

## Consiglio Nazionale delle Ricerche (CNR)

The Consiglio Nazionale delle Ricerche – National Research Council of Italy (CNR) was founded as legal person on 18 November 1923 (Royal Decree 2440/1923). The mission of CNR, defined in the first Statute of 1924, is to coordinate and stimulate research activity at a national level in the different areas of science, to keep in contact with various stakeholders on scientific matters and to establish national scientific laboratories. More than 8000 people work in the 88 research institutes of CNR.

Five of the 88 research institutes are involved in EMBRC-IT:

- 1) Istituto per lo studio degli impatti Antropici e Sostenibilità in ambiente marino – Institute for the Study of Anthropic Impact and Sustainability in the Marine Environment (IAS);
- 2) Istituto di Scienze Polari – Institute of Polar Sciences (ISP);
- 3) Istituto per le Risorse BIologiche e le biotecnologie Marine – Institute for Marine Biological Resources and Biotechnology (IRBIM);
- 4) Istituto di Scienze MARine – Institute of Marine Sciences (ISMAR);
- 5) Istituto di Ricerca Sulle Acque – Water Research Institute (IRSA).

### *EU Research Infrastructures*

These five CNR Institutes are actively involved in EMBRC and other European Research Infrastructures recognized by ESFRI (European Strategy Forum on Research Infrastructures), distributed facilities that provide resources and services for research communities to conduct research and foster innovation.

CNR has a series of marine research stations that are already connected between them and that will increase their relevance and connections across Europe within the remit of EMBRC, strengthening collaboration, and enabling researchers to gain access to organisms, services and facilities to advance fundamental and applied marine research.

# ECOSYSTEM ACCESS

## SCUBA DIVING FACILITIES

Scuba diving facilities encompass a spectrum of scientific activities, including the procurement of materials across diverse coastal ecosystems, the installation, and meticulous upkeep of submerged structures and equipment, as well as the proficient recovery, transportation, and subsequent release of marine fauna.

- CNR-IRSA Taranto owns scuba diving equipment (ARA units, underwater video-photo systems, geolocation systems, underwater scooters Teseo BM2-9). Recently, due to PNRR financing, a surface drone and an underwater autonomous system for images acquisition were obtained.
- CNR-IAS Capo Granitola hosts the Gr.O.S.S. (Gruppo Operatori Scientifici Subacquei) formed by researcher and technicians able to support a great variety of underwater activities. The group owns scuba diving equipment ARA units as well as instruments for scientific sampling: underwater video-photo systems, sorbone, visual census equipments, ecc...

## COASTAL VESSELS

Several science vessels are in use at the different institutes and locations of CNR and specifically serve marine research activities. This service includes vessels equipped with experienced crews and state-of-the-art instrumentation for scientific investigations in coastal waters.

The available Research Vessels are:

- The M/B Gerax Vorax (Albatros 22 Open Space) at CNR-IRSA Taranto is propelled by an outboard Suzuki DF150 engine. It is equipped with navigation tools (RayMarine Axiom 9+ with fishfinder 600W, Down/Side/3DRealVision, GPS and Navionics cartography), an anchoring system GPS MotorGuide Xi5 and a stabilization system ZipWake 300S. Instrumentation for water sampling and multi-parameter probes for the execution of hydrological variable profiles on the water column (P, S, T, O2%, pH, chl-a, turbidity) are available, as well as different plankton nets,

for the sampling of all planktonic fractions of both phyto- and zooplankton, including the WP2 net. Instrumentation for acoustic analyses, by an aquatic drone equipped with a side scan sonar and a multibeam.



CNR IRSA Taranto – Research vessel

- The Lesina lagoon boat (1990) at CNR-IRBIM Lesina is a small flat-bottomed aluminum boat for navigation in shallow lagoon waters, propelled by an outboard engine generating 10 Hp. Equipped with navigational tool (portable GPS) and field instrumentation as multiparametric probes for a detailed environmental data acquisition. Research equipment includes also water samplers (NISKIN bottle) and sediment samplers (box corer and telescopic corer) for chemical and biological analyses, plankton nets providing sampling of planktonic communities and handmade sample sieving screens for field benthic macrofauna sorting (0.5-1 mm).



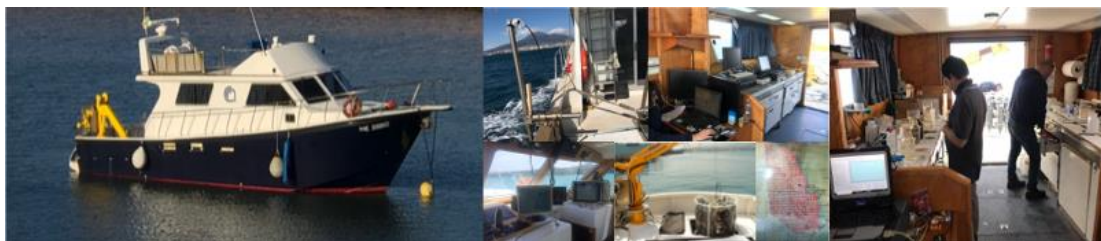
CNR IRBIM Lesina research vessel

- The Motorboat Litus at CNR-ISMAR, Venice; Gross tonnage 7.75 ton, Length 10.20 m, Width 3.10 m, Draught 1.60 m. Max n. of people on board 10 (including 2 crew members). Motors n. 2 FPT INDUSTRIAL SPA – 2×110 kW (2×149,6 HP) Navigation limit 12 NM. Equipment: Generator Group G&M Marine DIESELITE 6 kW, 220 V; Radar RAYTHEON 3200, range 32 mg; Echo sounder ELAC LAZ 72.1; Radiophone VHF LABES 510, 100 channels; GPS, magnetic compass RIVIERA. A bow lab, bow cabin with toilet, galley and a refrigerator can be fitted out. Large stern cockpit. A stern platform allows easy operations.
- Aretusa at CNR-ISMAR, Venice; Gross tonnage 4.67 ton, Length 6.75 m, Width 2.48 m, Draught 0.87 m, Max n. of people on board 6 (including 1 crew member), Motors Suzuki gasoline outboard 110.3 kW (150 HP), Navigation limit 12 NM. A vessel suitable for navigation in lagoon areas due to its shallow draft. Equipped with covered space, it allows sampling and monitoring activities of long duration.
- Boston Whaler at CNR-ISMAR, Venice; Gross tonnage 0.97 ton, Length 5.04 m, Width 1.71 m, Draught 0.50 m, Max n. of people on board 8 (including 1 crew member), Motors Yamaha gasoline outboard 51.5 kW (70 HP), Navigation limit 6 NM. A vessel suitable for

navigation in shallow waters, it allows sampling and monitoring activities in environments characterized by shallow water and strong tidal range such as the Venice Lagoon.



- (Capo Granitola) is a research motorboat registered in the Minor Vessel Register of the Port Authority of ME (No. 2880) with a gross tonnage of 16.73 tons, length 14.06 m, width 3.95 m, draught 1.43 m. Enabled for coastal navigation, within 12 nautical miles, can accommodate until 10 people including two crew members (CNR-IAS Capo Granitola). The vessel (made of fiberglass) is equipped with two 560-hp caterpillar diesel engines that can reach a speed of 28 knots, a side bow thruster, 3,000 liters of fuel and 1,000 liters of water. On-board instruments are: Radar, Echo sounder, VHF, GPS plotter, Magnetic compass, Autopilot, a 10 kw (220V) electric Generator to power the refrigerators (+5°C, -5°C, -20°C), acoustic instrument plates (Multibeam-ADCP). It is also equipped with hydraulic crane for water sampling with "Rosette" (12-bottle Niskin, 8 liters), CTD Sea-Bird 911Plus multi-parameter probe, sediment samplers (Box Corer, Bucket), plankton nets (Calvet, Bongo 40/60. ..) or for the use of acoustic instrumentations while Side Scan Sonar, Sparker, hydrophones.



*CNR-IAS of Capo Granitola, Research Vessel "Luigi Sanzo"*

## EXPERIMENTAL AND MAINTENANCE

## FACILITIES

The experimental facilities deal with the continuous or temporary breeding as well as the supply of marine model organisms for scientific purposes. This includes the care of Mediterranean and Polar species as well as some globally used animal models and alien species. These facilities operate through a framework of continuous management and rigorous monitoring, overseeing not only the species housed within the tanks but also the meticulous regulation of materials and activities within these controlled environments. This management guarantees optimal conditions for research, promoting a sustainable environment conducive to scientific research and experimentation.

