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OVERVIEW OF MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION

Relate to agenda item:12.4

Working paper ☐ Info paper ☒ Restricted ☐

Monaco Exploration

Abstract

The information paper presents the scientific expedition planned in late 2022 on the Saya De Malha Bank (within SIOFA subarea 8) by Mauritius and Seychelles, and to be undertaken by Monaco Explorations.

MONACO EXPLORATIONS
Reconnecting Humanity and the Sea

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OVERVIEW OF MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION

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1. General Framework

The "Indian Ocean Expedition" is the first item of the "Monaco Explorations" project endorsed as a contribution to the United Nations Decade of Ocean Sciences for Sustainable Development 2021-2030.

The project is coordinated by Monaco Explorations, a collective platform funded by the Government of the Principality of Monaco, which brings together under the aegis of the Government, the Prince Albert II of Monaco Foundation, the Oceanographic Institute, the Scientific Centre of Monaco and the Yacht Club of Monaco, to serve the commitment of HSH Prince Albert II of Monaco to knowledge, sustainable management and protection of the Ocean.

The expedition will cover the area between Reunion Island, Mauritius, and Seychelles (see Figure 1) with the following objectives:

- to understand through a multidisciplinary scientific approach the ecosystemic status and functioning of the area explored and to advise stakeholders through a holistic scientific approach (sustainability science);
- to share the issues and knowledge with the greatest number of people through an ambitious outreach programme;
- to mobilize governments, through diplomatic action, by making available information and analyses to support the sustainable management of maritime areas.

The expedition is expected to benefit from an extensive media coverage and should result in the production of a documentary film for international distribution and the writing of a book by a renowned author.

It is planned that the mission will be coordinated with an official visit to the region by HSH the Sovereign Prince. Other official activities of the Sovereign Prince related to the objectives of the mission, in particular His interventions in various forums dealing with the protection of the Ocean, may illustrate the context related to the political dimension of the expedition.

The science programme is guided by the four main themes of Monaco Explorations (the protection of corals, the protection of the megafauna, the development of marine protected areas and new exploration technologies). It focusses on meeting the needs of the Governments of Seychelles and Mauritius while also relating closely with relevant international and regional organs and initiatives, notably the United Nations Decade of Ocean Sciences for Sustainable Development (2021-2030) as already mentioned – including the Nippon Foundation GEBCO project Seabed 2030 and the continuation of the Second International Indian Ocean Expedition (IIOE-2 – 2015-2025).

Outreach activities will be based mainly on the scientific dissemination programme "Dialogue Science-Decision Makers for Integrated Management of Coastal and Marine Environments" (DiDEM) in the Western Indian Ocean

basin (Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, United Republic of Tanzania) coordinated by the French Research Institute for Development (IRD). In addition, active collaboration will be requested from all the participating entities in order to optimize the use of the preparation, progress, contents, and results of this expedition for pedagogic and educational purposes and more generally for public outreach and communication.

Initially planned in April and May 2021, the expedition is currently planned for October and November 2022 through a charter, currently under negotiation, of the South African oceanographic vessel *S.A. Agulhas II* which would be made available from Cape Town from 1 October to 30 November 2022.

2. Scientific Programme

The scientific programme is being consolidated on the basis of eight projects. It focuses on two types of maritime areas:

- The joint Mauritius-Seychelles management area of Saya de Malha: this is a relatively unknown area, located beyond the exclusive economic zones of the two States. The expedition aims to gather scientific elements that could help consolidate the joint governance of an area with potential outstanding universal value. This area is the priority focus of the expedition.

- A selection of islands (or even seamounts): the main objective is to characterize the function of refuges for biodiversity and to help preserve it against the impacts of anthropic pressure and climate change.

The eight projects are as follows:

- A major structuring project: A1: Saya de Malha: multidisciplinary study of the joint Mauritius-Seychelles management area of Saya de Malha, led by Francis Marsac, IRD, French joint research unit "MARine Biodiversity, Exploitation and Conservation" (UMR MARBEC);

- Seven projects addressing specific themes relevant to the whole area or to particular sites:

    - A2: Megafauna: study of marine vertebrates around the islands and seamounts of the region, led by David Mouillot, University of Montpellier, France, on behalf of the international Megafauna Consortium.

    - B1: FROID: study of the impact of coral reefs on planctonic diversity, led by Christine Ferrier-Pagès, "Coral Ecophysiology" team from the Monaco Scientific Centre (CSM);

    - B2: OCEsANte: study of the impact of human activity and ocean warming on the emergence of pathogenic bacteria led by Dorota Czerucka and François Seneca, CSM "Ecosystems and Immunity" team, in collaboration with
      B8: MADCAPS: characterization of plastic debris potentially carrying coral pathogenic microorganisms led by Margot Thibault, French joint research unit "Tropical Marine Ecology of the Pacific and Indian Oceans" (UMR ENTROPIE).

    - B3: GECOS: study of the genetic structure and levels of contamination and stress in marine turtles led by Quentin Schull and Jérôme Bourjea, UMR MARBEC.

- B4: 4Sea: study of the combined impacts of coastal human activities and climate change on marine ecosystems led by Sylvain Bonhommeau, Ifremer Indian Ocean Delegation and Julien Barde, UMR MARBEC.

- B5: BGC-Argo-IO: extension of the international BGC-Argo monitoring programme led by Hervé Claustre, Oceanography Laboratory of Villefranche-sur-Mer, France.

- B6: EMPREINTE ILOI: study of the footprint of islands and geomorphological structures through the analysis of stable isotopes of carbon and nitrogen and environmental DNA led by Sébastien Jaquemet, UMR ENTROPIE.

The activities related to the investigation of the Saya de Malha Bank are set out in Annex 1. The activities envisaged around the islands and seamounts are described in Annexes 2 and 3. The expedition will also include underway activities which are indicated in Annex 4. **These activities may be adjusted subject to the partners involved and the actual availability of equipment**. As an example, the possibility to contribute to the World Coral Conservatory project is being investigated.

The participation of partners from Mauritius and Seychelles as well as other institutions active in the region is being consolidated both at the level of individual projects and at the level of Monaco Explorations. A preliminary list of partners is provided in Annex 5.

A particular effort will be devoted to the restitution of the expedition, notably the investigation of the Saya de Malha area, when drafting the expedition report, in a holistic approach, based not only on the elements collected during the expedition but integrating as much as possible all the available knowledge on the area, including historical and socio-economic aspects, so as to propose well-founded guidance for the sustainable management of the area in a logic of sustainability science.

3. Outreach and Communication

The outreach and communication plan will take into account:

- the participation of Monaco Explorations in the DiDEM programme, including:
    - the scheduling of events likely to be coordinated with the visit of HSH the Sovereign Prince, for example in connection with:
        - the application of the "The Future of" approach to the development of the blue economy of the Seychelles,
        - the animation of the PAREO community (*PAtrimoine RÉcifal de l'Océan Indien entre nos mains*[1]) by the setting up of an Educational Marine Area (EMA) in Seychelles (including possible twinning with the EMA of Monaco);
    - the setting up of post-expedition activities, including the restitution of the expedition's work, in particular in relation to:
        - the legal study on the governance of maritime areas beyond national jurisdictions,
        - the thematic school on reef geosystems,
        - events organized by the Western Indian Ocean Scientific Association (WIOMSA);

- the outreach activities of the expedition itself, to be articulated with DiDEM, including:
    - participation of students and early career ocean professionals from Mauritius and Seychelles in the expedition mission (data collection, post-processing, etc.),

[1] Indian Ocean Reef Heritage in Our Hands.

    - on-board school during the expedition (feasibility to be investigated),
    - live broadcasts with the research vessel including dialogue with scientists,
    - school visits aboard the research vessel (Reunion Island, Mauritius, Seychelles),
    - school exchanges/collaborations Monaco-France / Seychelles-Mauritius-Reunion,
    - the definition and implementation of scientific projects in partnership with the regional and national entities concerned,

- other expedition-specific activities, for example:
    - the articulation with the "Sea Explorers and Citizens" scheme concerning the high schools of Nice Academy,
    - the development of interactive educational tools for Monaco national education system,
    - contributing to the redesign of the "Monaco and the Ocean" exhibition at the Oceanographic Museum of Monaco.

Communication about the expedition should be based on the following elements:

- a 90 min documentary;

- multimedia products associated with the documentary, including:
    - video clips for television and social media,
    - content for TV magazines,
    - an educational series of about fifteen 5/7 min films;

- an artistic production, including an author's book, photographic coverage, an illustrated travelogue…;

- a presence on social media, newspapers, and TV magazines.

The outreach and communication plan will cover not only the Expedition itself but also pre- and post-expedition activities.

4. Management structure

The overall coordination of the Expedition is led by the Directing Board of Monaco Explorations chaired by the Minister of State of the Principality of Monaco.

The preparation of the Expedition is guided by an International Advisory Committee composed of fourteen experts and chaired by Mr Carl Gustaf LUNDIN (Mission Blue Managing Director, formerly IUCN Global Marine and Polar Programme Principal Scientist) (see Annex 6). The International Advisory Committee warrants that the Expedition implements a holistic approach based on a multidisciplinary programme including natural and social sciences.
In that perspective, the Committee ensures that the scientific projects contributing to the Expedition are relevant and properly integrated. To this end, it draws not only on the elements collected during the Expedition but on all the information available on the area, from oceanographic data to historical, cultural, sociological, and economic aspects, in order that the Expedition outcomes provide relevant advice for the sustainable management of the area, in accordance with the maxim of Monaco Explorations: "Reconnecting Humanity and the Sea".

The Expedition will be managed by an Executive Board composed of representatives of the main partners and chaired by the Chief Operation Officer of Monaco Explorations.

5. Cruise Plan

The ship will be chartered from Cape Town; mobilisation and demobilisation are envisaged in Port Louis, Mauritius. It should be possible to board and disembark in Cape Town at the beginning and end of the charter as well as at stopovers during the expedition.

Figure 2 indicates the tentative cruise plan. It will be adjusted to allow a meeting with H.S.H. the Sovereign Prince, in principle in Aldabra (Seychelles). A stopover in Reunion Island is envisaged, rather at the beginning of the expedition, and a stopover in Mahé (Seychelles) rather in the middle of the expedition.

Two islands are envisaged for the activities described in Annex 2: Aldabra and Saint-Brandon.

Transits between Cape Town and Mauritius and back could also be "valorised" provided that the ship is not slowed down too much in order to maximise the time spent in the area.

6. Terms of participation in the Expedition

6.1 Financing

Monaco Explorations will cover the chartering cost and the logistical and operational costs during the Expedition from the port of departure to the port of arrival.

Subject to exceptional circumstances, which will be considered on a case by case basis, the logistical costs before and after the Expedition (costs up to boarding and from disembarking, transport to / from the port of departure / arrival of equipment and samples, etc.) are normally the responsibility of the participants.

6.2 Relevant regulations

Participation in the Expedition implies a commitment to comply with the provisions of the United Nations Convention on the Law of the Sea relating to marine scientific research and the Nagoya Protocol as well as the principles of good practice of the OSPAR Code of Conduct for Responsible Marine Research[2].

