *Malacologia: International Journal of Malacology*, 47(1-2). ConchBooks: Hackenheim, Germany. ISBN: 3-925919-72-4, 397 pp.

In this recent publication, Bouchet and Rocroi propose a new classification scheme for the molluscs; the classification that was proposed by Vaught, however useful, is out of date, and has some serious problems for some taxonomic groups. Where possible, the new classification of Bouchet and Rocroi was adopted. Since the publication only lists names above genus level, it is not a complete alternative to the older work of Vaught.

Marine Species Database for Eastern Africa - MASDEA

Reference: www.vliz.be/vmdcdata/Masdea/

The Marine Species Database for Eastern Africa (MASDEA) was conceived to fill the need for a comprehensive species register for the western Indian Ocean. The database was created to enter all species records from the western Indian Ocean that were published in peer-refereed publications. The database thus includes a species register for the region and a road map to the scientific literature relevant to biogeographical studies in the region.

Further information on this database can be found in annex II.

OBIS Indo-Pacific Molluscan species database

Reference: http://data.acnatsci.org/obis/find_mollusk.html

This database attempts to document all names that have ever been applied to marine molluscs in the tropical Indo-West Pacific. The primary objective is to provide a database of the estimated 25,000 named species of molluscs in the Indo-Pacific region, with summary data on their distribution and ecology. A secondary objective is to combine Indo-Pacific data with existing databases for Western Atlantic and European marine mollusc species and for higher taxa of molluscs to form the basis of a global database for Mollusca.

The Indo-Pacific Molluscan species database was compiled by teams at the Academy of Natural Sciences, the Australian Museum, the Muséum National d'Histoire Naturelle, and the California Academy of Sciences, with support from the Alfred P. Sloan Foundation, the National Oceanographic Partnership Program, and the Australian Biological Resources Study. This database is part of the Ocean Biogeographic Information System (OBIS).

Checklist of European Marine Mollusca – CLEMAM

Reference: www.somali.asso.fr/clemam/index.clemam.html

CLEMAM is a taxonomically oriented database of the marine Mollusca of Europe and adjacent areas aiming to a comprehensive coverage of the species in the eastern Atlantic from 26°N to the North Pole, the Mid Atlantic Ridge and the Mediterranean and Baltic Seas.

The database lists the species currently accepted as valid, thence for each one its basionym and all synonyms and questionable synonyms known to the CLEMAM editor. Subsequent references to the species are not exhaustive; these include "chresonyms", and misidentifications. Page references are given for all entries registered after 1995, and are being completed gradually for the initial batch, where only a statement of the name, author and date of publication were given.

There are currently about 17.000 references, of which ca. 3.500 are valid names. CLEMAM aims at being the standing reference for the systematics of European Mollusca, as well as a tool for species-oriented bibliographic search. The list of valid names of Mollusca in CLEMAM was contributed in 1999 to the European Register of Marine Species, an E.C. funded project led by Mark Costello, and we expect the CLEMAM framework to be the taxonomic base for other published and Internet checklists, catalogues and identification guides.

CephBase

Reference: www.cephbase.utmb.edu/

CephBase is a dynamic relational database-driven web site that has been online since 1998. The purpose of CephBase is to provide taxonomic data, life history, distribution, images, videos, references and scientific contact information on all living species of cephalopods (octopus, squid, cuttlefish and nautilus) in an easy to access, user-friendly manner. There are now about 6.000 ceph papers in the reference database, including 27 papers published in 2005, 49 papers published in 2004, 134 papers published in 2003 and 1.165 references in PDF format, available for download. Currently, they are only able to sporadically enter new papers into the database

Other additions include: several links for cephalopods with genetic info in GenBank (a genetic sequence database from the National Center for Biotechnology Information), some life history data, more common names to include names in different languages and more predator data and occurrence records.

The CephBase project is supported by the National Oceanographic Partnership Program and is physically located at the National Resource Centre for Cephalopods at the University of Texas Medical Branch. CephBase is part of the Census of Marine Life, an international program to explain the diversity, distribution and abundance of marine life.

Nomenclator Zoologicus

Reference: www.ubio.org/NomenclatorZoologicus/

In 2003, uBio received permission from the Zoological Society of London to undertake the digital conversion of Volumes 1-9 of Nomenclator Zoologicus. In 2004, uBio received funding from the Global Biodiversity Information Facility and the Andrew W. Mellon Foundation to assist in the conversion.

Nomenclator Zoologicus is a continuous record of the bibliographical origins of the names of every genus and subgenus in zoology published since the 10th ed. of Linnaeus' *Systema Naturae* in 1758 up to 2004 in ten volumes. Names are listed alphabetically, with a bibliographic reference to the original description of each one and an indication of the animal group to which it belongs. There are an estimated 340,000 genera represented in the text as

well as approximately 3,000 supplemental corrections. This version of the data is very accurate but the conversion process may have introduced some errors in the digital record.

Mauritius

Full reference: Database of marine organisms of the Mauritian maritime zone - *excel files*

The “Database of marine organisms of the Mauritian maritime zone” project was initiated by the Mauritius Oceanography Institute in May 2005. It aims at producing a database of marine species in Mauritian waters, which will be linked to the existing databases on marine organisms such as Marine Species Database for Eastern Africa (MASDEA) and Ocean Biogeographic Information System (OBIS).

The database will also be an important source of information for researchers and a decision making tool for policy makers, industry and resource managers.

At the initial stages of this project, Excel was chosen for data capture as it provided flexibility at the level of data input, data search, data cleaning and data migration. The Excel format enabled the development of a codification scheme to reduce the risk of introducing errors during data input. It also provided the possibility to start the parallel process of designing an own project database.

Information on marine molluscs was obtained from the following major sources:

- Michel, C. (1974). Notes on Marine Biology Studies, Made in Mauritius. The Mauritius Institute Bulletin, 7(2): 1-287.
- Michel, C., Coowar, M. & Takoor, S. (1985). The Marine Molluscs of Mauritius. The Regent Press, 6, Chaussée, Port Louis, Mauritius
- The Marine Biodiversity of Rodrigues (Indian Ocean). Oliver, P. G., Holmes, A.M. (Ed). Proceedings of The First International Biodiversity Workshop for Rodrigues. Journal of Natural History.
- Online databases such as MASDEA and Indo-Pacific Molluscs.

Malacological Fauna from the Cape Verde Archipelago

Full reference: Rolán, E. (2005). Malacological fauna from the Cape Verde Archipelago: 1. Polyplacophora and Gastropoda. ConchBooks: Hackenheim, Germany. ISBN 3-325319-73-2, 455 pp.

Rolán developed an interest in Cape Verde molluscs from an interest in shell collection. This book builds its knowledge from Rochebrune (1881) up through Burnay & Monteiro (1977). It contributes to the knowledge of the interesting fauna on these islands and is useful for tourists, amateurs and collectors.

