ALL-ATLANTIC OCEAN RESEARCH ALLIANCE

Creating an Atlantic Ocean Community by Implementing the Galway and Belém Statements

AA-BIOTECMAR Report:

JPA Roadmap and Action Plan for the development of sustainable marine biotechnology and bioeconomy in the Atlantic

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

Report Identifier

Report name	**AA-BIOTECMAR Report: JPA Roadmap and Action Plan for the development of sustainable marine biotechnology and bioeconomy in the Atlantic**
Related Project title	AANChOR - All AtlaNtic Cooperation for Ocean Research and innovation
Related WP	WP4 – Knowledge Transfer for Ocean Innovation and Economy
Joint Pilot Action name	All-Atlantic Marine Biotechnology Initiative (AA-BIOTECMAR)
Related JPA Task	Task 5: Roadmap and Action Plan
Authors	Fabiano Thompson (UFRJ), Cristiane Thompson (UFRJ), Roberto de Pinho (MCTI) & Ricardo Kruger (UNB)

Disclaimer

Copyright

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

ALL-ATLANTIC JOINT PILOT ACTIONS

Following a year-long collaborative process among more than 70 stakeholders at the Atlantic level, the All-Atlantic Ocean Research Alliance Multi-Stakeholder Platform, divided into 5 sub-multi-stakeholders platforms, identified more than 1000 initiatives towards strengthening marine research and innovation collaboration at the Atlantic level, 56 gaps and 79 needs/recommendations to achieve the All-Atlantic Ocean Research Alliance ambition, guided by a total of 20 Strategic Objectives, 20 Operational Objectives, and 10 Key Performance Indicators.

Based on these findings and on the idea of collaboration, alignment, and use of existing resources, they have developed six ambitious and long-term collaborative Joint Pilot Actions:

- All-Atlantic Training Platform (AA-TP)
- All-Atlantic Aquaculture Technology and Innovation Platform (AA-ATiP)
- All-Atlantic Marine Biotechnology Initiative (AA-BIOTECMAR)
- All-Atlantic Data Enterprise 2030 (AA-DATA2030)
- All-Atlantic Blue Schools Network (AA-BSN)
- All-Atlantic Marine Research Infrastructure Network (AA-MARINET)

This report is developed by the **All-Atlantic Marine Biotechnology Initiative (AA-BIOTECMAR)** Joint Pilot Action, that is a collective effort to support the development of new and emerging technologies intended to improve human health, encouraging the sustainable use of marine resources through marine biotechnology and advanced technologies in aquaculture, food production, fisheries management, and environmental monitoring. AA-BIOTECMAR is promoting collaboration among countries of the Belem and Galway statements through workshops and technical visits, identify best methodologies for technology transfer, promote outreach and engage ocean leaders to support the blue growth.

This report is a deliverable in scope of JPA AA-BIOTECMAR, Task 5. Roadmap and Action Plan. It lays down fundamental actions and targets towards the development of marine bioeconomy across the Atlantic. Possible outcomes of this last task under the seed funding period are new start-ups and R&D projects with joint participation of academia-government-industry across the Atlantic.

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

CONTENTS

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

1. Context and Scientific Background

1.1. Food Security and Mariculture

Aquaculture responded for 123 million tons of fish, shellfish, and algae in 2022 (FAO 2022). Meanwhile, fisheries have reached a maximum and topped off at around 90 million tons since the late 1980s. The aquaculture sector generated approximately 20 million direct jobs, and US$281 billion in 2022 worldwide. Meanwhile, overfishing and pollution are causing the collapse of several fish stocks worldwide which suggest that fisheries management is needed. The potential for food production in the ocean has not yet been realized. For instance, in Brazil, only 5% (77,000 tons) of the aquaculture production is in the ocean, and 95% originates from the freshwater systems in the continent.

Low carbon aquaculture is critical for reducing protein deficiencies and supplementing the world's demand for seafood. However, the culture environment predisposes the aquaculture organisms to infectious diseases and the high density of a single species of fish, crustacean, mollusc, or alga allows for the rapid spread of infectious disease resulting in devastating losses. Some of the most damaging diseases in aquaculture are caused by bacterial and viral pathogens. The adaptive nature of pathogens has resulted in pathogens with altered pathogenicity, host range, and sensitivity to antimicrobial agents. This has led to the critical need to evaluate the impact of current control measures and optimise disease management schemes with an emphasis on global impact and sustainability. The overall risks, costs, and management efforts to combat (infectious) diseases have a substantial economic impact on all aquaculture sectors. Thus, biotechnology tools are needed to further develop the low carbon aquaculture sector. Biotechnology tools may contribute for the development of low trophic aquaculture and new low carbon food items, e.g. macroalgae.

