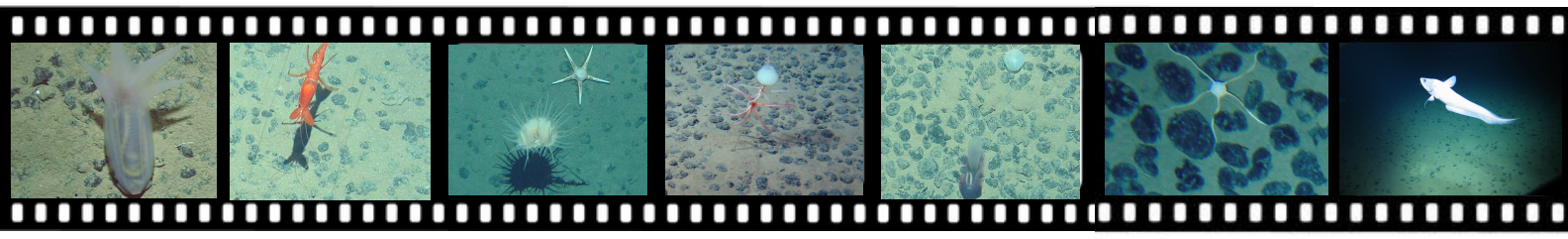
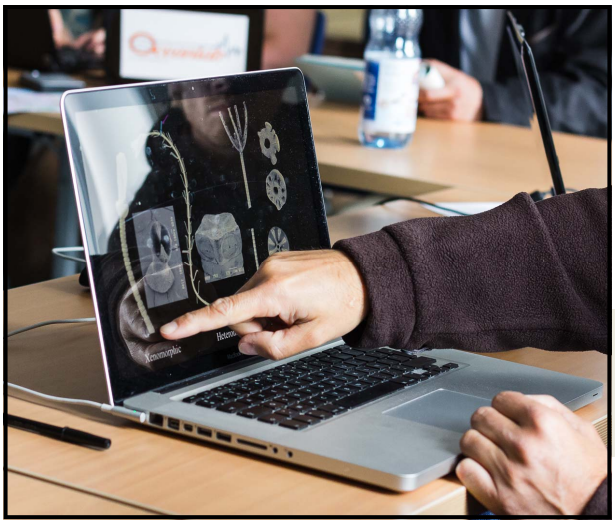
# Briefing Paper 02/2014



## TAXONOMIC STANDARDIZATION WORKSHOP SERIES 1: DEEP SEA MEGAFAUNA OF THE CLARION-CLIPPERTON FRACTURE ZONE

The approval of the environmental management plan (EMP) for the Clarion-Clipperton Fracture Zone (CCFZ) by the Council of the International Seabed Authority (ISA) (ISBA/17/C/19, 2011), and documented at ISBA/17/LTC/7, call for a series of priority actions that were requested by the Legal and Technical Commission (LTC) to be executed by the Secretariat to properly implement the EMP. One of those priorities deal with the standardization of the taxonomic work across the CCFZ. The task requires that all the contractors of the CCFZ participate and share their taxon list at the highest possible taxonomic resolution (taxa level) to establish a sound and defined protocol for reporting biodiversity to ISA. The taxonomic workshops in the series are divided by size of the fauna found at the seabed of the CCFZ. These workshops are entirely devoted to contractors (15 licences at the CCFZ, ISA 2014). The first workshop was designed for megafauna and the other workshops will be on macrofauna (2014) and meiofauna in 2015.



The megafauna workshop was convened at the Centre for Marine Biodiversity of Senckenberg Institute in Wilhelmshaven, Germany, on June 10-15, 2013. The workshop focused on the evaluation and difficulties in assessing megafaunal biodiversity in the deep sea, specifically at the CCFZ. The International Network for Scientific Investigation of Deep-Sea Ecosystems (INDEEP; www.indeep-project.org) also provided support for this meeting. The workshop comprised a series of lectures by taxonomic and technical experts, together with hands-on sessions, where the representatives of each of the contractors representatives discussed their images of morphotypes with each of the other taxonomists *(Figure 1)*. In this meeting, eight contractors participated actively in the workshop and each gave a presentation on the work they were doing and the sampling they were undertaking. Contractors present were: BGR, DORD, G-TEC, COMRA, IOM, IFREMER, TOML, and UKSRL. The main taxonomic groups analyzed in this workshop were: fish, holothurians, asteroids, criniods, ophiuriods, cnidaria and protistas. Images of crustaceans, cephalopod molluscs and sponges were analyzed after the workshop by relevant taxonomic experts.