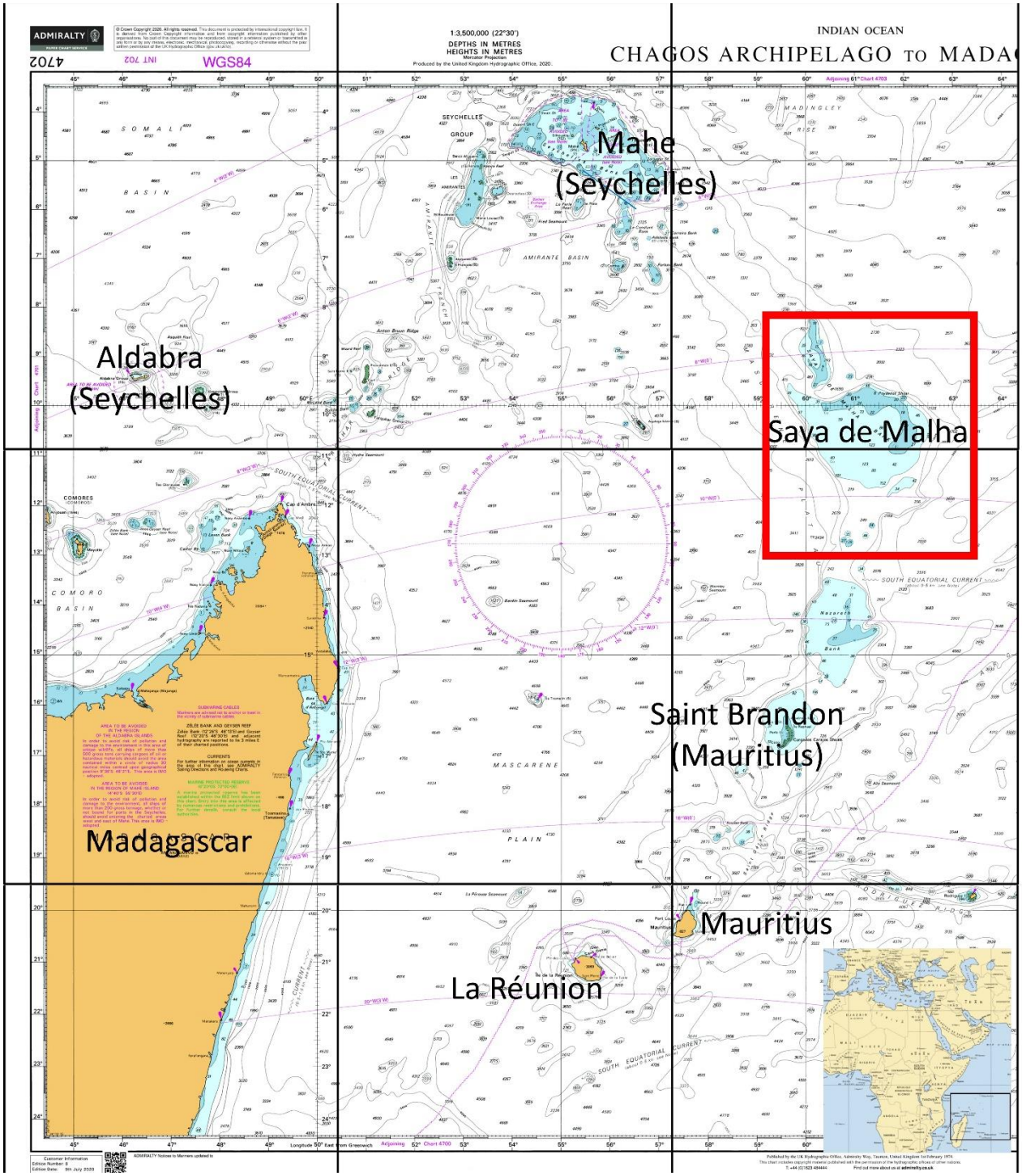
Particular attention will be paid to the control of environmental impact risks.

6.3 Available means and equipment

The characteristics of *S.A. Agulhas II* and the equipment available are specified in Annex 7.

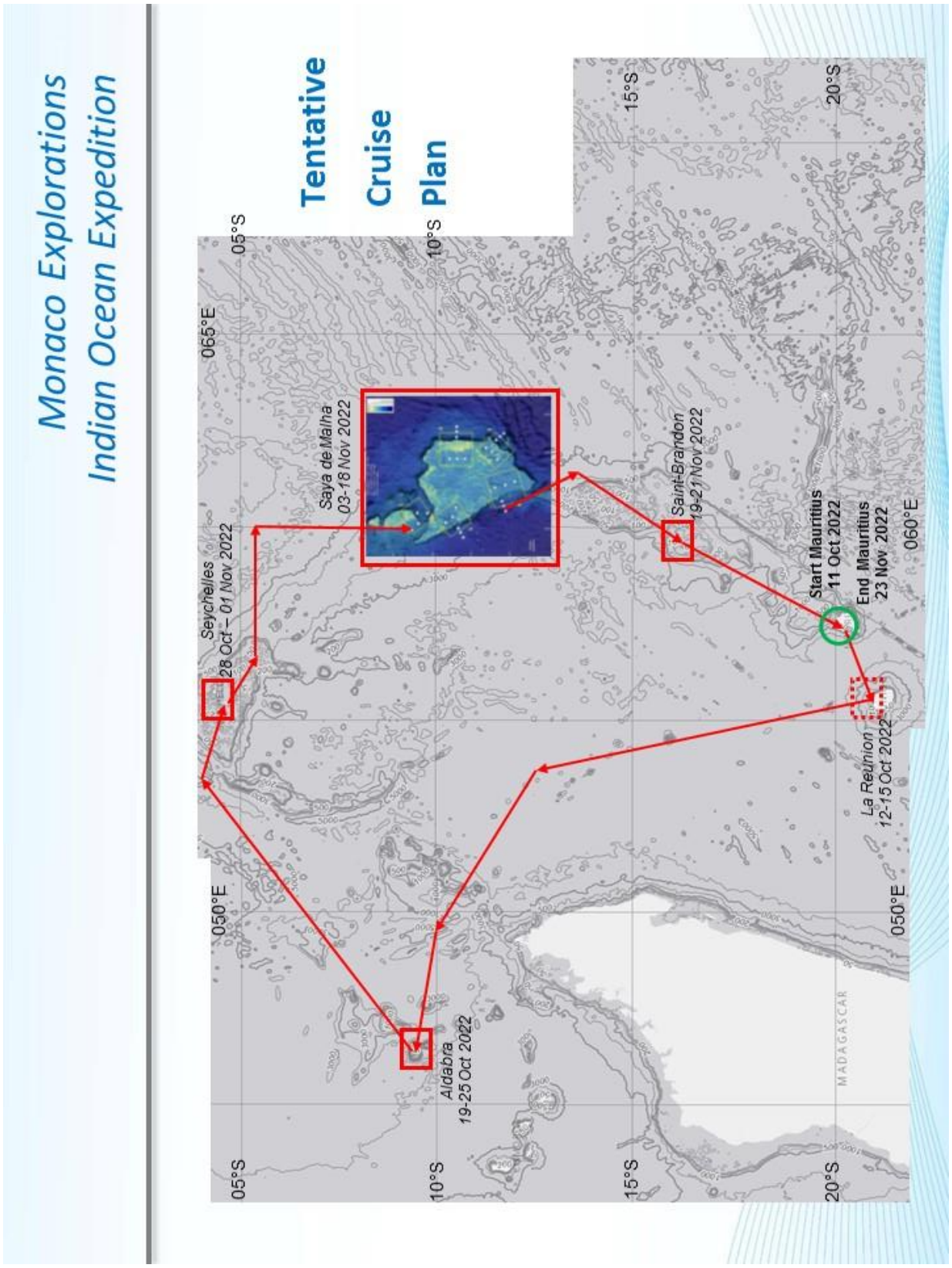
[2] https://www.ospar.org/documents?d=32633

Figure 1
Location map



Source: Admiralty Chart GB 4702

Figure 2



2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Annex 1

Investigation of the Saya de Malha Bank

Project	Activities	Comments
A1 Saya de Malha	Underway measurements - bathymetric survey with shallow water MBES - surface temperature and salinity; current profile - XBT profiles - eDNA filtering	Subject to availability of MBES
	Station measurements - vertical profiles of temperature, salinity, dissolved oxygen and fluorimetry with simultaneous water sampling at different depths (CTD+ rosette) - vertical profiles with Underwater Vision Profiler (UVP) and Acoustic Zooplankton Fish Profiler (AZFP)	
	Low speed measurements (1 to 2 knots) - transects with ROV - oblique transects with Bongo nets - transects with Manta net - towed gear (suprabenthic sled, beam trawl, Warén dredger)	
	Sampling of benthic biodiversity by divers (visual, underwater cameras, underwater sucker, brush)	
A2 Megafauna	Non-destructive sampling (biopsy, netting, fishing) Scuba diving in the 0-20m zone	Subject to pooling with A1. Operations requiring three tenders, each with a capacity of 4 persons + diving equipment.
	eDNA filtration 5 surface transects around the area, 5 mesophotic transects Counting reef fish by divers Scuba diving in the 0-80m zone	
	eDNA filtration 10 deep sampling around the area (water and sediment) on board the research vessel	
	Deployment of reef cameras on transects sampled with eDNA. Scuba diving in the 0-40m zone	
	Drone operated from the research vessel	
B2 OCEsANté B8 MADCAPS	Shallow (30 m) and/or deep-sea sediment sampling	Subject to pooling with A1.
B4 4SEA	Data collection using various platforms (autonomous instrumented board, drone, kitesurf, paddle, snorkelling) operated in seagrass areas	Subject to pooling with A1. Offer to support the other projects when not active.
B5 BGC-ARGO-OI	Deployment of floats and/or profilers Hydrology stations Sampling of zooplankton with a towed net	Subject to pooling with A1.
B6 EMPREINTE-ILOI	CTD casts down to 500 m or 20 m from the seabed	Subject to pooling with A1.

Annex 2

Activities around the islands

Project	Activity	Comments
A2 Megafauna	Non-destructive sampling (biopsy, netting, fishing) Scuba diving in the 0-20m zone	Operations requiring three tenders, each with a capacity of 4 persons + diving equipment Programme to be adapted for Mauritius and Mahe (research vessel alongside).
	eDNA filtration 5 surface transects around the island, 5 mesophotic transects Counting reef fish by divers Scuba diving in the 0-80m zone	
	eDNA filtration 10 deep sampling around the island (water and sediment) on board the research vessel	
	Deployment of reef cameras on transects sampled with eDNA. Scuba diving in the 0-40m zone	
	Drone operated from the edge of the island or from the research vessel	
B1 FROID	Selection of investigation sites and determination of the direction of the current Collection of water samples downstream, upstream and on the reef	Pooling with A2. Programme to be adapted for Mauritius and Mahe (research vessel alongside).
B2 OCEsANte B8 MADCAPS	Shallow (30 m) and/or deep-sea sediment sampling Collection of plastic debris on the beaches	ROV operation subject to the navigational safety of the research vessel.
B3 GECOS	Prospection of areas hosting sea turtle juveniles and sampling of turtles Possible reinforcement of the Aldabra beacon network	Operation requiring a tender with a capacity of 4 people + equipment Operations conducted independently of the research vessel in Mauritius and Mahe. Pooling with B4. Consider any possible pooling with A2.
B4 4SEA	Data collection using various platforms (autonomous instrumented board, drone, kitesurf, paddle, snorkelling) operated from the coast.	Pooling with B3.
B6 EMPREINTE-ILOI	CTD casts down to 20 m from the seabed	Consider any possible pooling with A2. Stations in daytime (fluorescence profiling) Check feasibility of stations around Mauritius and Mahe.

Annex 3

Activities around seamounts (on an opportunity basis)

Project	Activity	Comments
A2 Megafauna	Non-destructive sampling (biopsy, netting, fishing) Scuba diving in the 0-80m zone	Operations requiring one tender with a capacity of 4 persons + diving equipment.
	eDNA filtration 10 deep sampling around the seamount (water and sediment) on board the research vessel	
	Deployment of deep-water cameras on the seamount from the research vessel	
	Drone operated above the seamount from the research vessel	
B6 EMPREINTE-ILOI	CTD casts down to 500 m or 20 m from the seabed	Consider any possible pooling with A2. Stations in daytime (fluorescence profiling)
Seabed 2030	Detailed bathymetric survey	Subject to the equipment available on board

Annex 4

Underway activities

Project	Activity	Comment
B2 OCEsANte B8 MADCAPS	Water sampling at stations with Niskin bottles. Sampling of plankton and plastics with a towed AVANI plankton net at regular intervals.	Pooling with B5 and B6.
B5 BGC Argo IO	Deployment of floats and/or profilers Hydrology stations (CTD)	Pooling with B6 and B8.
B6 EMPREINTE ILOI	Hydrology stations (CTD)	Pooling with B5 and B8. Stations in daytime (fluorescence profiling).
Seabed 2030	Recording of bathymetry data underway	Subject to equipment available on board
	Investigation of altimetry signals related to possible seamounts	Investigation associated with activities of project A2 of appropriate (see annex 3).

