INSTITUT DE CIÈNCIES DEL MAR. CSIC.
BARCELONA (ICM)

(Instituto de Ciencias del Mar. CSIC)
(Institute of Marine Sciences, Barcelona)
(Summary of research activities in 1995 and 1996)*

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INTRODUCTORY OVERVIEW

The Institut de Ciències del Mar (ICM) [Institute of Marine Sciences], a Institute belonging to the Spanish Council for Scientific Research (CSIC) is a multidisciplinary centre for the study of the seas and oceans and is involved in research in Mediterranean, Atlantic, Pacific, and Antarctic areas. To that end it has been organized around three departments: Oceanography and Marine Biology, Marine Geology and Physical Oceanography, and Renewable Resources and a number of support units [Chemical analysis, Electron microscopy, Computer centre, Graphics and design service, Biological Collections (with 6 000 specimens catalogued), Library (containing 5 000 volumes and 1 200 periodicals), and an Oceanographic Vessels Unit]. The Institute runs an Oceanographic Research Ship, the R/V GARCÍA DEL CID, 37 m in length, providing services for oceanographers and researchers from different Spanish Institutes. The Oceanographic Vessels Unit also manages the scientific equipment assigned to the Oceanographic Research Ship R/V HESPERIDES, 80 m in length, funded by the Comisión Interministerial de Ciencia y Tecnología (Interministerial Commission for Science and Technology) and operated by the Spanish Navy. The ICM also manages the logistics of the Spanish Antarctic Base under the auspices of the Comisión Interministerial de Ciencia y Tecnología. Since 1955 the ICM has published the quarterly journal Scientia Marina (with the collaboration of the CIIRC since 1996), which also publishes a series of monographs on topics in marine science.

The Institut de Ciencias del Mar currently has a staff of 160 (30 permanent staff scientists, 65 contract researchers and grant holders, 41 technicians, and 24 administrative and general service personnel). In the period 1995-1996 outside guest scientists also worked at the Institute for varying lengths of time.

The annual budget is about 875 million pesetas (1995 figures), including outside funding for research projects (250 million pesetas) and equipment procurement (175 million pesetas).

Most ICM projects are multidisciplinary in nature, with participation by research personnel from more than one department (projects are listed in subsequent sections according to the department of the Head Scientist) or from other research centres in Spain, the European Union, or other countries around the world. The ICM maintains international relations with 16 countries (70 centres) through joint projects and/or personnel exchanges and has two cooperation agreements, one with the Alfred Wegener Institut für Polar- und Meeresforschung and another with several national and international institutions, within the framework of an European Associated Laboratory for Marine Science. In addition, the ICM is a member of two networks in Catalonia, one focusing on coastal and littoral resources and another on aquaculture, which link together different institutions to consider topics of broad general interest. During the period 1995-1996 the ICM participated in a total of 27 international projects, 28 national projects, and 42 oceanographic surveys, culminating in the completion of 10 Ph.D. theses and 264 publications.

HISTORICAL OVERVIEW

(Prepared by Dr. J. Castellví)

Interest in marine biology arose at the Faculty of Sciences at the University of Barcelona, the only Spanish university with a Natural Sciences Section in the 1940s. Promoted enthusiastically by Professor Francisco García del Cid, Director of the Institute of Applied Biology (CSIC), work on marine topics culminated in the creation of the Marine Biology Section in 1949.

The natural impetus of scientists working in the field and the needs of the authorities soon made it plain that there was a call for researchers in the area of marine science. The first step was a course taught jointly at the University of Barcelona and in the town of Blanes, at facilities of the Botanical Garden, loaned by Mr. Carlos Faust. Fishermen from the town made their vessels available for sampling and practical exercises by students.

The first researchers worked at very basic laboratories located in Barcelona, Blanes, Castellón, and Vinaroz. In 1951 studies began off the coast of Galicia, with the centre of activities in Vigo. In view of the trajectory of the Marine Biology Section, the CSIC (Spain’s Council for Scientific Research) decided to establish an independent Institute with its seat in Barcelona, the Instituto de Investigaciones Pesqueras [ Fisheries Research Institute ] (hereinafter IIP), which was a subsidiary of the Patronato Juan de la Cierva. Another laboratory was later installed in southern mainland Spain at the express request of the city of Cádiz.

The IIP did not have a building of its own in Barcelona until 1957, when its scientists and technicians took up residence in a new building erected in the area known as “Muntanyeta” in the Barceloneta district, at a site located between the fishing harbour and the sea. The building’s ground floor housed a public aquarium conceived as a teaching institution for the general public, while the upper floor contained oceanographic research laboratories. At the end of the 1970s the main IIP laboratories (in Barcelona, Vigo, and Cádiz) became independent, and the Instituto de Investigaciones Pesqueras de Barcelona [Barcelona Fisheries Research Institute ] (IIPB) was established.

In 1987 the IIPB underwent a restructuring of its departments, taking over responsibility for the Marine Geology Unit that had been established at the Jaume Almera Institute (CSIC) and changing its name to Instituto de Ciencias del Mar [ Institute of Marine Sciences ] (hereinafter ICM) in response to the expanded scope of its involvement in marine studies. In the course of its 40 years of work, the ICM has undergone a series of reorganizations and changes. Currently, a new building is under construction to host the ICM as part of an interdisciplinary centre intended to carry out leading research in all major fields of marine sciences.
SCIENTIFIC OBJECTIVES OF THE ICM

Ocean structure, dynamics, and interfaces

From a physical standpoint the ocean is a fluid medium, with dynamics driven mainly by the mechanisms for the exchange of energy, momentum and mass between the water masses and the atmosphere, the continents, and the ocean floor. Depending on their nature, these mechanisms may span different spatio-temporal scales, giving rise to a broad spectrum of phenomena, ranging from turbulence to changes on a planetary scale, with a temporal variability extending over decades. Since the dynamics of fluid media are essentially non-linear, the ocean comprises one of the most complex of natural systems as a result of the large number of different scales present and the interactions among them. The complexity involved in integrating studies on such disparate processes has led to international cooperation in defining priority objectives and combining efforts. In this respect, two aspects have come to the forefront on the basis of their potential social impact.

First, knowledge of mass and heat transfer among the oceans, the atmosphere, and the continents on a global scale is a necessary basis for an understanding of the ocean’s role in climatic change. Studies of this kind are in progress in the framework of the World Ocean Circulation Experiment (WOCE) and represent a tremendous mobilization of observation resources (both in situ and remote sensing) and numerical modelling. These investigations are designed to lay the foundation for more practical considerations (climate predictions) in the framework of the Global Ocean Observing System (GOOS) starting in the year 2000.

Mesoscale variability comprises the other major group of phenomena receiving major attention from the international scientific community. The spectrum of phenomena at this scale covers the formation of eddies, fronts, filaments, and other structures. These structures are of particular importance in coastal ocean areas through interaction with bottom topography and the coast. Physical processes common to mesoscale phenomena are essentially diffusion and advection processes, a knowledge of which is basic to an understanding of the structure and evolution of all stages of marine ecosystems and to a quantification of the flow of elements within biogeochemical cycles.

The energy brought into ocean ecosystems by physical processes is a determining factor in biological production. Definition of the spatio-temporal scales on which physico-biological coupling operates is an essential prerequisite for an understanding of the origin and dynamics of ocean production processes. For instance, the main features of large-scale oceanic circulation are basic in determining the distribution of production worldwide; at the other extreme, small-scale variability directly influences the activity of and interactions among planktonic organisms. Thus, the study of physical and biological interactions is a key aspect of research into fisheries, ecosystem dynamics, and quantification of matter and energy transfer in the ocean.

A knowledge of circulation and exchange mechanisms between coastal waters and the open sea is fundamental in evaluating the consequences of pollution due to human activities and in developing an understanding of the degradation of the littoral strip with a view to the preservation of oceanic and littoral habitats.

Selected research topics

The ICM is carrying out research projects in the following areas:

- Large-scale ocean circulation and instabilities
- The dynamics of mesoscale phenomena
- Mixing processes and turbulent diffusion
- Coastal geological dynamics
- Influence of physical dynamics on the production, species composition, and activity of organisms
- Interactions between physical structure, hydrodynamic processes, and transport of particulate matter and associated pollutants
- Ocean-atmosphere interactions
- Continent-ocean interactions; small and mesoscale littoral biological processes

The ocean floor: structure and dynamics

In the past ten years the study of the dynamics of processes involving the ocean floor have shown that they are much more active than it was previously thought. Nevertheless, even though it is one of the largest areas, covering 69% of the Earth’s surface, the ocean floor remains one of the most poorly understood regions of the planet. Ocean floor dynamics span biological, geological, and hydrodynamic processes regulating the transport of matter from the atmosphere, the surface, and coastal ecosystems to the seabed. Displacement from the coast and estuaries across the continental shelf, submarine canyons, and continental slope to the abyssal sea floor is controlled by a variety of factors, including the activity of benthic organisms, bottom topography, the amount and type of sedimentary inputs, and dynamic processes such as
deep currents, turbidity currents, and small-scale turbulence at the benthic interface. Activity by benthic organisms modifying the structure of the solid substratum has an especially important effect on the dynamics of the settlement of suspended matter in coastal areas.

The keys to an understanding of the history of the environmental changes taking place on our planet have been recorded in the ocean sediment. In addition, continental geodynamics generates a series of phenomena such as earthquakes, volcanic activity, and mudslides that affect the ocean floor surface and structure. These phenomena are particularly active along oceanic ridges and at the margins of lithospheric plates. The seabed on the continental shelf particularly important from the economic and environmental point of view because it receives the discharge of large amounts of anthropogenic materials, contains natural resources, and interacts with the coastal dynamics, thereby exerting important effects on human activities in the coastal zone.

In recognition of the importance of our knowledge of the ocean floor and subfloor, a number of European and international programmes have selected specific aspects related with it as research objectives, resulting in an increase in the number of studies of the sea bed. A variety of current projects under the auspices of the European Union and the U.S. National Science Foundation are aimed at defining priority objectives and putting together the technical and human resources required to attain them.

