General Assembly Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction

Intersessional Workshop on the conservation and sustainable use of marine biodiversity beyond areas of national jurisdiction

Marine genetic resources

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ABSTRACTS

Panel 1

Basics of marine genetic resources

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Marine genetic resources (MGRs) are applicable genetic materials from marine macroorganisms and microorganisms. The biodiversity of marine microorganisms is probably much higher than that of marine macroorganisms. MGRs are one of the most valuable parts of marine biological resources. 65% of the ocean lies beyond the exclusive economic zones and the potential hot spots for MGRs are mainly distributed in areas beyond national jurisdiction. However, MGRs from areas beyond national jurisdiction may share high similarity with that from areas within national jurisdiction. An endemic species possesses some unique MGRs but can easily become endangered or extinct if their restricted habitat changes. In general, migration and colonization enlarge the diversity of MGRs.

Panel 1

Marine genetic resources in areas beyond national jurisdiction
Clarifying terminology and constraining expectations

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Meaning and Scope

The CBD and CBD Nagoya protocol provide definitions for terms and concepts such as “Utilization of genetic resources” and “biotechnology”. As we move forward with discussions, further clarification of commonly used terminology is required, to avoid ambiguity and confusion. In my view there is a hierarchy of complexity and molecular refinement where:

1) Biomolecules and natural products are extracted and purified from marine biomass which may or may not be composed of whole organisms,
2) Biomolecules are simpler in composition than natural products which can be composed of several biomolecules.
3) Marine genetic resources (MGR) are contained within marine biomass but not necessarily within natural products or biomolecules.
4) Genes are the source of biomolecules and natural products.

Extent and types of research, uses and applications

The discovery of a new marine organism or a chemical compound, enzyme or gene in a known organism represents the critical first step in the path leading to commercialization. Marine scientific research field research is primarily led by academic or government scientists and is aimed at increasing our knowledge of the ocean and marine organisms. Field programs in ABNJ are most commonly undertaken by consortia of research institutions, funded by State agencies in developed countries, although there have been a few recent, highly publicized biodiversity expeditions funded by combinations of private, public and non-governmental organization support. State funding is also critical to early laboratory studies that document marine biodiversity and identify genes, organisms and biomolecules that may be of future interest for exploitation by the biotechnologies. The key step in the transition from basic to applied research is a screening process to identify potential leads. The probability that a ‘hit’ identified in the initial screening process will lead to a commercial product is very low. The path from the collection of samples in the field through to the commercialization of a product from a marine organism is mostly discontinuous and there is no clear point of transition from state funded basic research to industry funded applied research. Nonetheless, it is probably accurate to state that identification of a promising lead marks the point where most scientists involved in basic research cease to participate in the pathway leading to commercialization. In contrast to the more limited development of new drugs and biopolymers from marine organisms, the rapidly growing nutraceutical industry makes use of marine biomass, such as fish waste or harvested algae, to produce health food products and restorative cosmetics. This gives rise to the question of the role of the commercialization of nutraceuticals in the MGR debate. Is this biomass-based industry simply another form of living resource extraction like agriculture, aquaculture, fisheries and forestry? Or does it involve the development of MGR that relies at least in part on R&D and related intellectual property.

Panel 1

Marine microbiological research and possible applications – [Speaking Notes]

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"Marine Biological Resource" is generally used in a very wide meaning. It occasionally applies to aquatic resources, macro- and microbiological resources, and genetic resources. Aquatic resources are discussed in various occasions under the fishery category. This presentation will focus on marine microorganisms and their application since they are relatively well studied and are highly considered as possible candidates of use for mankind in the near future rather than marine genetic resources due to difficulties in access and limited scientific knowledge. Generally speaking, implementing marine scientific research is not an easy task, in particular marine biological investigation, since sampling at sea becomes a key factor in its success with obtaining and studying actual living resources. Moreover, technologies related to sampling marine microorganisms, separation and storing are still not well established and their application to industrial use has started recently in Japan. A few examples of success by JAMSTEC scientists will be introduced on this opportunity.

Panel 2

Why should marine genetic resources be conserved?

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Marine Genetic Resources are genetic information from marine organisms with current or potential value, including direct economic value and ecosystem services. The potential value of existing genetic resources cannot be determined because future environmental conditions and novel future technologies are unknown, therefore all genetic variation can be considered to have potential value, thus being a resource.

What is the function of marine genetic resources in the marine ecosystem?