*Figure 1: Representatives of Contractors with Licences at the CCZ analyzing their taxonomic samples with the taxonomic experts during the working sessions of the workshop on megafauna of the CCFZ.*

## ECOLOGICAL CHALLENGES AT THE CCFZ

Extreme abiotic conditions including enormous pressures, eternal darkness and low ambient temperatures as well as a scarcity of nutrients have led to the evolution of highly adapted life forms in the abyss. They form part of the living resources of the common heritage of mankind under the United Nations Convention on the Law of the Sea (UNCLOS).

Dr. Pedro Martínez Arbizu, Director of the Centre for Marine Biodiversity, explained the abiotic conditions present in the CCFZ. There are important productivity and depth gradients across the area which may be responsible for differences in biodiversity at the regional scale. The need for standardization of sampling and preservation protocols was the first recommendation achieved during the workshop. The abiotic characteristics of the deep sea result in a low number of individuals sampled (local heterogeneity). In addition there is a scarcity of baseline abiotic information (spatial and temporal). These factors increase the difficulties in undertaking environmental impact assessments (EIA) which are important for developing and implementing environmental management plans for this region. *The key to monitoring the deep sea environment (biotic and abiotic) is focused collaborative efforts from all stakeholders working on living and non-living natural resources at high seas in the Area*.

## CCFZ MEGAFAUNAL DIVERSITY

In the workshop sessions the taxonomic experts reviewed our current understanding of the diversity of the fauna.

### *Fishes*

A major group of vertebrates found in the deep sea are fishes. These animals are difficult to quantify and have been mostly observed in pictures and video samples. Collecting species from abyssal depths is difficult and specimens can be damaged during the retrieval process. Nonetheless, for the CCFZ, Dr. T. Linley, from University of Aberdeen, Scotland, mentioned that as many as 25 different species could be attracted to a bait in just seven hours *(Figure 2).*

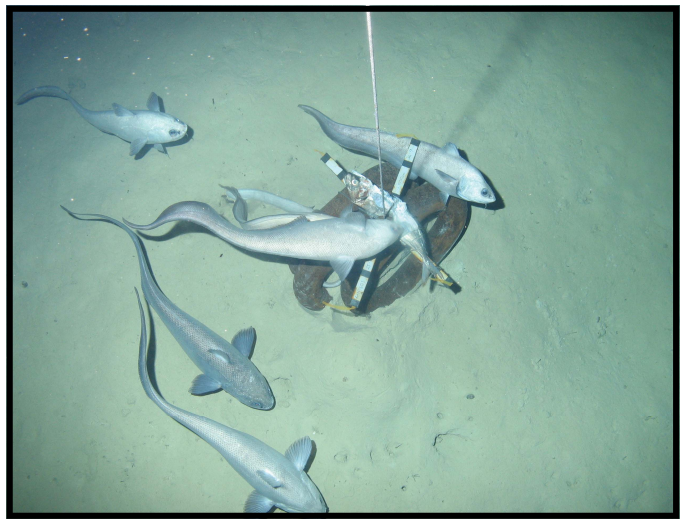


*Figure 2: The most abundant fish species of the deep sea, Coryphaenoides yaquinae (darker colour) and C. armatus (lighter shade). Both are easily recognised by the reflection of artificial light source. ( © T.Linley - HADEEP cruise KAH1301)*

### *Echinodermata: Holouthroidea*

Drs. Andrey Gerbuk and Antoinina Rogacheva from the Russian Shirshov Institution of Oceanology presented a review of the current knowledge on the holothuroidea class of the phylum echinodermata for the CCFZ. There are at least 700 species recorded from the deep sea, with approximately 80 species presented at the CCFZ (examples are shown in *Figure 3*). There are at least seven species that are relatively abundant at the CCFZ, for example, mesothuria murrayi, that can be found in densities of as many as 40 ind. ha-$^{1}$.