The marine fauna and flora of Cape Verde are of great biological richness and exceptional scientific interests. It is located at the boundary between temperate and tropical regions of the province of West Africa, thereby representing both temperate and tropical fauna. Ekman (1953) states that endemism for molluscs is 63% in the Cape Verde Archipelago.

This book reviews all malacological fauna of the Cape Verde Archipelago. Information is given about the number of species, relationships with other molluscan fauna, endemism and new records. Per species, a number of items are described, such as for example the reference of the original description, what the type locality is and – if possible - where the type material

is deposited. A distribution is given, including other countries in addition to the Cape Verde Archipelago. If necessary, some general remarks are written down. The book also discusses the future of Cape Verde's fauna with regards to more research and protection of some habitats and species on the islands.

Conchas e Moluscos de Angola

Full reference: Gofas, S., Afonso, J.P., Bandão, M. (ed.) (S.a.). Conchas e Moluscos de Angola = Coquillages et Mollusques d'Angola. [Shells and molluscs of Angola]. Universidade Agostinho / Elf Aquitaine Angola: Angola, 140 pp.

This book does not aim at representing all molluscan species present at Angola; it rather wants to give an overview of the diversity of species present. As the molluscan fauna is very rich, they are also hardly known. Identifying all the known molluscan species from Angola, would ask for a team of zoologists and a lot of time, since the literature is still very scattered. As this book is also meant for the naturalist, it starts by giving some didactic information, for example some information on the distribution of the larvae, the habitat of the different molluscan species and an overview of the seven classes currently representing the Mollusca. General information is given per family, together with distribution details on some representative species. Gofas has represented 3 species of Polyplacophora, 333 species of Gastropoda, 2 species of Scaphopoda, 121 species of Bivalvia and 4 Cephalopoda species in this book.

Shells of Gabon

Full reference: Bernard, P.A. (Ed.). (1984). Coquillages du Gabon. [Shells of Gabon]. Pierre A. Bernard: Libreville, Gabon. 140, 75 plates pp.

This book gives an inventory of the shells living along the West-African coast, and especially the coasts of Gabon. 296 species (or sub-species or local forms) can be found, accompanied by 265 coloured and 31 black-white pictures. A dozen of micro-shells are also represented in the book. Of these 296 species, 257 belong the Gastropods, 35 are Bivalves, 3 are Scaphopods and only 1 Chiton is represented. Information is given about the species themselves, their habitat, their description including information about colour variations in forms and the zones where they were collected.

West African Seashells

Full reference: Ardevini, R., Cossignani, T., 2004. West African seashells (including Azores, Madeira and Canary Is.) = Conchiglie dell'Africa Occidentale (incluse Azzorre, Madeira e Canarie). English-Italian edition. L'Informatore Piceno: Ancona, Italy. ISBN 88-86070-11-X. 319 pp.

This book gives an exhaustive inventory of seashells found along the West-African coast, stretching from Cap Blanc (Mauritania and southern area of the Moroccan Sahara) till the coasts of Namibia, where the South African province of Western Cape starts. The represented taxonomic levels are Class, Family, Genus, Species and Sub-species. For every species, the authority is mentioned. Illustrations are accompanied by a note describing the geographical distribution of the species.

Two Oceans: a guide to the Marine Life of Southern Africa

Full reference: Branch, G.M., Griffiths, C.L., Branch M.L. & Beckley, L.E., 2002. Two Oceans. A guide to the marine life of Southern Africa. D. Philip Publishers, Cape Town. Revised 5th Impression, 360 pp. ISBN 0-86486-250-4

This book gives an overview of the data capture for Southern Africa (i.e. South Africa, Mozambique and Namibia). In addition to the geographical range of the occurrence of the species, the book also provides a number of pictures.

Les Cônes du Sénégal.

Full reference: Pin, M., Tack, K.D.L., 1995. Les cones du Sénégal [The Conidae of Senegal]. La Conchiglia 277 (Suppl.): 1-55.

In this document, the authors give an illustrated inventory of the Conidae of Senegal. For each species, a description of the species and their habitat is given.

Banc d'Arguin – Mauritania

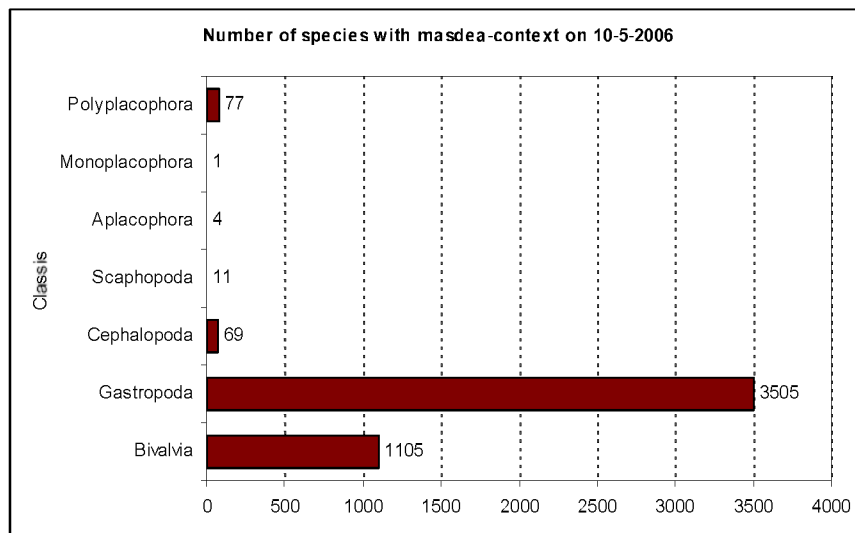
Full reference: Wolff, W.J., Duiven, A.G., Esselink, P., Gueye, A., Meijboom, A. Moerland, G. & Zegers, J., 1993. Biomass of macro benthic tidal flat fauna of the Banc d'Arguin, Mauritania. Hydrobiologia 258: 151-163.

This paper reports on the biomass of the benthic macro fauna of the tidal flats of the Banc d'Arguin and discusses some aspects of this fauna, based on observations made mainly in late winter and early spring of 1986. This article is an ecological article, in contrast with all the other sources which are taxonomic.