The climate and chemistry of the oceans and atmosphere, have and continue to be shaped by the ocean´s genetic resources; by genes that evolved in the seas to perform all the essential functions that support ecosystems, from production of organic matter to its cycling and recycling. Major surprises have been discovered in the last few decades, such as chemoautotrophic microorganisms that can live in symbiosis with various invertebrates and the domain Archaea as major players in the deep oceans with interesting gene functions. Some genetic resources with high current and potential value are derived from slow growing sedentary invertebrates that provide support to diverse biotic communities and have evolved powerful defensive compounds produced by genes with biotechnological interest. Another interesting genetic function is detoxification of the water column and ocean sediments. Bioluminescence genes, from free living or symbiotic bacteria to plankton and invertebrates, are important in deep sea ecosystems but also in surface waters at night. These have found many applications in biomedical and environmental analyses and have even resulted in a Nobel Prize. The potential for discovery of new genetic functions is very large and expected to grow exponentially as genomic technologies allow their study from very small samples and without the need for cultivation. As key potential for the future, one important function of genetic resources is acting as an insurance against environmental changes, by allowing adaptation to take place. The lower the genetic diversity the more likely it is that groups of organisms will go extinct instead of adapting.

Why is it important to preserve genetic diversity?

Genetic diversity contains current value as services to the ecosystem and direct applications, but the future potential of genetic diversity is enormous, particularly for the deep sea which is mostly unknown and already so many novel genetic variants have been discovered. However, many deep sea marine genetic resources occur in ecosystems with high vulnerability and low resilience, i.e. low capacity to recover from perturbations within the time scale of human generations. Marine genetic resources are a stock of genetic and chemical diversity that will surely have much more potential in the future, as new technologies advance exponentially. It is therefore necessary to discover and describe it, in order to preserve it for future generations.

How is genetic diversity impacted?

Major human impacts on marine genetic resources are known from fisheries, but effects of mining, acidification, climate change effects on water mixing, and pollution are also potentially of concern for the high seas. These can act upon genetic diversity by reducing effective population size, including demographic effects, and by altering connectivity. Conservation of genetic resources has the additional challenge of their cryptic nature. Distinct genetic traits are not evident and their loss can easily go unnoticed unless specifically studied, a serious concern because genetic variation is the basis for adaptation to future environmental changes and for future benefits to be derived from the species. In some cases our own original marine genetic resources might never be known if human impacts dramatically reduce populations to sizes where most genetic variants are lost, even if populations could recover numbers and biomass. The recovery of genetic diversity occurs at much slower temporal scales than population size, thus leaving shifted genetic baselines.

Panel 2

Requirements for marine resources and approaches for managing the future

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The marine food chain starts with dinoflagellates and diatoms that tend to nourish successively larger species up the chain, ultimately to humans, whales and similarly large species. Most of this nourishment is usually measured in terms of protein requirements, but each step in the food chain also concentrates levels of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), two vital omega-3 fatty acids. These fatty acids are required for human development and reproduction and for the optimal function of our cells, governing genetic expression and protein function.

Examining preservation of the ocean's resources through the lens of nutrients like EPA and DHA is not necessarily a traditional way to manage marine species. However, EPA and DHA can only be obtained naturally from marine organisms. This approach seeks to shed light on the requirements of humans as stakeholders and dependents of marine diversity, but it also accelerates innovation and research into new solutions to reduce the burden on the oceans.

The human population has grown to a size where our requirements for omega-3s exceed what can be sustainably harvested from the oceans, even under resource-optimized conditions. This means that threats to living marine resources are threats to mankind that will manifest themselves in the form of higher healthcare costs and increases in chronic and genetic diseases. Destruction of marine genetic diversity is just one of the factors that can threaten fisheries and reduce the ocean's ability to provide these vital nutrients.

A number of steps are being taken to sustainably preserve the ocean's resources, most of which are fishery-specific. However, few of these management schemes currently seek to preserve genetic diversity. Sustainability is a moving target, though, and when it comes to managing marine resources, genetic diversity concerns may become a vital part of fishery sustainability schemes.

In addition, there are multiple projects that have either been commercialized or are in development, which have the effect of reducing the burden of fisheries to provide EPA and DHA. These include commercially growing and harvesting single cell organisms, improving aquaculture operations, and genetically modifying plants and oilseed crops. Each of these sources has challenges to overcome before they can make a meaningful reduction on the EPA and DHA requirements of the oceans.

Panel 3

Environmental aspects of marine genetic resources

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Marine genetic resources are of actual and potential interest for commercial applications due to the higher success rate of finding undescribed active chemicals in marine organisms than in terrestrial organisms. Marine organisms that have yielded source materials for commercial applications include marine micro-organisms, sponges, molluscs, tunicates, worms (including hydrothermal vent tube worms), bryozoans, algae and vertebrates. Of particular recent interest are marine micro-organisms, which are common everywhere in the world ocean, including in the water column and sediments. The contribution of these micro-organisms to the functioning of marine ecosystems is of enormous importance. In recent years, many commercial applications have focused on micro-organisms found in extreme environments (so-called extremophiles), such as hydrothermal vent environments that are characterized by high pressure, temperature and heavy metals. Extremophiles resistant either to hot or cold temperatures, or to extremes of acidity and alkalinity, are a source of enzymes that are able to function under harsh conditions and are thus useful for a variety of industrial processes. Using patenting as a proxy of commercial intent, it is possible to document and map geographically areas of potential commercial interest, which include, but are not limited to, hydrothermal vents, seeps and deep sea sediments, coral and sponge reefs, as well as the water column itself. While some organisms are limited to specific habitats and may be endemics, others are more cosmopolitan and can be found in deep and shallow waters, and, in some cases, in terrestrial environments. Most patents and products on the market are based on organisms collected from coastal waters and EEZs, although examples of patenting of products based on organisms sourced from both the water column and deep seabed beyond national jurisdiction also occur.