- CNR-ISP Venezia.

The facility includes two Clean Laboratories dedicated to the ultra-clean manipulation/preparation of samples for inorganic and organic analysis, respectively. The inorganic clean laboratory is entirely made of plastic-coated materials designed for the low release of airborne particles, while the organic clean laboratory is entirely made of steel materials and components designed to minimize the release of organic substances and maximize the effectiveness of decontamination procedures.

The inorganic clean laboratory consists of 4 rooms ISO 6 equipped with laminar flow benches (one is additionally equipped with an extractor hood and glove box for the preparation of atmospheric aerosols filters), 1 room ISO 5 equipped with laminar flow bench and 1 room ISO 4.

The organic clean laboratory consists of 1 room ISO 7 for intermediate sample preparation, 2 rooms ISO 6 equipped with laminar flow benches, 1 room ISO 5 equipped with laminar flow bench and 1 room ISO 4.

All the clean rooms are at overpressure increasing as function of their class, equipped with ceiling installed HEPA filters for continuous filtering of the internal air and dedicated internal production systems of Ultrapure water (Elga LabWater).

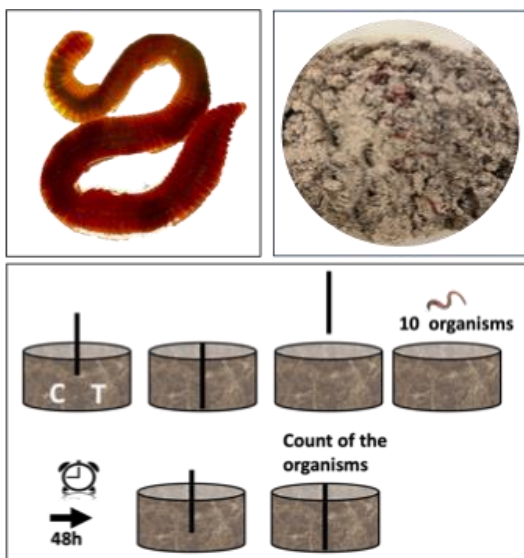
**Applications:** contamination-free manipulation and processing of samples for trace and ultra-trace level analysis of inorganic or organic species.

- CNR-ISP Bologna. The Organic Geochemistry Laboratory at the Institute of Polar Sciences in Bologna deals with modern processes and paleo reconstructions by coupling the information provided by fossil biomarkers and stable carbon and nitrogen isotopes. Biomarkers and stable isotopes are geochemical proxies used to investigate the feedback mechanisms between the Earth climate and the biogeochemical cycles. The laboratory is equipped with various instruments to extract, purify and analyze a suite of different biomarkers, including terrestrial compounds (e.g. lignin phenols, aliphatic chain lipids, cutin-derived products) to understand land-ocean carbon exchange (e.g. permafrost thawing, river floods, etc.), alkenones for paleo-temperature reconstructions and highly branched isoprenoids for sea ice reconstructions. In addition, the laboratory is equipped with a Preparative Fraction Collector (Agilent-Gerstel) for the collection of individual compounds. This technique is especially useful for the radiocarbon analysis of biomarkers and can be very useful to derive an age model for the sedimentary archives and to investigate the processes related to permafrost thawing.

**Facilities:** The Organic Geochemistry Laboratory is equipped with several gas chromatographers and mass spectrometers for the analysis of carbon and nitrogen stable isotopes, measurement of carbon, hydrogen, nitrogen and sulphur content in organic matter and the extraction/quantification of organic biomarkers, including

- Thermo Fisher Scientific FLASH 2000 Element Analyzer coupled with a mass spectrometer DeltaQ (EA-IRMS)
- GC Agilent GC 7820-MSD EI 5977B
- GC Agilent 8860-FID G2790A
- GC Agilent 8890 equipped by a Gerstel Preparative Fraction Collector (PFC)

- CNR-ISP Roma. The facilities at the laboratory *BioChem* “*Biological analysis laboratory to assess the effects of organic micropollutants on natural ecosystems*” housed at CNR-ISP-Roma, are dedicated to studying the ecotoxicological effects of



Example of Ecotoxicological test (*E. Foetida*)

legacy and emerging organic contaminants on target organisms; the bioaccumulation/biomagnification factors of organic micropollutants in the biota (fish, molluscs, terrestrial and aquatic earthworms, terrestrial and aquatic plant species); the persistence and effects of pollutants on natural microbial communities in different environmental compartments, such as surface waters and sediments (seas, rivers, lakes), snow/ice and soils. These evaluations are performed by laboratory-scale experiments set up (microcosm approach) using test organisms (e.g., *Eisenia foetida*) to evaluate the ecotoxicological risk associated with the occurrence of organic contaminants (single and mixture) in terrestrial and aquatic compartments. Moreover, the microcosm approach allows the evaluation of the effect of

chemical (e.g. pH, chemical composition), physical (e.g. temperature, relative humidity, light, moisture), and biological (e.g., microbial community structure) parameters on the distribution, occurrence, and persistence (expressed as half-life time, DT50) of organic micropollutants, their bioaccumulation factors and the effects on structure and functioning of microbial communities. The latter aspect can be evaluated in terms of assessment of:

- the spatial and temporal changes in the metabolism of microbial communities by a spectrophotometric method called community-level physiological profiling (CLPP);
- microbial profiling through a taxonomic fingerprint of the main microbial groups (Gram-positive, Gram-negative bacteria and Fungi) by biochemical methods (PhosphoLipid Fatty Acid analysis-PLFA).

The analytical methodologies performed at *BioChem* Lab at CNR-ISP-Roma are:

Pre-treatment methods (e.g. freeze-drying, filtration, etc.); Extraction/Clean-up methods (solid-phase extraction-SPE, pressurized liquid extraction-PLE, liquid-liquid extraction-LL); Sensitive and selective analytical methods based on the coupling of chromatographic techniques (HPLC or GC) and fluorescence, FID-ECD, and mass spectrometric (MS) detection; The *avoidance behaviour* test, based on the exposure of organisms, specifically earthworms belonging to the *Eisenia foetida* species, to different sub-lethal concentrations of organic contaminants, to evaluate their escape/avoidance behaviour in the contaminated area; The evaluation of the composition of natural microbial communities based on PLFA (PhosphoLipid Fatty Acid) profiling. This biochemical technique includes the extraction of fatty acids from microbial membrane phospholipids in the environmental matrix and a methylation reaction followed by separation and analysis with gas chromatography; The analysis of microbial diversity at a functional level, performed by the determination of the metabolic/physiological profile (CLPP). This physiological assay involves the incubation of the environmental sample in specific plates and spectrophotometric measurements at fixed times.

The *BioChem* Lab is equipped with the following analytical tools:

**Benchtop lyophilizer (freeze-dryer LABCONCO)** 2.5 L capacity, equipped with a touchscreen display, for the pre-treatment of solid matrices subsequently extracted with PLE.

**Solid Phase Extraction (SPE):** 12 inlets of the solid phase extractor are connected to cartridges packed with specific adsorbents for the extraction of target compounds from liquid matrices through a vacuum system.

**Syncore® Analytist** (Buchi) for the simultaneous pre-concentration of liquid phase samples.

**Rotavapor R 100** (Buchi), equipped with an electronic interface to control the vacuum system and the recirculating chiller.

**Gas Chromatograph** (Perkin Elmer, Clarus 480) **coupled to a FID-ECD detector** (Flame Ionization Detector- Electron Capture Detector). The instrument is connected to an autosampler (Autosystem, Perkin Elmer) and is controlled by TotalChrom Software.

**Gas chromatograph** (Thermo Fisher, Trace 3000) **coupled to a mass spectrometry (MS) detector** (Thermo Fisher, ISQ7000). The device is connected to an autosampler (Thermo Fisher, AI 1310) and is controlled by a Chromeleon software.

**HPLC** (quaternary pump, column Oven mod. LC-100 and Micro Pump Series 200, Perkin Elmer, USA) **coupled to a fluorescence detector** (Perkin Elmer Series 200a). The device is controlled by Chromeleon Software.