3. Results

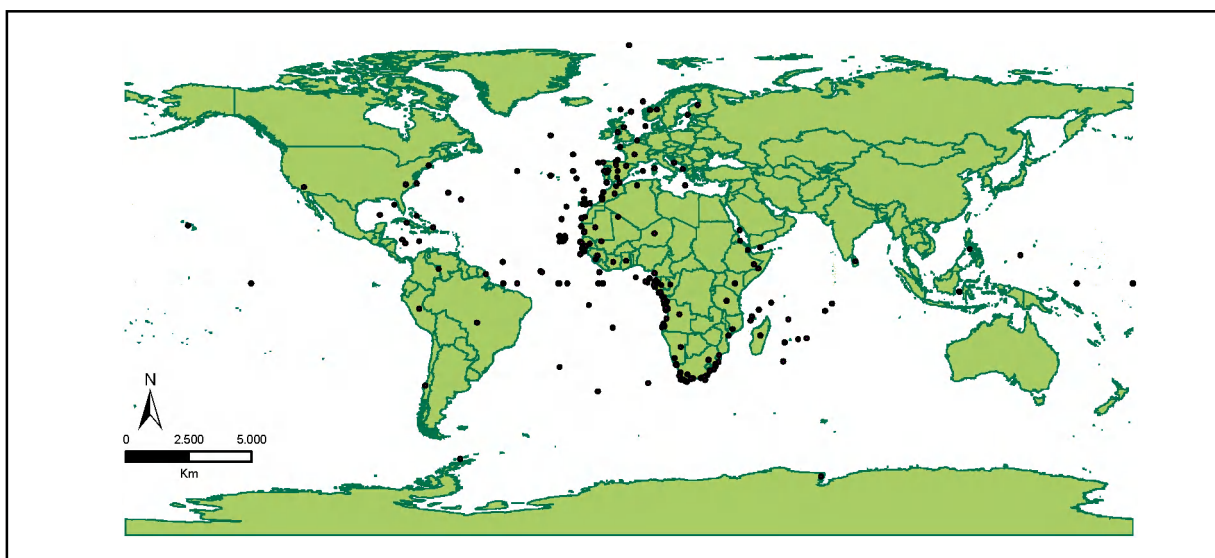
3.1 General

Already 6,460 records on Mollusca were entered into the aphia-database with a “Masdea”-context, representing 4,772 species. The majority of these species belong to the class of the Gastropoda (3,505 species or 73%), followed by 1,105 species (or 23%) belonging to the class of the Bivalvia. Up till now, only 224 of all these records are considered to be invalid taxon names. For 82% or 3,955 species, the authority is already known to the database.



3.2 Geographical

As shown on this general map, not only African distributions were mentioned in the used sources, also distributions from Europe, America and Australia are known to these sources and thus added to the database. 199 molluscan species are present in both Europe and Africa.

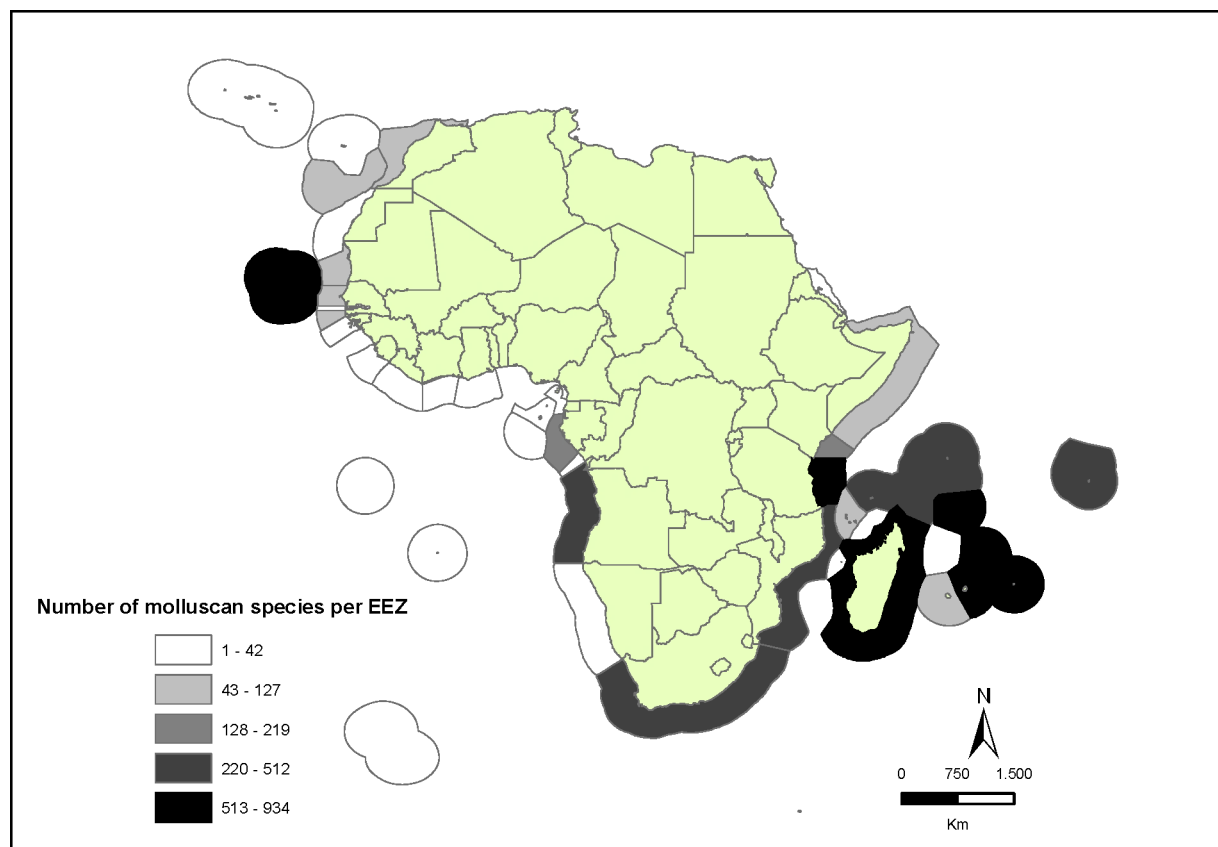


General map, representing the distribution of all molluscan species with a Masdea-context (dots on the map)

When further analyzing the species distributions within Africa, the highest number of molluscan species are found in the EEZs of Madagascar (934), Mauritius (932), Tanzania (720) and Cape Verde (704). A number of species were described to be found in e.g. the Atlantic and Indian Ocean. These species were not coupled to a specific EEZ and were thus not comprised in this analysis.

A comparison was then made between South-, East- and West-Africa. The following conclusions could be made:

- Most molluscan species are found in East-Africa (3184), followed by 1382 species in West-Africa and 407 species in South-Africa
- 165 species are shared between South- and East-Africa, 104 between West- and East-Africa and 29 between South- and West-Africa
- 13 species are shared between South-, East- and West-Africa



Number and distribution of molluscan species in the African EEZs

4. Discussion

4.1 Analysis

Before we discuss the results, the reader should be aware of the fact that our database shows incompleteness on two levels. First of all, not all data sources concerning African marine molluscs have been entered into the database. Secondly, publications on marine mollusc biodiversity in Africa only represent a limited reproduction of the actual number of marine mollusc species present in the region. This first ‘incompleteness’ can be overruled by actively searching for more publications on African marine molluscs (also see further) so that the database can become more complete. The second problem however is out of our league, although it can be very useful as gap-analysis: it can show researchers which information is lacking and maybe stimulate them to fill this gaps.

The results show that already a lot of molluscan species present in Africa have been documented in the database. For lots of species, multiple distribution locations are known, which gives the advantage to compare between different regions (eg. Europe vs. Africa; East-Africa vs. West-Africa). These comparisons can indicate if a certain species is bound to a specific region or if it is rather cosmopolitan. However, we still have to be careful with conclusions like this, as not yet all possible distribution records and species have already been entered into the database and thus the analyses are made based on an incomplete dataset (gap-analysis). There is still a lot of work to be done concerning the documentation of distribution records of African molluscan species: the more distributions can be documented, the more accurate the database and the analyses will become.