Generally, environmental impacts of biological prospecting are thought to be minimal to non-existent at the early stages of collection, where the size of samples collected is small. If a given species has shown biotechnology potential, repeated collection may require larger quantities, raising the likelihood of environmental impact. However, the synthetic manufacture in a laboratory of the chemical of interest generally eliminates the need for repeated collection. The development of some products requires continuous harvesting, which could have environmental impacts. Environmental impact also remains a concern if the target organism is rare, has a restricted distribution, and/or the collection is focused on a particular population or may impact on a pristine or sensitive environment. Adding to the uncertainty of potential impact is the fact that the population and life history characteristics of many source organisms are not well known, and data on ecosystems in marine areas beyond national jurisdiction are often lacking, making it more difficult to assess risks. The environmental impacts of biological prospecting may also be of concern when they are cumulative with other pressures already suffered by the source organism. While EIAs and SEAs in areas beyond national jurisdiction are currently rarely undertaken, it should be possible for such assessments to address the large scale of ocean ecosystems, connectivity of localized and separated ecosystems, and the specific characteristics of deep seabed and pelagic open ocean species, their trophic structures, and their environments.

Panel 3

Marine genetic resources: technical challenges values

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The marine realm represents 70% of the biosphere and encloses 34 of the 36 living phylum described so far. Marine resources have however long been underexploited, due to the technical challenge of accessing them. A large panel of drugs has been developed since several years from the limited repertory explored in coastal areas, including molecules used in treatments against cancer, HIV, or pain killers. Marine biodiversity is emerging as a large potential source of molecules with application from medical to food and energy industries. Yet, access to these resources is highly uneven across nations. As we improve technologies for oceanographic exploration and increasingly explore the Deep Sea Environment (ROV, submersible, sonars…), molecules involved in adaptation to rather extreme conditions are being isolated, providing new potential and inspiration for biotechnological applications. During the recent years new oceanographic challenges have been confronted to open access to hitherto unexplored areas in high seas, while the exponential progresses in molecular biology allowed getting beyond some limits previously hampering the exploitation of genetic resources. Those progresses have dramatically increased the ability to take full advantage of resources and to innovate, yet this ability is still clearly unbalanced across nations.

Panel 4

Access to marine genetic resources: collecting organisms and facilitating samples and data

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The marine environment is home to an enormous biodiversity. Marine ecosystems and habitats encompass a wide range of physical environments including, among others, total darkness in the deep sea, extreme cold in the polar regions and extremely hot environments with high pressures in and around hydrothermal vents. Life originated in the oceans and the marine biodiversity offers a huge biotechnological potential as marine organisms and their biological processes may have unique properties that can be of benefit for mankind and/or commercial applications.

Access to marine genetic resources can be made by collecting samples from their natural habitat. This often requires use of sophisticated field technology. Collecting samples from ice-filled waters in polar regions requires specialized vessels and equipment. Scientific research related to the seabed resources at great depths is restricted to a few due to technological and financial capacity. Special permits are normally required to collect marine genetic material from waters within national jurisdictions. Norway is among the few states that have established a legal regime regulating the access to, and exploitation of, genetic resources from waters within national jurisdiction.

Due to the cost of collecting marine genetic resources, biobanks and repositories holding marine samples of different origin are important facilitators for marine biotechnology and other marine scientific research. This type of access to marine samples results in more scientific groups having the possibility to be involved in such activities. The marine collections may constitute of living organisms or prepared samples conserved at low temperatures. Biogeographic sample information and documentation of legally collected material is prerequisite for a biobank or repository offering services to academia and industry. A material transfer agreement (MTA) is normally applied when distributing samples from a marine collection. Ownership, IP rights, benefit sharing and regulations regarding transfer of samples, processed material or results to third party are within the juridical frame when handling samples from a collection.

Sequencing genomes and metagenomes have today become a routine within molecular biology science. The scientific community and the scientific journals normally demand that genetic information is made publicly available when scientific work based on genetic material is published. Genetic information published in this way can easily be explored for the identification of enzymes or other bioactive compounds resulting in commercial products. Ownership and benefit sharing based on such access to data is an issue.

Panel 4

Exploring different benefits and benefit-sharing approaches

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This presentation will aim at introducing different benefit-sharing approaches, distinguishing different types of benefits that can be shared, and exploring benefit-sharing practices as well as their obstacles.