**HPLC** (binary pump, Vanquish TM Core HPLC system, Thermo Scientific TM, Italy) coupled to a high-resolution mass spectrometer (Orbitrap Exploris 120, Thermo Scientific TM, Italy). The device is controlled by XcaliburSoftware (version 5.1).

**Spectrophotometer** (Biolog Microstation System, Biolog Inc.) for the reading of microplates (96 positions). This instrument is controlled by specific software.



### *Spectrophotometer Biolog Microstation System and Biological microplates at ISP-Roma*

- CNR-ISP Messina can give access to microcosms of different sizes in Ny-Ålesund for Arctic marine invertebrate experiments (isolation and identification of microbial-associated organisms i.e. culture media, Petri dishes, antibiotic discs, gut microbiota, skin microbiota, kits for immunological and digestive parameters, etc). Further, the Culture Collection of Microorganisms from Cryoenvironments – MICR(Y)O was established in 2023. MICR(Y)O is embedded in the Laboratory of Microbial Ecology and Biotechnology (EcoBiM) at CNR-ISP in Messina, involved in research describing microbial biodiversity in extremely cold environments. The culture collection is composed of microbial strains, mainly bacteria, isolated from different environmental sources (e.g., freshwater, seawater, marine and freshwater sediment and benthic organisms) in the Arctic and Antarctica, as well as alpine sites, spanning from terrestrial to marine habitats. Currently, MICR(Y)O includes more than 100 strains of marine origin, but it is continually expanding. Isolates are identified by the 16S rRNA gene sequencing and phenotypically characterized by standard microbiological tests. All cultures are maintained in duplicate on agar slants at 4 °C and routinely streaked on agar plates from tubes every six months to control purity and viability. Cold-adapted strains are also preserved by freezing cell suspensions at – 80 °C in liquid broth to which 20 % (v/v) glycerol is added. Microbial strains, or their purified DNA, are available upon request from the scientific community. This biological resource may serve the needs of various R&D sectors, including blue biotechnology.

CNR-ISP in Messina is equipped with laboratories for the study of microbial structural and functional diversity, particularly for the phenotypic and biochemical characterization of microbial communities by culture and metabolic bioassays. Research activities at the Microbial Biogeochemistry (BiogeM) laboratory focus on the cultivation of aerobic microbial communities and on the assessment of the role of microorganisms in the biogeochemical cycles and in the Carbon biological pump, also in relation to climate change. In several environmental matrices (water, biofilms, sediments, snow, permafrost and brines) measurements of microbial metabolic activities are performed, including quali- and quantitative enzyme activity assays (i.e. leucine aminopeptidase, beta-glucosidase and alkaline phosphatase) using fluorogenic



substrates, respiratory activity assays for O<sub>2</sub> consumed and CO<sub>2</sub> produced by Electron-Transport activity assays, screening of bacterial isolates for antibiotic susceptibility, as well as the characterization (abundance, metabolism and diversity) of plastics-associated microbial community (“plastisphere”). Other research topics address fish physiology (digestive and immune assays such as lysozyme and hemolytic activities). At CNR-ISP Messina the following instrumentation is available: Glomax Promega fluorometer, Cary-Varian spectrofluorometer, Wood's lamp, thermostated incubators, autoclave, homogenizer, filtration systems, refrigerated Eppendorf centrifuges, and a BD Accuri C6 plus (Becton) flow cytometer (in next acquisition thanks to PNRR funds).

CNR-ISP Messina has developed a wet laboratory for testing bioremediation methodologies, equipped with tanks of 40 liters (microcosms). These tanks are temperature controlled, allowing experiments to be conducted either statically (using matrices created ad hoc, seawater, freshwater, brackish water) or dynamically, with a continuous flow of seawater. Different natural and artificial substrates can be added to simulate biodegradation experiments on sediment or in the water column. It is possible to change and monitor diverse physicochemical conditions (temperature, light, current regime) capable of mimicking various environmental conditions found in natural or artificial locations. A system has been developed to test electrokinetic soil/sediment bioremediation applicable to the aforementioned mesocosms.

CNR-ISP Messina has developed a system for sampling and maintaining bacterial strains under high hydraulic pressure (max tested 45 MPa). The sampler consists of titanium Niskin model sampling bottles with a volume of 8 liters, compatible with common Rosette Samplers, capable of maintaining the samples collected at in-situ pressure with a deviation of less than 20% from the original pressure. Additionally, there are stainless steel 1-liter pressure incubators capable of withstanding 50 MPa of hydraulic pressure, allowing static experiments with different pressure regimes.

- CNR-IRBIM Lesina, can give access to lagoon water tanks for *in vivo* fish and crustacea maintenance. Open-circuit underground basins are located near the southeastern shore of the Lesina lagoon. They are equipped with a pump that allows water intake directly from the lagoon, guaranteeing food, oxygenation and natural conditions for the hosted species. CNR-IRBIM Lesina houses inside humid laboratories for biological samples processing and benthic macrofauna observation, as well as laboratories for environmental chemistry analyses (nutrients, chlorophylls, DOC-CDOM).



*Open-circuit underground basins for biological species maintenance at CNR IRBIM Lesina*

- CNR-ISMAR provides access to the ecotoxicology and chemistry laboratories in Venice. These facilities allow performing analyses in the context of the integrated assessment of environmental quality through the application of biomarkers, measuring the biochemical, physiological and behavioral alterations correlated to the exposure of sentinel species (molluscs, polychaetes and fish) to stressogenic agents, both of anthropic and natural origin. Biomarkers are measured on cells, tissues and the entire organism: enzymatic determinations, cellular and physiological measurements able to highlight metabolic alterations and / or detoxification and biotransformation processes, neurotoxicity and genotoxicity and in general the physiological state of bioindicator organisms. The lab is equipped with Spectrophotometer Shimadzu RF6000, Spectrophotometer Shimadzu UV 1280, Centrifughe: Beckman Coulter Allegra 64R, , Beckman J2-21, Eppendorf 5804 R, Bio-Optica embedding control unit with 3 separate modules (PF100, DP500, UT200), Microtome Leica RM2125RT with thermostatic bath, Stereo-microscope Leica S9D and WILD Heerdrug, optic microscope Leica DMLB with videocamera Leica EC3. The integrated approach correlates the biological responses / alterations with environmental contamination. Concentrations of contaminants in organisms and environmental matrices can be analysed in the linked chemistry labs. These labs are equipped to measure organic pollutants using chromatographic techniques (PAHs, PCBs, Organotins, Aliphatic Hydrocarbons, Chlorinated Pesticides, TOSC), analysis of inorganic pollutants (heavy metals and arsenic). Labs are equipped with Agilent 7820A-5977E Single Quadrupole Mass Gas Chromatograph; Thermo Trace 1300 gas chromatograph with dual detector (FID and ECD): Agilent 1260 Infinity II HPLC with dual detector (DAD and Fluorescence), Atomic Absorption AAnalysis 100; ICP-OES Perkin Elmer Optima 2100 DV; Agilent 7700 ICP-MS; Anton Paar Multiwave 3000Solv microwave oven; Perkin Elmer Lambda3B spectrophotometer.
- CNR-IAS can offer the access to a laboratory for cultivation and test on *Posidonia oceanica* seed and seedlings as well as other marine plants. This facility consists of a mobile insulated air-conditioned container equipped with a large workbench and two batteries of 12 groups of aquaria of 20 and 60 liters. Each group of aquaria is served by a lighting, filtration, air conditioning and water independent monitoring systems. A total of 4/5000

seeds/seedlings can be cultivated in the laboratory and different treatment can be applied in order to test experimental hypothesis.



## LONG TERM ECOLOGICAL RESEARCH

CNR supports the activities of the Long Term Ecological Research sites “Mar Piccolo of Taranto” (LTER-IT22), CNR supports the activities of the Long Term Ecological Research sites “Mar Piccolo of Taranto” (LTER-IT22), “Venice Lagoon“ (LTER\_EU\_IT\_16) and North Adriatic (LTER\_EU\_IT-12) with the Gulf of Venice site (Acqua Alta oceanographic tower LTER\_EU\_IT\_057).