Virus infections are very frequent in marine aquaculture. For instance, shrimp farming has experienced several crashes worldwide due to infectious hypodermal and hematopoietic necrosis (IHHN; ssDNA virus), Taura syndrome (TSV, ssRNA virus), and Infectious myonecrosis (IMNV; dsRNA virus). In many systems where specific pathogens are problematic considerable effort has been devoted to the development of effective vaccines. However, as vaccination is not an option for shrimps, alternatives are needed. Management options include the use of medicated feeds to treat infectious diseases. Currently, shrimp production in the world is damaged due to infectious diseases. Recently, Early Mortality Syndrome (EMS) caused losses of over 70% of production in Asia. This syndrome is caused by the bacterium *Vibrio parahaemolyticus*. The White Spot Syndrome Virus (WSSV) caused financial losses of more than 1,000 million dollars, showing the negative effects and risks of pathogens for shrimp production. In general, viral diseases are the ones that cause the most damage. It is estimated that 60% of the annual production losses in shrimp farming is a consequence of these diseases. One alternative is the use of bioflocs. Biofloc consists of microbes (prokaryotes and eukaryotes) associated with particles (particulate organic matter). Diatoms associated with bioflocs seem to be a relevant component for shrimp nutrition. Indeed, phototrophic microbes play a major role in shrimp nutrition. Biofilm may help shrimp growth and survival possibly as a

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

direct food source and as a biofilter which improves water quality. Biofloc can also be applied to promote shrimp and fish sperm quality. Biofloc and biofilm allows sustains high stocking density levels. For example, shrimp culture in conventional systems around the world producers use to rear shrimps in low stocking densities ranging from 10 to 30 shrimp/m², however the culture of shrimp with bioflocs allow densities ranging from 500 to 600 shrimp/m². Bioflocs reduce potential pathogens in the shrimp culture. Indeed, the microbial community management as a tool to reduce the risk of Acute Hepatopancreatic Necrosis Disease (AHPND) outbreaks in biofloc systems has been demonstrated. Probiotic cocktails containing different types of bacteria (*Bacillus*, *Enterococcus*, *Thiobacillus*, *Paracoccus*) increased shrimp survival and growth. Biofloc can also reduce the cost of shrimp production with food as it replaces fishmeal in artificial food of shrimp and fish. Thus, bioflocs seem to be a relevant tool to enhance aquaculture rearing systems of fish and shellfish. In addressing this, biotechnology will be fundamental to the development of low carbon aquaculture.

1.2. Climate Change and Pollution Hinder Mariculture Development

Mollusc rearing is a relevant global economic activity. Approximately 1,74 million tons of scallops were produced in 2020, mainly in China, USA, and EU. This production corresponded to exports totalling USD 4.3 billion (2.8% of the exports of aquatic products). Scallop production represents a significant portion of this activity and most of the knowledge acquired in the last decades is related to *Pecten maximums* and *Argopecten irradians*. Bivalve rearing may also have a role in the carbon dioxide sequestration and warming mitigation as these organisms produce calcium carbonate shells on the basis of filter feeding. The expansion of scallop mariculture production has been hampered by global and local changes. Seawater warming is leading to mass oyster mortalities and the collapse of *Argopecten* production worldwide. Hypoxia and sewage pollution may also lead to scallop mortality. Increased seawater temperature induces physiological changes e.g. increase in heart beats. However, under hypoxia, the metabolic rate decreases (e.g. filtration rates), and bivalve physiology is further compromised. Transcriptomic and proteomic analyses of *Pecten maximus* revealed high temperature-dependent expression of autophagy (GAPDH and AP-1), remodelling of the cell structure, cytoskeleton, cell membrane, reduction in DNA repair, metabolism of reserve lipids under high temperature stress. The majority of the current knowledge is available for temperate/cold water scallop species. However, proportionally much less is known about the rearing of tropical Southwest Atlantic species, e.g. *Nodipecten nodosus*.