Different benefit-sharing approaches include bilateral and multilateral benefit-sharing approaches. An example for a bilateral approach can be found in the Convention on Biological Diversity (CBD) and its Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization. In this context, the presentation will refer to:

- The transactional character of the CBD's and Nagoya Protocol's benefit-sharing approach between a provider and a user; based on sovereign rights of a State over its natural resources (incl. genetic resources);
- The concepts of prior informed consent (PIC) and mutually agreed terms (MAT);
- Difficulties of applying such a bilateral approach to marine genetic resources from ABNJ.

Examples of multilateral benefit-sharing approaches can be found under the FAO's International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), but also under the WHO's Pandemic Influenza Preparedness Framework (PIPF). In this context, the presentation will introduce:

- The non-transactional character of the Multilateral System under the ITPGRFA which is based on multilaterally agreed terms and conditions; using a "global multilateral mechanism" including a fund;
- The common pool of resources that is created through the Multilateral System as well as the respective benefit-sharing obligations;
- The concept of directing benefits toward conservation of plant genetic resources for food and agriculture in developing countries;
- The general idea of the WHO PIP Framework and its multilateral benefit-sharing approach;
- The enabling clause under Article 10 Nagoya Protocol which introduces the idea of directing certain benefits to conservation and sustainable use of biodiversity globally.

In general, monetary and non-monetary benefits can be distinguished. Based on the indicative list of benefits included in the Nagoya Protocol Annex, the presentation will address different types of monetary benefits and distinguish the different stages where payments can be made, as well as refer to the insecurity/lack of clarity whether commercialization will take place and what comes out of it. With regard to different types of non-monetary benefits, the presentation will:

- Explain selected non-monetary benefits; and
- Refer to non-monetary benefit-sharing already foreseen under the United Nations Convention on the Law of the Sea (UNCLOS).

Finally, the presentation will take a brief look at benefit-sharing in practice, as well as its obstacles. For this a few examples of ongoing benefit-sharing will be shared.

Panel 4

Marine genetic resources: benefit sharing and obstacles

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Marine genetic resources of sovereign nations represent potentially significant economic value as biotechnological products, including novel drugs from the sea. However, the path to a new drug, from discovery through clinical trials to the pharmacy shelf, can exceed 20 years. With few samples making it all the way through clinical trials, the odds of monetary benefit sharing in the next "billion dollar drug" are exceedingly small. As such, it is very important that benefit sharing begins early and includes monetary as well as non-traditional subsidies. As a marine biologist collecting samples for biotechnological development, I am the primary partner with local stakeholders in the identification and commercialization of marine genetic resources. Initial contacts are often hampered by insufficient local knowledge related to marine genetic resources and/or unrealistic expectations regarding benefit sharing. Instead early benchmark benefits can include outreach and education related to the resource, environmental inventories/surveys and remediation of degraded habitat, as well as shared research results, training and capacity building relative to stakeholder participation in resource development and commercialization. Nonetheless, every situation is unique, and the benefits should be tailored to the specific needs of the stakeholders of interest. For example, contributions to the local economy, such as boat hires from indigenous fishermen, can provide direct benefits to stakeholders who would not ordinarily share in intellectual property compensation. Likewise, access fees in support of local management and conservation efforts will ensure that critical ecosystem services are available to all stakeholders long-term even if biotechnology efforts fail. Using examples from similar systems in the tropical Pacific and Caribbean, I will discuss benefit sharing in practice, as well as some of the obstacles involved, and I will make the case that the most successful non-monetary benefit is a graduate scholarship in marine biotechnology for qualified local stakeholders.

Panel 5

Appropriation of marine genetic resources through intellectual property rights

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Intellectual property rights, such as patents, give the right-holder the exclusive right to make, use, sell and import (with some limitations) the protected product (or to use a protected process). Patents usually last for 20 years (counted from the date of filing of the application). This means that, during this period, unless a voluntary or compulsory license is granted, the patent owner controls the respective market. He can prevent production and sale from other producers and charge consumers prices above the marginal cost of production.

Patents protect 'inventions'. The concept of invention is broadly understood in some countries. After the landmark decision by the US Supreme Court in the Chakrabarty case, the patentability of living materials have been accepted in many jurisdictions. Moreover, the TRIP/WO Agreement obliged WTO members to grant patents over microorganims.

The isolation of a particular organism or biological material (including genes), and the identification of its function or use may be sufficient, under certain legal regimes, to apply for and obtain a patent. The distinction traditionally made by patent laws between 'invention' and 'discovery' has been blurred.

An invention, to be patentable, needs to meet the patentability requirements: novelty, inventive step (or non-obviousness) and industrially applicability (or usefulness). In some countries, the inventive step requirement is loosely applied, thus allowing for the proliferation of patents (sometimes called of 'low quality') on developments that would have been obvious for an expert in a particular field.