These LTER sites are aimed at understanding the variability of ecological processes over extended temporal and spatial scales, The main lines of research are centered on the survey of physico-chemical and hydrological environmental variables, on the ecology and distribution of phyto- and zooplankton with a particular focus on biodiversity and alien species. These studies include both ecological investigations aimed at tracing the time variability of the systems and complementary research based on experiments or additional observations flanking the routine monitoring for shorter periods of time.

The oldest and most continuous historical data sets from the Mar Piccolo of Taranto site are on chemical-physical variables and phytobenthos, and allow the study of changes occurred in the basin due to both anthropogenic activities (e.g mollusk import-export) and the climate change.

More irregular data series are on phytoplankton (including cyanobacteria and resting stages) and invertebrates (mainly Amphipods). The PNRR financing allowed the start of new data series, such as emerging pollutants, mollusks, bacteria, zooplankton (including resting stages). One of the main goals is to provide real-time access to the data obtained from long-term monitoring.

Venice LTER historical datasets consist of over 20 years of hydrological and plankton data collected through various *ad hoc* designed nets (phytoplankton and mesozooplankton).

# RESEARCH & TECHNOLOGY PLATFORM

- CNR-ISMAR provides access to the Acqua Alta Oceanographic Tower and the meteorological and hydrological datasets. This unique research facility is installed about 8 miles off the coast of Venice, in a stretch of sea having a depth of about 16 m (GPS 45.3142467 N, 12.5082483 E). It consists of a laboratory module and accommodations, as well as sophisticated distribution facilities that includes complete meteorological and oceanographic stations whose data are both recorded on board and transmitted in real time to shore. Real time transmission and cation capabilities; ICT infrastructures; Biological laboratories; Housing facilities, electrical supply by photovoltaic panels and wind turbines connected to lithium batteries and diesel generators; Recorded time-series: meteo (air temperature and pressure, wind speed, gust and direction, RH, precipitation); ocean (pCO<sub>2</sub>, temperature, salinity, dissolved Oxygen, fluorescence, turbidity, current speed and direction, sea level height, wave height, period and direction, images). For the past few years, webcams that can be accessed through the Institute of Marine Sciences website ([www.ismar.cnr.it](http://www.ismar.cnr.it)) and through the ISMAR Data smartphone application have also been installed on the platform. The historical series of directional wave measurements, uninterrupted for over exceeds 40 years, represents one of the longest historical series available in the world. As the only permanent and mannable point at sea, it has provided sea truth for the calibration of instruments installed on artificial satellites such as the ERS-1 altimeter and the optical properties of the sea measured by SeaWiFS and OLTS. The High Water Oceanographic Platform contributes to the European research infrastructures DANUBIUS-ESFRI, and JERICO-RI, LTER, EMBRC, as well as the NASA Aeronet monitoring network, LTER - Long Term Ecological Research Network and the European Marine Omics Biodiversity Observation Network (EMO BON).





**CNR-ISMAR Acqua Alta Oceanographic Tower (Venice)**

- CNR-ISP Messina provides access to a specialized technology platform for acoustic data analysis, designed for research focused on underwater noise and environmental acoustic components. Our capabilities extend to evaluating ecological dynamics through the analysis of marine mammal acoustic vocalizations. Furthermore, our resources support in-depth investigations into the biochemical, physiological, and behavioral responses of animals exposed to acoustic disturbance. The data collection platform is strategically located in Ny-Ålesund, offering researchers a unique opportunity to conduct studies in this Arctic environment.

The BioSoundEcology Lab, an acoustic laboratory located at the Messina site of CNR-ISP(<https://www.isp.cnr.it/index.php/en/infrastructures/laboratories/item/361-acoustic-biodiversity-and-marine-ecology-lab-biosoundecology-lab>), will facilitate the development of analytical tools and experimental approaches for acoustic data analysis. Researchers can benefit from collaboration with this specialized laboratory, further enhancing their capabilities and resources for conducting cutting-edge research on marine acoustics and the impact of sound on marine ecosystems.

## SEQUENCING AND MOLECULAR ANALYSES

The sequencing and molecular analysis facilities, together with the bioinformatics and data management capabilities, offer logistics for barcoding and metabarcoding experiments. Such facilities are available at CNR-IAS Capo Granitola, CNR-IAS Oristano, CNR-ISP Bologna, CNR-ISP Messina, CNR-IRSA Verbania.

## THE ADVANCED MICROSCOPY FACILITIES

The microscopy facilities combine light, standard, confocal fluorescence, and electron microscopy. In detail:

- CNR-IAS Capo Granitola has at its disposal stereo and light microscopes, equipped for both biological and geological observations. Photo and video cameras, as well as software for imaging analysis, are available for the operators. Moreover, a fluorescence microscope is available in Capo Granitola.
- CNR-IRBIM Lesina provides access to stereo and light microscopes, equipped with cameras for direct observation of the samples and the taxonomic identification.
- CNR-IRBIM Messina provides access to stereomicroscopes and optical microscopes. There is also an imaging system connected to the optical microscope.
- CNR-IRSA Verbania provides access to light microscopes to handle samples and specimens and the taxonomic identification of the organisms.
- CNR-IRSA Taranto has available stereo and light microscopes (including also inverted microscopes) for the direct observation of the samples and the taxonomic identification. Some of these instruments are equipped with photo and videocameras.

## ACCESS TO AUTONOMOUS MARINE OBSERVATORY IN KONGSFJORDEN, SVALBARD ISLAND

CNR-ISP Bologna, A permanent instrumented mooring has been installed in the inner part of Kongsfjorden (Svalbard Islands) at a depth of about 100 m with the aim of studying the intensity and composition of the flows of particles falling to the sea bottom, while monitoring the main physical properties of the water column. The mooring called Dirigibile Italia (MDI) was first installed in September 2010 and is serviced annually.

The oceanographic sensors on MDI are positioned along the mooring at different levels in the water column. The list of measured parameters includes:

- water temperature at 25, 36, 54, 62, 85 and 92 m
- speed and direction of currents at 37 and 93 m
- conductivity / salinity at 25 and 85 m
- turbidity and dissolved oxygen at 85 m
- total mass and particulate organic carbon flows at 83 m.

The Amundsen-Nobile Climate Change Tower (CCT) is a scientific platform dedicated to studying the thermodynamic characteristics of the atmospheric boundary layer and the exchange processes between the surface and the lower layers of the atmosphere. The structure is composed of 17 modules equipped with patch boxes to provide a power supply and data connection that ends in a dedicated hut at 40 m from the tower, where the acquisition systems are located. The CCT provides continuous profiles of meteorological parameters at four levels up to 34 m, measurements of turbulent fluxes of momentum heat and moisture at two levels as well as of radiation balance components (visible and infrared). Measurement of the characteristics of the snow layer (depth and temperature) are also provided in conjunction with the atmospheric parameters.

Both these infrastructures could host other instruments from other research groups based on funded research projects.

Several equipped laboratories have been also available in the Dirigibile Italia Base to perform many different lab activities.

## STRUCTURAL AND CHEMICAL ANALYSIS AND DATA ANALYSIS TOOLS

The structural and chemical facilities include different technologies providing data to support and integrate monitoring strategies of natural ecosystems.

- **CNR-ISP Venezia**

The site makes available state-of-the-art instrumentation and technical expertise for advanced studies of chemical identification and quantitative determination at extremely low levels and/or in complex matrices and structural analyses at the micro-to-nano scale for micro/nano plastics characterization.

**Inductively coupled plasma - sector field mass spectrometer (ICP-SFMS)**

The high-resolution mass spectrometer Element XR (Thermo Scientific) allows performing interference-free high-precision quantitative determination of elements and isotopic/elemental ratios in liquid samples down to the ultra-trace level.

Thanks to a combination of high-resolution mass filter and counting, analog and Faraday detection modes, the linear dynamic range of the detector extends from sub fg/g (ppq) to over 12 orders of magnitude in solution mode.

The instrument is equipped with a SC-4 autosampler (ESI) for continuous data acquisition and can be equipped with ARIS (ESI) or ARIDUS (Cetac) desolvating nebulizer systems for further reduction of solvent-based interferences such as oxides and hydrides.

Applications: quantitative multi-elemental and isotopic analysis at trace and ultra-trace levels in environmental samples, geological analysis, material sciences, conservation sciences, forensics, clinical samples, food and biological materials.

