

# Deep reef ecosystems of the Western Indian Ocean: addressing the great unknown

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## Abstract

Indian Ocean coral reef ecosystems are some of the least explored, least funded and least protected worldwide. "[First Descent: Indian Ocean](#)" represents a series of research expeditions undertaken by Nekton between 2018-2022 in partnership with Governments in the Indian Ocean region to contribute to establishing a baseline of marine life and catalyse 30% protection by 2030. Two recent expeditions, the [2018 WILDOCEANS/ACEP Comoros Mesophotic Biodiversity Expedition](#) (led by WILDTRUST), and the [2019 First Descent: Seychelles](#) (led by Nekton Foundation) systematically surveyed deeper reef ecosystems in those areas, resulting in collections of biological material and underwater footage.

In August 2019, taxonomic experts from across the globe, attended a workshop in order to identify the collected material and provide a first snapshot of the diversity of the surveyed habitats. Part of the workshop also focused on providing taxonomic training to host nation scientists and early career researchers.

This document is a report on the proceedings and some of the first outcomes of this workshop.

## Keywords

Taxonomy, training, deep reefs, corals, sponges, Western Indian Ocean, Seychelles, Comoros, South Africa

## Date and place

The taxonomic workshop was held at the National Research Foundation, South African Institute of Aquatic Biodiversity (NRF-SAIAB) in Grahamstown between the 1st to the 9th of August 2019.

## List of participants

The workshop was divided in 2 parts:

- Part 1 (01.08.2019 – 05.08.2019) was attended by taxonomic experts only, who worked together in order to identify the collected biological specimens, and process the associated underwater footage.
- Part 2 (06.08.2019 – 09.08.2019) also included host nation scientists and early-career researchers, who were trained in the identification of the major groupings represented in the collected samples and imagery.

A total of 28 people from 10 different countries were directly or indirectly involved with the workshop, with diverse affiliations ranging from Universities and Research Institutes, to Governmental Departments and Non-Governmental Organisations.

Sixteen were taxonomic experts covering all major benthic groups. Six of those physically attended the workshop and provided hands-on training sessions and lectures, five joined remotely to give online lectures, and a further five were involved with identification of specimens post-workshop.

Finally, a total of nine individuals from Seychelles, Comoros and South Africa joined for the training session.

For a full list of participants see Table 1.

Table 1. List of participants.				
Name	Role	Affiliation	Country of Institution	Nationality of individual
Lucy Woodall	Organiser; Benthic ecologist	University of Oxford	UK	UK

Name	Role	Affiliation	Country of Institution	Nationality of individual
Paris Stefanoudis	Organiser; Benthic ecologist	University of Oxford	UK	Greece
Sheena Telma	Organiser	Ministry of Environment, Energy and Climate Change	Seychelles	Seychelles
Kaveh-Samimi Namin*	Organiser; Octocoral Taxonomist	University of Oxford	UK	Iran
Carlos Moura	Hydrozoan Taxonomist	University of Azores	Portugal	Portugal
Jennifer Olbers	Ophiuroid Taxonomist	Ezemvelo KZN Wildlife	South Africa	South Africa
Liesl Janson	Sponge Taxonomist	Department of Environmental Affairs	South Africa	South Africa
Monika Bryce	Octocoral Taxonomist	Western Australia Museum	Australia	Austria
Robyn Payne	Sponge Taxonomist	University of Western Cape	South Africa	South Africa
Toufiek Samaai	Sponge Taxonomist	Department of Environmental Affairs	South Africa	South Africa
Catherine McFadden*	Octocoral Taxonomist	Harvey Mudd College	USA	USA
Chris Mah*	Sea star Taxonomist	Smithsonian National Museum of Natural History	USA	USA
Daniel Wagner*	Black Coral Taxonomist	NOAA	USA	USA
Rowana Walton*	Scleractinian Taxonomist	Consultant	UK	UK
Charles Messing**	Crinozoa Taxonomist	Nova Southeastern University	USA	USA
Paul Clark**	Brachyuran Crab Taxonomist	Natural History Museum London	UK	UK
Sammy De Grave**	Caridean Shimp Taxonomist	Oxford Museum of Natural History	UK	UK
Wayne Florence**	Bryozoan Taxonomist	Iziko South African Museum	South Africa	South Africa
Zoleka Filander**	Sea Urchin Taxonomist	Department of Environmental Affairs, South Africa	South Africa	South Africa
Ashley Pothin	Trainee	Ministry of Environment, Energy and Climate Change	Seychelles	Seychelles