The patentability of marine genetic resources, whether found within or outside national jurisdictions, is subject to the same rules applicable to other genetic resources. There are numerous examples of patens covering marine resources and/or components thereof found in areas beyond national jurisdiction. Derivatives of such resources (used in various industries) may also be patented. If a patent is obtained, all the benefits resulting from the commercialization of the patented materials accrue to the right holder.

National laws may, consistently with the international law, exclude or limit the appropriation of genetic resources through:

- a definition of 'invention' that rewards products or processes that are created and not discovered;
- the exclusion from patentability of plants and animals, as permitted by the TRIPS Agreement;
- the rigorous application of the patentability standards, particularly inventive step;
- if patents are granted on genes, protection should be limited to the function effectively disclosed in the claims; and
- research on patented inventions should be allowed without restrictions.

Panel 5

Infringement and innovation in respect of access and benefit sharing in areas beyond national jurisdiction

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This presentation addresses the implications of current research on the innovation effects of the patent system for the design of an optimal regime for access and benefit sharing in areas beyond national jurisdiction (ABS in ABNJ). There is growing evidence that in many areas of technology, the patent system impedes innovation rather than promoting it. The extensive literature is well summarized in Bronwyn Hall, Christian Helmers, Georg von Graevenitz, Chiara Rosazza-Bondibene, "A Study of patent thickets: Final Report Prepared for the UK Intellectual Property Office (2012) (available here) and the US Federal Trade Commission Report "The Evolving IP Marketplace: Aligning Patent Notice and Remedies With Competition" (available here). This research shows that intellectual property rights that are not clear ex ante are likely to have a chilling effect on innovation. A right is said to be clear ex ante if anyone is able to determine prior in advance whether their planned activities will infringe the right.

This research implies that an ABS regime in which it is difficult for a party to determine in advance whether it will be required to share the benefits of its research and development investment will be likely to chill innovation related to MGRs in ABNJ. This would be undesirable for two reasons. First, if there is little innovation based on such MGRs, there will be few benefits to share. Second, a poorly designed regime has the potential to impede the research not only on MGRs in ABNJ, but also in related fields, such as MGRs derived from territorial waters.

Whether the ABS regime is likely to have such a chilling effect depends on the details of how it is designed. Existing ABS systems generally focus on a system involving prior informed consent and an accompanying material transfer agreement. If the ABS regime for MGRs in ABNJ were based on a similar concept, the potential for a chilling effect would arise if a party may be required to share in benefits even if it could not reasonably have known in advance that it was deriving a benefit from MGR in ABNJ, so that it would not have known to seek the required consent and obtain an MTA. More generally, the potential for a chilling effect will depend on the scope of the ABS regime: in exactly what circumstances will a party be considered to have derived a benefit which it will be required to share? The presentation will set out a number of examples illustrating circumstances in which a party might be found to have derived a benefit and will consider whether an ABS right granted in those circumstances would be clear ex ante.

Panel 5

Monitoring marine genetic resources using taxonomic and patent data

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Recent research has pointed to the growing importance of marine genetic resources for commercial research and development. Patent activity provides a key indicator of commercial research and development involving genetic resources and insights into patterns in the utilization of genetic resources of relevance to the conservation and sustainable use of biodiversity.

The fundamental challenge in addressing marine genetic resources in patent data is one of scale in three respects. First, the scale of marine organisms with the WoRMS database recording 219,714 accepted species and 381,278 species names. The second is the scale of the global patent system involving over 60 million documents in multiple languages. The third challenge is linked to debates on disclosure of origin and involves identifying and mapping the origins of marine genetic resources appearing in patent data.

This presentation argues that challenges of scale can be overcome by exploiting the opportunities provided by the growing availability of digital taxonomic and patent data. The presentation illustrates these opportunities by presenting the results of research to text mine 11 million patent documents for 6 million species names from the GBIF/EOL *Global Names Index*. The research identified over 4,000 marine organisms in over 40,000 patent documents and permits the identification of patent trends, key actors and technology areas involving marine organisms. The federation of patent data with taxonomic data permits the mapping of the distribution of species at the level of geo-referenced occurrences and a potential way forward in clarifying the distribution of species in areas beyond national jurisdiction.

The presentation concludes by considering debates on the disclosure of origin of genetic resources in patent documents and discusses the United States requirement for a statement disclosing sources of federal funding in patent applications as a potential model for marine genetic resources. The links between disclosure statements of this type and the scientific literature are also considered. The presentation concludes with best practices in improving monitoring of marine genetic resources taxonomic and patent data.

Panel 6

Global regimes on genetic resources: the Convention on Biological Diversity and the Nagoya Protocol

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This presentation will focus on the access and benefit-sharing provisions of the Convention on Biological Diversity (1993) and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (2010). The innovative access and benefit-sharing provisions of both instruments will be highlighted generally, and as they relate to the utilization of marine genetic resources from areas within and beyond the limits of national jurisdiction, keeping in mind the indicative list of questions outlined in the workshop's programme of work.