**Inductively coupled plasma - quadrupole mass spectrometer (ICP-QMS)**

The instrument iCAP-RQ (Thermo Scientific) is dedicated to the quantitative determination of trace elements and elemental ratios in liquid samples. The system is equipped with a Qcell technology assembly which can be run using He as collision gas and/or H<sub>2</sub> as reaction gas to achieve reduction of spectral interferences. Additional accessories include an autosampler ASX-560 (Cetac) for high-throughput analysis, sample introduction kit for the analysis of HF mineralized samples and cone inserts for high sensitivity/robust/high matrix analysis. The instrument allows performing highly reproducible quantitative multi-elemental determinations over 9 order of magnitude in concentration in a variety of sample matrices across the entire mass range.

Applications: quantitative multi-elemental analysis from major to low-trace levels in environmental samples, geological analysis, material sciences, conservation sciences, forensics, clinical samples, food and biological materials.

**Inductively coupled plasma - optical emission spectrometer (ICP-OES)**

The instrument iCAP 7400 (Thermo Scientific) is dedicated to the quantitative determination of major-to-trace elements and elemental ratios in liquid or (appropriately) dissolved samples. The system is equipped with high-efficiency light transmission system, radial or duo (radial + axial) plasma view configurations to suit a wide variety of sample types and elements of interest and a simultaneous wavelength acquisition system. Elemental concentrations can be determined with detection limits in the ppb or sub-ppb level with high instrumental precision and long-term signal stability even in complex matrices or at consistently high levels with minimized memory effects. Additional accessories include an autosampler ASX-560 (Cetac) for high-throughput analysis.



Applications: quantitative multi-elemental analysis from major to trace levels in environmental samples, geological analysis, material sciences, conservation sciences, forensics, clinical samples, food and biological materials.

### **Mercury analyzer**

The Mercur DUO plus (Analytik Jena) is an atomic absorption (AAS) and atomic fluorescence (AFS) spectrometer specifically designed and dedicated to the analysis of mercury in compliance with the standards EPA, EN and ISO. An integrated module with two gold collectors allows simple or cascade enrichment of mercury (according to EPA method 1631) to achieve determination limits from the low ppt to the ppq range with high method robustness, depending on the type of sample and configuration. Additional accessories include an autosampler AS-FD for high-throughput analysis.

Applications: determination of mercury in drinking and natural waters, wastewater, soil and sediments, rocks, ashes, biological fluids, food, beverages, quality control of materials.

### **Fourier-transform infrared spectroscopy (FT-IR) microscope**

The instrument is an infrared microscope Nicolet iN10 (Thermo Scientific) integrating a high-resolution CCD optical camera and a FT-IR spectrometer and is designed to perform microanalysis with lateral resolution down to a 50-microns at room temperature or a few microns with liquid nitrogen cooling. The instrument is equipped with motorized stage, MicroTip ATR device for direct contact sampling and analysis of fine structures (down to 3 microns), motorized visible polarizer for visual inspection, MTC-A detector with spectral range 7800–650 cm<sup>-1</sup> and the dedicated software package OMNIC Picta for spectral identification of pure compounds and mixtures. Acquisition can be performed in transmission, reflection, or ATR modes. Particles analysis can also be performed to extract species-specific distributions of morphological parameters (size, shape).

Applications: microspectroscopy, material identification, packaging and laminate, coating, active pharmaceutical ingredient (API) mixture distribution mapping, identification of contaminants, microplastics identification and characterization.

### **High performance ion chromatograph - mass spectrometer (HPIC-MS)**

The instrumentation consists of a high performance ion chromatograph ICS-5000 Standard Bore and Microbore System (Dionex, Thermo Scientific) coupled to a single quadrupole mass spectrometer MSQ Plus (Thermo Scientific) and is dedicated to the quantitative determination of and water-soluble and ionic organic/inorganic compounds in liquid media. The chromatograph can operate up to 5000 psi to achieve high performance separation and is equipped with an eluent generator ICS 5000EG (Dionex, Thermo Scientific) configured with carbonate or hydroxide eluents for anions and metanesulfonic acid (MSA) for cations determination, suppressors ASRS 500 or CCES 300 (Thermo Scientific) to remove the salts from mobile phase before entering the MS source, and CD conductivity detector. The mass spectrometer is equipped with an electrospray source (ESI).

Applications: determination of inorganic ions and water-soluble and ionic organic compounds (e.g. sugars, organic acids) in water, sediment, soil, atmospheric aerosol, food and beverages, composite materials.

#### **High performance liquid chromatograph - tandem mass spectrometer (HPLC-MS/MS)**

The instrumentation consists of a 1100 series HPLC system (Agilent Technologies) coupled to an API 4000 triple quadrupole mass spectrometer (Applied Biosystems/MDS SCIEX) and is dedicated to the identification and quantitative determination of low abundance organic compounds in liquid media. The HPLC is equipped with a vacuum degasser, a binary HPLC pump system, an autosampler and a thermostatted column compartment. The mass spectrometer is equipped with a Turbo V source for flexible exchange between atmospheric pressure chemical ionization (APCI) source and Turbolon spray probe, capable of achieving maximized ionization efficiency and minimized chemical noise and instrumental drift.

Applications: identification and quantitative determination of low abundance organic compounds in clinical samples (e.g. pesticides/drug residues), forensic toxicology, environmental matrices, food and beverages, composite materials.

#### **Ultra performance liquid chromatograph - high resolution mass spectrometer (UPLC-HRMS)**

The instrument consists of an ultra-high performance liquid chromatograph (UPLC) Ultimate 3000 (Thermo Scientific) equipped with a nano pump and autosampler for high throughput, coupled to an LTQ Orbitrap XL mass spectrometer (Thermo Scientific). The ionization is obtained using a Nanospray Flex ion source (Thermo Scientific) equipped with a Picotip silica emitter. The MS/MS acquisition is downstream to a collision induced dissociation (CID) fragmentation and provides accurate mass measurement (<10 ppm) with high mass resolution (600,000) and sensitivity (low femtomole to high attomole). This instrument can carry out quantitative proteomics and metabolomics analyses over a wide dynamic range, including low-abundance peptides, and untargeted analysis of environmental and clinical samples with accurate identification of unexpected compounds.

Applications: proteomics, PTM characterization, metabolomics, untargeted analysis of compounds in complex liquid media.

#### **Gas chromatograph - tandem mass spectrometer (GC-MS/MS)**

The instrument consists of a GC Trace 1310 (Thermo Scientific) equipped with user-exchangeable instant connect injector and detector modules, coupled to a TSQ 9000 triple quadrupole MS/MS detection system. The ExtractraBrite ion source is fully removable without breaking the vacuum probe interlock (VPI) to achieve fast operationality and switching from electron ionization (EI) to chemical ionization (CI). For the highest level of sensitivity the Advanced Electron Ionization (AEI) source can be configured to reach instrument detection limits into the attogram range. The instrument is suited for quantitative targeted and untargeted analysis of volatile/semi-volatile compounds.

Applications: SPE samples, pesticides residuals, persistent organic pollutants in food and beverages, waters, clinical samples, forensic sciences.

## **Gas chromatograph – mass spectrometers (GC-MS)**

Three GC-MS analyzers are available at the institute lab:

1. single quadrupole 7890A-5975C GC-MS instrument (Agilent Technologies), equipped with an autosampler (G4513A, Agilent Technologies) and electron ionization source operated in positive mode. The instrument allows qualitative screening and quantitative determination of pesticides, lipids, persistent organic pollutants in environmental and biological matrices (aerosol, water, soil, sediment, biota).
2. A single quadrupole 7890A-5975C Cryo-GC-MS instrument (Agilent Technologies), equipped with a Unity2 (Markes International) thermal desorption system. The instrument is suited for the analysis of volatile and semi-volatile organic compounds (VOCs and SVOCs) in environmental matrices (indoor and outdoor air quality), food, forensics, consumer and other application fields (flavors and fragrances).
3. A PyGC-MS instrument 6890-5973N (Agilent Technologies), equipped with a pyrolyzer (CDS 5150). The instrument is suited for qualitative analysis of volatile (persistent organic pollutants, pesticides, etc.) and involatile compounds (paints, adhesives, plastics, synthetic fibers), in environmental, clinical, and forensic samples.