From the analysis, it is also visible which African countries are well documented (cfr. high number of species in their EEZ) and which are poorly documented (low number of species in their EEZ) for molluscs. From this, one can possibly conclude that the countries with little molluscan species should perhaps get a priority treatment when looking for more data for the database. Having a low number of species in the EEZ does not necessarily mean that there are no species present; it is merely an indication of the efforts that have been made to document the presence of marine molluscan species in those areas or countries.

4.2 How do we deal with conflicts?

During the input of Molluscan species into the database, several ‘imperfections’ were found.

- For some records, two sources were mentioned as “basis of record”, which is not possible. One should look up both sources again and find out which one formed the basis of the record. The other source then becomes an “additional source”.
- The used sources do not always mention an exact geographical distribution. This makes it difficult to fill in a distribution record. When the distribution is very broad (e.g. Atlantic or circumtropical), it becomes rather difficult to represent this on a graph or a map, since the reader can interpret it in various ways.

There were also some problems with the used sources. The same species can be mentioned in different sources, but which source should then be considered as the ‘basis of the record’? If variation in spelling, authority, year of publication and synonymy appeared, which source should be seen as the correct one? For these and similar problems, we turned to the following sources:

- On genus or sub-family or family level, the book of Vaught (see 2.3) was consulted to give a definite answer (e.g. what is the higher taxonomic level, authority ...). If the

family could not be found in the book of Vaught, the book 'Malacologia' was consulted.

- On species level, Professor Serge Gofas is seen as the taxonomic expert for Mollusca. If there was any doubt about a species, we considered his literature to be correct.

For certain families, the sub-families were not yet entered into the database. Before entering a new record for a sub-family, the book of Vaught had to be checked to see if that sub-family is an accepted taxon. Especially the book of Rolán (see 2.3) contained a lot of sub-families which were not yet in the database.

5. Conclusion:

5.1 Information sources

During the workshop, a large number of species have been entered into the database. All species were extracted from (monographic) literature and articles at our disposal. A lot of sources on African marine molluscs are present at the VLIZ-library; other sources were introduced by the participants themselves. An overview of the present sources at VLIZ and other literature concerning African molluscs is given in the annex “Monographic literature on African marine Mollusca”.

Although a lot of information on literature concerning marine Mollusca in Africa is readily available, there is still a lot of information out there. This stresses the fact that – in the future – it will be very important not only to enter the species of the available literature into the database, but also to look for yet unknown literature. Further completing the database will be necessary to stay up to date with the available literature and existing species.

5.2 What for the future?

Miss Nina Wambiji from Kenya was appointed as the coordinator of this group and she will be in charge of follow-up of the project, dealing with problems in meeting deadlines and submitting deliverables. She will also be responsible for contacting the Regional Biodiversity Coordinators on issues relating to data sources.

We intend to have distance arrangements where data will be entered from a country other than Belgium. There is also an agreement to maintain lists with possible resources and to update this list frequently.

It will be possible to continue working on the database through a web interface, such as for example the World Porifera database. Rights to add or change distributions will be given to the members of this workshop, although taxonomic changes will not be allowed. Data managers will be able to send the OBIS-staff an excel sheet with the following five elements: family, genus, species, authority and sources. The datacenter at VLIZ will then be responsible for taxonomic changes or adding new species, and this in close consultation with taxonomic experts (e.g. Serge Gofas for molluscs). When this has been done, the distribution records can be added on-line by the members of the workshop.

The whole group will continue working on this project. Different museums have information on their collections in electronic formats. The Regional Biodiversity Coordinators have already been requested to contact these museums requesting for information on all holdings on all groups including molluscs. All information collected on molluscs will be directed to this group.

The Regional biodiversity coordinators will be further contacted to better define their roles and how they can do more in the future. They will be responsible for the internal communication, the communications with the heads of different institutions that possibly hold useful information and they should also contact the project manager in case of problems.

6. Participants

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ANNEX I

Monographic literature on African marine Mollusca, available in VLIZ Library

Aiken, D.W.; Fuller, K.J. (1970). The living volutes of Africa. Richard E. Petit: North Myrtle Beach, USA. 70 pp.

Ardevini, R.; Cossignani, T. (2004). West African seashells (including Azores, Madeira and Canary Is.) = Conchiglie dell'Africa Occidentale (incluse Azzorre, Madeira e Canarie). English-Italian edition. L'Informatore Piceno: Ancona, Italy. ISBN 88-86070-11-X. 319 pp.

Bartsch, P. (1915). Report on the Turton Collection of South African marine mollusks, with additional notes on other South African shells contained in the United States National Museum. Bulletin. United States National Museum, 91. Smithsonian Institution: Washington DC (USA). XII, 305, 54 plates pp.

Bernard, P.A. (Ed.). (1984). Coquillages du Gabon. [Shells of Gabon]. Pierre A. Bernard: Libreville, Gabon. 140, 75 plates pp.

Braga, J.M. (1952). Materiais para o estudo da fauna malacológica de Moçambique. [Material for the study of the malacological fauna of Mozambique]. Anais da Junta de Investigações do Ultramar 7(3): 5-67, 14 plates.

Burnay, L.P.; Monteiro, A.A. (1977). Seashells from Cape Verde Islands (1). [S.n.]: Lisboa, Portugal. 85 pp.

Coulombel, A. (1994). Coquillages de Djibouti. [Shells from Djibouti]. Edisud: France. ISBN 2-85744-707-8. 143 pp.

Dautzenberg, Ph. (1912). Mission Gruvel sur la côte occidentale d'Afrique (1909-1910): mollusques marins. [Gruvel mission on the western coast of Africa (1909-1910): marine molluscs]. Ann. Inst. Océanogr. Paris (Nouv. Sér.) 5(3): 1-111.

Dautzenberg, Ph. (1923). Liste préliminaire des mollusques marins de Madagascar et description de deux espèces nouvelles. [Preliminary list of marine mollusks from Madagascar and description of two new species]. J. Conchyl. 68: 21-74.

Dautzenberg, Ph. (1929). Contribution à l'étude de la faune de Madagascar: Mollusca marina testacea. [Contribution to the study of the fauna of Madagascar: Mollusca marina testacea]. Fauna from the French colonies, III(fasc. 4). Société d'Editions géographiques, maritimes et coloniales: Paris, France. 321-636, plates IV-VII pp.

Dautzenberg, Ph. (1932). Mollusques Testacés marins de Madagascar, supplément. [Testacean mollusks from Madagascar, supplement]. J. Conchyl. 76: 5-119, 1 plate.

Gofas, S.; Afonso, J.P.; Brandão, M. (Ed.). (S.a.). Conchas e Moluscos de Angola = Coquillages et Mollusques d'Angola. [Shells and molluscs of Angola]. Universidade Agostinho / Elf Aquitaine Angola: Angola. 140 pp.