Panel 6

Global regimes on genetic resources: the food and agriculture, and health sectors

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This presentation will focus on two global regimes on genetic resources, namely: 1) the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) of the UN Food and Agriculture Organization and 2) the Pandemic Influenza Preparedness Framework for the Sharing of Influenza Viruses and Access to Vaccines and Other Benefits the World Health Organization (WHO PIP Framework).

In particular, the presentation will provide an overview of:

- their objectives, scope of application and basic principles;
- their provisions on benefit sharing;
- their provisions related to intellectual property;
- the role of standard material transfer agreements;

Finally, it will conclude by assessing the extent to which the above mechanisms and arrangements may potentially be useful in the context of the utilization of marine genetic resources, as well as their limitations.

Panel 6

Regional regimes on genetic resources, experiences and best practices

Arianna Broggiato

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The contribution will highlight both the positive aspects and the shortcomings of regional regimes and experiences on genetic resources (GR), putting the emphasis on the innovative elements that have contributed to their success.

In the 1990s, regional regimes on GR emerged in Latin America, Asia, Africa and Central America, as frameworks for the implementation of the principles of the Convention on Biological Diversity. They include the Andean Pact decision 391 on the Common Regime on Access to GR, the ASEAN Framework Agreement on Access to Biological and Genetic Resources, the African Model Law for the Protection of the Rights of Local Communities, Farmers and Breeders, and for the Regulation of Access to Biological Resources, as well as the Central American Agreement on Access to GR and Bio-chemicals and related Traditional Knowledge. These regimes establish common frameworks with minimum legal requirements in terms of access to GR in both in-situ and ex-situ conditions, as well as the sharing of benefits deriving from the resources' use. They constitute interesting steps toward the harmonization of national policies and foster cooperation among the members. They however enclose gaps in terms of implementation and/or effectiveness.

A non-binding access and benefit-sharing scheme targeting the scientific community is being built up by the Mediterranean Science Commission through the adoption of the Charter on ABS. The Charter is a voluntarily code of conducts for scientists sampling in marine areas within and beyond national jurisdiction, designed to support the exploration of marine ecosystems by promoting the sustainable use of MGRs without penalizing potential biotechnological (economical) development.

Since one of the most promising sources of marine genetic diversity is microbes, it is interesting to examine regional policies and common practices in material transfer agreements for microbial GR. Best practices of GR exchange have been developed by the microbial research community within the framework of the World Federation of Culture Collections (WFCC). WFCC provides a global framework for the exchange of microbial genetic resources for upstream and downstream research, in compliance with the CBD (through the implementation of the Microorganisms Sustainable Use and Access Regulation International Code of Conduct (MOSAICC) and the World Data Centre for Microorganisms). It also covers marine genetic resources from areas beyond national jurisdiction and it keeps track of the geographical origin of the resources. Based on a consolidated scientific sharing ethos, it essentially implements the concept of "common pools of resources". The European Culture Collection Organization (ECCO) core material transfer agreement is indeed based on a premise of non-commercial utilization, within which recipients are allowed to transfer the material to third collaborating parties (within the same lab or between partners in different institutions collaborating on a project) if they use the same licensing conditions. In case of commercialization recipients have to negotiate in advance the terms of benefit-sharing with the country of origin. In a parallel stance, the European Union funded research project Micro B3 (Microbial Biodiversity, Bioinformatics, Biotechnology) is developing a standard ABS agreement for ocean sampling activities based on an innovative distinction between research and development for the public domain and proprietary research and development. It provides for a viral license clause and a come-back clause to re-negotiate monetary benefit-sharing if the products reach commercialization.

Some of the experiences and best practices implement the concept of "common pools of resources", which offers the advantages of preserving the public domain condition of common or shared resources, while also providing the main benefit-sharing that is usually sought: access to resources or to data and research results for the benefit of mankind, without impairing possible commercial applications.

Panel 6

Scientific data about plankton ecosystems are key for decision making about high seas governance and monitoring

Eric Karsenti

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Plankton organisms include viruses, bacteria, single cell photosynthetic eukaryotes (protists), as well as "zooplankton" encompassing large carnivorous protists, copepods, small crustaceans, and larval stages of larger animals. All these organisms drift in currents and form the basis of the oceanic food chain. Their ancestors made the atmosphere we know off today by producing oxygen and sequestering CO2 to the bottom of the oceans. They are still the major recycling system that maintain our atmosphere composition and detoxify the oceans. It is not one single organism that is key to producing oxygen and sequestering CO2. It is the WHOLE PLANKTON ecosystem that does it. There is a circulation of energy (starting from solar energy) and matter through this system that allowed and still allows the evolution of life and the existence of our complex societies. Yet we know almost nothing of them, of their composition, their resilience to climate change and pollution, the genes they contain and their diversity in the various oceans of our planet.