Annex 5

Preliminary list of partners

1. International and regional organizations

Coastal Oceans Research and Development – Indian Ocean (CORDIO) East Africa
General Bathymetric Chart of the Oceans (GEBCO)
Indian Ocean Commission
Intergovernmental Oceanographic Commission (UNESCO/IOC)
Nairobi Convention
Southern Indian Ocean Fisheries Agreement (SIOFA)
Western Indian Ocean Marine Sciences Association (WIOMSA)

2. National partners

Country	Organization	Project
Australia	Reef Life Survey	Megafauna
Canada	Fisheries and Oceans Canada	BGC-Argo
Denmark	Aalborg University	GECOS
France	Ecole pratique des hautes études (EPHE)	Megafauna
	French Research Institute for Exploitation of the Sea (Ifremer)	Megafauna GECOS 4 SEA
	Kelonia	GECOS
	National Centre for Scientific Research (CNRS)	Saya de Malha
	National Museum of Natural History (MNHN)	Saya de Malha
	Oceanography Laboratory of Villefranche-sur-Mer	Saya de Malha BGC-Argo
	Research Institute for Development (IRD)	Saya de Malha Megafauna 4 SEA
	University Centre of Mayotte	Megafauna
	University of La Réunion	MADCAPS EMPREINTE
	University of Montpellier	Megafauna
	University of Nice Côte d'Azur	OCEsANte
Mauritius	Albion Fisheries Research Centre	Saya de Malha
	Mauritian Wildlife Foundation	Megafauna
	Mauritius Oceanography Institute	Saya de Malha
	Mauritius Marine Conservation Society	GECOS
	Reef Conservation Mauritius	FROID
	University of Mauritius (Faculty of Science - Department of Biosciences & Ocean Studies)	Saya de Malha FROID EMPREINTE
Monaco	Scientific Centre of Monaco	FROID
Norway	REV Ocean (tbc)	
Poland	Université de Lodz	Saya de Malha
Seychelles	Marine Conservation of Seychelles	GECOS
	Nature Seychelles	GECOS
	Seychelles Fishing Authority	Megafauna
	Seychelles National Parks Authority	Saya de Malha Megafauna FROID
	Seychelles Islands Foundation	Saya de Malha FROID

Country	Organization	Project
		GECOS 4 SEA EMPREINTE
	Sustainable Ocean Seychelles	FROID
	The Ocean Project Seychelles	OCEsANte MADCAPS
	University of Seychelles (Blue Economy Research Institute)	Saya de Malha Megafauna
South Africa	Nelson Mandela University - Ocean Sciences Campus - South African National Biodiversity Institute	 Saya de Malha 4SEA
	South African Navy Hydrographic Office	Seabed 2030
	Southern Ocean Carbon and Climate Observatory (SOCCO)	BGC-Argo
Switzerland	ETH	Megafauna
United Kingdom	Foundation Bertarelli The Zoological Society of London	Megafauna
	Liverpool John Moores University	EMPREINTE
	Plymouth Marine Laboratory	EMPREINTE
	University of Lancaster	Megafauna
United States	University of Maine	BGC-Argo

Annex 6

Membership of the Advisory Committee of Monaco Explorations Indian Ocean Expedition

Carl Gustaf LUNDIN	Chair	Mission Blue, USA (formerly Director for the IUCN Global Marine and Polar Programme)
Dominique BENZAKEN		Australian National Centre for Ocean Resources and Security, University of Wollongong, Australia - World Bank (consultant)
Dick D'ADAMO		University of Western Australia - Oceans Institute (formerly Head of UNESCO IOC Perth Programme Office)
Sylvia EARLE		Mission Blue, USA
Tessa HEMPSON		Oceans without Borders
Nirmal JIVAN SHAH		Nature Seychelles
Heather KOLDEWEY		Zoological Society of London & Bertarelli Foundation, UK
Olivier LAROUSSINIE		CEREMA, France
Margaret LEINEN		Scripps Institution of Oceanography, USA
Nadine MARSHALL		formerly at CSIRO
David OBURA		CORDIO East Africa
Alex ROGERS		REV Ocean, Norway
Anwar RUMJAUN		Mauritius Institute of Education
François SIMARD	Secretary	formerly at IUCN

'S.A. AGULHAS II'

Steel Hulled, Ice strengthened Antarctic Supply/Oceanographic Research Vessel

SPECIFICATIONS

Classification	DNV + 1A1 Passenger Ship
Built	2011 STX Finland Oy, Rauma, Finland
Flag	South Africa
Port of Registry	Cape Town
IMO Number	9577135
Call Sign	ZSNO

MAIN DIMENSIONS

Length OA	134.0m
Breadth	22.0m
Moulded Draft	7.70m
GRT	12897T
NRT	3870T

Main Engines	4 x 3,000kW
Power	9000kW shafts
Prop. Motors	2 x 4,500kW
Cruising speed	14.0 knots
Maximum speed	18.0 knots
Range	15,000 nautical miles
Endurance	90 days
Complement	144 comprising 44 crew and 100 scientific/other staff
Affiliation	Department of Environmental Affairs, Republic of South Africa Directorate Antarctica and Islands

PROPULSION

Four uni-directional Wartsila 6L32 turbo-charged and intercooled 6 cylinder 4 stroke diesel engines directly coupled to four Converteam B128P8 Generators.
Total power MCR 12,000kW, service power at 85% MCR 10,200kW
Two Converteam N3HXCH2LL8CH Propulsion motors, Total power 9,000kW Two 750kW Rolls-Royce TT2000 DPN FP Bow thrusters, Total power 1,500kW One 1,200kW Rolls-Royce TT2400 DPN FP Stern thruster, Total power 1,200kW Bunker oil capacity: Maximum 3,009 tonnes, at 95% 2,858 tonnes.

ELECTRICAL POWER

Generated for propulsion at 3.3kVA, 3 phase, 50Hz, by the Wartsila/Converteam combination mentioned above From the above Hotel Services are supplied at 3 phase, 50 Hz, 400V
Harbour Generator: Mitsubishi S12R-Z3MPTAW-4 diesel engine, developing 1351kVA, 3 phase, 50Hz, 400 v. Generator Stamford PM734CZ
Emergency Generator: Volvo-Penta D 16MG diesel engine, developing 490kVA, 3 phase, 50Hz, 400V. Generator Stamford HCM534E-1
220v AC, 50Hz domestic supply
220v AC, 50Hz stabilized domestic supply.

African Marine Solutions Group (Pty) Ltd
31 Carlisle Street, Paarden Eiland, 7405
P.O. Box 1339, Cape Town, 8000
+27 21 507 5777 amsol@amsol.co.za
www.amsol.co.za

NAVIGATION EQUIPMENT

Integrated Navigation System by Raytheon Anschutz, GMBH, Kiel, Germany

Gyrocompass	2 x Anschutz Type
22 Digital Autopilot 2025	Anschutz NautoPilot
Radars	1 x Raytheon Anschutz S-Band 30kW ARPA Chartradar Blackbox System 2 x Raytheon Anschutz X-Band 25kW ARPA Chartradar Blackbox Systems. One fitted with a high-speed scanner. 1 x Sigma S6 Integrated Radar Processing System, for ice navigation
GPS	2 x Saab R4 DGPS Receivers
ECDIS	2 x (Main + Secondary) Raytheon Anschutz ECDIS Blackbox Version with
overlay Speed log	Skipper DL850 2 Axis Doppler Log
Echo Sounder	Raytheon Anschutz GDS101 50/200kHz
Conning Screen	The ship's operating parameters such as position, speed, propeller pitch, rudder angle, wind direction, wind speed, etc. are displayed either in graphic or alpha numeric form on the bridge and in the Captain's cabin.

METEOROLOGICAL EQUIPMENT

2 x Lambrecht Weather Sensors, indicating wind speed and direction, air temperature, barometric pressure and relative humidity.
Sea temperature given by the Skipper Log

DYNAMIC POSITIONING SYSTEM (LEVEL 1)

- 1 x Navis 4001 DP System
- 1 x Navis 4011 Joystick Control System
- 1 x Model LID3-G1 DGPS Receiver for the DP system

COMMUNICATIONS

Radio and Satellite Equipment, to GMDSS Sea Area 4

BRIDGE Communication Console

- 2 x Raytheon Anschutz MF/HF DSC Radio Controllers CU 5100
- 1 x Raytheon Anschutz VHF DSC Controller RT 5022
- 1 x Sailor Inmarsat C Message Terminal TT3606E
- 3 x Raytheon Anschutz printers H1252B/TT-3608A for above
- 1 x Raytheon Anschutz GMDSS Alarm Panel AP 5042
- 3 x Sailor GMDSS VHF Portable Radios, SP 3520
- 1 x ICOM Air band Portable VHF Radio (With headset and microphone)

Bridge Main Console

- 1 x Raytheon Anschutz VHF DSC Duplex Controller RT 5020
- 1 x Motorola GM 360 UHF radio
- 1 x Raytheon Anschutz GMDSS Alarm Panel AP 5065

Bridge Helicopter Console

- 1 x Raytheon Anschutz VHF Radio Controller CU 5000
- 1 x Becker Air band VHF Radio
- 1 x Motorola VHF Radio DM 3600

Bridge Starboard Console

1 x Sailor VHF Radio 6210

Bridge Port Console

1 x Sailor VHF Radio 6210

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www.amsol.co.za

Bridge, After Bulkhead
2 x SARTs, Sailor 6913A-SART (1 Port, 1 Starboard)
1 x EPIRB, TRON 40S Mk II 406 Mhz

Monkey Island (Deck 10)
1 x EPIRB (Float Free), TRON 40S Mk II 406 MHz
1 x VDR Capsule

Bridge, Office
22 x UHF Radios, Motorola
Navtex Receiver, NCR-333
Weather Facsimile Receiver, Raytheon Anschutz Blackbox FAX-30

ECHO SOUNDING EQUIPMENT
Raytheon Anschutz GDS 101 50/200 Hz Echo Sounder
Simrad EA 600 Deep Sea Echo Sounder

WINCHES
- 1 x Hatlapa Electric Windlass with 2 x 160kN @ 5/15m/min. Cable Lifters and 2 x 150kN @ 15/30m/min. Warping Drums
- 2 x Hatlapa Electric Capstans, 100kN @ 15/30m/min
- 1 x Rapp Hydema HW 2300 E CTD Winch, 6,000m x 11.73mm conductor cable
- 1 x Rapp Hydema HW 2300 E CTD Winch, 6,000m x 12mm Kevlar cable
- 1 x Rapp Hydema HW 200 E Vertical Plankton Winch, 1,650m x 6.35mm conductor cable
- 1 x Rapp Hydema DSW-4006 E Deep-water Coring Winch, 5,000m x 14mm SWR
- 1 x Rapp Hydema HW 500 E Plankton Towing Winch, 2,500 x 11.73mm SWR
- 1 x Rapp Hydema HW 500 E General Purpose Towing Winch, 2,500m x 12mm SWR
- 1 x Rapp Hydema HW 500 E Undulating Vehicle Winch, 760m x 8.41mm SWR (100m faired)
- 1 x Rapp Hydema CF 600 E General Purpose Capstan, 3.0T @ 12m/min

LABORATORIES
- Meteorological laboratory
- Operations Room
- Underway Sampling Laboratory
- Wet Biological Laboratory
- Dry Biological Laboratory
- Wet Geological Laboratory
- Liquid Scintillation Counter Laboratory
- General Chemistry Laboratory.
- Provision made for 6 “Own-User” Container Laboratories on deck aft.

SCIENTIFIC WORKING AREAS
Helicopter flight deck and hangar, when available
Enclosed poop deck space of 400m² with a 50m² wooden working deck served by a hydraulic A-frame with 6 loading points and a vertical sliding stern gate.
Also on the after deck is a 4T SWL Deep Corer Davit by Triplex, with a 1T SWL Deep Corer handling Frame attached.
The Environmental Hangar boasts a Triplex A-Frame for CTD deployment, with a SWL of 7T

ON BOARD SCIENTIFIC SYSTEMS

A Network Data System acquires data from selected navigational, meteorological and scientific instrumentation. The data is sent to a dedicated server once per second and mean values logged once per minute. The real time data is transmitted continuously over the LAN and the logged data is made available in a shared folder on the network.

- Seabird 911 CTD and Rosette Sampling System
- Seabird S38 Remote Temperature Probe
- Seabird SBE 45 Thermosalinograph and De-Bubbler
- Kongsberg Topaz P18 Sub-bottom Profiler
- A Moon Pool, dimensions 2.4 x 2.4m, for CTD deployment in ice covered waters

A Drop Keel, extending to a depth of 3.0m, containing:

- Scientific Echo Sounder, Simrad EK 60, 38/120/200kHz
- Scientific Deep Water Echo Sounder, Simrad EA 600
- Acoustic Doppler Current Profiler, RDI Instruments Ocean Surveyor II, 75kHz

HABITABILITY

All officers and crew are housed in single quarters. Vessel is air conditioned as well as heated for Antarctic conditions.

Passenger accommodation:

- 2 VIP suites
- 16 single berth cabins,
- 15 two berth cabins
- 13 four berth cabins
- Upper and lower passenger lounges
- Library
- Live TV, via satellite, streamed to all cabins
- Full laundry facilities
- Fresh water capacity is 290T supplemented by a 28T/day fresh water generation capability when at sea
- Hospital with surgery facilities
- Doctor normally carried
- Small gymnasium, with sauna, shower and change room facilities
- Baggage Room

CARGO CAPACITIES AND CARGO HANDLING EQUIPMENT

Three cargo hatches, all with tween deck and lower hold.