Selected research topics

The following programmes are being carried out in the framework of the ICM’s interdisciplinary approach:

- Dynamics of sedimentation and pollution: continental-oceanic transfers
- Coastal sediment dynamics and their interaction with anthropogenic activities
- Structure and functioning of coastal, shelf, and abyssal bottom communities
- Paleoclimatic and paleo-oceanographic evolution and the effect of the sea level changes on the sedimentary record
- Geological evolution of continental margins and oceanic basins
- Geological processes and natural risks associated with seismic and volcanic activity

Biodiversity and dynamics of marine communities

In recent years biodiversity is receiving considerable attention in both the scientific literature and the press. Humankind is now aware that the loss of biological richness is a pressing problem. This new vision is based on the realization that human activities have significantly increased the rate of extinction of species.

Although nearly a million and a half species have been described, we have no clear idea of the total number of species that may actually exist on our planet. This gap in our knowledge is particularly severe in the case of microorganisms but applies to all groups of living beings.

The planet’s biodiversity is a repository of the genetic sequences used by life to colonize a particular habitat at a given moment in time. Though the abundance of many of those genes may be low at any point in evolution, they nonetheless make up a gene pool available for use.

Any significant decrease in that gene pool constitutes a potential threat of unknown proportions to our quality of life and perhaps to the survival of the human species. The reason for this is that there is evidence of a link between diversity and production, stability, and the ability of ecosystems to absorb anthropogenic impacts and recover to their natural state. Another reason is that biodiversity is a storehouse of information for substances that have therapeutic properties or are simply useful to our species.

In a global context, marine biodiversity has certain special characteristics. The oceans appear to contain greater animal diversity at the phylum level but lower diversity at the species level than do terrestrial systems. In the case of microorganisms, the existence of cryptospecies differentiable solely by molecular methods and the existence of bacterial clones entirely unknown to conventional bacteriology have been demonstrated. As a result, it is not surprising that a large numbers of unknown species are being discovered on the seabed at great depth. All these findings suggest that marine biodiversity has received insufficient attention and that there are large numbers of as yet undescribed organisms.

The inclusion of quantitative aspects of population dynamics is necessary to any understanding of the functioning of marine ecosystems. For larger organisms, models for estimating abundance and predicting changes in population levels in response to both natural conditions and exploitation by humans need to be improved. For smaller organisms, methods of measuring biomass and determining activity levels need to be developed. An example of the importance of this type of quantitative study is the recent discovery that prochlorophytes, a group of prokaryotic organisms unknown just ten years ago, which are responsible for a substantial proportion of phytoplankton biomass and primary production.

Community structure and dynamics in ocean ecosystems are closely linked to the presence and variability of physical features of the habitat. Marine primary production is based on sunlight, which furnishes energy for photosynthesis. But there are also other forms of energy that may interact with organisms. The movement of water masses, for instance, are of basic importance in selecting the dominant forms of primary producers and accordingly in determining the routes for energy transfer from primary and secondary production through the food web.
The recent concern about community composition and dynamics has resulted in numerous international programmes and meetings intended to promote studies in this area. For example, Systematic Agenda 2000 on biodiversity promoted by the U.S. National Science Foundation and a variety of scientific bodies and the Diversitas programme sponsored by IUBS, SCOPE, UNESCO, and other international bodies, culminating in the U.N. Conference on the environment and development held in Rio de Janeiro in 1992. Population dynamics are of great importance in the Global Ocean Ecosystem Dynamics (GLOBEC) programme sponsored by Scientific Committee on Oceanic Research and other bodies, aimed at explaining the effects of physical processes on predator-prey interactions, population dynamics, and their links to oceanic ecosystems in the context of a global system of climate and anthropogenic change.

Selected research topics

The projects encompassed under the present section undertaken by the ICM are related to the mechanisms determining population abundance, species composition, and functioning of marine communities. These include, for example:

- An interdisciplinary approach to the identification of new species in all groups of marine organisms
- The study of community composition as a function of environmental conditions
- Research into the mechanisms causing organisms to form aggregations of high biomass and low diversity (for instance, medusae and toxic phytoplankton) and hence to become potential pests
- Use of both conventional and molecular methods to study the extent and patterns of variation in the diversity of the microbial plankton
- Consideration of the repercussions of the trophic ecology of certain pelagic, demersal, and benthic species in the transfer of matter and energy
- The study of the population dynamics of fishes and other organisms to establish changes in composition due to exploitation patterns or altered environmental conditions

Biogeochemical cycles in oceanic and coastal systems

To define the sources and sinks of the major substances present in the ocean and to quantify the processes regulating element cycles, it is necessary to have an understanding of the physico-chemical variability of water masses and their interfaces, the biological activity of marine organisms, the geology of sinking particulate matter and the interactions among all these factors. The interest of enhancing our knowledge of oceanic biogeochemical cycles by bringing together experts in different fields and countries has resulted in the launching of major international programmes like Joint Global Ocean Flux Study (JGOFS). The particular features of the biogeochemical carbon cycle in a given area will affect the equilibrium of CO₂ with respect to the atmosphere and will determine the values of parameters such as the sinking rate of carbonates to the seabed, the rate of decomposition of pollutants or the production of exploited species. Coastal regions are particularly relevant from the standpoint of human activities. On the other hand, the size of the pelagic zone makes it of primary importance for many processes. The magnitude of primary production and its consequences for the environment are related to whether new or recycled production predominates. In the planktonic ecosystem, carbon may circulate mainly via the microbial food web or through the classical pathway; the amount of primary production reaching the sediment will depend upon the balance between the two pathways. In turn, secondary producers may affect both the growth and biomass accumulation by primary producers. The different components and processes integrated in the biogeochemical cycles present close links at many different scales. For example, recent research has linked the sulfur cycle to a climate control loop via sulfur-containing compounds synthesized by certain species of phytoplankton. For all these reasons an understanding of the mechanisms governing the rates and circulation patterns of biogenic elements is basic to making any prediction of the future behaviour of the marine environment and hence to establishing a scientific groundwork for proper management of that environment.

Selected research topics

Within the framework of this objective, the ICM studies several key processes in the oceans. Some examples are:

- The influence of physical structure and dynamics on the production, species composition, and activity of organisms in the planktonic, nektonic and benthic communities.
- The contribution of both the classical and microbial pathways to the transfer of primary and secondary production to other trophic levels in different marine habitats
- The ecological role of the deep chlorophyll maxima in oligotrophic seas
- The contribution of meso (herbivorous) and macrozooplankton (carnivorous, including gelatinous predators) to the pelagic food webs
- The role of benthic suspension feeders in the processes of energy transfer between pelagic and benthic ecosystems.
-The quantitative study of population changes in response to growth, grazing and physical forcing.
-Variability in the sedimentary flows of major detrital or biogenic elements and pollutants

**Resources and sustainability**

Sustainable exploitation of natural resources is one of the principal challenges facing mankind today. There have been many historical episodes of overexploitation or improper exploitation leading to the collapse of resources. Fisheries are a special and important case of exploitation of a renewable resource, which can be managed for the benefit of society as a whole, although management of these resources remains problematical. A succession of frequent crises and collapses have marked the activities of fisheries in different parts of the world.

Resources are an integral component within ecosystems, and it is unlikely that we will be able to understand the dynamics of the resources themselves unless we are able to understand the way the system operates as a whole. The study of exploited or exploitable ecosystems is perhaps the most basic link in gaining an understanding of the source of much of the variability experienced by resources that otherwise appears to be random and accounts for much of the uncertainty in predictions. Specifically, larval development and recruitment mechanisms, the incorporation of young individuals to the exploited stock, cannot be understood except from an ecological perspective. We know that ecosystems respond the environmental variations, but the many different pathways by which alterations are transmitted makes effects unpredictable.

The spatial distribution of resources is very uneven. However, the inclusion of spatial considerations in the study of resources is relatively new, made possible today thanks to the development of geographic information systems (GISs), among other ways of analysis. This approach provides explanations for certain phenomena that remained outside the scope of conventional models that do not encompass such spatial considerations.

In addition, fisheries exert an impact not only on the exploited species but also on the rest of the ecosystem. Many fishing gears have a wide range of effects on the ecosystem: from long surface drift nets, which have important repercussions on non-commercial or even protected species (sea turtles, whales, seabirds) to gears towed along the bottom (trawls, dredges, etc.) that change or damage the benthos. In most cases the capture of non-commercial species destroys a large amount of biomass generally returned dead to the sea, thus producing still greater alterations in the cycling of matter through the food webs.

Fisheries are primarily an economic activity. It is pointless to focus exclusively on the biology of exploited ecosystems or the population dynamics of exploited resources, because in the final analysis it is the economic system that exerts pressure on the resource, and while technically based management measures (closed seasons and areas, minimum sizes, effort restrictions, quotas, mesh sizes, etc.) are necessary, they are not sufficiently effective within a socio-economic context, in which other types of tools are needed to manage human behaviour, essentially in the form of subsidies or levies.

The development of mathematical models is absolutely necessary to the future of fisheries science. Modelling has already made possible the interpretation of certain aspects of the dynamics of exploited resources and the behaviour of fishermen, and as a result we now know why fisheries are driven to overexploitation. Such models have two key aspects: their consideration of uncertainty and their consideration of the regulatory mechanisms affecting the system, including the economy.

**Selected research topics**

This objective contains several lines of research, all connected with the aforementioned research areas:

- Ecology of demersal communities, the study of the spatio-temporal structure of such communities, identification of populations, analysis of their responses to fishing pressure, the study of competition for resources by different gears
- Ichthyoplankton studies: spatial and temporal patterns of distribution and its relation to environmental factors. Role of mesoscale physical structures on the processes of concentration and dispersion of fish eggs and larvae. Taxonomy and systematics based on ontogenic characters
- Adaptive mechanisms of organisms to different habitats, both on the continental shelf and in the deep-sea regions, larval stages, metabolism, morphology, physiology, behaviour, food webs, taxonomy and systematics
- Environmental impact of fisheries, effect of dredges and mobile gears on the seabed, the study of the deterioration and regeneration of the benthos, discards
- Ecology of short-lived pelagic resources, research into recruitment mechanisms
- Modelling, development of bio-economic models accounting for control mechanisms regulating fishing activity in the Mediterranean
- Application of geographic information systems (GISs) methodology to fisheries, development of GIS tools in support of fisheries management
- Experimental culture in life-cycle research (feeding, reproduction, larval stages)
PRINCIPAL GEOGRAPHIC AREAS OF STUDY

For reasons of proximity and convenience, the Mediterranean Sea is obviously one of the main field study areas addressed by the ICM. However, research interests are not restricted to the Mediterranean, and by the same token, studies carried out in the Mediterranean Sea are not considered to be only of local interest. Experimental work is carried out in the laboratory along with and theoretical studies an on the development of methods of numerical analysis and new instrumentation.