The TARA OCEANS expedition sailed 60 000 miles across most of the planet oceans, collected 27 000 samples and thousands of associated environmental data from 153 stations carried out in highly diverse environments from surface waters, 50 meters deep and the mesopelagic area (200-600m). The goal is to obtain quantitative imaging and genomic data associated with environmental parameters aiming at:

1- Establishing a reference data set to monitor the evolution of the system in the coming years
2- Develop automatic sensors for monitoring in situ the health state of planktonic ecosystems world wide
3- Feed predictive models of the global plankton ecosystem evolution as a function of global warming.

In addition to that it is clear that the genomic data will be of interest to the general community and may lead to industrial applications in the fields of medicine and energy.

For these reasons, it is important to develop an appropriate policy concerning the sampling and monitoring of high seas as well as of the use of scientific data associated with such activities for commercial purpose. In that regard, best practices include:

1- Freedom of sampling for scientific and monitoring investigations both in high seas and coastal areas according to a structured international legal framework.
2- Public availability of all scientific data in an interoperable universal data format.
3- Governance of commercial use of scientific data through international agreements - the deadlines defined in the Rio+20 Conference to launch negotiations on the UNCLOS implementation agreement are an opportunity to secure it.
4- Through international agreements, constraints on mass exploitation of high productivity and high diversity zones identified by scientific investigations, which partly could be settled on the ambition to protect at least 10% of the oceans with MPAs as defined on the CBD Aichi target 11.

Panels 7 & 8

Exchange of information on marine biodiversity research

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Areas beyond national jurisdiction encompass significant reservoir s of global biodiversity. Organisms that inhabit these ecosystems may provide significant opportunities for scientific discovery and commercialization. As exploration of these ecosystems becomes less cost prohibitive; bioprospecting for genetic material within these environments is increasing. The conservation and sustainable use of these resources has therefore become the focus of growing international attention, with some countries and interest groups proposing protective, equitable regimes while others are attempting to facilitate profitable, commercial extraction.

The major constraint to effective integrated management of these areas lies in the limited availability of data and in the lack of mechanisms for disseminating information, since no integrated system exits. Data are dealt with in a piecemeal manner often constrained by sharing policies and restrictive memorandums of understanding. In cases were data are available it is left up to the organization that requires it to seek it out. Some nations and agencies share experts on their technical boards and committees in order to facilitate the exchange of scientific data. However, scientific research requires human and financial resources which scientists and nations are not quick to relinquish. Even with the on-going trend of ecosystem based management and holistic approaches towards research, a paradigm shift will be required to facilitate the exchange of research information in these trying economic times. The exclusive exploitation by a few can have serious national and global economic and social implications. Therefore the debate persists as to whether the areas beyond national jurisdiction are "the common heritage of mankind" or the future intellectual property of bioprospecting enterprises and nations.

Panels 7 & 8

Analysis on the scientific cooperation and research projects on the Tara Arctic and Tara Oceans expeditions as an innovative model for international scientific cooperation on marine biodiversity

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Tara Expeditions is a private Foundation working for the past 10 years on planning and implementing scientific expeditions with the Tara vessel, studying some of the most important issues on marine biodiversity and climate change. The scientific cooperation is built on a project basis gathering different universities, labs and institutes mutualizing the Tara vessel structure on trans-disciplinary researches around a common expedition. The projects are built on a bottom up characteristic with scientists from different countries being involved from the beginning of the projects, defining goals, disciplines, materials, details of the course including the itinerary and also creating bridges with civil society. Beyond data generation and scientific goals and outputs, the dialogue between science and civil society is also a priority for Tara and demands concrete outreach and pedagogic tools to support the educational projects like *Tara Junior* and *From the boat to the Lab*. With the aim to create awareness on the global civil society on some of the most important oceans issues, several films and exhibitions were produced along and after the expeditions.

Access to and freedom for sampling in ABNJs are a key issue for the next years concerning marine biodiversity research. Promoting international cooperation is essential to involve different scientific cultures on the projects and to avoid national and geopolitical interests to overcome scientific goals. We also need to improve and promote data sharing and make sure access to biodiversity samples is ensured.

Tara Arctic: From September 2006 to February 2008, Tara conducted a unique research mission over 507 historic days in extreme conditions. The schooner was the central platform for the DAMOCLES European scientific program during the International Polar Year. Embedded in and carried by the pack-ice, the schooner drifted through the Arctic sea with a dozen men and women on board.

Tara Oceans: The expedition, started in 2009, is the very first attempt to make a global study of marine plankton, a form of sea life that includes organisms as small as viruses and bacterias, and as big as medusas. Tara Oceans is a multidisciplinary programme with unique plankton sampling, including oceanographic, optical and genomic tools used to describe plankton (viruses, bacteria, archaea, protists and metazoans) in its physico-chemical environment with new and original methods. Various disciplines including oceanography, remote sensing, ecology, genomics, molecular biology of cells and systems, taxonomy, bioinformatics, data management and modeling are involved in processing data.