Nodipecten nodosus is produced at higher temperature (24-26°C) compared to the other scallop species (15-18°C). However, the current production of *N. nodosus* in Brazil is only ~16 tonnes per year, mainly in Southern Brazil, more precisely, in Santa Catarina State. This scallop is also a rich source of novel antithrombotic and antitumor molecules which deserves great attention for further pharmaceutical developments. However, increased seawater pollution has hampered further mariculture production. High loads of sewage pollution were previously documented which may lead to scallop mortality.

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

Significant mass mortality of the Pacific oyster *Crassostrea gigas* has been reported during the summer period in Europe since 2008 as possible effect of pathogen prevalence, water quality, oyster nutrition and genetics. The Pacific Oyster Mortality Syndrome (POMS) is a polymicrobial disease. A primary infection by Ostreid Herpes virus (OsHV) appears to weaken the immunological response of the bivalve host by compromised hemocyte physiology. Subsequently, a secondary opportunistic bacterial infection (vibriosis) promotes hemocyte/tissue lyses. The vast cytotoxic arsenal of vibrios allows them to destroy the host tissue particularly in warmer and polluted waters. A proteomic study demonstrated infected oyster immune processes included signal transduction (G-protein coupled receptors), ubiquitin-like proteins, RNA interference, interferon-like pathway, antioxidant defence (superoxide dismutases, catalases), autophagy (endocytosis and exocytosis), lysosomal proteins which contribute to the defence and resistance of pacific oysters to viral infection. These findings contribute to develop a more durable and sustainable low carbon mariculture.

South Africa has demonstrated that the abalone mariculture sector deserves great promise. The current production corresponds to ~1500 tons of abalone and ~40 million dollars in South Africa yearly. Seaweeds (kelps) are grown in mariculture systems to feed abalones.

1.3. Global Changes and Energetic Transition

Global sea surface temperatures are related to major phytoplankton and chlorophyll declines in the past century worldwide. Declines in chlorophyll are observed in different oceanic basins (Indian, Pacific, and North Atlantic). Changes in biodiversity, with declines in diatoms and chlorophytes, and increases in cyanobacteria were observed. Decadal trends of increased water temperature lead to weakening of vertical mixing in the upper ocean, reduced N and light, and consequently, reduced phytoplankton productivity. Increase in seawater temperature and reduced phytoplankton productivity may hamper bivalve recruitment and mariculture. Furthermore, ocean pollution also enhances the effects of climate changes.

Several Oil companies aim to be carbon neutral by 2050. However, certain oil companies have not yet implemented a pact with society and actions towards this end. Meanwhile, new energy resources are required. Bioenergy is one reasonable option, including biohydrogen and macroalgae-based fuel. Options for investments in nature based solutions are in the European Bank (>US$ 1 trillion in sustainable and green bonds for clean energy, clean transport, and sustainable management), the Green Climate Fund (e.g. multimillion projects for coral reef and mangrove restoration), the Brazilian green bonds (US$ 9 billion for projects) and the UN blue bonds (US$24 trillion). Therefore, nature based solutions and a new green deal are required.

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

1.4. Marine Biodiversity and Biodiscovery

New drugs for the treatment of tumour diseases and infectious diseases are needed. Drugs that can be developed in Latin America and African countries, without the need for very costly imports from abroad. The SARS-COVID pandemic has demonstrated that new antivirals are needed to combat emerging diseases. Cyanobacteria are highly diverse, comprising morphologically heterogeneous organisms and with genomes rich in gene clusters that encode bioactive molecules. Cyanobacteria are considered one of the main sources for the discovery and sustainable production of new secondary metabolites with biological activity. For instance, the discovery of the antitumor dolastatin 10 (Ascentris®) in early 2000s and its current use against lymphomas. This antitumor was isolated from a filamentous cyanobacterium from the sea slug *Dolabella articulata* in late 1999. Other potent antitumor drugs of cyanobacteria are also being developed (Curacin A, Largazole and Apratoxin).