- Jarrett, A.G. (2000). *Marine shells of the Seychelles*. Carole Green Publishing: Cambridge, UK. ISBN 1-903479-00-2. 149 pp.
- Kilburn, R.; Rippey, E. (1982). *Sea shells of southern Africa*. Macmillan South Africa: Johannesburg, South Africa. ISBN 0-86954-094-7. xi, 249 pp.
- Nicklès, M. (1950). *Mollusques testacés marins de la côte occidentale d'Afrique*. [Marine mollusks from the West African coasts]. *Manuels Ouest-Africains*, 2. Paul Lechevalier: Paris, France. 269 pp.
- Oliver, P.G. (1992). *Bivalved seashells of the Red Sea*. Christa Hemmen/National Museum of Wales: Wiesbaden, Germany. ISBN 3-9255919-08-2. 330, 46 pl., drawings pp.
- Pasteur Humbert, C. (1962). *Les mollusques marins testacés du Maroc, catalogue non critique: 1. Les Gastéropodes*. [The marine mollusks of Morocco, general catalogue: 1. Gastropods]. *Travaux de l'Institut scientifique Chérifien. Série Zoologie*, 23. Institut scientifique Chérifien: Rabat, Morocco. 245 pp.
- Pasteur Humbert, C. (1962). *Les mollusques marins testacés du Maroc, catalogue non critique: 2. Les Lamellibranches et les Scaphopodes*. [The marine mollusks of Morocco, général catalogue: 2. Lamellibranchia and Scaphopoda]. *Travaux de l'Institut scientifique Chérifien. Série Zoologie*, 28. Institut scientifique Chérifien: Rabat, Morocco. 184 pp.
- Pin, M.; Tack, K.D.L. (1995). *Les cônes du Sénégal*. [The Conidae of Senegal]. *La Conchiglia* 277(Suppl.): 1-55.
- Pinn, F. (1977). *Seashells of East Africa: spider and wing shells*. Rex Collings: London, UK. ISBN 90-172-095-X. 39 pp.
- Rolán, E. (2005). *Malacological fauna from the Cape Verde Archipelago: 1. Polyplacophora and Gastropoda*. ConchBooks: Hackenheim, Germany. ISBN 3-325319-73-2. 455 pp.
- Rolán, E.; Ryal, P. (1999). *Checklist of the Angolan marine molluscs = Lista de los moluscos marinos de Angola*. *Reseñas Malacológicas*, X. Sociedad Española de Malacología: Madrid, Spain. 132 pp.
- Steyn, D.G.; Lussi, M. (1998). *Marine shells of South Africa: an illustrated collector's guide to beached shells*. Ekogilde Publishers: Hartebeespoort, South Africa. ISBN 0-9583889-5-4. ii, 264 pp.
- Steyn, D.G.; Lussi, M. (2005). *Offshore shells of Southern Africa: a pictorial guide to more than 750 gastropods*. Douw G. Steyn & Markus Lussi: South Africa. ISBN 0-620-33607-2. 289 pp.
- Zuschin, M.; Oliver, P.G. (2003). *Bivalves and bivalve habitats in the northern Red Sea. The Northern Bay of Safaga (Red Sea, Egypt): an actuopalaeontological approach: 6. Bivalvia*. *Naturhistorisches Museum Wien*: Vienna, Austria. ISBN 3-902-421-00-2. 304 pp.

Important articles

Kilburn, R.N. (1985). The family Epitoniidae (Mollusca: Gastropoda) in southern Africa and Mozambique. *Ann. Natal Mus.* 27(1): 239-337

Kilburn, R.N. (1985). Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique: 2. Subfamily Clavatulinae. *Ann. Natal Mus.* 26(2): 417-470

Kilburn, R.N. (1986). Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique: 3. Subfamily Borsoniinae. *Ann. Natal Mus.* 27(2): 633-720

Kilburn, R.N. (1988). Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique: 4. Subfamilies Drilliinae, Crassispirinae and Strictispirinae. *Ann. Natal Mus.* 29(1): 167-320

Kilburn, R.N. (1992). Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique: 6. Subfamily Mangeliinae, section 1. *Ann. Natal Mus.* 33(2): 461-575

Kilburn, R.N. (1993). Notes on some South African Ancillinae with descriptions of five new species of Amalda (Mollusca: Gastropoda: Olividae). *Ann. Natal Mus.* 34(2): 369-389

Kilburn, R.N. (1993). Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique: 6. Subfamily Mangeliinae, section 2. *Ann. Natal Mus.* 34(2): 317-367

Kilburn, R.N. (1994). Turridae [s.l.] (Mollusca: Gastropoda) of southern Africa and Mozambique: 7. Subfamily Crassispirinae, section 2. *Ann. Natal Mus.* 35: 177-228

Kilburn, R.N. (2000). Biogeography, biomes and the Mollusca of south East Africa. *Spec. Publ. Phuket Mar. Biol. Cent.* 21(1): 265 pp.

Lamprell, K.L.; Kilburn, R.N. (1995). The recent Spondylidae of South Africa and Mozambique, with the description of a new species (Mollusca, Bivalvia, Pectinoidea). *Moll. Res.* 16: 81-95

Lamprell, K.L.; Kilburn, R.N. (1999). De genera Lioconcha en Pitar in Zuid-Afrika en Mozambique, met een beschrijving van drie nieuwe soorten (Mollusca: Bivalvia: Veneridae). [The genera Lioconcha and Pitar in South Africa and Mozambique, with description of three new species (Mollusca: Bivalvia: Veneridae)]. *Vita Marina* 46(1-2): 19-41

Van Bruggen, A.C. (1952). Notes on South-African marine Mollusca. *Basteria* 16(1-2): 6-24

Available databases

Mauritius country list (Excel sheets)

MASDEA (Access MDB; integrated in database; needs checking/integration of taxonomy)

Data from SA – Natal Museum

Separate database of Dick Kilburn

Aphia

Available through the web

CLEMAM - Check list of European Marine Molluscs
(<http://www.somali.asso.fr/clemam/index.clemam.html>)

Indo-Pacific Molluscs by Gary Rozenberg (http://data.acnatsci.org/obis/find_mollusk.html)

Nomenclator Zoologicus (<http://www.ubio.org/NomenclatorZoologicus/>)

ITIS - Integrated Taxonomic Information System: <http://www.itis.usda.gov/>

Species 2000 (<http://www.sp2000.org/>)

CephBase (<http://www.cephbase.utmb.edu/>)

CIESM – The Mediterranean Science Commission
(<http://www.ciesm.org/online/atlas/index.htm>)

Referral systems/abstracting services

Aquatic Sciences and Fisheries Abstracts – ASFA - on Cd or on-line (www.csa.com, you need a password to enter the online database). Aquatic Sciences and Fisheries Abstracts (ASFA) is an International Cooperative Information System which comprises an abstracting and indexing service covering the world's literature on the science, technology, management, and conservation of marine, brackish water, and freshwater resources and environments, including their socio-economic and legal aspects.