### *Echinodermata: Asteroidea and Ophiuroidea*

Starfish and brittle stars (Echinodermata), are also found in deep sea habitats. Dr. Chris Mah (Smithsonian

*Figure 3: Holothurians are common megafaunal taxa of the CCFZ. Left: Oneirophanta (IOM). Right: Psychropotes semperiana (IFREMER).*

Institution) provided a review of starfish. At least ten species may be commonly present in the CCFZ. Images of this taxon are also relatively common during surveys, for example the multi-armed starfish belonging to the family Brisingidae *(Figure 4).*

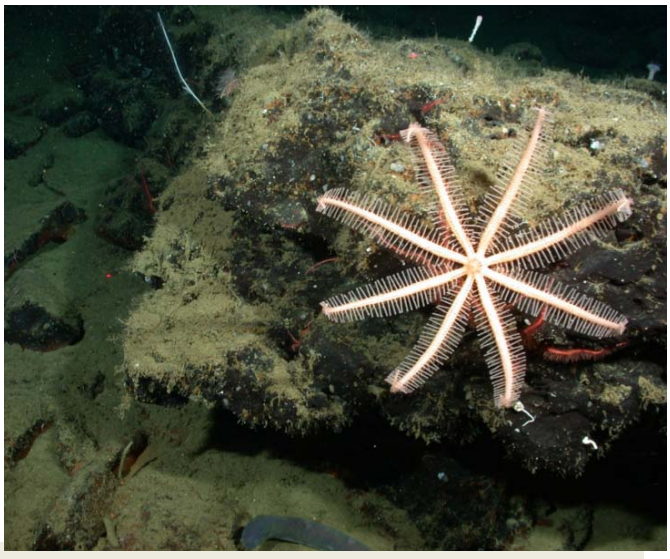


*Figure 4: Asteroidea, Brisingidae. Highly specialised filter feeders that can be found from 100-6000 m depth. (©Dr. Christopher Mah, Smithsonian Institution)*

### *Echinodermata: Crinoidea*

Dr. Marc Elèaume (Museum National de l'Histoire Naturelle, Paris) provided the background to the recognition and identification of crinoids, which in photographs can sometimes be mistaken for asteroids and *vice versa*. Fifteen species have been recorded from the abyssal Pacific. He noted that although specimens are needed for definitive identification, a good knowledge of the local fauna combined with colour or behavioural features may be added to classical morphological characters. When the image is of better resolution many of the taxonomic features can be distinguished and individuals can be tentatively identified.

### *Cnidaria*

Another important group of animals living in the deep sea are from the Phylum Cnidaria, (anemones, sea-pens, meduse and corals). Dr. Molodtsova's, Shirshov Institute of Oceanology, analysis suggests that there were around 100 species in the CCFZ. Many species of cnidarian live on hard substratum such as rocks but in the CCFZ only a few species have been found directly linked to nodules, such as the sea anemone Bathyphellia australis (Hexacorallia-Actinaria). However other groups are more common such as sea pens (Octocorallia-Pennatulacea). There are at least five families and perhaps as many as 33 species.