Name	Role	Affiliation	Country of Institution	Nationality of individual
Ayesha Bobat	Trainee	WildTrust	South Africa	South Africa
Gilberte Gendron	Trainee	Seychelles National Park Authority	Seychelles	Seychelles
Kady Ramjattan	Trainee	WildTrust	South Africa	South Africa
Louw Kyss	Trainee	Rhodes University	South Africa	South Africa
Rabia Somers	Trainee	Marine Conservation Society Seychelles	Seychelles	Seychelles
Ramadhoini Ali	Trainee	University of Comoros	Comoros	Comoros
Richard Jeanne	Trainee	Green Islands Foundation	Seychelles	Seychelles
Stuart Laing	Trainee	University of Seychelles	Seychelles	South Africa
*Indicates taxonomic experts that could not attend the workshop, but gave a remote lecture				
**Indicates taxonomic experts that could not attend the workshop, but who will process biological samples post-workshop				

## Background

The Indian Ocean is among the least known (<http://www.obis.org>), least funded (<2% of all financial commitments at Our Oceans 2018 was aimed for the Indian Ocean) and least protected water mass (<http://www.mpatlas.org>), with its coastal population highly reliant on seafood harvests (e.g. Obura et al. 2017). Global threats from the consequences of climate change (e.g. increased storm intensity and increased frequency and severity of coral bleaching events), and local effects of human activities (e.g. fishing, pollution) are evident and cumulative (e.g. Hoegh-Guldberg et al. 2014, Breitburg et al. 2018, Watson et al. 2012), highlighting the need for a better understanding and management of Indian Ocean marine ecosystems.

Most of the past and present reef surveys and monitoring efforts in the Indian Ocean have been focusing on shallow-waters ( $\leq 30$  m), leaving adjacent, deeper mesophotic (30–150 m) habitats understudied (Pyle and Copus 2019). Much less is known about species connectivity between the mesophotic zone and those that inhabit deeper reef habitats, such as those located in the rariphotic zone (150–300m). If we are to sustainably manage and conserve those deeper reef habitats to help ensure they thrive and provide a full range of ecosystem services, it is imperative to know what lives there.

Nekton Foundation launched “[First Descent: Indian Ocean](#)”, a series of research expeditions to take place between 2018-2022 in order to contribute to establishing a baseline of marine life in the Indian Ocean and address the issues raised above. In 2018, Nekton successfully collaborated with other research organisations ([WildTrust](#)) to conduct

field research in Comoros, and in 2019 completed its first major research expedition in Seychelles, working with, and on behalf of the Government of Seychelles.

During 48 days the First Descent expedition collected hundreds of biological samples from depths between 10–250 m. The real challenge, however, was still ahead: the processing, statistical analysis, and interpretation of the collected marine data. Taxonomic workshops represent invaluable tools to expedite this process. These events represent a unique opportunity to bring together participating scientists and taxonomic experts across the globe, in order to accelerate the taxonomic identification and analysis. At the same time, if designed appropriately, they can also provide training to early career researchers from the world's best experts, thus ensuring that taxonomic knowledge and expertise is passed on to the next generation of marine scientists.

## Aims of the workshop

The aims of the workshop were two-fold:

1. To accelerate the assessment of the deeper reef biodiversity of the Western Indian Ocean (WIO) fauna and flora, by examining biological specimens and underwater footage collected during the [2019 First Descent: Seychelles expedition](#). Additional specimens collected in the Comoros Archipelago during the [2018 WILDOCEANS/ ACEP Comoros Mesophotic Biodiversity Expedition](#) (led by WILDTRUST) were also included to better understand community similarities between those neighbouring regions.
2. Provide training to host nation scientists and early career researchers on mesophotic and deeper benthic organisms, including corals, sponges and other invertebrates, which will help contribute towards creating a legacy for long-term research and effective science-based ocean management for marine biodiversity.

## Agenda

During the first part of the workshop, the majority of activities took place in a laboratory setting in order to facilitate the identification of collected specimens by the taxonomists. During the training part, it was a mixture of lectures introducing the trainees to the major benthic taxonomic groups typical in reef habitats, followed by hands-on practical sessions with representative samples from some of these groups (see Fig. 1). Other events included a safari trip, and post-workshop social gatherings, which gave the participants the opportunity to get to know each other better and network. A full list of the activities that took place can be found on the workshop's agenda in Table 2.

Table 2.