Oceanic Abstracts (www.csa.com/factsheets/oceanic-set-c.php). Oceanic Abstracts is focused exclusively on worldwide technical literature pertaining to the marine and brackish-water environment. The database has long been recognized as a leading source of information on topics relating to oceans. The database focuses on marine biology and physical oceanography, fisheries, aquaculture, non-living resources, meteorology and geology, plus environmental, technological, and legislative topics.

Classifications

ITIS (Integrated Taxonomic Information System)

Aphia

Bouchet, P.; Rocroi, J.-P. (Ed.) (2005). Classification and nomenclator of gastropod families. Malacologia: International Journal of Malacology, 47(1-2). Conch Books: Hackenheim, Germany. ISBN 3-925919-72-4. 397 pp.

Vaught, K.C. (1989). A classification of the living Mollusca. American Malacologists: Melbourne, FL (USA). ISBN 0-915826-22-4. XII, 195 pp.

The classification of molluscs in the Aphia database will be based (or is already based) on the classification in the book of Bouchet & Rocroi and the book of Vaught. The book of Bouchet & Rocroi only gives an overview of the Gastropod families, while Vaught gives an overview of all mollusc classification up to genus level.

New literature surfaced during the workshop:

Rosso, J.-C., 1978. Faune malacologique de la plate-forme tunisienne: etude de quelques dragages et carottages effectués à l'intérieure ou au large du golfe de Gabès. Bull. Inst. Natn. Scient. Tech. Océanogr. Pêche Salammbô, 5 (1-4) : 17-41.

Azouz, A., 1973. Les fonds chalutables de la region nord de la tunisie. (1) cadre physique et biocoenoses benthiques. Bull. Inst. Océanogr. Pêche, Salammbô, vol. 2, n°4.

Azouz, A. & Capapé, C., 1971. Les relations alimentaires entre les selaciens et le zoobenthos des cotes nord de la Tunisie. Bull. Inst. Océanogr. Pêche, Salammbô, vol. 2, n°2.

Van Aartsen, J.J., Gittenberger, E. & Goud, J., 1998. Pyramidellidae (Mollusca, Gastropoda, Heterobranchia) collected during the Dutch CANCAP and MAURITANIA expeditions in the south-eastern part of the North Atlantic Ocean (part 1). Zool. Verh. 321: 3-57

Diop, M.S., 1988. ecologie et dynamique des populations de praires (Venus Rosalina) à l'ouest de Banc d'Arguin Mauritanie. UBO – CNROP – IFREMER

Wague, A., 2005. Campagne de chalutage a bord du N/O Al Awam AW0512D du 16 au 30 décembre. Rapport de Mission. Institut Mauritanien de Recherches Oceanographiques et de Peches. 14 pp.

Etats et tendances de la faune et de la flore marine cotiere. Etude réalisée par l'équipe de consultants nationaux de groupe Biodiversité Marine et Côtière : Mohamed Mahfoudh Ould Taleb ould Sidi, Mohamed Abdellahi Ould Samba, Diagne Ahmed, Mohamed Lemine Ould Abdellahi. 44 pp.

Chinguetti Development Project [Projet de Mise en Exploitation de Chinguetti]. Draft Environmental Impact Statement [Avant-projet d'Etude d'Impact]. Chapter 4 : Existing Environment [chapitre 4 : Aspects environnementaux]. November 2003.

Wolff, W.J., Duiven, A.G., Esselink, P., gueye, A., Meijboom, A. Moerland, G. & Zegers, J., 1993. Biomass of macrobenthic tidal flat fauna of the Banc d'Arguin, Mauritania. Hydrobiologia 258: 151-163.

M.R. van Stralen, 2005. Développement de la pêche coquillière en Mauritanie. Evaluation des stocks de coquillages, juin 2005. MarinX-rapport 2005.50

Dia, M.A., 1988. Biologie et exploitation du poulpe *Octopus vulgaris* (Cuvier, 1797) des côtes Mauritanienues. These présentée a l'université de Bretagne occidentale pour l'obtention du doctorat de 3^{ème} cycle.

Inejih, O.C.A., 1991. Estimation de la croissance et de la mortalité du poulpe (*Octopus vulgaris*, Cuvier, 1797) en Mauritanie par analyse de la composition en taille des captures. Université de Bretagne occidentale, faculté des sciences et techniques de Brest.

Annex II

MASDEA – Marine Species Database for Eastern Africa

Biodiversity is very much the order of the day, especially after the 'Rio Conference' (United Nations Conference on Environment and Development, Rio de Janeiro, 1992). While this recent attention to biodiversity is very welcome, it is all too often forgotten that a very old branch of the biological sciences, taxonomy, is a sine qua non for any work on biodiversity, or informed decision-making in conservation. Taxonomy is the science of naming living organisms, and classifying them in groups of common descent. Hence taxonomy provides the 'vocabulary' of the biodiversity language: it provides a standard way of referring to species, the basic building blocks of biodiversity.

Naming of species is governed by three different codes for taxonomic nomenclature: one for zoology, one for botany, and one for bacteria. These codes lay down rules on what constitutes a valid publication, how names should be formed, and how to take earlier descriptions into account. A very useful introduction on these codes has been written by Jeffrey (*Biological Nomenclature*, Edward Arnold: 1989).

Unfortunately, things are never as simple as they look. Naming and classifying all living organisms in a way that satisfies all taxonomists proves to be a daunting task. The number of species is enormous: some recent estimates put the number at 30,000,000 species of higher organisms, of which less than 1,500,000 have been described. No one really can even make an estimate of the number of bacteria species: every scoop of soil or bucket of water seems to yield new species.

Another set of problems stems from the historical nature of taxonomy: for every new species that is described, all earlier descriptions have to be taken into account. There are strict rules of priority, and a vague description in a 100-year old obscure publication might take precedence over a brand new one in a widely distributed international journal. Hence the need to build comprehensive databases of all species descriptions, so that a prospective author of a species description can stay clear of these pitfalls.

Taxonomists are human (usually), and humans tend to sometimes disagree, sometimes change their mind. When taxonomists do this, other users of the taxonomic nomenclature (like ecologists, physiologists...) suffer: species change name, and often the validity of a name depends on the taxonomist you are talking to. Hence, again, the need to create taxonomic databases, and to record, in those databases, the source of information used, and the need to keep track of synonyms or invalid names.

Taxonomic databases

In spite of the importance of standardized species lists for taxonomic nomenclature, no such lists presently exist for the Western Indian Ocean. In the light of recent interest in biodiversity this lack becomes even more glaring, especially as it is one of the factors to be taken into account when planning Integrated Coastal Zone Management.

Several global initiatives exist to inventorise all published taxonomic names. Botanists are fortunate in having started this exercise early enough. *Index Kewensis* has been published on paper for many years, keeping a record of all plant names. Since some years now, all information in the hard copy volumes is available on a single CD ROM, which can be

obtained from the Royal Botanic Gardens in Kew. Note, however, that this is just a list of published names; there is no information on which name is the currently valid one in a set of synonyms, and there is no distribution information.