### *Protista*

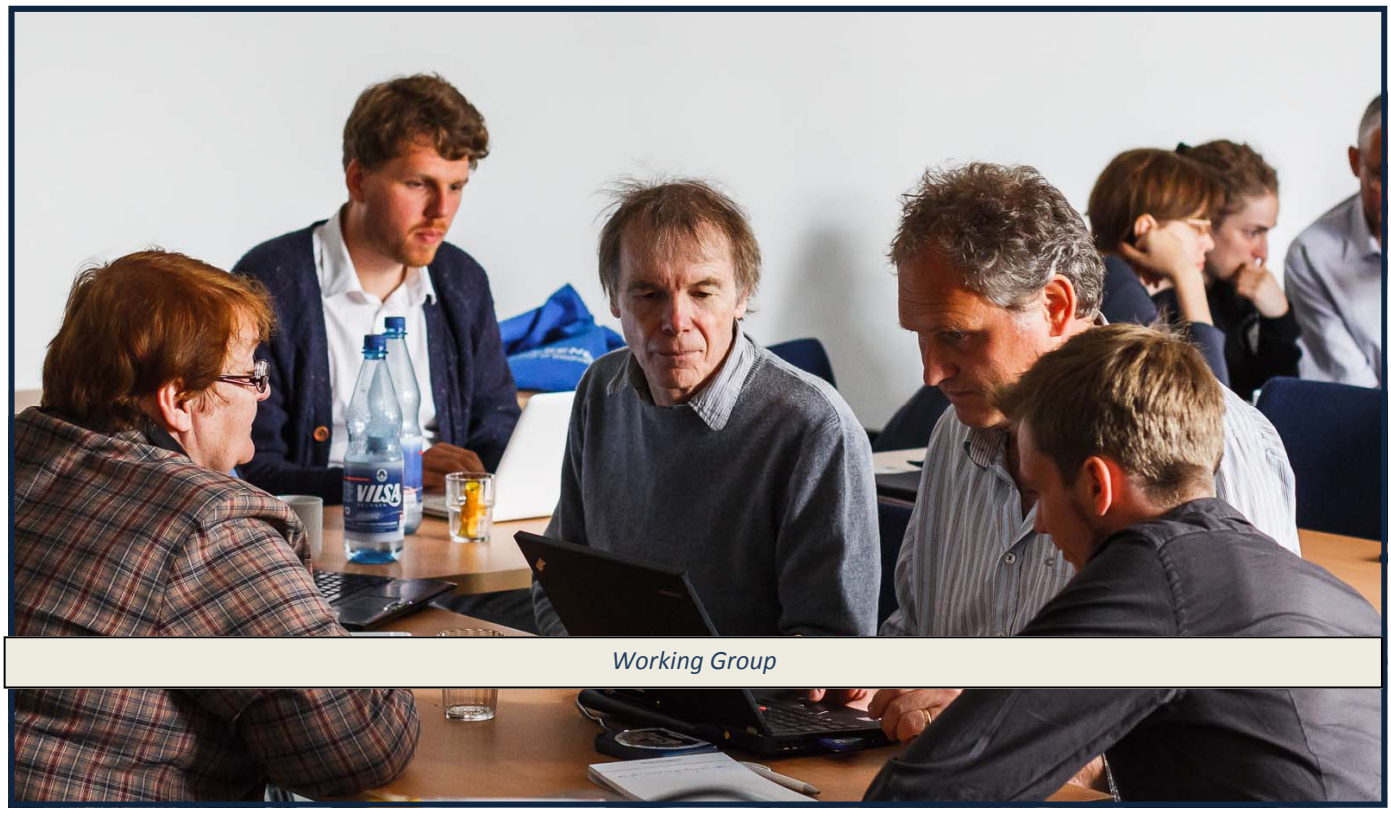
The deep sea is full of novelties to be discovered, and the gromiids are no exception. These protist organisms (single cell animals) were recently discovered in the Arabian Sea in 1994. Dr. A. Gooday, an expert in Protista from National Oceanography Centre, UK and Dr. O. Kamenskaya, explained that gromiids as well as xenophyophores, both related to Foraminifera (widely distributed single cell organism), are together, probably the most abundant living organisms in the deep sea. At the CCFZ, *xenophyophores* are found in 70 per cent of the pictures taken at a single site, accounting for more than 12 species and they are found in abundances as high as 1200 specimens per $km^2$ *(Figure 5).* The ecological importance is not clear but these living structures are very fragile and can be easily destroyed during collection.

*Figure 5: Xenophyophores from the deep sea habitats illustrating the range of morphotypes encountered. Left: Reticulate morphotypes (Collected from the UK CCFZ site. Courtesy of A. Gooday); Right: tubular Shinkayia morphotype (Courtesy of J. Pawlowski, Université de Genève).*

## CONTRACTORS' PROGRAMMES

Dr. L. Menot from IFREMER presented a summary of the megafauna found at the CCFZ from cruises carried out by IFREMER between 1970 and 1998 and in 2004. The outcome of these cruises showed that there were 90 different taxa and four different assemblages related to the presence/absence of polymetallic nodules. In the CCFZ, areas with no nodules are dominated by echinoderms, while areas with nodules are dominated by Cnidaria. A major difference in trophic functional groups was also observed; suspension feeders relate to the presence of nodules by showing low abundance and high diversity, compared to places without nodules. At the latter, deposit feeders were the dominant organisms. Clearly an increase on suspended particles in the bottom waters will have a differential impact if the community is a filter feeding trophic group or a deposit feeder.