## Agenda for the Workshop.

<b>Date</b>	<b>Time</b>	<b>Activity</b>	<b>Place</b>	<b>Responsible</b>
01-08-19	09:00-09:30	Introduction to taxonomic experts and safety tour	Library Meeting Room	Lucy Woodall
	09:30-10:00	Coffee break	Library	
	10:00-12:30	ID session 1	Laboratory	All taxonomic experts
	12:30-13:30	Lunch break	Cafeteria	
	13:30-15:00	ID session 2	Laboratory	All taxonomic experts
	15:00-15:30	Coffee break	Cafeteria	
	15:30-16:30	ID session 3	Laboratory	All taxonomic experts
	16:30-17:30	Catch up session	Laboratory	Lucy Woodall
	19:00	Networking event	Local venue	All participants
02-08-19	08:45-10:30	ID session 1	Laboratory	All taxonomic experts
	10:30-11:00	Coffee break	Library	
	11:00-12:30	ID session 2	Laboratory	All taxonomic experts
	12:30-13:30	Lunch break	Cafeteria	
	13:30-15:00	ID session 3	Laboratory	All taxonomic experts
	15:00-15:30	Coffee break	Library	
	15:30-16:45	ID session 4	Laboratory	All taxonomic experts
	16:45-17:00	Catch up session	Laboratory	Lucy Woodall
	19:00	Networking event	Local venue	All participants
03-08-19	08:45-10:30	ID session 1	Laboratory	All taxonomic experts
	10:30-11:00	Coffee break	Library	
	11:00-13:00	ID session 2	Laboratory	All taxonomic experts
	19:00	Networking event		All participants
04-08-19	Safari trip to Addo Elephant National Park			All participants
05-08-19	08:45-10:30	ID session 1	Laboratory	All taxonomic experts
	10:30-11:00	Coffee break	Library	
	11:00-12:30	ID session 2	Laboratory	All taxonomic experts
	12:30-13:30	Lunch break	Cafeteria	

Date	Time	Activity	Place	Responsible
	13:30-15:00	ID session 3	Laboratory	All taxonomic experts
	15:00-15:30	Coffee break	Library	
	15:30-16:45	ID session 4	Laboratory	All taxonomic experts
	16:45-17:00	Catch up session	Laboratory	Lucy Woodall
	19:00	Networking event	Local venue	All participants
06-08-19	08:45-09:15	Introduction to trainees and safety tour	Library Meeting Room	Lucy Woodall
	09:15-10:00	Lecture 1 - Scleractinian Taxonomy*	Library Meeting Room	Rowana Walton
	10:00-12:30	Lecture 2 - Sponge Taxonomy	Library Meeting Room	Toufiek Samaai
	11:00-12:30	ID training session 1: Sponges	Laboratory	Toufiek Samaai, Liesl Janson, Robyn Payne
	12:30-13:30	Lunch break	Cafeteria	
	13:45-15:00	ID training session 2: Sponges	Library Meeting Room	Toufiek Samaai, Liesl Janson, Robyn Payne
	15:00-15:30	Coffee break	Library	
	15:30-16:30	Lecture 3 - Sea Star Taxonomy*	Library Meeting Room	Chris Mah
	16:30-17:00	Catch up session	Laboratory	Lucy Woodall
	19:00	Networking event	Local venue	All participants
07-08-19	08:45-09:45	Lecture 1 - Hydrozoan Taxonomy	Library Meeting Room	Carlos Moura
	09:45-10:00	Coffee break	Library	
	10:00-11:00	Lecture 2 - Octocoral Sample Collection, Processing and Identification Techniques*	Library Meeting Room	Kaveh Samimi-Namin
	11:00-12:30	ID training session 1: Octocorals	Laboratory	
	12:30-13:30	Lunch break	Cafeteria	
	13:30-14:00	Lecture 3 - Octocoral Taxonomy	Library Meeting Room	Monika Bryce
	14:00-15:00	ID training session 2: Octocorals	Laboratory	Monika Bryce
	15:00-15:30	Coffee break	Library	

Date	Time	Activity	Place	Responsible
	15:30-16:00	Lecture 4 - Ophiuroid Taxonomy	Library Meeting Room	Jennifer Olbers
	16:00-17:00	ID training session 3: Ophiuroids	Laboratory	Jennifer Olbers
	17:00-18:00	Lecture 5 - Octocoral Systematics*	Library Meeting Room	Catherine McFadden
	19:00	Networking event	Local venue	All participants
08-08-19	08:45-09:30	ID training session 1: Using Underwater Benthic Footage	Library Meeting Room	Paris Stefanoudis
	09:30-10:00	Coffee break	Library	
	10:00-12:30	ID training session 2: Focus on Underwater Benthic Footage	Library Meeting Room	Paris Stefanoudis
	12:30-13:30	Lunch break	Cafeteria	
	13:30-15:00	ID training session 3: Focus on Underwater Benthic Footage	Library Meeting Room	Paris Stefanoudis
	15:00-15:30	Coffee break	Library	
	15:30-16:45	ID training session 4: Free session customised to trainees' needs	Laboratory	All taxonomic experts
	16:45-17:00	Catch up session	Laboratory	Paris Stefanoudis
	19:00	Networking event	Local venue	All participants
09-08-19	08:45-10:00	Practical Session: Using z-stacking in a Stereomicroscope	Laboratory	Jennifer Olbers
	10:00-10:30	Coffee break	Library	
	10:30-12:30	ID training session 1: Free session customised to trainees' needs	Laboratory	All taxonomic experts
	12:30-13:30	Lunch break	Cafeteria	
	13:30-15:00	Cleaning lab and curating samples	Laboratory	All taxonomic experts, Paris Stefanoudis and Sheena Talma
	15:00-16:00	Lecture 1 - Black Coral Taxonomy*	Library Meeting Room	Daniel Wagner
	16:00-16:15	Wrap-up session	Library Meeting Room	Paris Stefanoudis
	19:00	Networking event	Local venue	All participants
*Indicates lecture given remotely				