Most of the physical processes and phenomena that occur in other oceans also take place in the Mediterranean, though obviously on a more limited physical scale. This may provide considerable advantages when planning a sampling strategy for a given area, and for that reason the Mediterranean has sometimes been considered an excellent laboratory or oceanic model. A series of workshops and international meetings analysing the role of the world ocean in climate, the initial stage of which has centred on the Mediterranean (Ocean Processes in Climate Dynamics: Global and Mediterranean Examples, Sicily, 1993; Ocean Forecasting, Maratea, Italy, 1993) is a recent example of the importance of the Mediterranean Sea as a testing grounds for new theories and experiments.

The ICM takes part in studies in other ocean regions pursuant to its own projects and in cooperation with other national and international bodies. Besides the benefits obtained from working with other scientists, work of this kind offers an opportunity to conduct comparative studies and to contribute to the definition of a global perspective, which, as already mentioned previously, is the benchmark of current oceanography today. In particular, the ICM has gained particular experience in the upwelling regions off western Africa, North Atlantic Ocean, Pacific Ocean and the Antarctic Ocean through Spain’s National Antarctic Research Programme and other national and international projects and surveys.

BILATERAL AGREEMENTS

The ICM has entered into a series of national and international cooperative agreements with the research bodies listed below, for projects to be completed between 1996 and the year 2000:

In the framework of the European Associated Laboratory (EAL) for Marine Science, with:

Centre d’Estudis Avançats de Blanes (Blanes Centre for Advanced Studies) (CSIC), Blanes, Girona, Spain.
University of Barcelona, Barcelona, Spain, and specifically with the following teams:
  - Marine Geology Unit at the Department of Dynamic Geology
  - Littoral Benthic Ecology Unit at the Department of Ecology
  - Microbial Ecology Unit at the Department of Microbiology
Observatoire Océanologique de Banyuls (CNRS-Université Pierre et Marie Curie (Université Paris 6), France, specifically, with the following URAs:
  - Océanographie Biologique, URA 2017
  - Modèles en biologie cellulaire et évolutive, URA 2156
Université de Perpignan, Perpignan, France, specifically, with the:
  - Laboratoire de Sédimentologie et Géologie Marine URA 715
École Practique des Hautes Etudes, Perpignan, France, specifically, with the:
  - Laboratoire d’Ichthyocécologie Tropicale et Méditerranéenne URA 1453

Cooperative agreement with the Alfred-Wegener-Institüt für Polar und Meeresforschung, Bremerhaven, Germany

Agreement with the Faculty of Sciences of the Universitat Autònom de Barcelona [Autonomous University of Barcelona] providing for practical work by biology degree candidates, and with the Faculty of Biology of the Universitat de Barcelona

ACADEMIC ACTIVITIES

The ICM (CSIC) participates in training courses carried out in the framework of the Ph. D. Degree Programme in Marine Sciences organized by the Catalonia Polytechnical University, the University of Barcelona, and the Spanish Council for Scientific Research. ICM scientists teach training courses in the areas of marine biology and ecology, physical oceanography, marine geology, and fisheries.

The ICM (Physical Oceanography Group) is associated to the Catalonian Institute of Space Studies, an Affiliated Campus of the International Space University.
INSTITUTIONS AND LABORATORIES WITH ONGOING COOPERATIVE PROGRAMMES WITH ICM SCIENTISTS

BELGIUM
- GeoHydrodynamics and Environment Research Laboratory, Université de Liège, Liège.
- Laboratoire de Zoologie, Université Libre de Bruxelles, Bruxelles.
- Renard Centre of Marine Geology, Geological Institute, Université of Gent, Gent.

CANADA
- Département des Sciences Biologiques, Université du Québec à Montréal, Montréal, Québec.
- Department of Biology, McGill University, Montréal, Québec.
- Department of Fisheries and Oceans, Université de Moncton.

DENMARK
- Danish Institute for Fisheries Research, Charlottenlund.
- Freshwater Biological Laboratory, University of Copenhagen, Hillerød.
- Geological Survey of Denmark, Copenhagen NV.

GREECE
- Fisheries Research Centre (NARF), Kavala.

FRANCE
- Cabinet d’Études Techniques Industrielles et d’Innovations Scientifiques, Aix-en-Provence.
- Centre d’Océanologie de Marseille (Luminy), Marseille.
- Département de Géologie, Université de Bordeaux I, Talence.
- Département des Ressources Halieutiques (IFREMER), Sète.
- HEA, ORSTOM, Montpellier.
- Institut de Mécanique de Grenoble, Université Joseph Fourier, Grenoble.
- Laboratoire d’Arcachon, Université de Bordeaux.
- Laboratoire d’Écophysiologie, Faculté des Sciences, Université de la Réunion, Ille de la Réunion.
- Laboratoire de Sédimentologie et Géochimie Marines, Université de Perpignan, Perpignan.
- Laboratoire d’Océanographie Dynamique et Climatologie, Université Pierre et Marie Curie, Paris.
- Laboratoire d’Océanographie et de Biogéochimie, Centre d’Océanologie de Marseille, La Seyne.
- Observatoire Océanologique de Banyuls, Laboratoire Arago, Banyuls-sur-Mer.
- Observatoire Océanologique de Villefranche, Station Zoologique, Villefranche-sur-Mer.

GERMANY
- Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven.
- Federal Research Center for Fisheries, Institute for Sea Fisheries, Hamburg.
- Institut für Seenforschung, Langenargen.
- Institut für Meereskunde, Universität Kiel, Kiel.
- Max-Planck Institut für Limnologie, Plön.
- Senckenbergische Naturforschende Gesellschaft, Frankfurt/Main.
- Zoologisches Institut, Johann Wolfgang Goethe-Universitats Frankfurt/Main., Frankfurt/Main.

GREECE
- Fisheries Research Centre (NARF), Kavala.

ITALY
- Centro di Studio per il Quaternario e l’Evoluzione Ambientale (CNR), Roma.
- Centro interuniversitario di Biologia Marina “G. Bacci”, Livorno.
- Dipartimento di Biologia, Stazione di Biologia Marina, Università di Lecce, Lecce.
- Dipartimento di Ingegneria dell’Informazione, Università degli Studi di Pisa, Pisa.
- Dipartimento di Scienze dell’Uomo e dell’Ambiente, Università di Pisa.
- Dipartimento di Scienze della Terra, Università degli Studi di Genova, Genova.
- International Marine Centre of Oristano (IMC), Cerdeña.
- Instituto di Richerche di Pesca Marittima (CNR), Ancona.
- Instituto di Zoologia, Università di Genova.
- Stazione Oceanografica, LSDGM - CNR, La Spezia.

JAPAN
- Seto Marine Biological Laboratory, Kyoto University, Shihama, Wakayama.

MOROCCO
- Université de Tanger, Tanger.

NORWAY
- Department of Microbiology, University of Bergen, Bergen.
- Institute of Marine Research, Flåderigen Marine Research Station.

PORTUGAL
- Unidad de Ciencias e Técnicas Aquaticas, Universidade do Algarve.

SOUTH AFRICA
- Oceanographic Research Institute, Durban.

SWEDEN
- Kristineberg Marine Research Station, Fiskebuckskil.
- Tjärnö Marine Biological Station, Strömstad.
- Uppsala University, Institute for Earth Sciences / pal. Uppsala.

THE NETHERLANDS
- Department Physical Geography, University of Utrecht, Utrecht.

UK
- British Antarctic Survey (NERC), Cambridge.
- Plymouth Marine Laboratory (NERC), Plymouth.
- School of Biological Sciences, Queen Mary and Westfield College, University of London, London.
- School of Ocean Sciences, University of Wales-Bangor, Menai Bridge.
- Southampton Oceanography Centre, Southampton.
- The Centre for Environmental Fisheries and Aquaculture Sciences, Conwy Gwynedd.

USA
- Department of Biological Sciences, University of Southern California, Los Angeles.
- Department of Biological Sciences, State University of New York at Buffalo, Buffalo (NY).
- Department of Biology, Woods Hole Oceanographic Institution, Woods Hole.
- Department of Marine Biology, University of Santa Barbara, California.
- Department of Molecular and Cell Biology, University of Connecticut.
- Department of Oceanography, School of Ocean and Earth Science and Technology, University of Hawaii, Honolulu.
- Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York.
- Oceanography Group, Jet Propulsion Laboratory, California Institute of Technology / NASA, Pasadena, California.
DEPARTMENT OF OCEANOGRAPHY AND MARINE BIOLOGY

Head of Department: Dr. Marta Estrada

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Research Projects

MEDIPIELAGOS: Mediterranean pelagic ecosystem study: Plankton dynamics (EU-MAS2-CT93-0063) (Jan 93-Dec 95) (Coordinator: Dr. F. Rassoulzadegan, Observatoire Oceanologique de Villefranche-sur-Mer, France; ICM scientist in charge: Dr. M. Estrada).

Objectives: The general objective of MEDIPIELAGOS is to study nutrient limitations in the pelagic ecosystem in the Northwestern Mediterranean Sea. Specifically, the project consists of determining: 1) the nutrient/s (N,P) that limit primary production; 2) the pathways of nutrient cycling within the pelagic food web; and 3) the effect of external nutrient pulses. The hypothesis tested is that a hydrographically stable ecosystem will promote a "microbial-loop" based food web, whereas nutrient-pulsed systems (e.g., fronts) favour the development of a "classic" food web producing material settling to the sediment. The effect of nutrient pulses will be investigated using both field (cruise) and laboratory-based (microcosms) approaches. Existing process models describing nutrient cycling and the effect of nutrient pulses will be developed further.