Cyanobacteria have a large repertoire of gene clusters for the production of bioactive compounds. Many of these compounds are products of non-ribosomal peptide synthetase (NRPS) or polyketide synthase (PKS). More than 400 NRPS and PKS gene clusters have been identified in genomes of cyanobacteria, 91 are known products that encode multienzymatic proteins involved in the synthesis of well-described bioactive compounds, such as protease inhibitors, UV sun protection agents and toxins. These genes may be used in synthetic biology applications to produce new compounds with pharmaceutical applications which highlights the need for patent mechanisms in place, including relevant DNA sequences. Cyanobacteria produce metabolites distinct and structurally complex secondaries, including peptides, polyketides, alkaloids, lipids, terpenes, cannabinoids, lectins with potent properties and biological applications, e.g. antimicrobial, anticancer, immunosuppressive and anti-inflammatory capabilities. αKGH homologues (α-ketoglutarate-dependent halogenases) have been identified in the genome of the cyanobacterium *Fischerella* sp. PCC 9339. An identification of the metabolites corresponded to hyperhalogenated aranazoles (NPKS). The first non-type proteusin polytheonamide, landornamide A, which has inhibitory activity against the lymphocytic choriomeningitis (LCMV) was found. *Prochlorococcus* produces many cyclic peptides containing lanthionine (lantipeptides). Most peptides containing known lanthionines have antimicrobial activity and are referred to as Li lantibiotics. A recent study showed that *Synechococcus leopoliensis* produces the enzyme CPD-photolyase, used for cosmetic applications against cell photoaging of the skin and skin cancer.

It is also worth highlighting new frontiers in biotechnology using cyanobacteria. In addition to being the main primary producers in the oceans and playing a role important in the global nitrogen and carbon cycles, cyanobacteria are prolific producers of toxins such as microcystins, anatoxins and saxitoxins. Recent studies point out that cyanobacteria are promising sources for new bioproducts, including new enzymes Cas3

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

endonucleases and CRISPR systems and that these CRISPR systems may be involved in the defence against phage infection. New CRISPRS systems can be employed in new biotechnological applications.

1.5. Ocean Pollution and Biodegradable Plastics

Oil spills and plastic pollution are major problems in the marine environment. South Africa beaches have been intensively impacted by plastic pollution. At least 36,000 ha coral reefs were damaged by an oil spill in Mindoro (The Philippines) March 2023 after a tanker carrying 800,000 litres of fuel sank near the reef area. In September 2019, an oil spill from an unknown source reached the coast of northeast Brazil, affecting at least 3,000 Km coastline, coral reefs, and over 130 coastal cities. This oil spill is considered one of the major recent marine disasters, along with the ore tailing spill (Samarco-Vale-BHP) in November 2015 and which reached the Abrolhos coral reefs. Novel energy sources will be required in the future towards an energy transition and academia will have to play a central role in the STI of new bioenergy alternatives.

To by-pass the accelerated production of plastics, new bioplastics could be developed. An alternative would be production of bioplastics and biodegradation of plastics by cyanobacteria. These microorganisms are known for their ability to accumulate precursor molecules of bioplastics biodegradable (polyhydroxybutyrate). Furthermore, cyanobacteria form biofilms on plastics and can aid in biodegradation. Cyanobacteria play an important role in capture and storage of CO_2, increasing the efficiency of RuBisCO. From photosynthesis, the cyanobacteria *Synechocystis* generates enough energy to keep a basic device running for long periods. In addition to CO_2 capture and fixation, the biomass produced by cyanobacteria can be used to produce biofuel or green plastic, naturally and sustainably. Cyanobacteria produce polyhydroxyalkanoate (PHA) and polyhydroxybutyrate (PHB), biopolymers considered an alternative to conventional plastics.

In the face of global climate changes, pollution, global war, and poverty, it became clear that countries need to join forces to develop STI initiatives based on co-creation, and co-development. An embracing, inclusive, and equitable STI environment is needed across the Atlantic. Nations face a variety of challenges including food security, lack of technology and education, and ocean pollution. For instance, million people are under starvation in Latin American and African Countries currently. One of the most comprehensive documents which bring together a consensus among Atlantic Nations was signed on the July 13 2022 in Washington (All-Atlantic Ocean Research & Innovation Alliance Declaration signed on the 13th of July 2022; https://allatlantic2022.com/wp-content/uploads/2022/07/All-Atlantic-Declaration-signed-7.13.2022.pdf). In addition, the Brazilian government also developed a relevant action plan in 2018 (Plano de Ação em Ciência, Tecnologia e Inovação para Oceanos, 2018) which could also serve as a basis for further developments. Unfortunately, this plan was not put forward in the last four years in the face of the SARS pandemics. The Plan for the Implementation of the Ocean Decade (https://decada.ciencianomar.mctic.gov.br/wp-content/uploads/2022/01/Plano-Nacional-de-

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

Implementac%CC%A7a%CC%83o-da-De%CC%81cada-da-Cie%CC%82ncia-Ocea%CC%82nica-links.pdf) and Science in the sea plan https://ciencianomar.mctic.gov.br/sobre-o-programa/ (MCTI Nº 4.719, 05/05/2021) also deserve great attention. They have a great focus on outreach and communication initiatives.