- **CNR-ISP Bologna:**

- . The analytical facilities at the the Organic Geochemistry Laboratory at the Institute of Polar Sciences in Bologna include:
  - Thermo Fisher Scientific FLASH 2000 Element Analyzer coupled with a mass spectrometer DeltaQ (EA-IRMS)
  - GC Agilent GC 7820-MSD EI 5977B
  - GC Agilent 8860-FID G2790A
- GC Agilent 8890 equipped by a Gerstel Preparative Fraction Collector (PFC) .

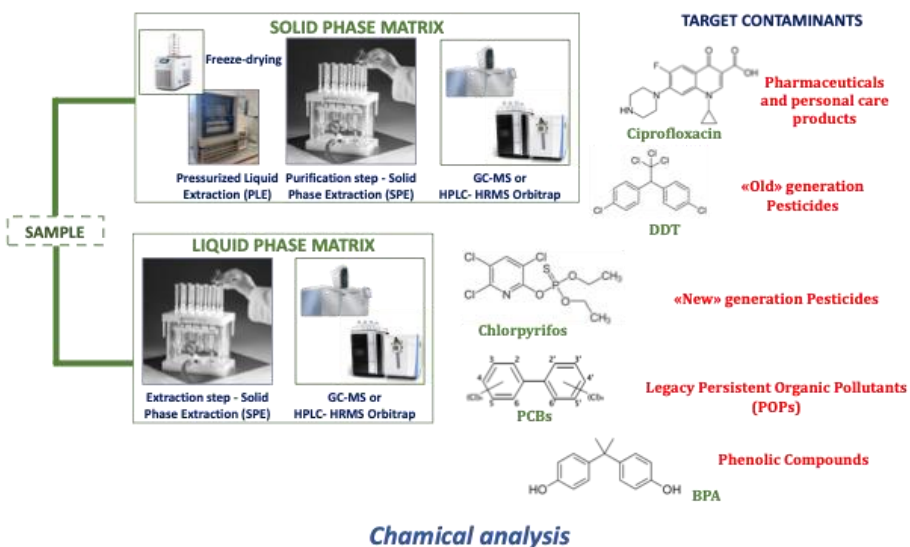
- **CNR-ISP Roma.**

The laboratory *MicroChem* “Laboratory for the analytical determination of legacy and emerging organic micropollutants” housed at the CNR-ISP Roma, offers services for the analysis of legacy

and emerging organic micropollutants in biotic (organisms and vegetation) and abiotic (water, sediment, soil, sewage) environmental compartments.

It is equipped with various high sensitive and performant instruments, including gas-chromatography coupled with mass spectrometry (e.g. polycyclic aromatic hydrocarbons - PAHs, polychlorobiphenyls - PCBs, old and new generation pesticides- i.e. CUPs-, and polybromodiphenylethers - PBDEs) and liquid chromatography coupled with high-resolution mass spectrometry (e.g. pharmaceuticals and personal care products - PPCPs, pesticides, plasticizers Bisphenol A and phenolic compounds)

In particular, the extraction of target contaminants from solid matrices includes different stages:



1) Freeze-drying, to remove the water contents from the biotic and abiotic samples;

2) Pressurized liquid extraction (PLE) to extract target contaminants by a suitable organic solvent in controlled high temperature and pressure conditions;

3) Solid phase extraction (SPE) to clean up the PLE extracts to minimize potential interferences from the matrix;

4) Gentle nitrogen flux to concentrate the analytes and

resuspended them with a solvent suitable for the chromatographic analysis.

The extraction and clean up of liquid samples are performed simultaneously with SPE followed by evaporation of the sample under gentle nitrogen stream flow.

The concentrations of target compounds in the different environmental compartments (water, soil, sediment, soil and biota) provide crucial information to improve the knowledge on their environmental distribution, sources, transformation and fate as well as the estimate of risk associated to the contamination detected in different matrices of aquatic and terrestrial compartments.

The *MicroChem* Lab is equipped with the following analytical tools:

**Benchtop lyophilizer (freeze-dryer LABCONCO)** 2.5 L capacity, equipped with a touchscreen display, for the pre-treatment of solid matrices subsequently extracted with PLE.

**Solid Phase Extraction (SPE):** 12 inlets solid phase extractor connected to cartridges packed with specific adsorbents for the extraction of target compounds from liquid matrices through a vacuum system.

**Sonicator** (Branson, mod. 2510) for the extraction of chemical compounds from solid matrices by using suitable solvents.

**ASE 150** (Dionex, Thermo Scientific) to perform pressurized liquid extraction (PLE) of organic pollutants from solid matrices.

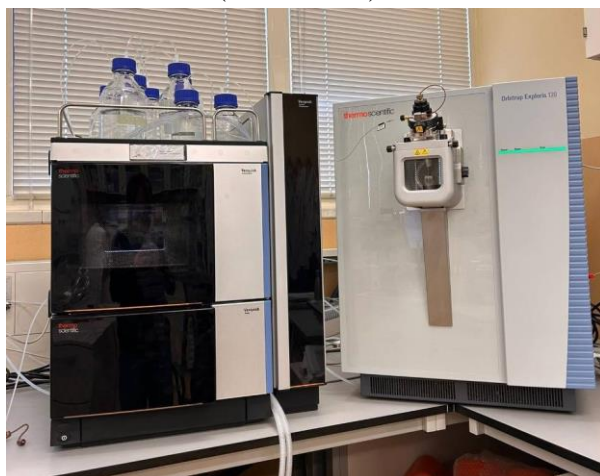
**Speed Extractor E-916** (Buchi) to perform simultaneous pressurized liquid extraction (PLE) of 6 samples, operating in different modes.

**Rotavapor R 100** (Buchi), equipped with an electronic interface to control the vacuum system and the recirculating chiller.

**Gas chromatograph** (Thermo Fisher, Trace 3000) **coupled to mass spectrometry (MS) detector** (Thermo Fisher, ISQ7000). The device is connected to an autosampler (Thermo Fisher, AI 1310) and is controlled by a Chromeleon software.

**HPLC** (quaternary pump, column Oven mod. LC-100 and Micro Pump Series 200, Perkin Elmer, USA) **coupled to a fluorescence detector** (Perkin Elmer Series 200a). The device is controlled by a Chromeleon Software.

**HPLC** (binary pump, Vanquish TM Core HPLC system, Thermo Scientific TM, Italy) coupled to a high-resolution mass spectrometer (Orbitrap Exploris 120, Thermo Scientific TM, Italy). The device is controlled by XcaliburSoftware (version 5.1).



*HPLC- HRMS Orbitrap Exploris 120, Thermo Scientific TM at ISP-Roma*



*GC-MS Thermo Fisher, ISQ7000 at ISP-Roma*

### **The biogeochemical laboratories**

IAS-CNR is doted of laboratories dedicated to the clean manipulation/preparation of samples for inorganic and organic analysis, a sedimentology lab and other technical expertise for advanced studies of geochemical characterization, chemical identification and quantitative determination.

#### **· SAMPLE PREPARATION LABORATORY**

The sample preparation Lab is equipped with:

##### ***-Digested Microwave system***

The rock, sediment, soil, seawater or biological samples to be analyzed are digested in a pressurized microwave digestion system. Our Discover SP-D 80 produces a clear aqueous digest for elemental analysis by ICP-OES and ICP-MS. Since each vessel has its own method, you can mix and match samples and acids within the automation rack, providing your laboratory great flexibility. Digestion time is 10 minutes or less, providing rapid turnaround and the ability to accommodate rush samples. To increase the productivity of our Discover SP-D80, it is also equipped with an Explorer autosampler. It is a technologically advanced robotic arm, capable of moving the samples from the rack to the digestion cavity and then back to the rack.

##### ***-Freeze-dryer***

The freeze- dryer LIO5P is an instrument useful to carry out almost all laboratory freeze-drying processes thanks to the wide range of accessories available. This is a unit used primarily for freeze-drying of sediments and tissues in order to eliminate the water in the samples. LIO5P, installed on laboratory benches, essentially consists of a drying chamber containing 5 product shelves with a cooling, obtained via a direct

expansion refrigeration circuit, and heating via an electric resistance, a vacuum pumping unit, a steam condenser, a PLC control panel for regulation and safety devices.