MARE: Nutrients in the Northern Adriatic Sea: Consequences of N/P/Si loads and different ratios for the development of microalgae, with particular reference to harmful species. (EU-EV5V-CT92-0215) (Feb 93-Feb 96) (Coordinator, Dr. E. Funari, Instituto Superiore di Sanità, Rome, Italy; ICM scientist in charge: Dr. M. Estrada).

Objectives: The general objective of this project is to determine the importance of macronutrients in relation to harmful algal phenomena in the northern Adriatic Sea. The specific aim of Spanish participation is to evaluate the importance of macronutrient (N/P/Si) ratios in the structuring of phytoplankton communities.

DIADEME: Digital Image Analysis Development in European Marine Ecology. (EU-MAS2-CT93-0077) (Feb 94-Dec 95) (Coordinator: Dr. P.K. Bjørnsen, Marine Sciences Institute, Univ. Copenhagen, Denmark; ICM scientist in charge: Dr. C. Pedrós-Alion).

Objectives: 1) To develop and validate a versatile and user-friendly instrument and software package for automatic classification and quantification of marine microplankton biomass by epifluorescence microscopy; 2) To support the building of expertise in digital image analysis (DIA) at four European marine research institutes and promote collaboration among these four institutes in applying DIA to marine ecology; 3) To explore the potential for using neural network technology for automatic classification of marine microplankton.

MEDEA: Microbial Ecosystem Dynamics (EU-MAS3-CT95-0016) (Feb 96-Feb 99) (Coordinator, Dr. T.F. Thingstad, Univ. of Bergen, Norway; ICM scientist in charge: Dr. C. Marrasé).

Objectives: The main objectives are: 1) To look at how photic zone nutrient content relates to the balance between production and degradation of dissolved matter. 2) To look at specific groups of organisms that are apparently difficult to merge into the overall concept, in particular the role of mixotrophic protists and the coexistence of heterotrophic bacteria and autotrophic picoplankton. 3) To improve our knowledge of processes presently not well understood, in particular the role of bacterial ghosts and viral lysis in nutrient carbon flows. 4) To look at how turbulence affects the structure and function of the planktonic food web, in particular the size distributions of phytoplankton and nutrient regeneration by heterotrophs.

MATER: Mass Transfer and Ecosystem Response (EU-MAS3-CT96-0051) (Jun 96 - Jun 99) (Coordinator: A. Monaco, Univ. Perpignan, France; ICM scientist in charge of Biological Team: Dr. M. Estrada).

Objectives: Through an extensive experimental and physical and ecological modelling programme, MATER aims at globally studying the Mediterranean system, with the following common goal: 1) to study and quantify the triggering and controlling processes of mass and energy transfer between the different compartments (land-sea, sea-atmosphere, water-sediment, living-non-living, pelagos-benthos) and in contrasting environments, from eutrophic to oligotrophic. 2) to appraise the temporal and spatial scales of the phenomena, in identifiable structures in the Mediterranean system (basin and subbasin scale, mesoscale, local scale). 3) To investigate ecosystem response to such transfers and changes over time.

METRO-MED: Dynamics of matter transfer and biogeochemical cycles: modelling in coastal systems of the Mediterranean Sea (EU-MAS3-CT96-0049) (Jul 96-Jul 99) (Coordinator, Dr. A. Anagnostou, Institute of Oceanography, NCMR, Greece; ICM scientist in charge: Dr. J.M. Gili).

Objectives (Subtask 2.2. item iii): The overall objective of the proposed project will focus on evaluat-
ing the role of hard-substratum benthic suspension and soft-substratum deposit feeders in energy and matter transfer processes in littoral marine communities. To this end, a few representative species have been selected and field work will be carried out in two littoral areas: the Medes Islands and Banyuls-sur-Mer. The results of prior studies have raised three questions, and the three specific objectives of the present project have been designed to provide answers to those questions. The first two relate to the fact that when establishing the energy balance for one of the species studied, total ingested biomass (inputs) did not cover the species’ energy demand for respiration, growth, and reproduction (outputs). The third is the large error introduced in considerations of a population as a whole (without taking into account functional variability of each individual or colony) arising from variations among individuals or colonies when replicating assessments (ingestion rate, growth rate, etc.).

**Study of the Mediterranean pelagic system: Analysis of plankton dynamics** (CICYT-AMB94-1019) (June 94-Dec 95) (Scientist in charge: Dr. M. Alcaraz).

**Objectives:** Coupling between the temporal scales of physical and biological phenomena is the main determining factor affecting selection of food webs based on herbivorous zooplankton (classical food webs) or on microheterotrophs (microbial loop). Mediterranean production is nutrient-limited, though it is not clear which of the main nutrients (N or P) is responsible for the limitation on primary production. The effects of nutrient pulses in a hydrographically stable system presumably based on microheterotrophs should trigger the development of classical, herbivorous food webs, either temporal (inputs of external energy, such as wind-driven mixing) or spatial (hydrographic structures such as fronts). In such a situation the features of pelagic systems should be reflected in the variables of state and the rate processes of planktonic communities. To study such processes, we propose an interdisciplinary approach based on an oceanographic survey on board the “R/V Hesperides”.

**FRUELA: Carbon flux in an area of high productivity: Western Bransfield Strait and Gerlache Strait, Antarctica** (CICYT-ANT92-1186) (Nov 1995-Feb 1996) (Coordinator, Dr. R. Anadón, Univ. Oviedo; ICM scientist in charge: Dr. M. Estrada).

**Objectives:** The general objective is to determine carbon fluxes among plankton components in a region of high productivity in the Southern Ocean. Specifically, this project aims at establishing a model of the biogeochemical fluxes in the selected area, in order to quantify the exchange of CO₂ between the atmosphere and the ocean and the transfer of organic and inorganic particulate carbon between the photic zone and the sediment. The field work is based on a cruise to the Bransfield Strait area.


**Objectives:** The main objective is to approach the diversity of bacterioplankton using the RNA band patterns in different communities. This technique consists of non-selective isolation of total RNA, followed by separation by gel electrophoresis under conditions that separate the low-molecular-weight RNAs, 5S rRNA and tRNA. This approach will provide answers to a series of ecological questions related to diversity. Diversity of bacterioplankton will be analysed together with that of phytoplankton in a series of freshwater and marine ecosystems. We will check whether the abundance of viruses is correlated with low diversity of prey. Diversity will be determined along environmental gradients of productivity and salinity to establish whether bacterioplankton diversity behaves according to ecological theory. Finally, sulfur phototrophic bacteria will be used as a case study. This group has been chosen because it offers several advantages for our purposes: species can, in general, be differentiated morphologically, they are very abundant in nature, and several species can coexist in a guild, allowing us to check whether such coexistence is due to slight differences in physiology, as predicted by theory.


**Objectives:** 1) To study the mesoscale hydrographic structure of the Catalan Sea. 2) To analyse the relationships between mesoscale hydrographic structures and the distribution of primary producers. 3) To determine the biomass and turnover rates of the main components of the planktonic food web (from pico to macroplankton) and the transfer rates among them along environmental gradients related to mesoscale hydrographic features. The project is based on two oceanographic cruises and laboratory experiments.

**Anoxic events in Mediterranean estuarine bays: genesis, persistence and consequences** (CICYT, AMB95-0171C0201) (Jan 95-Jan 98) (Scientist in charge: Dr. J. Camp).

**Objectives:** The bays of the Ebro River Delta are stratified estuarine environments where hypoxia occurs seasonally; evolution of hypoxia into acute anoxic events depends upon a series of factors (high freshwater and nutrient inputs, persistent saline stratification, low primary production in deep waters, slow-down in estuarine circulation, accumulation of macrophyte detritus); coincidence in space and/or time of these factors leads to genesis of anoxic conditions in deep waters. We propose to
examine that hypothesis by quantifying the different phenomena relevant to the generation of anoxia. Moreover, this project is aimed at designing steps intended to control and ameliorate the deep-water quality of such bays, based on the hydraulic infrastructure of the area. The results will be of general value to Mediterranean estuarine ecosystems, whose dynamics have generally been overlooked in the literature.

Environmental control of the role of benthic suspension feeders in energy transfer processes in marine ecosystems (DGICYT, PB94-0014-C02-01) (Sep 95-Oct 98) (Scientist in charge: Dr. J.M. Gili).

Objectives: In recent years the paramount role of benthic suspension feeders in energy transfer processes in littoral ecosystems has become evident. Most work has been performed on molluscan populations, and very little is known about dense suspension-feeder populations on hard substrata, such as sponges, ascidians, cnidarians, and bryozoans. A previous study pointed out the importance of several cnidarian species in the transfer of energy from the planktonic system to the benthic system. In addition, there is some evidence that the finer fraction of suspended organic matter (bacteria, organic particles, phytoplankton) may represent a greater contribution to diets than previously suspected, especially in filling the energy requirements of suspension feeders. This project will therefore focus on two poorly understood aspects of the trophic ecology of benthic suspension feeders: first, assessing the role of the fine organic matter fraction in the diet of benthic suspension feeders; and second, and more importantly, establishing the role of environmental control in regulating the rate and frequency of prey capture through a spatio-temporal assessment of hydrodynamic conditions.


Objectives: This project proposes two oceanographic cruises off the Galician coast. The main objectives are: 1) Characterization of small-scale temporal variability in the hydrographic structure and circulation at the Rias Baixas and the adjacent shelf. 2) To determine the influence of this variability on the carbon flux and population exchange between the rias and the shelf; special attention will focus on toxic phytoplankton. 3) To study the structure of the food web compartments and to characterize the fluxes between them.

Mechanisms regulating aquatic microbial food webs (DGICYT, PB95-0222) (Sep 1996-Sep 1999) (Scientist in charge: Dr. C. Pedrós-Alió).

Objectives: The main objective of the present project is to elucidate the mechanisms governing the composition and functioning of aquatic microbial food webs. This objective will be approached at three different levels. First, an empirical study will try to ascertain the relationships between the components of the webs in different ecosystems. Second, an experimental study will be carried out with whole communities incubated in controlled microcosms. The two variables whose effects are to be studied are turbulence and inorganic nutrients. Several variables will be monitored: macromolecular composition of the plankton (nucleic acids, proteins, pigments, and polysaccharides), size distribution and taxonomic diversity. The purpose is to identify those variables which can be used in the field to establish the importance of turbulence and nutrients on planktonic assemblages at sea. Finally, a few representative species of microorganisms will be selected for continuous culture studies designed to reveal the physiological responses of these organisms to turbulence and nutrients.