Zoologists are not that lucky, and face problems that might seem insurmountable. First of all, the number of animals is at least an order of magnitude higher than the number of plants, possibly even two. Another set of problems is the zoologists' own making: many of the species descriptions are published in languages that are not widely spoken (botanists stick to Latin), and the rules and regulations for the nomenclature are somewhat more lax than for botany. Two global programmes dealing with botany and zoology are Species 2000, and ETI.

Some databasing efforts are directed specifically at gathering information on marine organisms; some examples are

- Veron's global list of Corals, which is in preparation
- Sheppard's Corals of the Indian Ocean, which will be distributed on a CD ROM
- FishBase, a CD ROM produced at ICLARM, Manila, giving global information on fish
- ETI's series of CD ROM products, which includes one on Sea Cucumbers of Northern Australia, and one on Marine Mammals
- The WDC-A's NODC Taxonomic Codes. While this database does not include distribution information, it is a useful for checking spelling and higher taxonomy
- The Marine Species Registry of UNESCO, developed in collaboration with ETI.

In spite of the above list, we felt that there was still a lack of information for the Western Indian Ocean region. With the exception of Sheppard's data, all of the above have a world-wide scope, which makes progress for this (or for any particular) region frustratingly slow. And, with the exception of the coral databases, and of FishBase, most are far from completion. Even FishBase, which approaches being comprehensive in its taxonomic covering, still has ways to go to exhaust all possible sources for species distribution.

Objectives and guiding principles for development

Late 1996, we started developing a database application at the RECOSCIX RDC to fill this gap. We are actively looking for partners in this project, mainly taxonomists with knowledge of the flora and fauna of the region. In these early phases of the project, any advice is very welcome; we are especially looking for lists of references on the biogeography of any taxonomic group. Also, we are looking for collaboration with other databasing projects; data managers are invited to contact us to discuss modalities for collaboration.

In part, this project was inspired by the fact that some data had been collected during a project funded by UNESCO/ROSTA, for which no follow-up funding was provided. Our enthusiasm for this project received a boost during the Fourth Session of the IOCINCWIO, where we got the go-ahead from the region.

The software for the database is developed in Access. A short summary of the structure is presented below. A number of guiding principles were observed while developing the structure and the user interface:

Importance of keeping wrong and outdated information

Very often, while scanning the literature, one comes across taxonomic name changes, or a statement that an earlier distribution observation was based on a misidentification. Very

often, such wrong species distribution records are propagated through literature, with the result that many species lists are inflated, containing distribution records based on these misidentifications. Also, very often a taxon is included several times: once under the currently valid name, and under one or more invalid synonyms: hence the need to store information on synonymy, and to keep the distribution record linked with the name under which it was originally published.

Importance of leaving an 'audit trail'

All sources where the information is taken from are documented in the database. Both taxonomy records and distribution records have a field to include a literature reference, so that anyone who wishes can check the contents of the database against the primary sources. The ultimate goal of this exercise is to provide biologists with a reference tool; while the database is being developed, and its contents validated, it can serve as a roadmap to the literature available on biogeography of the Western Indian Ocean.

Don't force an extra layer of codes on the users

Taxonomic nomenclature is, in itself, a coding system with very elaborate rules and regulations, and well understood by trained biologists. These rules are internationally accepted, and documented in the 'Code for Zoological nomenclature' and the one for Botanical nomenclature. There is no need to develop an extra set of codes, which only carries information that is already contained in the taxonomic names. Chances are that these latter codes will be specific to a given databasing exercise, and create unnecessary confusion. There are, obviously, codes that link records in the relational structure of the database, but these are internal to the system and could be completely hidden from the user.

Keep it simple

Only those fields have been created that were essential to capture the biogeographical information. For all additional information, memo fields are provided. This way, the user is only presented with, and forced to fill, those fields he/she is really interested in. There is also the added advantage of ease of development, and the performance gain of the completed system.

Structure of the Database

The database consists of a synonymised list, with distribution records referring to the taxon name with which the distribution information was originally published. Each distribution record (in principle presence in one of the countries of the region) is referenced to the literature. It is also possible to keep track of records of which it is known that they are false or doubtful. This feature, together with the way synonyms are treated, should ensure that false records or records with invalid names are only entered once, and appropriately flagged.

As illustrated in the diagram, four tables form the core of the structure: 'Countries', 'Records', 'Literature', and 'Taxonomy'. Records table links country and taxonomy, plus a reference to the literature, making it possible to keep track of sources of information on the level of occurrence of taxon in a country. A separate table gives information on the higher taxonomy; book-keeping of the flow of information into the system is possible through the table with Log session information.

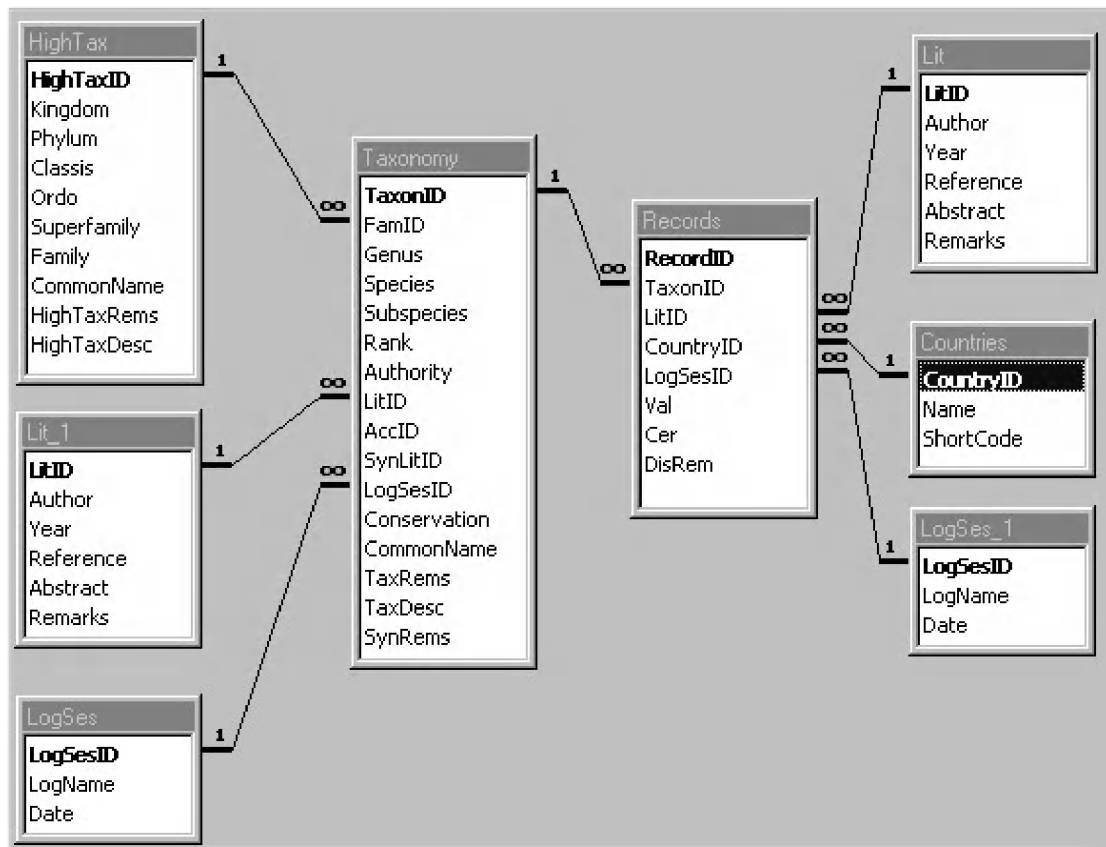


Figure 1: structure of the database.