## · **ICP LABORATORY**

The Plasma Chemistry Laboratory provides high-precision elemental analyses of environmental, biological, geological materials using inductively coupled plasma (ICP) technology. Quantitative and qualitative elemental analyses are available using ICP mass spectrometry (ICP-MS) and optical emission spectrometry (ICP-OES). The most common applications for ICP instrument are in biological, environmental, geological, and industrial fields.

### ***-ICP-OES***

The Inductively Coupled Plasma Optical Emission (ICP-OES) is dedicated to analyzing major elements and some trace elements in sediments, waters and other biological matrices. The laboratory utilizes a Thermo iCAP 6000 ICP-OES, which allows measurement of a wide range of concentrations within the same run. ICP-OES analysis is best suited for high-throughput analysis of samples where multiple-elemental analysis is necessary and analyte content is expected to be within 10 ppb to 1 percent.

Typical applications of ICP-OES include: analysis of rocks, soils, sediments and biological materials need to be digested prior to analysis.

### ***-ICP-MS***

The Inductively Coupled Plasma Mass Spectrophotometer (ICP-MS) is dedicated to high-precision elemental analysis of low-concentration and trace-elements in a variety of samples. Our Thermo Fisher Scientific iCAP Q is equipped with collision cell technology (CCT) and kinetic energy discrimination (KED) analysis, for improved analytical measurement when polyatomic interferences are of concern. These technologies help to minimize the presence of interferences that complicate the analysis of Al, K, V, Cr, Mn, Fe, As, and Se. Detection limits vary, generally in the ppb range for light masses and the ppt range for high masses in solution. Therefore, a CETAC ASX 520 autosampler is available which can hold up to 240 samples.

Typical applications of ICP-MS include rare earth analysis of geologic and environmental samples, heavy metals analysis in environmental systems as seawater (dissolved and particulate phase) and biological samples.

The iCAP Q ICP-MS is in a room separated in the ICP lab. The clean environment of the room complements the high sensitivity of the instrument.

## · **DIRECT MERCURY ANALYZER LABORATORY**

Using the principle of the thermal decomposition, amalgamation and atomic absorption, the direct mercury analyser - DMA80 (Milestone, Wesleyan University, Middletown, CT, USA) allows to perform a direct Hg analysis in both solid and aqueous samples both with equal efficiency. Milestone's Tri-Cell DMA-80 combines an innovative mercury measuring system with a unique optical path spectrophotometer, achieving a detection limit of 0,0015 ng of mercury. The DMA-80 enables the operator to do direct determination of total mercury without the need for acid digestion or other wet chemistry sample treatment prior the analysis; this means no hazardous chemicals to purchase, handle and dispose. Typical applications that the DMA-80

is used to include environmental, geochemical, petrochemical, food and feed, clinical and polymer samples.

## · **SEDIMENTOLOGY LABORATORY**

The lab is equipped to perform textural and physical analyses of sediments of natural (marine and continental) and anthropogenic origin. The main analytical activities have as their purpose the assessment of sedimentological characteristics of the seabed in relation to the quality of the environment and the bioavailability of contaminants that may occur. The laboratory also develops operational methodologies for surface and deep sediment sampling using bottom samplers (Van Veen 25 Litres Grabs and Light Corer Box).

The laboratory is equipped with the following analytical instrumentation:

- "Horiba Partica LA-950V2" laser granulometer (range: 0.01 - 3000  $\mu\text{m}$ ) for wet particle size analysis;
- Vibrosie sieve shaker "FRITSCH" analysette 3 SPARTAN and sieve shaker with basculating system "CONTROLS model 15-D0410" both equipped with several stacks of sieves for dry particle size analysis;
- Automatic quartering machine "FRITSCH LABORETTE 27" for preparing samples for particle size analysis;
- Glove Box for extrusion and cutting of sediment cores under controlled nitrogen flow;
- "RETSCH RM 200" mortar mill and "RETSCH PM 100" planetary ball mill for grinding, homogenization of sediment samples.



Van Veen 25 Litres Grabs



Light Corer Box



Glove Box





Vibrosie sieve shaker "FRITSCH"  
analysette 3 SPARTAN

sieve shaker CONTROLS model 15-  
D0410

Horiba Partica LA-950V2" laser  
granulometer

## **ORGANIC LABORATORY**

The lab provides to investigate persistent and emerging organic pollutants in the Organic Laboratory. It is equipped with both gas and liquid chromatographs and any tools to extract from water/seawater, sediment, and fish tissue, the above-mentioned contaminants,

The equipments used are:

- GC with ECD/FID detectors and autosampler (Thermo Fischer TRACE 1310 and Autosampler Triplus)
- HPLC with DAD/RF detectors (Shimadzu LC 20AD) with Autosampler.
- Rotavapor and Multivapor by Buchi V850, Sonicator Probe Bandelin Sonoplus HD 2070, Vacuum Manifold, and ultrasound bath complete the apparatus used to treat the samples.
- FTIR with ATR (Thermo Nicolet IS5) is also used to characterise the microplastic above 200um dimension collected by fish stomachs, seawater, and sediments.

Moreover CNR-IAS of Capo Granitola provides remediation techniques, both on a lab-scale and pilot-scale, using:

- a BenchTop Filter Reactor with a vessel until 5 litres of volume
- a little plant enabled to treat until 100 kg of sediments consisting of two vessels of 400 litres, one of which with a mechanical agitator and another used to sediment the clay, before separating from sand using a hydrocyclone. Finally, the water could be cleaned using a series of sand and activated carbon and pulled into a tank.

Bench top filter reactor (on the left), pilot plant to sediment remediation (on the right)

## · **SCANNING ELECTRON MICROSCOPE**

Thanks to the high magnification power ( $<7-1,000,000 \times$ ), the scanning electron microscope ZEISS EVO MA10 permits to analyze samples of rocks, sediments, synthetic material, alloys ceramics and nanostructures to observe morphology, defects, or mechanic faults. Secondary electrons (SEs) originate from the sample surface makes detailed examination of surface morphology; backscattered electrons (BSEs) are high-energy electrons re-emitted from the sample and reveal chemical compositional differences (atomic number contrast).

ZEISS EVO MA10 can work under high void conditions and low void conditions, with variable pressure, for this reason the microscope is suitable to analyze both conductive and non-conductive materials. ZEISS EVO MA10 is equipped with Bruker Quantax 200, an advanced system of elemental microanalysis by energy-characteristic x rays generated in the sample.

## · **X-RAY POWDER DIFFRACTION (XRD)**

The Bruker D8 ADVANCE based on the unique D8 diffractometer family platform is designed for all X-ray powder diffraction, including traditional X-ray powder diffraction. D8 ADVANCE can measure all sample types, from liquids to powders, from thin films to solid blocks, on a single instrument. The XRD is equipped with SOL-X detector (Li-drifted Silicon sensor) that permits to obtain a high-resolution analysis, because of its capacity to remove unwanted background features due to the incident beam which causes secondary X-ray emission (i.e. fluorescence). Also, SOL-X can be set to remove undesired diffraction peaks (e.g. K- $\beta$ s). Bruker D8 ADVANCE is associated to XRD Diffrac. Eva a software able to solve crystalline phase identification and to give a semiquantitative analysis of crystalline phase.

## · **ISOTOPE RATIO MASS SPECTROMETRY (IRMS) LABORATORY**

The IRMS laboratory is equipped with a Thermo Fisher mass spectrometers Delta V Advantage coupled with:

- EA (Elemental Analyzer) producing  $\text{CO}_2$ ,  $\text{N}_2$  through combustion of solid and liquid samples for analyses of C, N isotopes;
- Gas bench for the analysis of C and O isotope analyses in dissolved inorganic carbon (DIC) and carbonates;
- CONFLO IV interface.

Below a short list of its applications in the environment:

- The isotopic composition of carbonate rocks and/or biogenic and non-biogenic carbonate components in marine and continental sediments is a primary investigative tool for the study of palaeoclimate, palaeoceanography, carbon cycle, etc.
- The study of the carbon isotopic composition of the dissolved inorganic carbon in seawater is a tool of particular interest for investigating processes related to: (i) the evolution of the carbonate system at the air-sea interface due to the interaction processes between DIC and atmospheric  $\text{CO}_2$ ; ii) the role played on the carbon budget by the biological pump; iii) the role

played by the ocean circulation system and the distribution of DIC linked to different water masses.