Development of submersible equipment for the evaluation of physiological parameters in benthic organisms in situ (CICYT-PTR94-0119) (Jun 95-Sep 96) (Scientist in charge: Dr. J.M. Gili).

Objectives: The main objective is to develop a new equipment to assess in situ data on particle capture, respiration and excretion in benthic invertebrates. The prototype is composed of two incubation chambers with oxygen and ammonia sensors and pumps to ensure continuous water renewal. A special computer program will be designed to permit continuous automatic data recordal.


Objectives: Suspension feeders are abundant in Antarctic benthic communities. They might play an important role in energy transfer processes, mainly by their feeding activity on the seston. During the Antarctic summer, planktonic production is higher, and it might be hypothesized that suspension feeders should also exhibit higher feeding activity. Cnidarians are one of the more important macrobenthic suspension feeding groups in the Antarctic, but there is little information on their diet and feeding rates. The objective of this study was to identify the most abundant cnidian suspension feeders, to analyse their diet and the energetic value of their prey items, and to measure their feeding rates as estimated from intensity of predation and digestion time.

Study of toxic plankton in the Catalan coastal area (Generalitat de Catalunya-Departament d’Agricultura Ramaderia i Pesca) (Apr 93-Apr 96) (Scientist in charge: Dr. J. Camp).
Objectives: The main objective was the identification and quantification of toxic phytoplankton in the coastal waters off Catalonia, focused mainly on the effect on humans (shellfish ingestion) and fish cultures. This subject is covered by a regular monitoring programme (weekly sampling) with results reported immediately (1-5 days after collection of samples). Among the most important toxic organisms in our geographical area are PSP producers (*Alexandrium minutum*), DSP producers (*Dinophysus spp.* and *Prorocentrum spp.*), and organisms associated with fish mortalities (*Gyrodinium coruscum*). The spatial and temporal distribution of poisonous outbreaks and compilation of knowledge of recurrence (annual or non-annual) of these events are also important objectives.

Environmental study of Catalan coastal waters
(Convenio de investigación con el Departament de Medi Ambient de la Generalitat de Catalunya) (Oct 96-Dec 97) (Scientist in charge: Dr. J. Camp).

Objectives: Extensive study of the physico-chemical characteristics of the Catalan coast in relation to eutrophication and algal bloom formation: regulating factors, inputs and effects of continental discharge on the coastal marine environment.

Current research activities of Department members

Staff scientists

**Dr. Miquel Alcaraz** (Profesor de Investigación). Zooplankton ecology. Physical-biological interactions in the planktonic domain. Effects of exosomatic energy (hydrodynamic forcing, small-scale turbulence) on structural and functional properties of planktonic systems. Planktonic secondary production, food webs and carbon budgets. Extensive properties (biomass, chemical composition, distribution patterns) and zooplankton rate processes (feeding, metabolic carbon requirements, N and P excretion, etc.) in relation to the time scales of environmental variability.

Selected publications


Selected publications


Selected publications:


**Dr. Marta Estrada** (Profesora de Investigación). Biological oceanography. Phytoplankton ecology. Role of environmental factors in regulating primary production and carbon fluxes through the planktonic food web. Effects of hydrodynamic variability on phytoplankton. Selection of phytoplankton life-forms and distribution of phytoplankton assemblages in relation to physico-chemical forcing.

Selected publications


**Dr. Josep-Maria Gili** (Investigador Científico). Ecology of sublittoral benthic communities, especially production and dynamics of benthic invertebrates. Influ-
ence of environmental factors (hydrodynamics and sedimentation) in the life history and in situ studies of feeding, growth, reproduction, metabolism and energy budgets. Trophic ecology of benthic suspension feeders and their role in pelagic-benthic coupling processes. Ecology of zooplankton, especially patterns of abundance and distribution, feeding ecology and life cycles of gelatinous zooplankton.

Selected publications

Dr. Mikel Latasa (Colaborador Científico). Physiology and ecology of phytoplankton. Ecology of the different groups of phytoplankton characterized by their pigment markers. Mortality rates of phytoplankton due to microzooplankton grazing. Effect of nutrients and light and diel rhythms on the pigment content of microalgae. HPLC analysis of pigments.

Selected publications


Selected publications

Dr. Carles Pedrós-Alló (Investigador Científico). Aquatic microbial ecology. Structure of, and carbon flow through, microbial food webs in contrasting environ-

ments. Diversity of microbial assemblages. Importance of organic matter, inorganic substrates and temperature in regulating heterotrophic bacterial production. Physiological ecology of selected microbial organisms including bacteria, algae and ciliates.

Selected publications

Dr. Enric Saiz (Colaborador Científico). Ecology of micro and mesozooplankton in marine environments. Special emphasis on i) laboratory research regarding aspects such as ecophysiology (feeding, excretion, growth), behavioural studies, effects of small-scale turbulence, roles of predation and patchiness as forcing factors, and ii) field studies focusing on the role of copepods as grazers in the NW Mediterranean as well as their contribution to regenerated production and also on the quantification of juvenile and adult copepod growth rates in relation to hydrographical singularities.

Selected publications

Ms. Isabel Trepat (Titulada Superior). Zooplankton: ecology and systematics of Thaliacea and appendiculari-

ans. Laboratory culture of copepods, egg production methods.

Selected publications

Dr. Dolors Vaqué (Colaboradora Científica). Aquatic microbial ecology. Role of bacteria as carbon sources for higher trophic levels (i.e., protists). Factors regulating bacterial activity and biomass in coastal waters and the open sea (Mediterranean, Atlantic Ocean and Antarctic waters).
Selected publications


Other Scientists

**Dr. Víctor Alvà** (Investigador contratado). Ecology of benthic marine invertebrates, especially cnidarians and echinoderms. Study of their life histories, focusing on feeding, reproduction, ontogeny and demographic parameters. Trophic ecology of benthic suspension feeders. Functional morphology of digestive, storage and reproduction systems and their relationships to life history. Biogeography of echinoderms, in particular Ophiuroidea.

Selected publications


Selected publications


Selected publications:


**Dr. Angela Fara** (Becaria postdoctoral). Ecophysiology of plankton, especially the study of dynamics of amino acid, protein, carbohydrate, RNA and DNA in cultures of different phytoplankton species growing under N and P starvation. Comparative study of the biochemical composition of the pico- and nanoplankton size fractions of natural communities. Identification of specific biochemical indicators of phosphorus and nitrogen deficiency.

Selected publications


**Dr. Josep M. Gasol** (Investigador contratado). Factors regulating the abundance of planktonic microorganisms and microorganism community structure (size and functional structure). How predation and resources regulate microorganism (in particular, bacterial) abundances and how they regulate the composition of the microbial “black box” in terms of size structure and metabolic characteristics of the community. Empirical analysis of data bases of organism abundance, growth and loss rates, generated mainly on cruises; and more detailed studies of community composition with the combined use of image analysis and flow cytometry, and metabolic fluorescent probes.

Selected publications


**Dr. Xabier Irigoien** (Becario postdoctoral). Ecology of mesozooplankton in coastal and oceanic environments. Special emphasis on feeding and secondary production by copepods in estuarine systems in relation to such environmental parameters as salinity, turbidity and phytoplankton distribution. Determination of reduction on secondary pro-
duction by food limitation in coastal and oceanic areas in the NW Mediterranean and Antarctica. Development of methodology for copepod grazing experiments.

Selected publications


Dr. Akira Kuwata (Becario postdoctoral). Ecology of phytoplankton, especially the population dynamics of marine planktonic diatoms. Physiological ecology of life cycles and survival mechanisms under environmental fluctuations. Comparative study of life histories.

Selected publications


Selected publications


Dr. Ramon Massana (Investigador contratado). Trophic relationships among microorganisms, with particular interest in the physiological ecology of ciliates. Molecular approaches to microbial diversity. Currently pursuing the latter field at the University of California-Santa Barbara.

Selected publications


Dr. Francesc Pagès (Investigador contratado). Ecology and systematics of gelatinous zooplankton, particularly siphonophores, medusae and ctenophores. Small-scale and mesoscale coupling between hydrological parameters and zooplankton distribution. Trophic impact of gelatinous carnivores on zooplankton. Biological associations with gelatinous zooplankton. Geographic areas: Mediterranean, Benguela System, Arctic and Southern Oceans.

Selected publications


Selected publications:


Dr. M. Montserrat Sala (Investigadora contratada). Determination of the limiting factors in microbial communities in the Mediterranean Sea. Influence of turbulence on bacterial activity and production. Degradation of organic matter in aquatic ecosystems: microbial populations and enzymatic activities involved. Formation of bacterial aggregates during the degradation of organic matter. Microbial ectoenzymatic activities (alkaline phos-
phatase, aminopeptidase and glucosidase), bacterial production, and bacterial volume by image analysis.

Selected publications

Dr. Renate Scharek. (Investigadora contratada). Ecology of phytoplankton and protozoa; Ecology of phytoplankton and sea-ice algae in the Southern Ocean; Interactions of phytoplankton and trace metals; Ecology of diatoms in the North Pacific Central Gyre; Vertical flux of phytoplankton; Diatom aggregation and disaggregation

Selected publications

Ph.D. Students


Selected publications

Dr. Albert Calbet (Becario predoctoral, 1996) (ICM Ph.D. advisor: Dr. M. Alcaraz). Marine plankton ecology, with emphasis on zooplankton. Trophic dynamics of copepods. Relationships between different frequencies of fluctuating food availability and copepod egg production and development as well as the modulating effect of other environmental factors such as light and temperature. Study of daily rhythms in ingestion and egg production. Field studies for quantification of juvenile and adult copepod growth rates in relation to hydrographical singularities in the NW Mediterranean.