Progress so far, and the future

Since logging began in December 1996, we have entered approximately 22890 distribution records, and 10160 taxon records. Apart from these, there are just over 500 family-level records. The information sources are just over 230 literature references (numbers of 12/6/98).

Details of the taxonomic and geographical coverage are given in tables 1 and 2. The following is a rough outline of the present content of the database:

- Sea turtles have been taken from the FAO species catalogue, and an IUCN manual has been used for the marine mammals. We consider both these groups as completed.
- Fish information has been extracted from FishBase. As noted before, the taxonomic covering of FishBase is virtually complete, so the same is true for MASDEA in this respect. We are working on extra distribution records, and inserting synonyms we encounter in the scanned literature. One valuable source are the FAO Species catalogues.
- The work of Sheppard on reef-building corals has served as the basis for this group. More recent information has been added, and this part of the database has been validated by David Obura from the Coral Reef Conservation Project (for which our thanks). There will always be new information, or forgotten old information, but we expect this part of the database to be more or less complete.
- A major effort went into logging information on Decapods. No single source was available, but thanks to Prof. Vaninni of the University of Florence, we have a reasonably complete set of references on the Repantia. Also Mr Ruwa from the KMFRI has

contributed some references and articles. Virtually all of it is logged, but still is to be validated.

- Echinoderms were taken from the standard work of Clark & Rowe (*Monograph of the shallow water Indo-West Pacific Echinoderms*, British Museum (Natural History), London: 1971), and supplemented with some more recent information. Dr Massin of the Royal Belgian Institute for Natural History, and Ives Samyn of the Free University Brussels have made available more references and articles on Holothuriae, which will be logged in the near future.
- Several sources have been used for molluscs; several of these had been logged already at the CRCP under Tim McClanahan, while the ROSTA project was still active. Mr Ruwa helped us with several references. Unfortunately, no taxonomic revisions were available to allow us to harmonise the taxonomy used in the different works.
- A list of plants and algae is being prepared by Dr Helida Oyieke of the National Museums of Kenya, and will be uploaded later.
- Dr Vincx and her team made available lists of references on nematodes and copepods. They are still to be logged.
- Several works on general natural history have been used, The two most import ones are by Vine (*Red Sea Invertebrates*, Immel Publishing, London: 1988) and by Richmond (*A guide to the Sea Shores of Eastern Africa and the western Indian Ocean*, SIDA, Sweden: 1997).

Software development now is concentrated on producing a user-interface for report definition. After this, some work will have to be done on the way log sessions are recorded; this will allow logging to take place outside the RDC, and information logged elsewhere to be merged with the master database at the RDC. As soon as this is finished, the database, including data, will be widely distributed to taxonomic experts for validation.

Apart from the main objective behind creating this database, there are two other goals we set ourselves to realise through this project. The first is to develop a directory of marine taxonomists with knowledge on the flora and fauna of the region. The RECOSCIX Project has been explicitly invited to do so by the fourth Session of the IOCINCWIO, and we hope that the contacts made during the development of the database will serve as a solid basis for such a directory. The second objective is to compile comprehensive bibliographies on the biogeography of the region, for selected groups. This will be an automatic spin-off of the main project, once it is completed, but will require input from others to improve the coverage. Everyone with an interest in marine botany or zoology is invited to join us, to bring not only this minor objective, but also the main project, to a good end.

Table 1: number of taxa (synonym and valid) per classis

Phylum	Classis	Synonym	Valid
<Avrainvillea>	<Avrainvillea>		3
Annelida	Polychaeta	16	646
Anthophyta	Monocotyledonidea	1	22
Arthropoda	Branchiopoda		3
Arthropoda	Crustacea	158	2306
Arthropoda	Pycnogonida		7
Bryozoa	Gymnolaemata		120
Chlorophycota	Chlorophyceae		72
Chordata: Vertebrata: Pisces	Actinopterygii	357	1868
Chordata: Vertebrata: Pisces	Elasmobranchii	29	137
Chordata: Vertebrata: Pisces	Holocephali		1
Chordata: Vertebrata: Pisces	Sarcopterygii		1
Chordata: Vertebrata:	Mammalia		28
Chordata: Vertebrata:	Reptilia		6
Cnidaria	Anthozoa	147	714
Cnidaria	Hydrozoa		61
Cnidaria	Scyphozoa		14
Cyanophycota	Cyanophyceae		14
Echinodermata	Asteroidea	2	81
Echinodermata	Crinoidea	1	25
Echinodermata	Echinoidea	2	76
Echinodermata	Holothuroidea	18	249
Echinodermata	Ophiuroidea		107
Echiura	<Echiura>		2
Hemichordata	<Hemichordata>		3
Magnoliophyta	Magnoliopsida		2
Mollusca	<Mollusca>		5
Mollusca	Cephalopoda		44
Mollusca	Gastropoda	60	1911
Mollusca	Pelecypoda	5	577
Mollusca	Polyplacophora	2	24
Mollusca	Scaphopoda		3
Nemertea	<Nemertea>		5
Phaeophycophyta	Phaeophyceae		30
Plathelminthes	Turbellaria		37
Porifera	Calcarea		7
Porifera	Demospongiae		37
Rhodophycota	Rhodophyceae		99
Sipuncula	<Sipunculids>		15
Tunicata	Ascidacea		1

Table 2: number of distribution records per country. Headings in the first line indicate the value of the distribution data quality flags as discussed above. VC: both flags are set (ie the record is both valid and certain); V: Valid flag set, Certain flag cleared (probably valid); C: Certain flag set, Valid flag cleared (certainly wrong); -: both flags cleared (probably wrong)

Name	-	c	v	vc
Aldabra	1		4	881
Cargados Carajos			1	6
Chagos	2		1	886
Comores		1	2	471
Djibouti				9
East Africa	1		3	438
Eastern Africa &	1			249
Eritrea		1	3	143
Kenya	2	2	27	2011
Madagascar	5	5	22	2060
Mascarene Islands	4			970
Mauritius	1	2	10	1636
Mozambique	1	2	52	2475
Red Sea	6	7	14	3954
Reunion			3	841
Rodriguez			1	218
Seychelles	2	2	20	2165
Somalia		2	9	841
South Africa				317
Tanzania	4	7	29	1889
Western Islands				171