Dr. C. Rühlemann's (BGR) presentation summarized the current exploration of the German claim area. BGR had completed five exploration cruises including a joint cruise with IFREMER in 2012. Cruises had focused on providing both data to map the sea floor as well as samples of the nodules and the fauna living in the sediment. An array of imaging equipment (OFOS, SCAMPI and MFT) was deployed to survey megafauna in the claim areas. Comparison of the megafaunal composition between the German and French claim areas indicated that only nine morphotypes were common to both sites while up to 90 morphotypes appeared to be found only in one area, suggesting a high degree of endemism.




*Working Group*

Dr. V. Melnik, (Yuzhmorgeologiya State Scientific Centre, Gelendzhik, Russia), joined the meeting via a Skype link. He provided information on the extensive exploration activities undertaken by YMG in the Russian claim areas. Dr. Melnik illustrated the equipment deployed to image and capture megafaunal morphotypes and provided information on the abundance and distribution of morphotypes within the areas.

Prof. Qian Pei Yuan (Hong Kong University of Science and Technology representing COMRA) provided a summary of the activities in the Chinese claim areas, including the deployment of the Chinese submersible *Jiaolong*. Chinese studies had developed a baseline but with new technologies being deployed more information was being collected, including specimens. Prof. Qian Pei Yuan stressed the need for training in taxonomy and for intercalibration to ensure that data produced was of sufficient quality to support exploration and monitoring studies.

Prof. Takaaki Matsui and Dr. Akira Tsune (representing DORD) summarized the activities being undertaken by DORD in the Japanese claim area. The range of equipment and the results were discussed with the workshop participants.

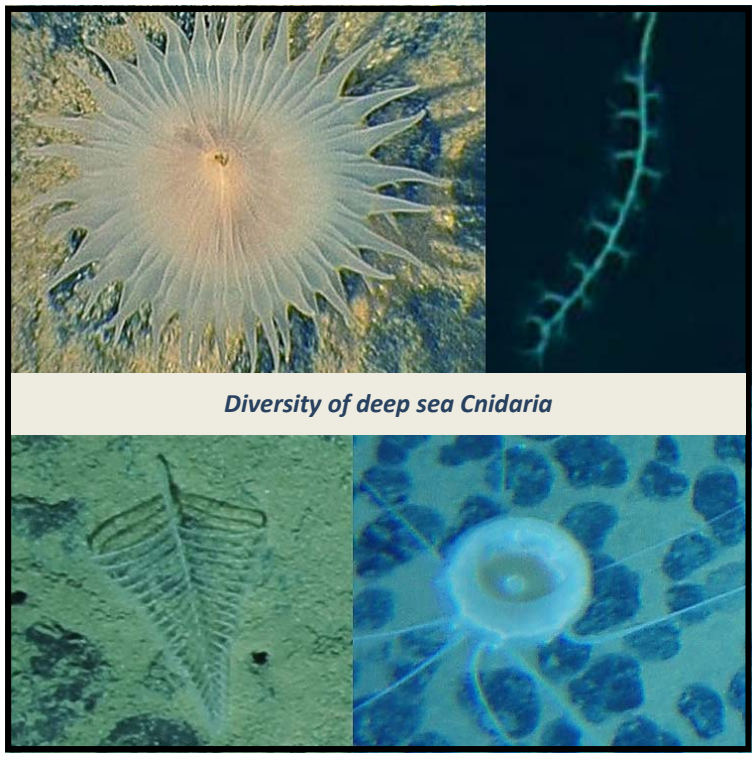
Short presentations were also given by Jaques Paynjon (G-TEC), Jennifer Durden (NORI), William Saleu (TOML) and Amanda Ziegler (UKSRL). These contractors had only just begun and so indicated future plans for studies in their claim areas.