Selected publications

Mr. Juan I. Calderón-Paz (Becario predoctoral) (ICM Ph.D. advisor: Dr. C. Pedrós-Alió). Biomass and heterotrophic production of bacterioplankton in diverse aquatic ecosystems: from coastal solar salterns to Antarctic marine waters. Low-molecular-weight rRNA band patterns as indicators of bacterial diversity in aquatic ecosystems.

Selected publications


Selected publications

Selected publications


Selected publications

Ms. Núria Guixa-Boixereu (Becaria predoctoral) (ICM Ph.D. advisor: Dr. C. Pedrós-Alío). Abundance and importance of bacteriophages in diverse aquatic ecosystems: from coastal solar salterns to Antarctic marine waters. Factors determining the relative abundance of bacteria and viruses in planktonic systems.

Selected publications

Mr. José A. G. Morán (Becario predoctoral) (ICM Ph.D. advisor: Dr. M. Estrada). Marine plankton ecology, with special focus on phytoplankton. Primary production, both particulate and dissolved, and its relationship to hydrographic features in the NW Mediterranean. Interaction between phytoplankton and bacterioplankton through the release of organic carbon by phytoplankton and uptake by bacteria. Compartimental analysis of carbon fluxes between components of planktonic food webs.

Selected publications


Ms. Marta Ribes (Becaria predoctoral) (ICM Ph.D. advisor: Dr. J.M. Gili). Trophic ecology and energetics of benthic suspension feeders. Feeding behaviour, prey capture and selectivity by gorgonians, sponges and ascidians. Respiration. Field experiments with incubation chambers.

Selected publications

Mr. Sergi Rossi (Becario predoctoral) (ICM Ph.D. advisor: Dr. J.M. Gili). Evaluation of the role of environmental control in regulating the rate and frequency of prey capture by benthic suspension feeders through a spatio-temporal assessment of hydrodynamic conditions. Littoral sediment traps. Activity rhythms. Protein and lipid analysis.

Selected publications

Mr. Evaristo Vázquez (Becario predoctoral) (ICM Ph.D. advisor: Dr. D. Vaqué). Marine plankton ecology, with special focus on: bacterioplankton, bacterial production, grazing of flagellates on bacteria, carbon fluxes between components of microbial food-webs and relationship between hydrographic features, size distribution and production by bacteria.

Selected publications

Ms. Magda Vila (Becaria predoctoral) (ICM Ph.D. advisor: Dr. M. Delgado). Ecology of phytoplankton, especially geographic distribution and seasonal abundance of phytoplankton along the Catalan coast. Monitoring of toxic dinoflagellates and red tides. Biological factors that allow development of phytoplankton (vertical and horizontal migration, cyst formation). Grazing on dinoflagellate blooms.

Technicians

Selected publications


Ms. Pilar Sacristán (Ayudante de Investigación). Laboratory assistant specializing in bacterial cultures, filtration and staining procedures for plankton samples. Maintenance of data bases.

Ms. María Vélez (Ayudante de Investigación). Laboratory assistant specializing in phytoplankton cultures, filtration and staining procedures for plankton samples. Maintenance of data bases.

**DEPARTMENT OF MARINE GEOLOGY AND PHYSICAL OCEANOGRAPHY**

Head of Department: Dr. Belén Alonso

http://www.icm.csic.es/geo/gmo_index.html

**Research Projects**

**STEAM: Sediment Transport on European Atlantic Margins** (EU-MAS2-CT94 0083) (July 94-Jan 97) (Coordinator, Dr. P. Weaver, Southampton Oceano- graphic Centre, UK; ICM scientist in charge: Dr. B. Alonso).

Objectives: To determine sediment transport processes from the continental margin and the flanks of volcanic islands to the deep marine environments, including frequency, magnitude and causes of sediment instability.

**Detail Reconnaissance of the Catalan-Balearic continental margin with a combination of new high-resolution tools (SWBS, high-resolution seismic-TOPAS, and TOBI).** (HC & Mobility Programme European Access to Sea Floor Survey Systems-IOS) (June 95-June 96) (ICM scientist in charge: Dr. B. Alonso).

Objectives: A very detailed study of current and recent morphology of the sea floor in the Valencia Trough area, to establish the main settlement and erosional processes using high-resolution seismic and acoustic equipment on board the BIO HESPERIDES, such as the EM 12 multibeam echosounder, TOPAS parametric echosounder, and the TOBI side-scan sonar system.


Objectives: Specific research on the continental margins in the Northwestern Mediterranean of high biologi-

Objectives: To use the Synthetic Aperture Radar, altimeter and Along-Track Scanning Radiometer on the ERS-2 satellite to study the Algerian basin, namely: 1) generation and evolution of large anticyclonic eddies over a temporal scale of months, 2) drift of Modified Atlantic Water (MAW) in relation to these large eddies, and 3) identification of mesoscale current-shear structures in the Algerian current.

OMEGA: Observations and modelling of eddy scale geostrophic and ageostrophic circulation. (UE-MAS3-CT95-0001, CICYT MAR96-1447-CE) (Feb 96-Jan 99) (Coordinator, Dr. J. Tintoré, Univ. Illes Balears, Spain; ICM scientist in charge: Dr. J. Font).

Objectives: To determine three-dimensional ageostrophic circulation at mesoscale (10-100 km) fronts and eddies and quantitatively estimate the vertical velocity; to evaluate the impact of ageostrophic vertical motion on the biogeochemical properties in the upper 400 m; and to provide the scientific community with a standardised tool for the computation of vertical motions from routine CTD and ADCP data.

MATER: Mass transfer and ecosystem response. (UE-MAS3-CT96-0051, CICYT, MAR96-2586-C03-02-E) (Aug 96-July 99) (Coordinator, Dr. A. Monaco, Univ. Perpignan, France; ICM scientist in charge (physics team): Dr. J. Font).

Objectives: MATER is the second phase of the Mediterranean Targeted Project (MAST-Regional Seas). The team is participating in two workpackages: Basic scale process studies, modelling and straits monitoring; and multidisciplinary studies in the western Mediterranean Sea. It has the responsibility of the interdisciplinary study of mesoscale instabilities in the Algerian basin, including a high resolution interdisciplinary in situ study, monitoring of the Balearic channels, long-term monitoring of mesoscale activity, and long-term multi-satellite monitoring of the Algerian basin.

SOFARGOS: Development of a Lagrangian technique adapted for large-scale and mesoscale current observations in the Mediterranean Sea. (UE-MA52-CT92-0046 and CICYT, AMB93-1006-CE) (Mar 93-Des 95) (Coordinator: Dr. J.C. Gascard, LODYC Univ. Paris VI, France; ICM scientist in charge: Dr. J. Font).

Objective: To develop and test a prototype float adapted for observing large-scale and mesoscale subsurface currents in the Mediterranean Sea. The SOFARGOS float has neutrally buoyancy at a predetermined constant depth, where it drifts according to the horizontal currents. The float is located by triangulation using long-range acoustic propagating signals transmitted by sound sources fixed on moorings at prescribed positions and is able to record vertical motion.

Evaluation of ERS-1 microwave sensor capability in the study of oceanic fronts. (European Space Agency, Earth Observation Program, AO E1) (Jan 91-Des 94) (Scientist in charge: Dr. J. Font).

Objectives: Development of methods for using the Synthetic Aperture Radar and altimeter of the ERS-1 satellite to identify and follow changes in surface mesoscale structures associated with density fronts.

RADARSAT SAR application study in the Western Mediterranean (Canadian Space Agency, ADRO321) (Apr 96-Mar 99) (Coordinator: Dr. J.J. Martínez, Univ. Politécnica de Catalunya, Spain; ICM scientist in charge: Dr. J. Font).

Objectives: To test the use of the wide-swath, low-resolution SAR of the Canadian RADARSAT satellite in tracking large mesoscale structures in the western Mediterranean Sea.


Objectives: To collect medusae in the Palamós canyon to study the biodiversity in submarine canyons, to verify whether relict species may remain confined in this marine environment.

FRUELA: Carbon Flux in an area of high productivity: Western basin of the Bransfield Strait and Gerlache Strait, Antarctica (CICYT-ANT94-1010) (Jan 1995-Dec 1996) (ICM scientist in charge (Geological Team: Dr. A. Palanques).

Objectives: The general objective is to determine carbon fluxes among plankton components in a region of high productivity in the Southern Ocean. Specifically, this project aims at establishing a model of the biogeochemical fluxes in the selected area, in order to quantify the exchange of CO2 between the atmosphere and the ocean and the transfer of organic and inorganic particulate carbon between the photic zone and the sediment. The field work is based on a cruise to the Bransfield Strait area.

Objectives: This is a study to detect hydrothermal activity in the Bransfield Strait.


Objectives: This is a study of variability in thermal redistribution and the associated oceanographic parameters resulting from glacial-interglacial climatic change in the Southern Pacific to analyse the history of circulation and productivity in the region and contribute to existing knowledge of the behaviour of CO$_2$ and its impact on global warming.

MAYC: Continental margins and deep basins: sedimentary record of paleoenvironmental and palaeoclimatic variability. (CICYT-AMB95-0196) (Sep 95-Sep 98) (Scientist in charge: Dr. B. Alonso).

Objectives: A detailed geological study, from high-resolution data, and modelling of the environmental and climatic history of the system consisting of continental margins and oceanic basins on a global scale. Different seismostratigraphic, morpho-structural, paleoenvironmental and palaeoclimatic objectives are proposed in different geologic settings, such as passive (Agadir), active (Venezuela and Colombia) and mixed (Alboran) margins.

Interdisciplinary oceanographic study of the Catalan-Balearic Sea (CICYT-AMB94-0706-C02) (June 95-June 98) (Scientist in charge: Dr. B. Alonso).

Objectives: To describe in detail the morphological and structural and sedimentological characteristics of the Ibiza Channel. To determine the origin and evolution of the 400 km-long Valencia Channel that runs parallel to the Valencia Trough between the Iberian Peninsula and the Balearic Islands. To investigate submarine erosion and transport processes in the submarine canyons and channels in the Ebro slope. To record the surface topology of submarine landslides on the distal Ebro margin.

CANALES: Mid-Ocean Channels and Fracture Zones: mutual interaction. Recent evolution of the Equatorial and Vidal Channels (Equatorial Atlantic) (CICYT-ANT95-0889-C02-02) (95-96) (Scientist in charge: Dr. J. Baraza).