- The study of isotope fractionation of C and N by kinetic effect along the marine trophic chain is an ideal tool for defining the distribution of food chains in different and complex marine environments.

### **Nutrient laboratory**

In this lab analyzes of inorganic macronutrients (nitrates, nitrites, phosphates, silicates and ammonia) are carried out in seawater samples through the use of a continuous flow autoanalyzer from Seal Analytical called "QUAATRO". The instrument is equipped with four channels and allows simultaneous and continuous nutrient analysis. The chemical procedures followed for the analytical determination of dissolved nutrients are based on classical methods adapted to automated measurement systems. The laboratory also expresses high analytical performance of total nitrogen and phosphorus in seawater samples. The laboratory's operations are completed by a sample digestion system with heating plate, model Velp DK20, an autoclave and a Milli-Q water production system.

# TAXONOMY PLATFORM

## MARINE ORGANISM TAXONOMY

The CNR institutes host expertise on taxonomy of various marine organisms, offering counseling at different levels for different taxa. Such activities provide support for research activities on the biodiversity of marine organisms in institutional projects and for third-party activities, ensuring controlled procedures in the production of taxonomic data. Merging traditional morphological approaches and modern technologies such as light and electron microscopy, imaging, barcoding, DNA taxonomy, and metabarcoding, CNR provides a wide range of services in taxonomy. Expertises on the following taxa are covered by the different research sites of CNR:

- CNR-IAS Capo Granitola: Bony fish, particularly pelagic species. The Acoustic survey are carried out by researchers using Simrad EK60 scientific echosounder, equipped with three split beam transducers (38, 120 and 200 kHz), available at CNR-IAS Capo Granitola. These acoustic sampling are joined with biological sampling, using pelagic trawls with a codend of 18 mm mesh size. These data deployed to assess the pelagic fish species composition, length frequency distribution of species, as well as density and distribution of pelagic fish stocks. At the same time, a multiparametric probe allows to collect oceanographic data, like salinity, temperature, pH, etc.  
The laboratories in Capo Granitola involved two wet labs for morphometric fish analysis. Moreover, a histological lab is equipped with Leica automatic instruments for tissue thin section preparation: Automatic Tissue Processor, Paraffin Embedding System, Semi-Automatic Rotary Microtomes, Automated Slide Stainer.
- CNR-ISP Messina: The EcoBiM Laboratory at CNR-ISP in Messina offers services for the characterization of cultivable microbes and/or microbial communities from samples collected from polar and cryo-environments, through genomics, biomolecular analyses, bioinformatics, isolation and cultivation. Cultivable diversity is analyzed by the utilization of a plethora of culture media for microbial isolation, followed by purification and characterization by genotypic and phenotypic assays. The laboratory is equipped for handling and characterizing aerobic cold-adapted microbes. Microbial community diversity is estimated after nucleic acid extraction by next generation sequencing, followed by bioinformatics analyses. EcoBiM also offers bioinformatics services on molecular datasets eventually provided by the users. EcoBiM is specialized in the analysis of microbial communities associated with marine benthic invertebrates. The EMBA (Extreme Microbiology, Biotechnology and Astrobiology) laboratory offers users an advanced analytical platform suitable for high-quality research on extreme microbial taxonomy. The proposed technology platforms are Genomics, Imaging (microscopy), Molecular analysis, Cultivation and Bioinformatics. The laboratory is well equipped for the microbial and molecular genetic techniques and for handling of strictly anaerobic and/or extremophilic microorganisms. EMBA unit is experienced in isolation of taxonomically and physiologically new extremophilic prokaryotes, including extreme halophilic anaerobes, polysaccharidolytic archaea, psychrophilic hydrolytic and electroactive bacteria, methylotrophic methanogens and previously uncultured ultrasmall representatives of candidate phylum Nanohaloarchaea.
- CNR-IRBIM Lesina: Benthic macrofauna (Crustacea, Mollusca).
- CNR-IRBIM Messina: Bony fish, Cephalopods, Crustaceans, Elasmobranchs.
- CNR-IRSA Verbania: Annelida, Rotifera.
- CNR-IRSA Taranto: Seaweeds, Seagrasses, Phytoplankton (including resting stages), Cyanobacteria, Crustacea, Mollusca, Echinodermata.

# BIOPROSPECTING

The institutes at CNR include laboratories for the bioprospecting of natural products from marine sources.

- CNR-ISP Messina: The EMBA unit is equipped with sampling tools and all necessary microbiological facilities (Laminar flow hoods; Regulated incubators; Optical microscope; etc.) for the bioprospecting of new enzyme obtained from microorganism isolated from extreme environments. EMBA unit applies a series of bioassays for the identification of enzymes with high biotechnological potential (esterase, lipase, etc).

# E-SERVICES

## HPC FACILITIES FOR DATA MANAGEMENT

## AND BIOINFORMATICS

- Computing and storage infrastructure (On-site and remote service)
- High-performance computing clusters, network and dedicated storage.
- Design, implementation and maintenance of dedicated databases and software.
- Data analysis tools and software (On-site and remote service)
- NGS data analysis

CNR-ISP Messina provides users with an environment for the analysis of in silico data at its bioinformatics facility. EMBA unit is equipped with high-performance computing and dedicated storage, datasets and data analysis tools and software.

# DATA SETS

The institutes at CNR include access to datasets on the occurrence and distribution of marine organisms, both publicly available for example in GBIF and still under construction. Expertise is available on how to handle data and retrieve information using R and commonly used database software.

- CNR-ISP Bologna: More than 10-year time series of data for climate purposes is currently available from marine environment and atmosphere.

Marine mooring (MDI) allows us to continuously monitor the variations of the thermohaline characteristics of:

- a) surface water from glacier melting;
- b) intermediate water that derives from the intrusion of Atlantic-type water;
- c) bottom water produced locally during the winter.

Furthermore, through the collection of particulate matter, information is acquired on sedimentary processes and interactions between water and particulate matter with microzooplankton, glaciers and coastal runoff. The complex interplay between the processes that drive the input of native and alien particles into Kongsfjorden has now been understood, some interpretations of possible future changes in particle flows for Arctic fjords in a warming scenario global can be suggested.

Since 2012, the Climatic Change Tower (CCT) area have become a point of reference for the integrated observation of the components of the climate system. An amount of data of several atmospheric parameters has been acquired along the 32m high of the infrastructure able to understand the complex structure of low atmosphere

All the data acquired and stored by the various instruments in both the infrastructure are downloaded during maintenance, checked for QA/QC and uploaded to the Italian Article Data Center (IADC) were are available, under request, for alla the scientific international community.

Products based on marine and atmospheric data set are available upon request.

- CNR-IRBIM Lesina: Historical data series of benthic Mollusca of Lesina and Varano lagoons from 2000.
- CNR-IRSA Verbania: Stygofauna Mundi (a global database of animals in subterranean waters including marine and anchialine caves), Rotifera (a global database of distribution of rotifers).
- CNR-IRSA Taranto: Herbarium TAR (a collection of dried specimens of seaweeds and seagrasses from the Mar Piccolo of Taranto (mainly) and other parts of the world. The historical “Pierpaoli’s herbarium” is also stored at Taranto. It is property of Stazione di Biologia Marina di Porto Cesareo (University of Salento) and contains dried seaweed

samples collected in the 20's in the Mar Piccolo of Taranto and along the Conero coast (Adriatic Sea, Italy).



*Dried specimen of Herbarium TAR at CNR IRSA Taranto*

- CNR-IAS Capo Granitola: Acoustic survey are carried out by researchers using Simrad EK60 scientific echosounder, equipped with three split beam transducers (38, 120 and 200 kHz), available at CNR-IAS Capo Granitola. These acoustic sampling are joined with biological sampling, using pelagic trawls with a codend of 18 mm mesh size. These data deployed to assess the pelagic fish species composition, length frequency distribution of species, as well as density and distribution of pelagic fish stocks. At the same time, a multiparametric probe allows to collect oceanographic data, like salinity, temperature, pH, etc. The laboratories in Capo Granitola involved two wet labs for morphometric fish analysis. Moreover, a histological lab is equipped with Leica automatic instruments for tissue thin section preparation: Automatic Tissue Processor, Paraffin Embedding System, Semi-Automatic Rotary Microtomes, Automated Slide Stainer.