Total dry cargo capacity:

Bale	3801m³
Grain	4602m³
Refrigerated space	79.4m³
Cargo oil capacity	510m³/408T

1 x TTS 35T @ 27.5m at 17m knuckle boom cargo crane on forecastle head
2 x TTS 10T @ 10m knuckle boom cargo cranes forward
1 x TTS 5T @ 18m knuckle boom stores crane aft
Two large 10m inflatable rafts with a working capacity of 15T per paired rafts
One 2 ton Electric Forklift Truck.

African Marine Solutions Group (Pty) Ltd
31 Carlisle Street, Paarden Eiland, 7405
P.O. Box 1339, Cape Town, 8000
+27 21 507 5777 amsol@amsol.co.za
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HELICOPTER SUPPORT AND FACILITIES

Enclosed hangar facilities for two PUMA size helicopters
Manual sprinkler system for hangar
113T JetA1 bunker capacity
Helicopters fitted with flotation gear, winches and cargo slings
Long range tanks available
Skid fittings
Radar and GPS receivers fitted

Radios:

- 1 HF SSB transceiver
- 2 VHF (AM) aeronautical transceiver, and
- 1 VHF (FM) marine band transceiver

OTHER FEATURES

Roll damping tank
Ice breaking heeling tank/pump system
Closed circuit television available to points around the ship
2 x 200hp 10 man SOLAS Fast Rescue Craft
1 x 230hp Weedo 710 Tug/Workboat, Bollard Pull 2.2T
1 x 40hp 4 man inflatable dinghy for inshore scientific work
CO2 flooding system for machinery spaces and cargo holds
Automatic water sprinkler system for accommodation spaces
Inert gas system for JetA1 pump room/tank space
Foam monitor cannons for flight deck and cargo deck helicopter operations
Remote control fire retarding doors for accommodation space
Cross flooding system for damage stability
CATHELCO impressed current, cathodic protection, system

UPDATED AS AT 1 DECEMBER 2016

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A1 - RESEARCH PROJECT WITHIN THE "SAYA DE MALHA BANK" JMA, AN AREA JOINTLY MANAGED BY SEYCHELLES AND MAURITIUS, AS PART OF THE "INDIAN OCEAN 2022" EXPEDITION OF MONACO EXPLORATIONS

Revised December 2021

1. Project leader and entity responsible for the project

Dr Francis MARSAC, IRD, UMR MARBEC, with the support of Mr Kenneth RACOMBO, Principal Secretary, Department of the Blue Economy, Seychelles.

2. Communication officer

Dr Francis MARSAC, in liaison with Anne-Claire JUCOBIN, Director of Communication and Information Sharing, IRD.

3. Outreach officer

Dr Francis MARSAC, in connection with Caroline VILATTE, Head of Public Outreach, IRD.

4. Background and scientific objectives of the project

Physical, oceanographic and biological background

Saya de Malha (59°E-63°E / 8°S-12°S) is the most northern submarine bank of the Mascarene Ridge. It is also one of the largest submerged banks in the world (40,000 km²) with a surface area equivalent to Switzerland. It is composed of two distinct structures, the small Ritchie Bank to the north, separated from the immense South Bank by a channel 30-50 km wide. The Mascarene Ridge extends over 2000 km between Seychelles and Mauritius (Fig. 1). Its origin is volcanic (65 million years for Saya de Malha, 35 My for Nazareth). It results from the subsidence of a chain of volcanic islands associated with the hot spot of Reunion Island, which emerged for a few tens of My. A thick (1,500 m) sedimentary layer (carbonates) covers the banks of the Mascarene Plateau. Some places of Saya de Malha outcrop less than 10 m from the surface and the depth is less than 50 m on the sectors located at the eastern periphery of the bank (Fig. 1). Depths generally remain less than 200 m in the central part of the Bank but soundings indicated on available nautical charts remain imprecise. It is possible that a depression of 300 to 400 m exists in the centre of the Bank.

Forming a barrier 3 km high against the south-equatorial current flowing westward, the Mascarene Ridge plays a major role in the oceanography of the region. The shallow shelves create disturbances in the ocean circulation, with important implications for biological productivity. New et al (2013), jointly analysing SAR (radar) and water colour (MODIS) satellite data, have shown the generation of solitary internal waves on the Saya de Malha Bank and a biological enrichment resulting from these waves on the shallower areas of the bank. While the waters surrounding the southern tropical gyre are oligotrophic (Longhurst, 1998), the banks are, on the contrary, areas of high biological productivity. Current knowledge holds that Saya de Malha may support the largest contiguous phanerogam meadow in the world with 80 to 90% of shallow bottoms being covered by seagrasses dominated almost exclusively by *Thalassodendron ciliatum* (Burnett et al. 2001) from depths up to 40 m.

The disturbances (eddies, upwelling) created on the slopes of Saya de Malha generate biological enrichment. These sectors are heavily visited by shearwaters nesting in Seychelles (Catry et al, 2009) and by the pygmy blue whale (*Balaenoptera musculus brevicauda*) for breeding and feeding (Branch et al, 2007).

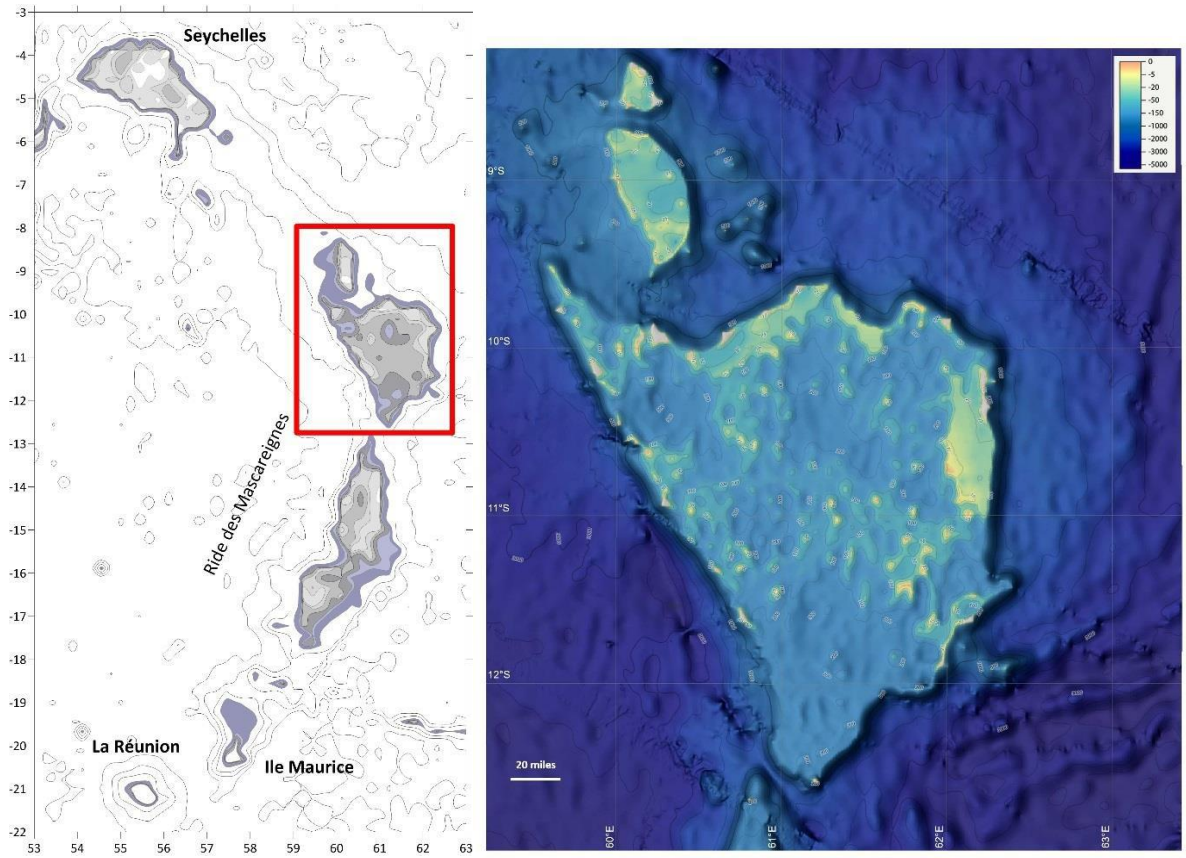

Fig.1 - Bathymetry of the Mascarene Ridge, from Reunion Island to Seychelles (left) and the Saya de Malha Bank (right), located in the red frame of the general map. Source: ETOPO1 Global Relief Model and GEBCO.

Governance issues

Beyond its biogeographical and scientific interest, Saya de Malha has a special status in terms of governance. Following a joint request by Seychelles and Mauritius to the Commission on the Limits of the Continental Shelf for the extension of their continental shelf, these two countries of the region obtained in 2011 the shared sovereignty of Saya de Malha granting them rights to exploit sedentary living resources (bottom dwelling) and mineral resources of the soil (metals) and subsoil (oil, gas). It is the only Joint Management Area (JMA) in the Indian Ocean and **a specific case study selected by the UNDP SAPPHIRE project** (2017-2023). The aim is to demonstrate the benefits of an innovative mechanism for ocean governance and compliance with good practices in order to draw lessons learned, improve the existing mechanism and guide similar initiatives that could be launched in other regions of the world. The objective is to build management capacity through marine spatial planning of the Saya de Malha JMA. SAPPHIRE has identified significant gaps in the knowledge needed to achieve this objective; this project aims to fill some of these gaps.

Potential activities in the joint area are closely linked to the Blue Economy initiatives of both countries, where the development of income-generating activities in the JMA is expected to cause a minimal impact on the ecosystem. The characterisation of the most fragile and vulnerable areas of critical habitats is a prerequisite for any maritime planning of future activities and this is the purpose of this project.

Expected Outputs

This project is designed with a goal of "Science for Marine Governance and Planning Support". The expected products are as follows:

- Collection of scientific information on still poorly known areas of the marine environment on the shallow areas of the Saya de Malha Bank and its slopes;
- Realization of an inventory of the benthic biodiversity, assessment of its specificities, in order to map the essential and sensitive habitats that could require, if necessary, specific conservation measures;
- Scientific promotion in international journals;
- Fact sheets on the habitats and communities of the Saya de Malha Bank;
- Concise policy brief for institutional stakeholders and policy makers in Seychelles and Mauritius.

These products address the "Coral Protection" and "Marine Protected Areas" themes of Monaco Explorations.

5. Partner and scientific entities directly involved in the project

At this stage of preparation of the project, a provisional list of participating institutions can be drawn up (pending confirmations are indicated by "TBC") as well as an estimate of the staff numbers concerned:

- Seychelles: University of Seychelles (Blue Economy Research Institute), Seychelles National Parks Authority, Ministry of Environment, Energy and Climate Change (TBC), Department of the Blue Economy (TBC), others (TBC) – at the moment, four scientists and two students;
- Mauritius: Albion Fisheries Research Centre (TBC), Mauritius Oceanography Institute (TBC), University of Mauritius (TBC), Ministry of Blue Economy, Marine Resources, Fisheries and Shipping (TBC) – a team of 12 people including students;
- France: Research Institute for sustainable Development (IRD), National Museum of Natural History (MNHN), National Research Scientific Centre (CNRS) - a team of 12 scientists, one law of the sea expert and one fishing master;
- South Africa: Ocean Science Campus, Nelson Mandela University, Port Elizabeth - two scientists;
- Five other scientists from various institutions: University of Lodz (Poland), National Taiwan University (Taiwan), Red Sea Research Centre (Saudi Arabia), Swedish Museum of Natural History (Sweden), Severtzov Institute of ecology and evolution (Russia).

In addition to this team, five specialists from Ifremer will be onboard to operate the various echosounders (including the multibeam echo sounders) and acquire bathymetric data all along the path of the Indian Ocean 2021 Expedition. The data collected on the Saya de Malha Bank and its slopes will be integrated into the project's products.

6. Details of the operations to be carried out and means required

Given the large size of the study area and the duration of operations limited to 15 days, it was necessary to define privileged sectors (according to depths and probable facies) on the Bank and along the slopes. We propose to deploy our efforts in 5 sectors, as shown in Fig. 2.