Objectives: To study the final sector of two deep depositional systems in the Equatorial Atlantic Ocean, the Equatorial Mid-Ocean Channel and the Vidal Channel, including analyses of the interaction of both channels with the activity of mid-ocean fracture zones like Fernando de Noronha and Barracuda. These fracture zones seem to control the behaviour of both channels in the area around their mouths and may have been partially responsible for the final abandonment and infilling of one of these deep-sea channels.


Objectives: To carry out an oceanographic cruise in 1996 for the study of the temporal variability and three-dimensional structure of a mesoscale meander in the Alboran Sea, quantification of differences in the results obtained using different objective spatial analysis techniques, and the study of the variability of Algerian current instabilities.

Characterisation and dynamics of coherent physical and biological oceanographic structures. (CICYT-MAR95-1861) (Des 95-Nov 98) (Coordinator: Dr. E. Hernández, Univ. Illes Balears; ICM scientist in charge: Dr. J. Font).

Objectives: To characterize coherent physical and biological structures associated with circulation in the Mediterranean Sea and further analyse their spatio-temporal variability by applying methodologies of complex signal analysis developed in the field of hydrodynamics to time series of satellite data (altimetry, temperature and chlorophyll).

INTERMESO. Interdisciplinary study of mesoscale instabilities and their interactions with local, regional and global circulation in the western Mediterranean. (CICYT-AMB95-0901-C02-01) (July 95-June 98) (Coordinator, Dr. J. Tintoré, Univ. Illes Balears; ICM scientist in charge: Dr. J. Font).

Objectives: To study spatial and temporal variability of mesoscale eddies and filaments and their effects on circulation in the western Mediterranean. To analyse the effects using theoretical and experimental interdisciplinary approaches on different scales: local (shelf/slope exchange), regional (sub-basin) and global (basin).

Study of mud and sediment contaminants: distribution in the Ebro River (Junta de Residus de la Generalitat de Catalunya) (May 95-Des 97) (Scientist in charge: Dr. A. Palanques).
Objectives: To evaluate the impact of heavy metal pollutants dumped in the Ebro River by a chemical plant near Flix.

**Current research activities of Department members**

**Staff Scientists**

**Dr. Belén Alonso** (Colaboradora Científica). Marine sedimentology and seismic stratigraphy, mainly in deep-water environments. Study of continent-ocean sediment transfer and resulting sedimentary accumulations, especially the role of submarine canyons in sediment transport on continental margins and analysis of bodies at the mouth of the canyons. Recognition of the effect of sea level and other global processes recorded in deep-sea sediments at a number of geographically separate localities. Determination of the causes of mass wasting processes, including contributions by changes in sea level, seismic activity, sediment supply, and volcanic activity.

Selected publications


**Dr. Jesús Baraza** (Colaborador Científico). Marine geologist specializing in the study of sedimentology and the physical properties of surface deposits on continental margins and in ocean basins. More specifically, conducting studies on high-resolution seismic stratigraphy and sedimentology on continental slopes and deep basins; geological evolution of deep-ocean depositional systems; sedimentary instability processes on continental margins and the flanks of oceanic islands and evaluation of potential geologic hazards; characterization of physical and geotechnical properties of the sediment and stability analyses of submarine slopes.

Selected publications


**Mr. Marcelli Farrán** (Titulado Superior). Marine geologist engaging in the acquisition, processing and management of a broad range of geophysical and oceanographic data (multibeam swath bathymetry, reflection seismics, side-scan sonar and magnetometry). Special interests: high-resolution seismic and sequence stratigraphy on continental shelf, slope and deep basin provinces; sea floor geological mapping and bathymetry of continental margins and oceanic basins; acquisition and processing of geophysical and multibeam bathymetry data; design of software for the tracking and control of data acquisition on oceanographic cruises.

Selected publications


Selected publications


Selected publications


Dr. Alberto Palanques (Colaborador Científico). Aquatic sedimentary cycles in the continental, littoral and marine environments focusing on: 1) Sediment dynamics, dynamics of suspended sediment and vertical sediment fluxes, ocean-continent transfer processes, morphodynamics and littoral sedimentary evolution, sedimentation in deltaic and shelf zones, morphology and sedimentary processes in submarine canyons, valleys and deep sea fans; 2) Environmental impact of anthropogenic actions, effect of dumping of pollutant solids, trawling, public works (dams, harbours, submarine pipelines) on the sedimentary cycle, dynamics of heavy metals in the sediment, historical record of contaminants; 3) Global change, role of sediment in biogeochemical cycles (C, Si), sedimentary and oceanographic variations on seasonal and historical scales, paleoceanographic evolution and sea level changes during the Neogene-Quaternary.

Selected publications

Mr. Jordi Salat (Titulado Superior). Descriptive physical oceanography. Oceanographic data acquisition and processing. Marine population dynamics. Geographical areas: Western Mediterranean, Eastern Atlantic.

Selected publications

Other Scientists


Selected publications

Dr. Gemma Ercilla (Investigadora contratada). Marine geologist engaging in the study of the morphostratigraphy and sedimentology of continental margins and ocean basins on temperate and polar continental margins. More specifically, conducting studies on high-resolution seismic and sequence stratigraphy and sedimentology on continental shelf, slope and deep basin environments; genesis, evolution and control factors in turbidite depositional systems and polar margins; sedimentary instability on continental margins, characterization of physical and geotechnical properties of the sediments and evaluation of geological hazards.

Selected publications

Dr. Jorge Guillén (Investigador contratado). Sediment dynamics in shallow waters, from the shoreline to the shelf-break. Morphodynamics and coastal evolution under different time-scales (from storm events to historical perspective). Field measurements of sediment distribution, hydrography, morphology and hydrodynamic forces for quantifying advective fluxes of sediment and identifying sediment transport processes. Relationships and sediment exchanges between different shallow water zones, focused on dune-nearshore interactions and the shoreface-shelf transition. Characterization of coastal areas affected by different hydrodynamic conditions using cross-shore distribution of individual grain size fractions. Scientific coastal management.

Selected publications

Ph.D. Students

Ms. Catherine Bouzinac (Becaria predoctoral) (ICM Ph.D. advisor: Dr. J. Font). Water mass distributions and hydrodynamic characteristics in the western Mediterranean Sea. Spatial and temporal variabilities of Modified Atlantic Water circulation between the Alboran basin, the channel of Sardinia and the strait of Sicily. Algerian eddy monitoring with sea surface temperatures (from NOAA/AVHRR and ERS1/ATSR) and altimetric sea level anomalies (from ERS1 and TOPEX/POSEIDON). Comparisons between remote sensing and in situ data (CTD and current measure-
Mr. David Casas (Becario predoctoral) (ICM M.Sc. advisor: Dr. J. Baraza). Interactions of sedimentology and physical properties in the marine sedimentary record. Lithologic control of density, P wave velocity and magnetic susceptibility in marine sediments. Current field area located in the clastic apron of Gran Canaria (Canary Islands), Ocean Drilling Program (ODP) Leg 157.

Mr. Ferrán Estrada (Becario predoctoral) (ICM Ph.D. advisor: Dr. B. Alonso). Marine geologist and geophysicist specializing in high-resolution seismic stratigraphy and structural configuration of continental margins. Processes and factors that have controlled the evolution of the depositional systems in tectonically active areas; interaction of eustatic and tectonic processes and the resulting sedimentary products. Trace metal geochemistry in pollution studies related to industrial wastes. Specializing in acquisition and management of seismic and oceanographic data.

Selected publications


Selected publications


Mr. Pere Masqué (Becario predoctoral) (ICM Ph.D. advisor: Dr. A. Palanques). Natural and artificial radionuclides in air (aerosols), natural and marine waters and sediments. Water mass transport. Scavenging rates of radioactive tracers. Particle residence times in waters. Sedimentation rates and radiogeochronology of sediments by 210Pb methodology. Historical anthropogenic impact of heavy metals and artificial radionuclides.

Selected publications

Ms. Ana María Plaza (Becaria predoctoral) (ICM Ph.D. advisor: Dr. A. Palanques). Geochemistry of the marine sedimentary record over the last 500,000 years applied to paleoceanographic and paleoclimatic studies. Current research focusing on the analysis of biogenic silica and other geochemical parameters in sediment cores from the Alboran Sea and Nazca Ridge.

Mr. Fernando Pérez-Belzuz (Becario predoctoral) (ICM Ph.D. advisor: Dr. B. Alonso). Marine geology and geophysics. High-resolution seismic stratigraphy, sea-level change and its preservation in the stratigraphic record. Factors controlling seismic architecture and facies distribution on continental margins, with particular emphasis on turbidite systems. Trigger mechanisms and evolution of mud diapirism in different tectonic contexts (Alboran Sea, Black Sea). Current research focuses on the Alboran Sea Neogene record.

Selected publications

Mr. Pere Puig (Becario predoctoral) (ICM Ph.D. advisor: Dr. A. Palanques). Sediment dynamics and geochemistry of suspended particles across continental margins. Sediment trap studies, measuring vertical particle...
fluxes and using the major sediment constituents (organic carbon, calcium carbonate and biogenic silica content) and mineralogy as tracers to deduce origins, transport pathways and fates of particles in the oceanic water column. Suspended particle distribution and interactions with hydrographic and topographic structures. Study of the physical processes through which sediments are transferred from the continent and deposited on the continental shelf, slope and rise. Trace metal geochemistry of inorganic pollutants associated with marine sediment and particles, applications in pollution studies in coastal, urban or industrial systems.

Selected publications

Mr. Simón Ruiz (Becario predoctoral) (ICM Ph.D. advisor: Dr. J. Font). Physical oceanography. Dynamics of western Mediterranean circulation (Alboran Sea and Almería-Oran front): horizontal velocity fields using multivariate objective analysis of ADCP + hydrographic data; diagnostic of vertical velocities.

Mr. José de Jesús Salas (Becario predoctoral) (ICM Ph.D. advisor: Dr. J. Font). Physical oceanography. Study of circulation in semi-enclosed seas (Gulf of California and Mediterranean Sea), at low frequencies due to atmospheric phenomena and high frequencies due to tides using current-meters and ADCPs. Study of the Algerian Current and its associated eddies with the help of ARGOS satellite-tracked drifters, NOAA infrared imagery, CTD and ADCP data.