2. Towards an All-Atlantic Sustainable Marine Bioeconomy

2.1. Motivation

In the face of global climate changes, pollution, global war, and poverty, it becomes clear that Atlantic Nations need to join forces to develop STI initiatives based on co-creation, and co-development. An embracing, inclusive, and equitable STI environment is needed across the Atlantic. Nations face a variety of challenges including food security, lack of technology and education, and ocean pollution.

2.2. Roadmap

This roadmap and action plan lays down fundamental actions and targets towards the development of marine bioeconomy across the Atlantic. The development of a sustainable bioeconomy can be achieved through biodiversity (the raw materials), biotechnology (the toolbox), and increased economic activity.

Harnessing marine biodiversity has not been completely achieved in the Atlantic, despite recent efforts from nations, e.g. the Brazilian Plan for Ocean Science Technology and Innovation (STI) (Plano de Ação em Ciência, Tecnologia e Inovação para Oceanos, 2018) and transnational initiatives (Belém Declaration 2017). Atlantic marine biodiversity is a great asset and offers many opportunities. However, bioprospecting is still very crude. Therefore, much is desired in terms of resources and effective actions for supporting the development of Ocean STI. New actions of Atlantic governments will need to promote STI on selected biodiversity hotspots, e.g. the Great Amazon Reef, Abrolhos, South African Coral reefs, the North-West Africa upwelling region, Africa polymetallic/cobalt-rich crusts, Oceanic Islands, and the deep ocean. Amazon megabiome offers unique opportunities for bioeconomy. A vanguard concept considers the Amazon will be a center for the development of knowledge on marine bio-economy, beyond the supply of raw materials. Similarly, South Africa and other African countries have several great biodiversity assets (reefs, metallic crusts, upwellings, fishing grounds) which could serve as a basis for the development of an bioeconomy of knowledge.

Significant investment is needed to leverage marine biotechnology and bioeconomy. Despite the accelerated climate change and pollution, innovative biotechnology processes may contribute to mitigate these problems. For instance, understanding the natural process of polymers degradation in the oceans will help the industry to design new environment friendly biopolymers. Furthermore, a low carbon aquaculture will require the incorporation of innovative biotechnology solutions. The development of new processes and products need to be in agreement with national regulations. Targets listed in this roadmap

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

will have to be based on co-creation, and co-development principles to enhance ocean durability and sustainability.

This roadmap and action plan are organized around action plans for three thematic areas that collectively address the stated goals.

2.3. Goal

Development of sustainable marine biotechnology and bioeconomy across the Atlantic.

2.3.1. Secondary Goals

1. To promote STI as the foundation for the development of marine bioeconomy.
2. To harness marine biodiversity and biodiscovery of marine hotspots.
3. To promote food security, environmental health, and the development of new drugs originated from the ocean.

2.4. Thematic Areas Action Plans

2.4.1. Thematic Area 1: Food Security

2.4.1.1. Goal

To develop STI studies in the field of food security. Studies include mariculture, multitrophic aquaculture, low carbon aquaculture, CO_2 capture and storage, biodiversity of pathogenic microbes (including virus, prokaryotes, and eukaryotes), new energy source (e.g. biohydrogen, and bioethanol), new food items, probiotics, and antibiotics. To develop new biofertilizers and biomaterials to be applied in agriculture, husbandry, and aquaculture.

2.4.1.2. Context

The world population comprises ~7,88 billion people. Only in the African continent, ~150 million people starve currently. The rising global population puts significant pressure over the edible Atlantic marine biological resources. Currently hundreds of EU and Asian fishery boats fish near the EEZ of several Latin American and African Countries, including Brazil, Uruguay, Argentina, Gulf of Guinea (e.g. Cameroon, and Ghana) and South Africa. Low carbon mariculture is an alternative to food supply and climate mitigation. Mariculture may also help to reduce fisheries in marine protected areas.