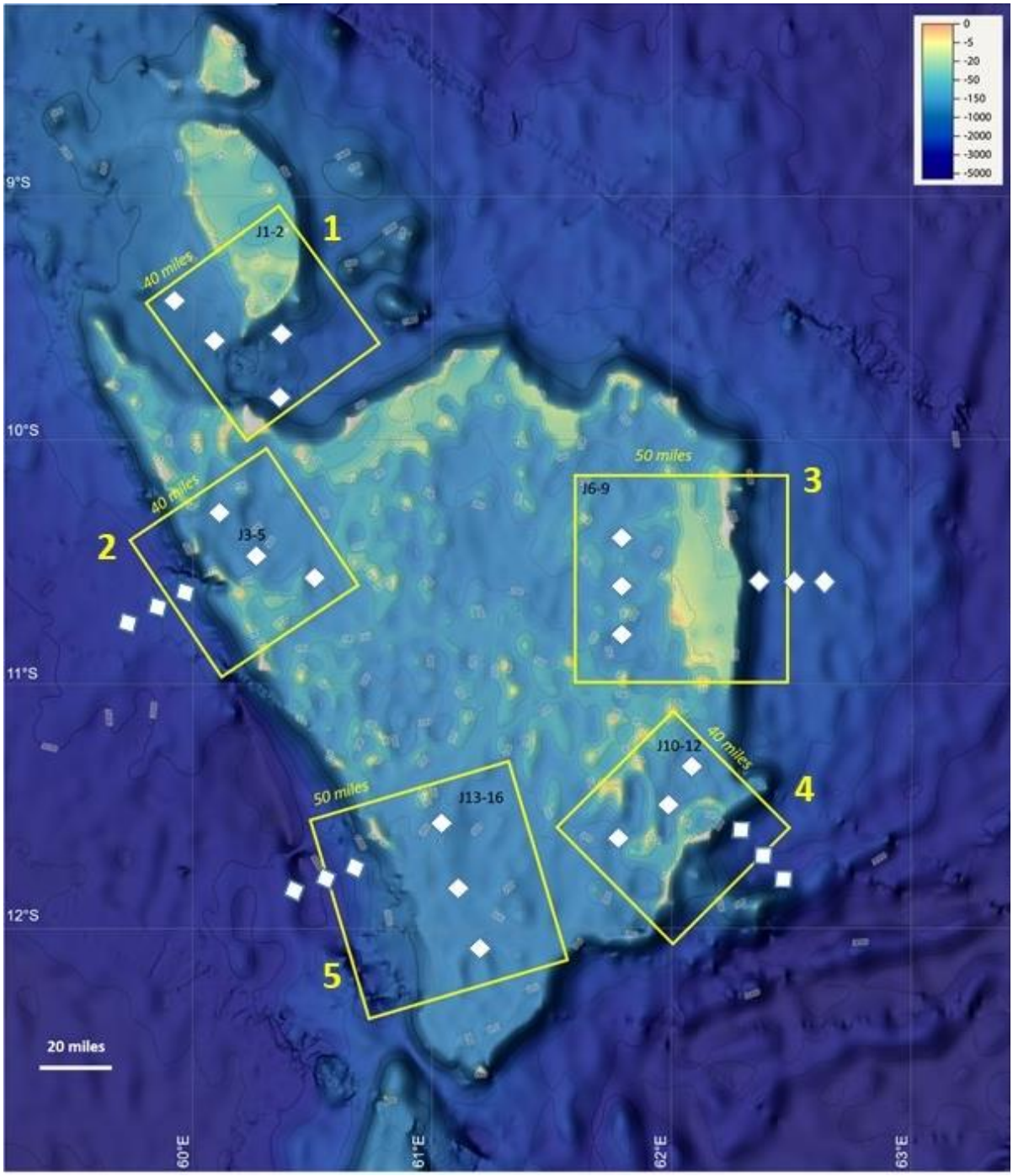

Fig. 2 - Delimitation of the five survey sectors, numbered chronologically from 1 to 5 around the Saya de Malha Bench. The Jx-x codes indicate the days of the project intended in each sector (e.g. J6-9: days 6 to 9 of the project). Fixed stations (hydrology and zooplankton) are indicated by white diamonds.

In addition, knowledge inputs from recent campaigns on Saya de Malha (see Annex 1) were consulted in order to avoid duplication of efforts and to focus on current gaps. We have identified the benthic compartment as the most poorly known and requiring special attention to inform JMA management policies. However, it seems that it is essential to combine this with complementary measures on the physical, biogeochemical and biological (zooplankton) environment of the water column.

The on-board work programme is divided into four scientific activities and a cross-cutting training/capacity building activity.

6.1 Nature of the operation

6.1.1 Three-dimensional mapping of the Saya de Malha Bank and characterization of the nature of the seabed

The existing cartography (British charts from the UK Hydrographic Office maps and French charts from SHOM) remains imprecise. However, two campaigns conducted by research vessels with multibeam sounders have been undertaken on Saya de Malha over the last 3 years. Firstly, a campaign by RV *Dr Fridtjof Nansen* (7-26 May 2018; Bergstad et al 2018) which provided exhaustive coverage of the Grand Bank in the form of east-west transect lines separated by 20 nautical miles; then a campaign by RV *Sonne* (24 Sept-18 Oct 2019; Lindhorst, 2019) on the central and southern area of the Bank. The areas prospected during these two surveys are presented in Annex 1. It would be very useful to have these three-dimensional bathymetric data available prior to the survey in order to better prepare the dive sites and identify the most suitable areas for the deployment of towed collection gear. Access to data from these surveys is governed by a Memorandum of Understanding (MoU) with Seychelles and Mauritius. It seems therefore conceivable to be able to obtain these data once the scientific programme of the cruise has been accepted by the Joint Commission of the JMA. The acquisition of bottom topography by multibeam echosounders is planned for the entire Indian Ocean 2021 Expedition and will therefore include the Saya de Malha Bank. On Saya de Malha, the 110 kHz shallow water multibeam echosounder (EM710) will be used. It is also necessary to acquire information on the nature of the seabed.

6.1.2 Study of the properties of the water column and circulation on the bank and slopes of Saya de Malha

The biophysical features already mentioned show the role of the topography of the banks on ocean circulation and the disturbances observed at local scales. Retention cells, eddies and upwelling of nutrient-rich water occur around the perimeter of the bank, especially under the current (western slope). These horizontal and vertical movements can support hotspots of pelagic production used by migratory species, but also hotspots of benthic fauna. Physical and biogeochemical measurements will be carried out using the following instruments:

- Continuous surface temperature and salinity using the thermosalinograph installed on board *S.A. Agulhas II*;
- The vertical structure of the current during the vessel's movements using the ADCP, installed on board the *S.A. Agulhas II*;
- Vertical temperature profiles using XBT expandable probes at the Bank's edge;
- Vertical profiles of temperature, salinity, dissolved oxygen and fluorimetry at hydrological stations, with a CTD probe in shallow water and outside the plateau, between 0 and 750 m, with simultaneous sampling of water at different depths with 6-8 litre Niskin bottles for the measurement of nutrients (dosing) and chlorophyll pigments (filtration);
- Measurements of pH and total alkalinity of the water collected from the bottles using a titrator and a spectrophotometer;
- In the event that surface drifting floats (SVP: Surface Velocity Profiler; GDP international program: Global Drifter Program) are made available by other teams within the framework of GOOS international program (Global Ocean Observing System), we will release these floats at different positions east of the Saya de Malha Bank to investigate the influence of topography on the circulation of the South Equatorial Current (SEC), and on the Bank to study the surface circulation;
- BGC-Argo floats that could potentially be launched by the B5 project of the Indian Ocean

2021 Expedition in the Saya de Malha area.

The fixed stations will be of two types: i) shallow water stations, on the Bank (depths > 50 m): ii) deep water stations (layer 0-750 m). In Sectors 2 to 5, there will be 3 shallow water stations and 3 deep water stations. The latter will be arranged along seaward tracks from the edge and spaced 10 miles apart (see Fig. 2). Sector 1 is too shallow for shallow water stations. On the other hand, 4 deep-sea stations will be set up in the channel between the Richie Bank and the Saya de Malha Bank where the South Equatorial Current flows in from the east. The total number of fixed stations envisaged during the project will therefore be at least 28. Depending on the time available, additional stations could be set up.

In parallel with the in-situ measurements, satellite measurements of surface temperature, surface chlorophyll concentration and sea surface height (altimetry) will be monitored in near-real time with the support of a shore team. This high spatial resolution information (1 to 9 km for SST and Chl; 25 km for altimetry) will make it possible to precisely orient the preferred locations to be explored in each sector. Continuous measurements of TRIOS-type optical sensors attached to the bow of the ship could also provide useful information for local calibration of satellite water colour data (as part of a planned collaboration with the team of H. Claustre, B5 project, from the Villefranche Oceanography Laboratory).

6.1.3 Sampling of plankton, neuston and suspended microplastics

Phytoplankton: Measurements of chlorophyll (a proxy for phytoplankton abundance) will be made from filtrations of water samples collected with the bottles. We will also measure the different size fractions of phytoplankton that provide information on water productivity (oligotrophy with small cells, upwelling enrichments with large cells such as diatoms).

Zooplankton*:* Zooplankton in the water column will be sampled at hydrological stations. This will include:

- A vertical profile of zooplankton abundance using an Underwater Vision Profiler (UVP);
- A vertical backscatter profile of zooplankton and fish using an Acoustic Zooplankton Fish Profiler (AZFP);
- Collection of zooplankton using oblique tows of 200 µm Bongo nets, between 0 and 200 m depth (maximum). The Bongo will be towed for 20 minutes at a speed of 1.5 to 2 knots;
- Collection of zooplankton using a multiple plankton sampler "Multinet" (Hydrobios). Subject to meteorological conditions and deployment capabilities on board the ship, this net could be used in addition (or replacement) of the Bongo.

Neuston: The neuston present on the sea surface will be collected using a Manta net (mesh size 300 µm) towed at a speed of around 1 knot, depending on the sea state.

Microplastics: Abiotic particles (microplastics) suspended in the surface layer will also be collected using the Manta net and sorted under a binocular magnifying glass.

Other possible measurements*:* If the equipment is operational on board, water filtration will also be carried out to collect environmental DNA, which will complement the measurements carried out in other areas sampled by *S.A. Agulhas II* during the Indian Ocean 2021 Expedition.

6.1.4 Inventory of the benthic biodiversity

Age, isolation, surface area: all these elements support the hypothesis that Saya de Malha would be an important centre of speciation and endemism of marine fauna and flora in the Indian Ocean. And yet, our knowledge of the fauna of the Mascarene Plateau in general, and of Saya de Malha in

particular, is limited. Only about thirty publications describing new taxa, i.e. about 50 marine species have been dedicated to this geographical area (mainly fish, molluscs and a few species of crustaceans - see bibliographical list). This is the state of our knowledge of a tropical shoal the size of Switzerland. Knowledge of the natural environment is a prerequisite for identifying the issues involved in its management and protection. The inventory, which will be implemented within the framework of the Saya de Malha project, aims to enrich our knowledge of biodiversity and to discover unknown species.

It is essential to decipher the complex assemblage of benthic communities of Saya de Malha in order to be able to delimit biodiversity hotspots to be protected in case extractive activities are implemented in the future. The expected high richness of habitats on the bank and the high degree of specialisation of organisms require the use of specific sampling methods. The objective of the inventory expedition is to aim for exhaustiveness within the targeted taxonomic groups (algae, scleractinian corals, molluscs, crustaceans, echinoderms, ascidians, fish) by integrating a wide range of sizes for all these taxa, with a particular focus on small species (of the order of mm) for molluscs, crustaceans and algae. These taxa, which are often small in size, have a high potential for diversity and are taxonomically challenging, are however in reality the most important contributors to the diversity and richness of marine habitats. It is through an original and naturalistic angle based on the description of these taxa often considered neglected in conservation policies, as opposed to "flagship" species (i.e. corals, teleost fish), that the data acquired during the expedition will enable us to meet management objectives for this ecological heritage.

Sampling will be carried out using two complementary approaches: diving and towed gear. The different methods are detailed in Annex 2. These are low environmental impact operations (see paragraph 7). Sampling (diving from 0 to 50 m and towed gear between 50-1,000 m) will be maximized on the selected sectors in order to optimize all types of habitats: soft bottoms, rocky bottoms, phanerogam meadows, calcareous algae beds, bioconstructive and non-bioconstructive coral communities.

Divers will operate from a small motorized boat (semi-rigid) which will remain under close surveillance throughout the dives. If sea conditions permit, two dives per day will be conducted.

Beyond fundamental scientific questions (evolution, magnitude and richness of marine biodiversity, macro-ecology and discovery of unknown species), taxonomic data (georeferenced occurrences of species) but also data on habitats will be intended for stakeholders in the conservation of marine areas in Seychelles and Mauritius and will be used in policies related to the management of economic development activities by these two countries.