## IMAGE ANALYSES PRESENTATIONS

The workshop participants recognized that significantly large volumes of video and stills data were being gathered during surveys. Processing and extracting the data needed posed a great challenge. The manual process of going through and watching endless videos and sifting through huge numbers of still images was laborious. There were data management issues to be resolved, as well as capacity in terms of personnel and time to undertake the image processing. Two presentations were made at the workshop by teams attempting to find ways to maximize the data being generated and to find automated ways to process large volumes.

Dr. T. Kwasnitschka (GEOMAR) gave a presentation on photogrammetric techniques for deep sea research.

Using this approach it was possible to reconstruct large areas providing highly detailed qualitative and quantitative reconstructions of the sea floor. Deep sea imagery using this approach yields high resolution, textured models of ocean floor features such as canyon walls, undersea volcanoes and vent systems. Such models can be used to undertake more detailed 'field studies' which are fully georeferenced. Quantitative studies of spatial relationships of objects within the model are also possible.



*Diversity of deep sea Cnidaria*

Prof. T. Nattkemper (Biodata Mining Group, University of Bielefeld, Germany) and his team carry out research on underwater informatics. Prof. Nattkemper demonstrated the Bio-Image Indexing and Graphical Labelling Environment (BIIGLE) data management system (www.biigle.de). As imaging of underwater habitats is now becoming a standard tool, the problems of processing the resulting video and still images present a range of issues relating to accuracy and repeatability of results, sheer volume of material to be processed and operator error. Prof. Nattkemper presented a number of case studies, including categorization of nodule areas, to illustrate the solutions that his group had developed to tackle these challenges. He went on to illustrate machine-base, automatic systems that his team had produced to analyze large volumes of both video and still images and return counts of abundance in the case of megafauna and coverage in the case of nodules.

## OPEN ACCESS TO IMAGE DATA

Many of the images and videos produced during surveys show the diversity of deep-sea organisms. These organisms are mostly unknown to the wider public and are a source of interest and wonder to them. John Cummings (Natural History Museum and Wikipedia) discussed the case for open access to images produced for surveys to fulfill ISA requirements. The advantages of open access to the contractors are recognition of the scientific work being done together with a greater profile in terms of the institution and its role. Organizations such as Wikipedia can help bring together the general public and research institutions to the mutual benefit of both groups. Organizations like NASA that provide images by a licence with attribution, effectively allow free use for non-commercial purposes. NASA images are accessed over eight million times on Wikipedia every day. The avid interest in marine animals and the unknown parts of our planet led Mr. Cummings to suggest that a similar impact would be possible if the ISA and the contractors released their images using a Creative Commons Attribution Share Alike licence.

## OUTPUT OF THE WORKSHOP

The main aim of the workshop was to produce a taxonomic atlas of the megafaunal morphotypes. Initially this was proposed to be a paper copy linked to a website. However, given the fact that some morphotypes may actually represent more than one species a more dynamic product is actually needed; one which can be updated as new taxonomic information is gained. Therefore the website has become the focus of the workshop's initial output. The website is modeled on the Wiki design (http://www.ccfzatlas.com) because it is easy to maintain and update and is a tried and tested format. This format gives the website stability and sustainability. The fact that the website is publicly accessible will facilitate public understanding and also reduce the reliance on staff for access rights and updating. A copy of the website can be downloaded and used in situations where internet access is not available or infrequent.

A more intangible output from the workshop is the development of collaborative links between the taxonomic community and the contractors. Access to taxonomic expertise is vital as exploration and survey work increase in intensity.

## CONCLUDING REMARKS

A common remark, echoed in the analysis of each of the zoological groups, was that: the exploration of the abyssal region of the CCFZ reveals that there is considerable biodiversity at many scales. Most of this biodiversity still remains undescribed or unreported.

*Workshop Participants*

There are many reasons for this which relate fundamentally to the great size of the region and difficulty in sampling at great depths far from land. This level of biodiversity means that long-term taxonomic support is critical to ensure that credible data are produced. The workshop participants discussed how such support could be established.

1. Develop a taxonomic clearing house mechanism. This is a mechanism which will provide taxonomic resources to contractors who need or request them by a taxonomist willing to assist with classification of specimens. The mechanism needs to provide funding to support this taxonomic work as funding enables taxonomists to prioritize work and ensure completion within a reasonable time frame — months rather than years.
2. Developing and increasing taxonomic capacity within the nodule community. Encourage collaboration between taxonomists and contractor groups to develop taxonomic capacity and awareness among the contractors and their agents by: exchange programmes; creating voucher specimens and depositing them in relevant collections facilities; lab placements; cruise participation and relevant workshops.