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

2.4.1.3. Motivation

Vast suitable areas are available in the marine environment which could be used for a low carbon mariculture. Bringing food production to the ocean helps to lower the pressure over the land resources and mitigate the use of water, soil, and other scarce resources. Many Atlantic countries are successful in precision agriculture. This successful experience could serve as a basis for the development of a low carbon mariculture.

2.4.1.4. Implementation Strategy

1. To support ongoing projects
2. To bring academia into the public policy formulation
3. To strength the triple helix (academia, industry, and government)
4. To promote the engagement of young researchers and to establish new emerging STI groups

2.4.1.5. Activities and Targets

1. To support at least 10 research and development projects towards the field of marine bioeconomy
2. To develop at least one prototype low carbon aquaculture facility
3. To promote at least 10 joint initiatives of academia, industry and government
4. To promote STI in Centers of excellence in Latin American and African Countries, for instance National Center for Bioimaging (CENABIO-UFRJ), The Marine Aquaculture Station (EMA-FURG), and the national marine biotechnology network (Biotecmar)
5. To create a center for marine bioresources and food security in the Amazon megabiome (The Great Amazon Reef System Center; GARS Center)

2.4.1.6. Adherence to the Sustainability and Development Goals (SDGS)

This thematic area contributes to the achievement of several SDGs (e.g. 1. No poverty, 2. Zero hunger, 8. Decent work and Economic growth, 9. Industry and innovation, 13. Climate action, 14. Life below water, 17. Partnerships for the goals).

2.4.1.7. Resources

$90million in 4 years.

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

2.4.2. Thematic Area 2: Drug Discovery

2.4.2.1. Goal

To develop STI studies in the field of drug discovery and development. Studies include the discovery of new drugs to fight neglected tropical diseases, infectious diseases, cancer, inflammatory diseases, metabolic syndrome, and degenerative disorders.

2.4.2.2. Context

Approx. 700,000 people are killed due to antibiotic-resistant infections and over 500,000 are killed by neglected tropical diseases yearly (WHO 2022). In 2050, predictions suggest over 10 million deaths per year globally due to antibiotic-resistant infections. Furthermore, the SARS-COVID pandemic has highlighted the need for new effective antivirals and antithrombotic molecules.

2.4.2.3. Motivation

Marine bioactive molecules which can kill SARS-COVID virus have been found in the ocean. These molecules associated with new nanoparticles are now developed as spray-based medicine for use in the clinics. However, the majority of the marine biodiversity remains locked. Therefore, unlocking marine biodiversity is timely.

To examine integration of natural product discovery workflows and to establish a prototype protocol for better microbial biodiversity biodiscovery (including bioinformatics) from meta- to other –omics to be used at all sites. The tools will enable users to participate to coral reef conservation actions, including coral farming. Furthermore, the discovery of chemolithotrophs, viruses, anaerobes, interface interactions, culturing the uncultivated microorganisms, the discovery of new food items, new drugs is also relevant. The marine biotechnology initiative for the Atlantic (BIOTECMAR) consortium (https://allatlanticocean.org/jointaction/all-atlantic-marine-biotechnology-initiative ; https://doi.org/10.3389/fmars.2018.00236; https://ciencianomar.mctic.gov.br/biodiversidade/) will develop new pipelines that protect and develop these valuable resources. Other initiatives e.g. the Operation Pakisa and AAORIA-BBAMM Blue Biotechnology, Aquaculture and Marine Microbiome Forum will also contribute to the development of an All Atlantic bioeconomy.

2.4.2.4. Implementation Strategy

1. To leverage ongoing projects on drug discovery
2. To bring academia into the public policy formulation
3. To promote the presence of national pharmaceutical and cosmetic companies in the field of marine bioeconomy
4. To support national biobanks for the safeguard of biological materials, e.g. the FIOCRUZ collection center

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

5. To formulate policies to safeguard the use environmental DNA as a raw material (the source code) for biodiscovery, processes, and drug development for patents in the context of synthetic biology
6. To promote the development of projects in centers and networks (e.g. Biotecmar network)

2.4.2.5. Activities and Targets

1. To support at least 10 research and development projects towards marine bioeconomy
2. To develop at least one new drug across the Atlantic
3. To develop at least one new cosmetic product across the Atlantic
4. To promote at least 10 joint initiatives of academia, industry and government
5. To create a GARS-Center for STI of drug discovery
6. To promote African government programs e.g., the Operation Pakisa

2.4.2.6. Adherence to the SDGs

This thematic area contributes to the achievement of several SDGs (e.g. 1. No poverty, 3. good health and well-being, 8. Decent work and Economic growth, 9. Industry and innovation, 14. Life below water, 17. Partnerships for the goals).