Figure 1. [doi](#)

Top left to centre right: Photographs representing the different training activities that took place during the workshop. Bottom: Group photo of participants.

## Key outcomes and discussions

During the workshop, we identified a total of 632 biological samples from the Seychelles expedition, including subsamples of larger organisms taken for post-workshop molecular and scanning electron microscopy work. These included (in decreasing order): 189 sponges, 99 octocorals, 67 brittle stars, 52 crabs, 36 hydroids, 19 sea urchins, 17 shrimps, 14 crinoids, 12 gastropods, 10 red algae, 9 sea stars, 9 polychaetes, 8 green algae, 7 bryozoans, 6 bivalves. The remaining 78 was a combination of other taxonomic groups and fin clips of fish, the latter to be used to facilitate an additional study led by one of the participants.

The respective numbers for the Comoros survey were 44 biological samples: 20 octocorals, 7 sponges, 3 crinoids and 14 belonging to other groups.

We also reviewed hundreds of taxa in their natural environment by examining the rich underwater footage collected from both research expeditions.

As a result of the participating experts it was possible, in just two weeks, to gain first impressions of the diversity of Seychellois and Comorian reefs. This task would have taken months, or in some cases it would have not been possible at all, if it was tackled by a few individuals or one institution alone. Initial results, revealed numerous genera and species

of sponges and corals, many of which represented new records for Seychelles and Comoros and in some cases for the whole of the Indian Ocean, as well as significant depth range extensions, thus improving our knowledge of the biogeography for the region. Interestingly, taxonomic experts thought they found potentially dozens of new species, both from shallow and deeper waters, indicating that reefs in the WIO are still poorly known. Additional, more detailed taxonomic work will be required to confirm those initial beliefs in the coming months.

Through the lectures and practical laboratory sessions, host nation scientists and early career researchers were able to obtain a holistic understanding of the different benthic groups present in reef ecosystems, and the multitude of steps required to make accurate identifications. Participants learnt, that identification of physical samples is a time-consuming, yet necessary process, which typically involves the use of stereo- and light microscopes along with identification guides, but in many cases requires additional steps such as comparisons with type specimens in museum collections, or the use of scanning electron microscopy and DNA sequencing. For those dealing with identifications of specimens from underwater imagery and videos, it became clear that identification is often made to the lowest taxonomic level possible, which depending on the taxon might be to genus or family level. Furthermore, matching the commonly observed organisms in marine footage with physically collected samples, can enhance the taxonomic robustness of a study.

## Conclusions

Overall, throughout the industrious nine days at NRF-SAIAB, we were able to enhance our taxonomic knowledge of the WIO reef fauna and provide networking opportunities and potentially foster new collaborations between scientists from the region. The provided training and knowledge exchange opportunities for host nation scientists and early career researchers, will hopefully prove useful in the coming years.

## Acknowledgements

We wish to thank NRF-SAIAB for being such excellent hosts and providing assistance with all associated logistics. In particular we wish to thank Dr. Angus Patterson for enabling us to host the workshop in NRF-SAIAB, Naniswa Nyoka for assisting with catering, travel and accommodation of all participants, Nkosinathi Mazungula and Maditaba Melfaf for providing access to laboratory and video-conferencing facilities, and finally, the Seychelles Ministry of Environment Energy and Climate Change for facilitating the transfers of all genetic material from Seychelles to South Africa.

This is Nekton Contribution No. 18.

## Hosting institution

National Research Foundation, South African Institute of Aquatic Biodiversity

## Ethics and security

All biological specimens processed during the workshop had appropriate permits in place, issued by the Government of Seychelles.

No CITES listed specimens were used.

## Conflicts of interest

We have no conflict of interest to report.

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