## WORKSHOP RECOMMENDATIONS

Imaging megafauna only during environmental surveys is not sufficient. The workshop participants strongly endorsed the recommendation of the LTC of the ISA that megafaunal specimens need to be collected to ensure taxonomic accuracy. We recommend that specimens of each morphospecies are routinely collected. Accurate identifications are based on both morphological and genetic characters. In nodule areas, megafauna sampling will require the use of submersibles or remotely operated vehicles.

1. **Create voucher specimen collections**. A key element in creating a standardized taxonomy is to have collections of voucher specimens of the species found in each claim area. Such specimens should be deposited in appropriate collections facilities, such as national museums. These collections must be available for further study.

2. **Establishing consistent methodologies and common protocols of best practice for collecting specimens is critical to ensure standardization and consistency**. Such standardization should also include, *inter alia*, minimum standards of sampling intensity, the use of taxon-specific preservation methods and the involvement of relevant taxonomic experts. Also, imaging of specimens with *in situ / in vivo* should be made before collection and where relevant, detailed images of the collected specimens before preservation.

3. **Samples of species must also include material preserved for molecular analyses**. Modern taxonomic practices rely increasingly on molecular as well as morphological characters, molecular bar-coding, for example. Also, sufficient large samples of key species need to be taken to provide unambiguous data on the biogeography and connectivity across the CCFZ.

4. **On-going taxonomic support of contractors could be provided through a clearing house mechanism with appropriate funding**. Establishing such a mechanism will assist with the development of taxonomic capacity in accordance with the ISA's aims to ensure that the standardization work is completed within a reasonable time frame.

5. **The ISA must ensure that robust data management, storage and access systems are in place**. Data management procedures and infrastructures must ensure that knowledge and images are available to all parties for further taxonomic classification. Spatial approaches are essential and any geo-referenced data must be kept in geo-spatial databases, allowing for further biogeographic analyses.

6. **The ISA and INDEEP should facilitate an expert workshop on imaging methodology, analyses and data management**. With so many contractors now operating in the Area there is a multitude of approaches and also a massive volume of imaging data being generated and stored. The capacity of any one contractor to analyze such volumes is becoming an issue. In addition, the ISA does not currently have the capability to establish standards. There are several automatic systems being developed and a workshop would be timely to review and develop future best practice.

7. **Foster cooperation among contractors for taxonomic inter-calibration**. As each contractor focuses on their own leased area there is the danger that identification of organisms is not inter-calibrated between the areas. Such gaps in our knowledge of the distribution of species matter because it is important to know whether a species is widely spread across or localized, possibly endemic within an area or region of the CCFZ. Training should be provided to ensure that all groups identifying organisms are working to the same standard.

8. **Encourage biology-focused cruises as a priority for the contractors**. While exploration of the Area focuses on the mineral resources, it is the living resources which will be impacted during any exploitation. The workshop participants felt more emphasis by contractors needed to be made on biologically-focused studies. In this context, the recent biology-focused joint French-German cruise (Bionod) by IFREMER and BGR was pointed out as a successful example of cooperation.

9. **Encourage contractors to provide additional high-resolution geo-referenced photographs and to grant permissions for reproduction**. There is considerable interest by the general public in the deepsea and its fauna. Images of the animals living in the abyss would be a good method of public outreach.

10. **Establish supporting taxonomic references for the dominant megafaunal morphotypes**. While printed catalogues are useful, it is clear that this is an on-going process, so the development of a collaborative web-based infrastructure would help contractors and taxonomists keep the data continuously updated. Such a website should be produced illustrating the dominant morphotypes found in the CCFZ as a first step towards a standardized taxonomy. The ISA would be the most appropriate host for such a website.

11. **The data generated should be used to support the app Abyssal Life**. The images used provide a significant opportunity for outreach.

12. **Finally, that contractors should use the nomenclature as given in the World Registry of Marine Species (WoRMS)**. This is the most comprehensive and up to date database on the scientific names of marine species.

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