2.4.2.7. Resources

$120million in 4 years.

2.4.3. Thematic Area 3: Environmental Health

2.4.3.1. Goal

To develop STI studies in the field of environmental health. Studies include the functioning and monitoring of marine systems, reefs, bays, islands, coastal areas, and the deep ocean. It also includes the monitoring of industrial settings in the ocean, for instance oil and mining activities.

2.4.3.2. Context

Microbiomes can be harnessed as biosensors for monitoring environmental and industrial processes. Several studies have shown that biosensors can be employed for monitoring different types of pollutants, including organic pollution (domestic and sanitary effluents), mining tailings, and hydrocarbons. Microbiomes have been employed in the study of the Amazon megabiome and demonstrated the connection among forest, mangroves, and the sponges in the bottom of the ocean (200 m depth). Biosensors can also be applied for the study of the paleoclimate modulation over biodiversity. Biosensors respond rapidly to pollutants in water. Viruses play a key role in the control of populations of primary producers present in the Amazon plume, a region that is responsible for capturing vast amounts of CO_2. Therefore, viruses act by releasing organic matter into the marine environment. Viruses can control the

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

ability of the plume to absorb CO_2. Reef protected areas have specific biosensors for health. Damaged reefs in unprotected areas of the Southwest Atlantic show an increase of pathogenic microbes, virus, and heterotrophic metabolism. One of the major causes of reef degradation is the loss of fish biomass through fishing and consequent phase shift, with increase of algae and pathogens. Biosensors may be applied in fisheries management in reef areas. The knowledge about marine viruses in the Atlantic is still very limited. Furthermore, microbial genes could be harnessed in a variety of applications in molecular biology, medicine, and environment. Transnational equitable agreements are needed to leverage STI on the basis of co-creation, and co-development.

2.4.3.3. Motivation

Global and local impacts on the ocean are observed worldwide. Oil spills, plastics and microplastics are examples of problems in ocean health. Transnational companies, national governments and municipalities will need to reinforce the further ocean monitoring programs to mitigate the impacts of local and global changes. To seek a clean ocean is mandatory for the sustainability of new generations.

2.4.3.4. Implementation Strategy

1. To leverage ongoing projects on biodiscovery, biosensors, and ocean monitoring
2. To formulate policies that safeguard environmental DNA as a raw material for biodiscovery and patents
3. To support the study of emerging rare pollutants and emerging marine pathogens
4. To support national initiatives on marine biodiversity health and monitoring (e.g. The Long-Term Ecological Monitoring Program on the Amazon Reefs, PELD-GARS)

2.4.3.5. Activities and Targets

1. To support at least 10 research and development projects on marine biodiscovery
2. To develop at least one new pipeline for biodiscovery
3. To develop at least one new computational tool (bioinformatics) for biodiscovery
4. To promote at least 10 joint initiatives of academia, industry and government
5. To establish a biodiscovery center for the GARS megabiome
6. To promote ongoing programs across the Atlantic (e.g. AORA microbiome, and Operation Pakisa, AAORIA-BBAMM Blue Biotechnology, Aquaculture and Marine Microbiome Forum)
7. To engage young researchers and to implement new young researcher STI groups in Latin American and African Countries

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

2.4.3.6. Adherence to the SDGs

This thematic area contributes to the achievement of several SDGs (e.g. 6. Clean water and sanitation, 8. Decent work and Economic growth, 9. Industry and innovation, 13. Climate action, 14. Life below water, 17. Partnerships for the goals).

2.4.3.7. Resources

$90million in 4 years.

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

AA-BIOTECMAR Contact Details

Main contact: Fabiano Thompson

Email: fabianothompson1@gmail.com

Web: https://allatlanticocean.org/jointaction/all-atlantic-marine-biotechnology-initiative

All-Atlantic Ocean Contact Details

Coordination: FCT – Fundação para a Ciência e a Tecnologia

Email: info@allatlanticocean.org

Web: http://www.AllatlAnticOcean.org/

Twitter**: @AllAtlanticO**

Facebook**: @AllAtlanticOcean**

YouTube: **All-Atlantic Ocean Research Alliance**

AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.