The comparison with the assessment by "Shoals of Capricorn" (1998-2001) (Burnett et al., 2001) will be a valuable piece of information on the trajectory of the biodiversity in the face of the combined impacts of fishing, global warming and ocean acidification. A link could be made with Ifremer's Seatizen project, which is developing protocols for collecting data on marine biodiversity using participatory science and low-cost sensors (underwater cameras, underwater drones) with high-accuracy georeferencing (centimetre accuracy RTK) as planned in the B4 project of the Indian Ocean 2021 Expedition. This would make it possible, in the medium term, to support the implementation of reference inventories on marine biodiversity in isolated sites, by guaranteeing the capacity to replicate a posteriori observations at the same positions and to carry out mapping and 3D modelling (photogrammetry).

The Saya de Malha seabed was fished intensively and unreasonably for three years (2015-2017) by 61 Thai trawlers (Panjarat and Boonsripum, 2018). Trawl dragging on the bottom has most likely damaged some of the seagrass beds, corals and sponges, which are fixed to the substrate and are habitats for emblematic and endangered species (e.g. sea turtles). In order to measure the extent of the degradation caused by these three years of exploitation, the results of the "Shoals of Capricorn"

expedition can be used as a reference. An ROV towed along transect lines will be the preferred vehicle to carry out this survey, in addition to the observations of the divers.

6.1.5 Training of students and junior scientists from Mauritius and Seychelles on project operations

Capacity building and training are major challenges in the region, especially when it comes to integrating information from different disciplines to support a holistic approach to marine spatial planning. The diversity of activities that will take place during the project will provide unique opportunities for training and skills development for students from the University of Seychelles and the University of Mauritius, as well as for young technicians and researchers from marine institutions in both countries.

The trainees will participate in sample conditioning operations, various analyses carried out on board (filtration), and the initial sorting of benthos harvests. It is also planned to propose mini research projects to BSc and Master's level students on board, which will begin with the collection of samples on board and continue ashore with analysis and the writing of dissertations. It is worth noting that Seychelles SeyCCAT project (Seychelles Climate Change Adaptation Trust https://seyccat.org/) offers scholarships to Seychelles students to complete their training in foreign universities and research teams. It would therefore be conceivable that the post-project work could be carried out in the project partner institutions if expertise or equipment were missing in Seychelles. It is very likely that similar arrangements exist in Mauritius.

It is also envisaged to organize thematic mini conferences on board *S.A. Agulhas II*, during the project, thanks to the presence of experts from the different disciplines represented.

6.2 Total duration of the project

The duration of the project should not be less than 2 weeks in order to cover all the announced objectives. It is obvious that an additional 3 or 4 days would be welcome, should the schedule of the Indian Ocean 2021 Expedition allow it.

6.3 Implementation conditions

- Seabed topography: this activity is planned on a continuous basis, 24 hours a day, as the vessel moves, with rotations of dedicated scientific staff;

- Hydrology: the fixed hydrological stations, in shallow and deep water, will take place at night to optimize the time at sea. The acquisition of surface parameters while the vessel is underway, is carried out automatically, 24 hours a day;

- Zooplankton sampling: this will be carried out in association with the fixed hydrological stations using profilers (UVP and AZFP) and by oblique Bongo tows between 0 and 200 m after each hydrological station. Carrying out zooplankton measurements at night will have the advantage of collecting a greater number of organisms from resident and migrating fauna (with a high proportion of large organisms). As time permits, UVP/AZFP profiles and daytime Bongo collections will also be carried out in shallow water (only) to compare abundances as a function of the day/night cycle;

- Benthic biodiversity inventory: dives will be carried out in calm sea conditions. They will only be conducted in daytime. On the other hand, operations using towed sampling gear (sled, dredge, trawl) may be carried out during in daytime or at night.

6.4 Vessel situation

The operations conducted on the Saya de Malha Bank will be done either underway (transits between study sectors, video ROV transects within sectors), at stations (a minimum of 28 fixed stations – devoted to hydrology and zooplankton sampling - distributed in the 5 sectors) or in fixed positioning (without anchorage) during the dives.

6.5 Resources deployed

Equipment of S.A. Agulhas II

- Simrad EA 600 Deep Sea Single Beam Echo Sounder
- Kongsberg TOPAS PS18 Parametric Sub-bottom Profiler
- RDI Instruments Ocean Surveyor II ADCP, 75kHz (current measurements)
- Thermosalinograph SBE45 with SBE38 remote temperature sensor
- ROV (supplied through AMSOL or through REV Ocean)
- CTD SeaBird SBE911+ underwater unit with a 24 x 12 litre SBE32 Carousel
- Light motorized launch (semi-rigid) for dives and deployments
- In the event that Monaco Exploration could provide a portable multibeam echosounder, it would be possible to survey the shallower areas with the launch
- -20°C and -80°C freezers (if available)
- 60°C drying oven (if available)

Project-specific resources (the providers of the resources are indicated in brackets)

- Drifting buoys equipped with a positioning system (if made available as part of the international GDP programme)
- XBT hand launcher
- XBT probes (in connection with the CORIOLIS service)
- Total alkalinity titrator (University of Seychelles)
- Spectrophotometer for pH measurement (University of Seychelles)
- Filter bar and pumps for the measurement of fractional chlorophyll (NMU)
- Fluorometer for measuring chlorophyll-a (NMU)
- -80°C freezer (if not available on board) or liquid nitrogen (for chlorophyll/HPLC filters)
- 60°C drying oven for pasteurization of nutrient samples (if not available on board)
- Oxygen titrator (for calibration of CTD sensors)
- Salinometer (for calibration of CTD sensors)
- Bongo plankton nets with depressor (NMU)
- Manta neuston net (Aix-Marseille University, UMR MOI)
- Zooplankton profiler UVP (NMU)
- If available, AZFP zooplankton and fish acoustic profiler (LEMAR Brest)
- Binocular loupes (MNHN)
- MACER-Giroq suprabenthic sled (INSU)
- Beam trawl and Warén dredge (MNHN)
- Photo stand (MNHN)
- Diving equipment: tanks, compressors, oxygen, underwater sucker, brush basket, oxygen therapy kit (MNHN)
- Containerized decompression chamber (to be provided for the expedition by Monaco Explorations).

6.6 Constraints and possible risks related to the storage or implementation of the project's own resources

On-board testing requires the carriage of chemicals that are classified as hazardous and therefore need

to be handled and stored with care. These are mercuric chloride, acetone, glutaraldehyde, 40% formaldehyde, 96° ethanol (600 l, mainly for benthos), borate, sulphuric acid, thiosulphate (+ Winkler reagents: hydrochloric acid and soda), and liquid nitrogen (dry shipper) for chlorophyll filter conservation if there is no -80°C on board.

This list is provisional. It depends on what will be feasible and available on board. The regulatory safety data sheets will be provided by the scientific team before the expedition.

6.7 Diving operations

Diving operations will be conducted from a semi-rigid launch equipped with a depth sounder and a GPS that ensures the launching and recovery of divers and equipment as well as surface safety during the dives. The dives will explore the area from the surface to 50 m deep. Total dive time (working time + decompression) will be limited to 2 hours with a maximum of 2 dives per day. The underwater sucker will be activated autonomously through tanks embarked for this purpose by the divers. Underwater suckers, brush and collection baskets are sent from the bottom to the surface by means of parachute lifts and must be recovered by the surface surveillance team. These sampling techniques will allow the harvesting of small (< 1cm) fauna that constitutes the bulk of biodiversity. Larger fauna and flora will be collected on sight. All harvests will be kept refrigerated before being sorted on board. It will be essential to have a containerised decompression chamber on board to guarantee the safety of divers in the event of a decompression accident.

7. Potential risks of environmental impact and risk control measures

The project will use environmentally friendly methods of investigation. None of the emblematic marine species (sharks, dugong, cetaceans, turtles, seabirds) are objects of study for the project, and the risk of capture or injury by accident is extremely low. The aim is to document the benthic fauna and flora using well-established methods and to carry out qualitative rather than quantitative sampling of benthic diversity. In this approach, all collected taxa are equally important for estimating biodiversity and therefore all harvested organisms are as far as possible preserved for inclusion in collections and will subsequently be studied by taxonomic experts. This strategy also aims to minimise the environmental impact of the operations carried out by maximising the value of all the samples collected.

Diving sampling: The habitats to be sampled include all types of bottom, from mud, sand, seagrass beds to coral debris and drop offs, with live coral reefs being only one of the habitat types to be studied between 50 m deep and the surface.

The impact of the proposed research can be estimated at the species and habitat level. In terms of species, **most of the animals sampled will be benthic invertebrates** (crustaceans, molluscs) less than 20 mm and flora (algae and phanerogams). Unlike commercial fisheries where fish is the target and invertebrates are the bycatch, here invertebrates and algae are the primary targets, and fish will only be considered as bycatch. This means that, as far as possible, **all specimens that are collected will be retained and nothing will be thrown back into the sea**. Within the framework of biological conservation, we will thus maximise the profitability of each station and avoid unnecessarily multiplying samples. The only fish specifically targeted will be small, cryptic, non-commercial species. The only corals sampled will be solitary species and non-constructive corals (ahermatypic corals), and fragments of colonies of species present on the reefs (hermatypic corals) will be selected, in the case of taxonomically difficult or cryptic species. In the case of large shellfish (e.g. newts, helmets, tiger cowries) and large crustaceans (e.g. lobsters, crayfish), a maximum of 5-10 specimens per species will be collected. In terms of habitats, samples of soft bottoms will be taken using underwater suckers with a sampling area of approximately 1 m^2 per collection station. On hard bottoms, we will use “baskets” to brush coral and other rocky debris to collect small invertebrates. These will be operated by divers over an area of 2 m^2 each.

Sampling by towed gear: at depths between 50-1,000 m, different "scientific fishing" gear will be used. The gears include the Warén dredge, beam trawl and suprabenthic sled (see Annex 2). These gears will be deployed from the vessel and their mechanical impact is extremely limited. **Each collection station is sampled only once**, even if the operation is moderately successful, in order to limit the impact on the deep environment.

The suprabenthic sled is a device that slides on the bottom using skis-like skids that allows sampling the small vagile fauna living in the suprabenthic compartment (between 0-1.5 m above the bottom). This biological component is mainly represented by small crustaceans (of the order of mm) belonging to the group of Peracarids (*Super Order Peracarida*) and including different orders such as Amphipods, Isopods, Cumaceae, Lophogastrida, Mysidaceae and Tanaidaceae. This sled is dragged on 1 nautical mile across the bottom.

The beam trawl, suitable for scientific research, is a small trawl 4 m wide, towed over 1 to 2 nautical miles, over soft substrates. This gear is quite different from the 40-metre otter trawls used by commercial fishing vessels, towed over about 10 to 20 miles. Thus, approximately 150 scientific beam trawl hauls would be required to cover an area comparable to a single commercial trawl haul. The Warén dredge is a small dredge with an 80 cm opening but heavy enough (100 kg) to allow sampling of hard substrates (small boulders, gravel). It is deployed in the same manner as the beam trawl, over 1 nautical mile but on slopes inaccessible to other gear.

The impact of each gear deployment is low, ranging from 0.002 to 0.01 km^2. The impact of these operations on the deep environment is therefore minimal compared to the value of the qualitative information provided on the deep environment. We estimate that the impacted area on the bottom resulting from the collections throughout the whole Bank will be much less than 1 km^2. It is useful to recall that the total surface area of the Saya de Malha Bank is 40,000 km^2.

Important note: distinction between Observing and Describing.

One could have the temptation to restrict the survey to ROV observations in order to avoid any detrimental interaction with the ecosystem. However, this type of sampling is largely insufficient. While it allows observing the benthic habitats, it does not allow describing them. After a decade of underwater photographs and videos, scientists have pointed out the limitations of the purely visual approach. In the Pacific Ocean, Kennedy et al. (2019) could not fully identify more than 20% of the visualized organisms. This renders ROV surveys unable to perform reliable biodiversity inventories. As **describing** the benthic biodiversity is a key objective of this cruise, an adequate and comprehensive sampling is required, by means of diving and towed gears or dredges.

8. Arrangements and time required for the exploitation of the work carried out on board

The bathymetric, acoustic (fish) and video surveys will produce preliminary results at the end of the project. These data will, of course, need to be filtered and consolidated in the laboratory to produce results that can be published and used for spatial planning by the two JMA countries. A period of 6 months to 1 year after the project (depending on the data) seems realistic to achieve this. Detailed taxonomic identifications could take somewhat longer, but characterization by major taxonomic groups is likely to be possible within 6 months after the cruise and will be provided first to the authorities of Seychelles and Mauritius.