Tara Oceans Polar Circle: The polar schooner Tara will depart from Lorient on May 19, 2013 for a new expedition around the Arctic Ocean via the Northeast and Northwest passages. Supported by the CNRS, CEA, EMBL and other private and public partners, this mission unites biologists and oceanographers. They will focus on plankton biodiversity in the Arctic and other specific issues in this region susceptible to climate changes. The research will be conducted at the sea-ice edge, where plankton activity is most important. All scientists and institutes involved in Tara Oceans will accompany the project, along with other laboratories specialized in Arctic research including the Takuvik laboratory (Joint International Research Unit, CNRS/Laval University), the Shirshov Institute of Oceanology (Moscow) and LOCEAN laboratory (CNRS/UPMC/MNHN/IRD). The team of scientists united since 2009, their collective expertise, the global ecosystem approach and the still available equipment, coupled with Tara Expeditions' logistical expertise in extreme environments are all key factors for the success of the voyage. The strategy is to compare the biological data about plankton in the physico-chemical environment of the Arctic with data collected from other oceans since 2009 during the Tara Oceans expedition.

Panels 7 & 8

Addressing collective marine biotech and bioprospecting challenges: development, coordination and alignment of national, regional and pan-European research strategies and programmes

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Marine Biotechnology encompasses those efforts that involve marine environment and its bioresources, either as source or target of biotechnological applications. An important component of marine biotechnology comprises bioprospecting activities in search of Marine Genetic Resources (MGR), including from areas beyond national jurisdiction (ABNJ), to create a range of biotechnological products and applications (e.g. new drugs and biomedical applications and novel enzymes of industrial interest). Interest in marine biotechnology has grown rapidly in the past decade owing to a recognition of the sheer scale of opportunity presented by the largely unexplored and immense biodiversity of our seas and oceans and the need to meet growing demands for food and new human health and new industrial products and applications that cannot be satisfied from terrestrial sources alone. The marine environment accounts for over 90% of the biosphere and an increasing number of scientists and entrepreneurs now believe that marine biotechnology represents an important key to unlocking the huge potential of the unique biodiversity of marine organisms and ecosystems. This growing interest is among others reflected in the growing number of gene patents associated with MGR with 95% of claims filed after 2000.

Recognizing the enormous potential of marine biotechnology to provide contributions to address some of the most burning societal challenges of today, a number of science policy discussions took place over the last 15 years to identify strategic actions to promote research and development in this field. These initiatives have also highlighted a number of important challenges and barriers that will have to be resolved and/or clarified to allow for a commercially viable, sustainable and ethical use of available marine genetic resources. For example, recent strategic assessments in the framework of among others the EC Collaborative Working Group on Marine Biotechnology (See CWG-MB scoping paper available at http://ec.europa.eu/research/bioeconomy/pdf/cwg-mb_to_kbbenet_report_final.pdf), the US-EU Task Force on Marine Biotechnology and the Marine Board Working Group on Marine Biotechnology (See Marine Board Position Paper 15 on Marine Biotechnology available at www.marineboard.eu/publications), have highlighted the wide range of legal and policy ambiguities, barriers and challenges associated with marine biodiscovery activities. In response, the European Commission has funded a range of projects to address these issues, notably the EU FP7 Projects PharmaSea (http://www.pharma-sea.eu), Bluegenics, SeaBioTech (http://spider.science.strath.ac.uk/seabiotech/) and MicroB3 (http://www.microb3.eu). Part of the PharmaSea project and its advisory groups, for example, will focus on:

- The disparity between the provisions and principles of the United Nations Convention on the Law of the Sea (UNCLOS) and the need to protect research investments by securing intellectual property rights (IPR);
- The lack of a common European position on the simplification and harmonisation of regulations on access and fair and equitable benefit sharing from the exploitation of MGR in the EU and beyond;
- The lack of ready-to-use, understandable, comprehensive and practical information for users (academic and industry researchers) on how to obtain access to MGR.

Another issue that has emerged as an important shortcoming is the fragmentation of the research efforts and infrastructures in Europe and the lack of information about who is doing what where and why. This knowledge is important to allow coherent and efficient European and international collaboration. In response, the European Commission has facilitated the creation of a range of coordination initiatives aimed at:

- Increasing our understanding of the science policy landscape (research strategies, policies and programmes) in relation to marine biotechnology research and development in various European countries (and beyond);

- Improving the collaboration between different research programme managers and developers by establishing a network of funding agencies.

This presentation will provide insight in relevant European efforts to coordinate the various actors involved in marine biotechnology and bioprospecting activities including policy, industry and research. In particular, the presentation will draw from landscape profiling done by the recently completed EU FP7 Coordination and Support Action in Marine Biotechnology (CSA MarineBiotech), a collaborative network consisting of 11 partners from 9 European countries, which has worked intensively to explore the opportunities and needs for European coordination, trans-national cooperation and joint activities in the area of marine biotechnology research.