Concerning the inventory of benthic biodiversity (see details of the workflow in Annex 3), the completion of all taxonomic identifications will take a long time (2 to 5 years depending on the taxa). However, at the end of the project, the first biodiversity estimates are expected to be established, high potential areas will also be discriminated and made available to Seychelles and Mauritius.

The data produced on board will be based on (i) a **set of specimens** sorted and preserved by large zoological and georeferenced groups (ii) **underwater photos** to document habitats (iii) the production of **unique photos of freshly collected organisms** to document colour patterns but also to assist in the taxonomic identification of specimens. (iv) **tissue samples** for rapid integration into molecular systematics studies. According to the workflow of MNHN collections and with the support of the network of taxonomists around the material from expeditions, one year after the project, all the material will be identified by family and/or genus and broken down among the taxonomic experts. The data will be accessible via MNHN databases (BasExp, INVMAR). The production of molecular data will allow the first results in phylogeny and molecular systematics. The traceability of all these data will be ensured by our research group in liaison with the team of managers of the MNHN marine invertebrate collection.

A reference collection will be handed over to Seychelles and Mauritius, including emblematic specimens and batches representative of the diversity of the area. The commitments of the scientific team with regard to the study of biological material are detailed in section 4 of Annex 3.

With regard to water column observations, the raw hydrological data will be delivered to the two JMA countries at the end of the project and then, within 6 months, the associated calibrated data. Chemical oceanographic data could take 9 to 12 months, depending on the workload of the laboratory conducting the analyses. Plankton and neuston samples, microplastic data and video sequences of benthic transects and fish could be analyzed in Seychelles and Mauritius, as part of mini research internships for students supervised by discipline specialists who participate in the expedition.

9. Association with the actors of the region

The regional partnership will operate at the level of training, communication and dissemination of scientific knowledge. The IRD thus proposes to participate in the dissemination of scientific knowledge engaged upstream and downstream of the project over the period 2020-2023 in the framework of the DiDEM programme (see below), in particular in a science-decision-makers exchange.

In Seychelles, thanks to the support of Monaco Explorations, activities to disseminate knowledge to civil society, associated with the C. component of DiDEM, could be initiated as early as 2020. This concerns two initial activities related to young people (environmental education with the PAREO approach) and the private sector ("The Future of Blue Economy" programme to support the emergence of multi-actor innovation projects associating research, entrepreneurship, associations). These actions conducted jointly with the Department of the Blue Economy of Seychelles will thus make it possible to consolidate a local network around the science-society dialogue, to better understand the state of diffusion of knowledge related to the marine environment among civil society actors on the spot, and will be the subject of communication initiatives towards various local and international media.

In a second phase, in parallel with the project and in the months that will follow, capacity-building activities (thematic schools, training workshops) will be offered to the scientific, decision-maker and management communities of the region, in coordination with the Science to Policy dialogue and exchange platform of the Secretariat of the Nairobi Convention and the programmes led by UNDP (SAPPHIRE) and UNEP (WIO-SAP). These schools and workshops will provide an opportunity for direct use of the scientific knowledge acquired during the project in order to feed the Science-Policy dialogue in the region. The support provided by Monaco Explorations to the DiDEM programme will enable it to directly implement its activities in Seychelles and to mobilize the technical coordination and the scientific networks of the programme at the regional scale.

The "Science-Decision Makers Dialogue for Integrated Management of the Coastal and Marine Environment of the Indian Ocean – DiDEM" programme.

A programme coordinated by IRD with the support of the French Global Environment Facility (FFEM) and various international public (UNEP, UNDP, ICDR, INTERREG) and private (including Monaco Explorations) donors, DiDEM

brings together in an interdisciplinary approach several regional scientific networks around 3 workshop zones, Deltas and Estuaries, Islands and Archipelagos, High Sea and Deep Sea - in order to promote the dissemination of scientific knowledge on the management of coastal and marine environments.

DiDEM is a programme planned for three years starting in July 2020 and including seven countries (Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles and Tanzania) and structured into three main components: A. Deployment of innovative tools and methodologies for the benefit of decision-makers in the Indian Ocean, from local to regional; B. Capacity building of scientific and management communities through thematic schools and training workshops; C. Inclusion of civil society through the implementation of environmental education activities for youth and partnership dynamics with private stakeholders.

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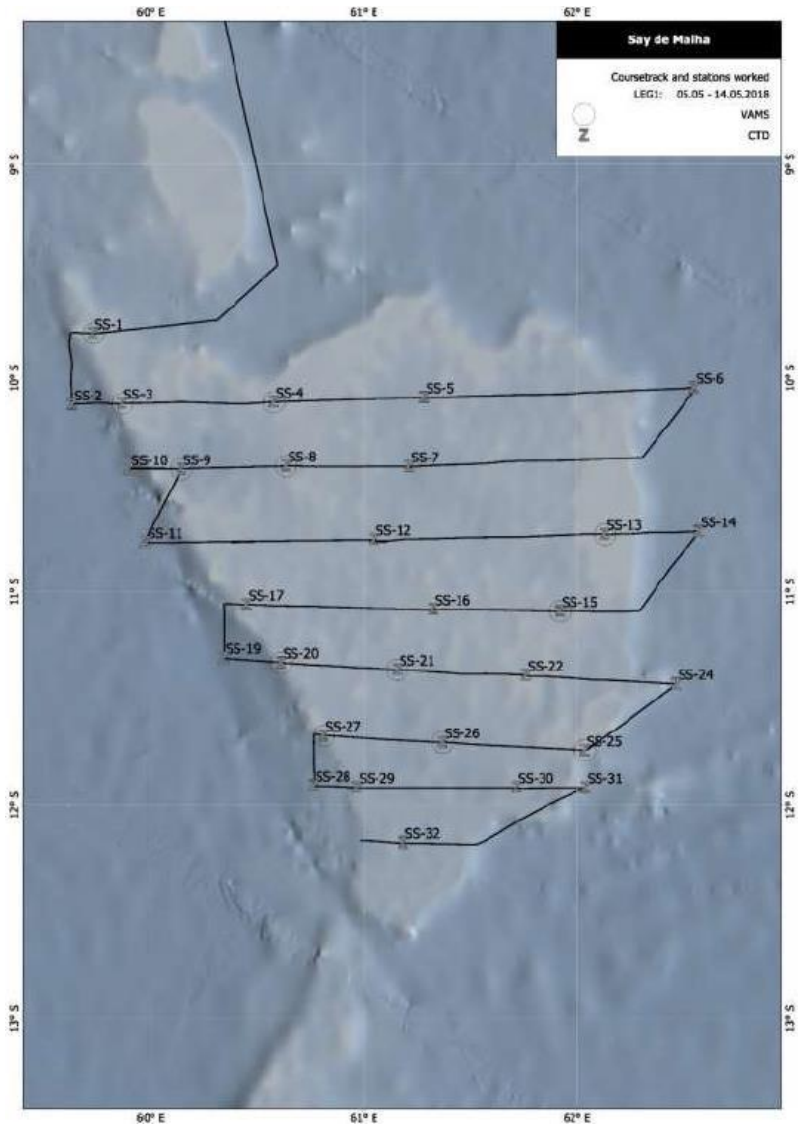
ANNEX 1

Recent oceanographic campaigns on the Saya de Malha Bank

RV Dr Fridtjof Nansen's 2018406 cruise

Multidisciplinary campaign.
Operations carried out:

- Bottom mapping (multibeam) and sediment sampling
- Physical (continuous and fixed station measurements), geochemical (dissolved oxygen, nutrient salts, pH, alkalinity) and biological (fluorescence) oceanography
- Video observations of the benthos, and collection by dump truck
- Collection of phytoplankton (and pigments), zooplankton, eggs and larvae, microplastics and debris
- Acoustic-echo-integration, micronekton (water column) and bottom (fish) trawling, and collection of biological tissues for genetic studies.
- Observations of top predators

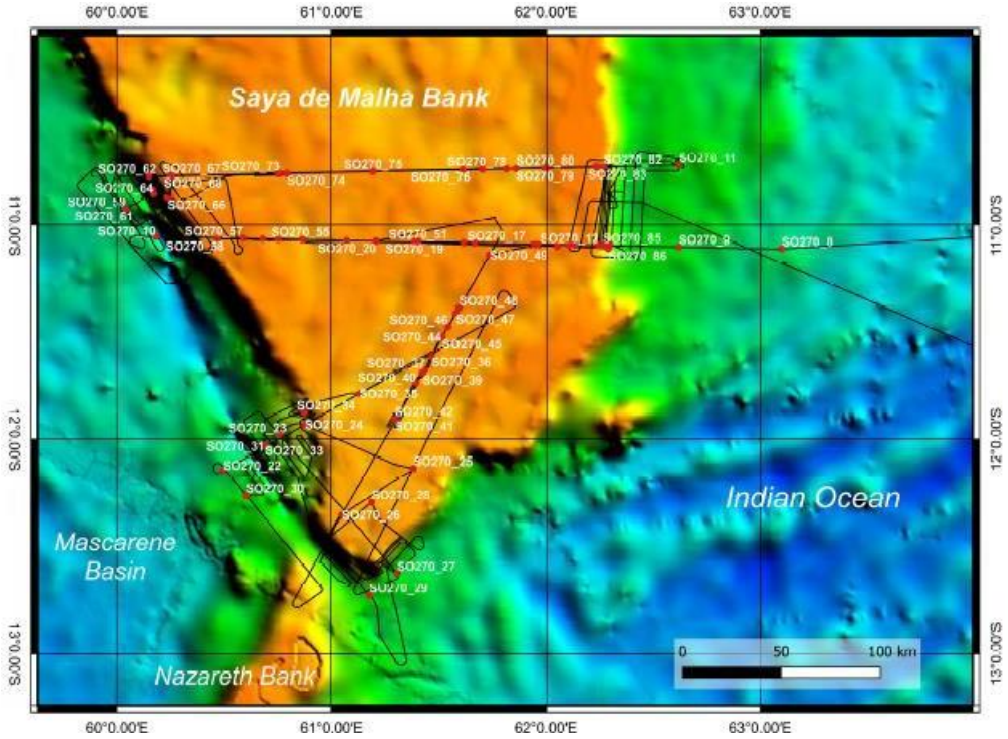


Trajectory of RV Dr Fridtjof Nansen from 5 to 14 May 2018

RV SONNE Cruise SO270 of the (MASCARA campaign)

This campaign focused on the study of carbonates deposited on the platform and slopes of the Saya de Malha Bank. Operations carried out :

- Bottom mapping (multibeam) and sediment sampling
- Physical oceanography (CTD, current)
- Sedimentology (seismic, acoustic), core sampling



RV SONNE Route from September 24 to October 18, 2019

ANNEX 2

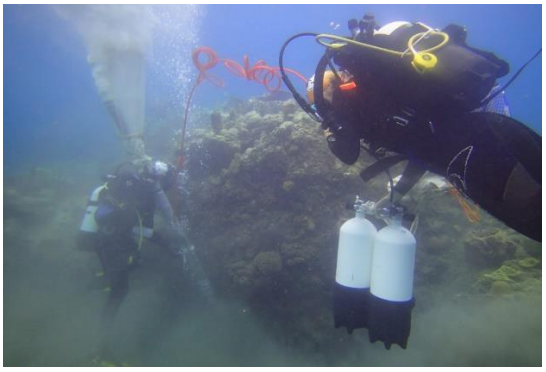
Benthic Biodiversity Sampling Protocols

1. Dive sampling

Sight sampling

Sight harvesting is a technique that requires specialists. Indeed, most organisms blend into their environment to often achieve perfect mimicry with their hosts. Sight harvesting requires know-how, experience and intuition: the choice of blocks to be turned, attention to differences in sediment granulometry, camouflaged species or individuals (homochromy or mimicry), etc. Only experienced divers and collectors will be able to spot commensals, parasites and animals living in symbiosis.

The underwater sucker or vacuum cleaner



The underwater sucker is one of the tools used on bottoms that are not accessible to the dredge, such as rocky, cavernous or crowded bottoms with solid-body organisms. The air delivered by a diving tank is delivered through a medium pressure hose at 7 bar to the base of a 2 m long PVC tube with a diameter of about 10 cm. As the air rises into the pipe, which should be as vertical as possible, it relaxes and piston. Particles and objects in the vicinity of the opening are sucked in and retained in a 1 mm mesh net. This tool does not, however, allow the sessile fauna to be removed.

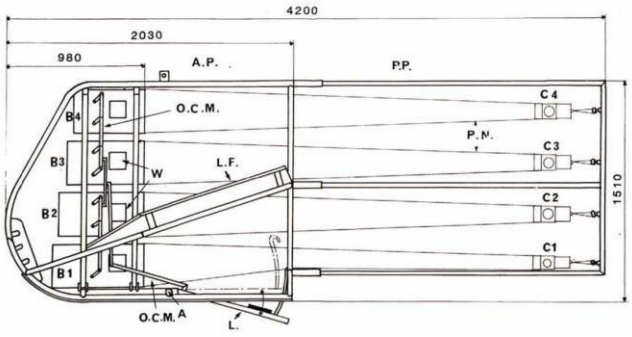
Brushing

For the epibionte fauna, which adheres strongly to the substrate, the brushing technique is used. It consists of cleaning a surface, usually large blocks of pebbles, with a hard plastic brush over a brush basket. The pebbles are then laid in the right direction on the bottom of the water. Underwater, the small blocks are brushed over two open-worked stacking baskets and a 500-micron mesh net caught in between. The assembly is heavily weighted by 8 kilos of lead fixed at each corner at the bottom of the basket.

2. Sampling with towed equipment

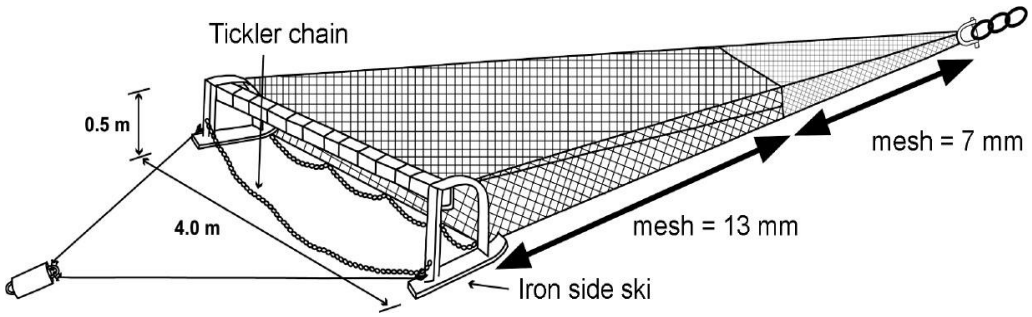
Suprabenthic Sled

Sampling of suprabenthic communities is carried out using the modified version of the MACER-GIROQ suprabenthic sled. This 4.2 m long sled is composed of four superimposed plankton nets that are hung from metal cans on the sled frame. This frame rests on two skids or "skis" that allow the sled to slide on the loose sediment. The size of each box is 0.60 X 0.30 m. The opening area is 0.18 ^{m2}. The bottom box samples wildlife 10 cm above the bottom. Sampling with this gear allows the capture of suprabenthic fauna above the sediment: 0.10 to 0.40 m (net 1); 0.45 to 0.75 m (net 2); 0.80 to 1.10 m (net 3); 1.15 to 1.45 m (net 4) in the benthic boundary layer. The mesh size of each net shall be 500 µm. Each box is equipped with an opening-closing mechanism with latches that are activated by a lever system located under the sled. This lever activates the opening when the sled comes in contact with the bottom. TSK" volumeters located in the opening of the net make it possible to estimate the volume of water filtered and thus the surface area sampled.



Beam trawl - soft bottom

The standard French beam trawl consists of a large 4-metre piece of wood fixed on two heavy iron slides at each end. These slides allow the trawl to slide along the sea floor. The height of the lateral iron runners (0.5 m, 0.45 m long, giving an effective height of 0.35 m) defines the vertical opening of the net, the pole determines the horizontal opening. The weight of the runners at the base of the net sets the trawl down and keeps it close to the ground. A very fine-meshed net (15 and 12 mm) is attached to this system; the net's bulge is reinforced by a chain to allow the net to sink into the sediment and extract (pull) organisms or substrates from and into the sediment. A scraper chain (4.5 m long, 10 kg) is placed in front of the net. A cone-shaped net is located behind the bead. This conical shape allows good water filtration and guides organisms caught in the net to the end of the trawl. The end of the net is lined, with a finer mesh inner pocket. The trawl is connected to the vessel's chain by two 4 m long ropes, forming a triangle with the pole. The trawl is usually deployed at a speed of 2.5 to 4.5 knots (with an actual (exit) speed of 1m/sec) and towed between 1 and 2.5, generally around the ground speed of 1.5 knots.



	French beam trawl
Type of frame	Iron side skis (100 kg) Wooden beam (70 kg)
Span	4.0 m
Mouth height	0.5 m
Mouth width	3.8 m
Mouth area	1.9 m^2
Net length	8.8 m
Stretched mesh width	13 mm 7 mm
Total weight	230 kg
Tickler chain	4.5 m long, 10 kg

Warén dredge - rocky bottom

The Warén dredge consists of a solid metal frame behind which a net is placed to retain sediment and wildlife. The metal frame is connected to a cable and pulled by a boat at low speed (1-2 knots), sometimes less depending on the agitation of the seabed. The dredge's pocket is made up of several layers; an inner pocket made of thinner mesh (3-5mm) and protected by 1-2 outer layers of larger mesh (20-50mm) and stronger. For the Warén dredge used in the Tropical Deep Sea benthos programme and related expeditions, the outer layer is made of a net of metal rings, strong enough to prevent the inner nets from tearing.

ANNEX 3

Data Workflow of the French National Museum of Natural History (MNHN)

1- Constitution of zoological collections on board

For each collection operation (diving or towed), the contents of the sample are photographed to document the nature of the substrate. These contents are then rinsed with seawater and sieved on deck over a series of sieves with decreasing mesh size. The organisms are then sorted (for small fractions, under binocular magnifying glasses) by large zoological groups (Crustaceans, Mollusks, Echinoderms, Cnidarians, Polychaetes, Fish, others...). A series of specimens representative of the diversity of the station is selected and will be photographed. The organisms are then packaged with a rot-proof label mentioning the station number, depth, date and mission. The whole set is stored in 80° ethanol or formaldehyde (fish, ascidians). For molecular studies, procedures have been set up in particular for organisms for which tissue samples must be taken before fixation as in the case of fish that are fixed with formaldehyde. Similarly, during fixation, shell mollusks have a tendency to shrink; the tissues are therefore poorly fixed if they are not collected in the field. A procedure has therefore been put in place to ensure traceability between the sample, the specimen and possibly the photo taken in the field. This procedure notably involves the use of Matrix tubes identified with a unique 2D bar code.

2- Processing of samples on land, integration into MNHN collections

Regularly enriched thanks to the expeditions of the "Tropical Deep Sea Benthos" (http://expeditions.mnhn.fr/program/tropicaldeep-seabenthos) and "The Planet Revisited" (http://www.laplaneterevisitee.org/fr) programmes, the MNHN collection of marine invertebrates is now an international reference collection, as much for its richness in species as for the originality of the fauna represented, some coming from regions still largely unexplored. It is around these expeditions and this collection that an international network of very active taxonomists gravitates. The scientific animation of this network allows the description of new taxa each year: more than half of the new mollusk species and 45% of the decapod crustaceans described in 2018 come from MNHN expeditions. Whether for mollusks, but also for crustaceans, cnidarians or echinoderms, the study of this material has also enabled the revision of numerous classifications based on molecular phylogeny approaches. MNHN via the Marine Invertebrate Collection is thus the first "provider" of new taxonomic knowledge on marine biodiversity. The significant scientific development of this collection is based on the collaboration between the research and collection teams in charge of it, and the network of international collaborators, specialists in the different taxa. The core of this collaboration is based on the collection of the material collected during these expeditions and the associated data, making this material available to specialists. The key phase of this process is the post-dispatch processing of the biological material. On return from a mission, the material is stored in barrels containing several specimens of the same taxonomic group (crustaceans, mollusks...) arranged by collection stations, and not taxonomically. The post-dispatch stage therefore consists of sorting these specimens by taxonomic subgroups (mainly at family level). Collection" is also carried out during this stage with the addition of an inventory number that will allow the integration of this information into the MNHN databases. It is only after these steps that the material is then available and distributed within the international network of taxonomists.

3- Database and Barcoding

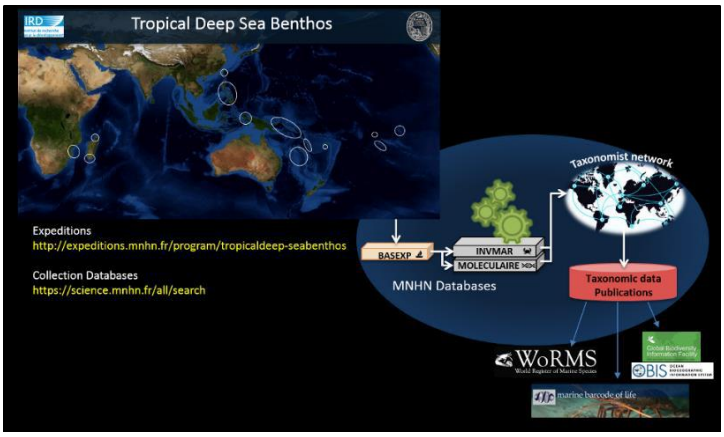
With the development of the Barcode of Life project some 15 years ago, taxonomy work now integrates classical morphological approaches and genetic data. The MNHN teams belonging to UMR7205 have been particularly involved in the renewal of these approaches, particularly concerning mollusks, crustaceans and algae, by developing strong collaborations with the network of taxonomists that gravitates around MNHN expeditions. The links between the data from the campaign and the production of

taxonomic data (morphological and molecular) are based on three publicly accessible databases:

(I) BASEXP, a database dedicated to information on sea campaigns, geographical data and images on board substrates (http://expeditions.mnhn.fr/)

(Ii) INVMAR, specimens and taxonomic database, where specimens (and their associated collection data and photos) for marine invertebrates collected by MNHN in recent years are recorded (https://science.mnhn.fr/all/search)

(Iii) MOLECULAR, a database dedicated to molecular data, where all the different steps of the sequencing process (tissue sampling, DNA extraction, PCR and DNA sequences) are recorded for each specimen.



The MNHN database system is detailed in Puillandre et al (2012). Since 2008, we have produced and put in molecular collection mainly for crustacean and mollusc groups: 62110 tissue samples (computerized 2D tubes for DNA analysis) and 47684 DNA extracts. The taxonomic repository in the MNHN databases is also linked to the World Register of Marine Species (WORMS). Molecular data will also be published regularly in BOLD (Barcode of Life data system) and GenBank. The MNHN workflow not only guarantees the traceability of all data, but also facilitates the management of these data.

***Référence** : Puillandre N., Bouchet P., Boisselier-Dubayle M.C., Brisset J., Buge B., Castelin M., Chagnoux S., Christophe T., Corbari L., Lambourdière J., Lozouet P., Marani G., Rivasseau A., Silva N., Terryn Y., Tillier S., Utge J. & Samadi S. (2012) New taxonomy and old collections : integrating DNA barcoding into the collection curation process. Molecular Ecology Resources, 12(3), 396-402. https://doi.org/10.1111/j.1755-0998.2011.03105.x*

4- Commitments related to the study of biological material

The material collected may only be used for basic research purposes. Neither the animals collected, nor their products, nor the associated genetic resources, nor any results of the research carried out, are intended for direct or indirect commercial use.
Due to the atypical legal status of the Saya de Malha area (Joint Management Area between Mauritius and Seychelles), the ABS regulations on genetic resources (Access and Benefit Sharing) included in the Nagoya protocol cannot be applied in a conventional manner.

Part of the specimens collected in the area will be returned to the countries concerned after study of the material in order to constitute reference collections to be kept in the respective countries. MNHN undertakes to transmit in a privileged manner and to keep at the disposal of Mauritius and Seychelles via their research or governmental institutes, all the information allowing to ensure the traceability of all the samples that will be collected during the campaign. The sampling data (position, depth, type of bottom, sampling method, date) will be transcribed on the forms accompanying each lot or specimen. The traceability of the samples and related data (photos of living organisms, parts or tissues of organisms)

associated with a particular individual will be ensured by a unique identifier including the specific registration number relating to the agreement that will be established as part of the shipment in addition to the specific code used by MNHN for each individual. MNHN will be able, on a scientific basis only, to transmit to scientific experts all the samples collected, while ensuring traceability. MNHN also undertakes to ensure that the experts to whom the samples are entrusted comply with the non-commercialization clauses.