Selected publications


Technicians

Mr. Agustí Julià (Titulado Técnico). Oceanographic instrumentation. Mooring of autonomous data recording systems (current meters) during long-term periods. Development of physical oceanography instrumentation (Lagrangian drift buoys with or without sensors) and other instrumentation.

Selected publications

Mr. Oscar Chic (Técnico contratado, 1996). Synergy between optical and radar remote sensors. SAR imagery segmentation and speckle reduction. Multisensornal classification of crops: ERS.SAR imagery and Landsat TM. Recently, infrared and SAR imagery studies applied to determination of mesoscale oceanographic structures.

Selected publications

Mr. Oriol Rius (Técnico contratado). Computer scientist interested in a) data visualization techniques and rendering of two and three dimensional data sets, b) widget graphical developer (IDL, C, C++) and c) object-oriented programming.


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Ms. Benedicta Paracuellos (Ayudante de Investigación). Laboratory assistant specializing in sedimentological and mineralogical analysis. Expertise in the use of X-ray, grain size analysers, sedimentation column, and sample preparations for multiple purposes.

Ms. María Rosa Vitrià (Ayudante de Investigación). Secretarial assistant engaging in drawing up project proposals, specifications and manuscripts and in maintenance of data bases.

DEPARTMENT OF RENEWABLE RESOURCES

Head of Department : Dr. Isabel Palomera

http://www.icm.es/gim/recursos.html

Research Projects

FIGIS: Spatio-temporal analysis of fishery resources, their environment and exploitation in the Mediterranean: experimental use of Geographical Information Systems (EU-FAIR CT950419) (Jan 96-Dec 98) (Coordinator: Dr. G. Le Corre, IFREMER, Sete, France, ICM scientist in charge: Dr. J. Lleonart).

Objectives: Development of a fisheries GIS including environmental information applied to the northwestern Mediterranean Sea.

Evaluation and analysis of the interaction of fishing gears in the demersal fisheries of the Western Mediterranean (EU-MED/92/009) (March 93-May 95) (Coordinator: Dr. P. Sánchez, ICM).

Objectives: a) Analysis of species composition in different areas and over time and its relationship to different gears and levels of fishing effort; b) Development of multispecies approaches to stock assessment; c) Implementation and evaluation of multispecific multigear methodologies.

Experimental squid jigging with light attraction (EU-MED/93/19) (Jan 94-Dec 95) (Coordinator: Dr. P. Sánchez, ICM).

Objectives: a) Examination of the vulnerability of Loligo vulgaris and Todarodes sagittatus to different types of jigging and lighting systems; b) Determination of the effectiveness of this gear in comparison to gears in use; c) Evaluation of the efficiency of this gear in relation to operating costs when used by small scale fishery boats; d) Estimation of some biological parameters on Loligo vulgaris in the Gulf of Kavala.

Impact of bottom trawling on sediment and benthic communities in the NW Mediterranean (EU-Study 95/52) (Jan 96-Jun 98) (Coordinator: Dr. P. Sánchez, ICM).

Objectives: a) Assessment of the role of otter trawling in modifying the bottom sediments off the continental shelf of Catalonia and its role as an erosional process, in order to estimate its impact versus natural sedimentological processes; b) Examination of the effect of disturbance on the benthic ecosystem by measuring qualitative and quantitative changes in benthic communities in response to intensive experimental trawling; c) Estimation of the survival of organisms captured or damaged by the trawling process; d) Examination of behavioural responses of opportunistic scavenging species to trawling disturbance.

Discards of the western Mediterranean trawl fleets (EU-DG XIV 94/027) (Apr 95-May 97) (Coordinator: Ms. A. Carbonell, Instituto Español de Oceanografía, ICM scientist in charge: Dr. P. Martín).

Objectives: Analysis of the composition of the discards of trawl fleets in different areas of the western Mediterranean, both from a quantitative and a qualitative point of view, considering seasonality, depth, and vessel or gear type as factors that might affect discards.

Study of abundance indices for demersal species in the Spanish Mediterranean Sea (EU-DG XIV MED/95/54) (Apr 97-May 97) (Coordinator: Mr. L. Gil de Sola, Instituto Español de Oceanografía, ICM scientist in charge: Dr. D. Lloris).

Objectives: Demersal trawl survey; relative abundance indices; maturity indices; collection of data for age reading; comparison of populations by depth; importance of 30 species common to Mediterranean EU countries.

Assessment of relationships between oceanographic parameters and spatio-temporal fluctuations in pelagic fish populations using satellite images and acoustics (EU-AIR1-CT92-0314) (Jan 93- Sept 96) (Coordinator: Mr. J. Rucabado, ICM).

Objectives: T-ECHO research project with participation by state research agencies [IRPEM (Italy), ORSTOM (France), and ICM (Spain), ICM being the
general coordinator for project execution], for assessment of the relationships between the spatio-temporal fluctuations in small pelagic fish populations and environmental conditions in the central and western Mediterranean and analysis of the structures and dynamics of the distribution of small pelagic fishes and the main oceanographic descriptors. Study area: northern Adriatic, where there is a historical data series for acoustic and environmental trials covering the last 17 years. Case study area for testing the results in the Adriatic: Catalan Sea.

**Nephrops norvegicus**: Comparative biology and fisheries in the Mediterranean (EU-MED/92/008) (Mar 93-Dec 96) (Coordinator: Dr. F. Sardá, ICM).

Objectives: Assessment of community management of the fishery on the *Nephrops norvegicus* resource in the Mediterranean and adjacent Atlantic areas based on comparative analysis of the biology and fisheries for this species. Current stage: design of the sampling period strategies for the different areas.

**Concerted action for the study of the biology and fisheries of deep shrimps in the Mediterranean and adjacent seas** (EU-FAIR-CT95-0208) (Jan 96-Set 97) (Coordinator: Dr. F. Sardá, ICM).

Objectives: Establishment of a scientific basis for the study and definition of specific objectives in the context of Mediterranean deep-sea shrimps in order to elucidate the main topics for future research.

**Actions for coordinated research on the European anchovy** (EU-AIR3-CT94-1855) (Jan 95-Dec 95) (Coordinator: Dr. I. Palomera, ICM).

Objectives: To maintain and enlarge the European research groups working on anchovy and establish a network of researchers that will have periodic meetings, workshops and seminars for the purpose of exchanging methods and results and standardizing techniques. Meetings: 1) Anchovy and its environment; 2) Anchovy research during 1994; 3) Research proposals for 1995; 4) Thematic workshop meetings: larval and juvenile otolith microstructure and growth; acoustic surveys; methodological improvements of DEPM

**Spatio-temporal variation in benthopelagic and demersal community structure on the deep slope in the Catalan Sea and trophic interaction** (CICYT-AMB93/0283) (Jun 93-Jun 96) (Scientist in charge: Dr. F. Sardá).

Objectives: Determination of the spatio-temporal variations in benthopelagic and demersal community structure on the deep slope in the Catalan Sea, with special emphasis on decapod crustaceans and including a study of the trophic relationships among different organisms.

**Age and growth of the cephalopods Sepia officinalis and Octopus vulgaris** to progress in the existing knowledge of their life cycles and to assess the influence of biotic and abiotic factors on growth. To improve and develop ageing methods from periodic growth increments.

**Biological conditions of anchovy early life stages in contrasting environmental areas and their influence on larval survival** (CICYT-MAR95-1918-C02-02) (Dec 95-Dec 97) (Coordinator: Mr. A. García, Instituto Español de Oceanografía, ICM scientist in charge: Dr. I. Palomera).

Objectives: Analysis of the influence of environmental factors on the distribution of anchovy eggs and larvae on a mesoscale level to determine: 1) the level of aggregation of eggs and later dispersion or concentration in relation to hydrological phenomena, currents, eddies, filaments; 2) larval development by studying daily growth, the RNA/DNA rate, and the biological effects of xenobiotics; 3) larval survival and variability in recruitment.

**A bioeconomic model for Spanish Mediterranean Fisheries** (CICYT-MAR95-1767) (Jan 96-Dec 98) (Scientist in charge: Dr. J. Lleonart).

Objectives: Development of a bioeconomic model for explaining the behaviour of Spanish Mediterranean fisheries (probably hake and anchovy as test fisheries), with two research priorities: a) To further understanding of the functioning of fisheries as a complex bioeconomic system; and b) To evaluate the effects of different management strategies with differing objectives, including different optimization criteria, reliability of results, and risk analysis.

**Culture of Octopus vulgaris to the juvenile stage** (Generalitat de Catalunya, Departament de Agricultura, Ramaderia i Pesca, 30013/96) (Jul 96-Dec 96) (Scientist in charge: Dr. P. Abelló).

Objectives: To determine the conditions for rearing and growth of the larval stages of *Octopus vulgaris*. Estimation of the potential use of *Octopus vulgaris* as new species for aquaculture.
Current research activities by Department members

**Staff scientists**

**Dr. Pere Abelló** (Colaborador Científico). Ecology of decapod crustaceans; population biology of epihentic decapod crustaceans (continental shelf and slope); behavioral ecology of coastal crustaceans (rhythmic behaviour, activity patterns, reproductive behaviour); biodiversity and biogeography (zoogeography, distribution and related factors) in the western Mediterranean; larval ecology (zoogeography, recruitment and larval behaviour); seabird ecology: offshore distribution; relationships with mesoscale oceanographic patterns.

Selected publications:


Selected Publications

**Dr. Domingo Llorís** (Colaborador Científico). Continuing studies on the ichthyogeography of the Mediterranean Sea (western and eastern, Black Sea included) with a by-product: the ICTIMED CD-ROM Data Bank. One paper on the phenomenological and massive presence of *Capros aper* in Mediterranean waters. Two projects (MEDIT and DEEP-FISHES) in the Mediterranean Sea funded by the European Community.

Selected publications

**Dr. Paloma Martín** (Titulada Superior). Exploited populations. Fisheries. Links between yield and environmental factors. Fish biology. Selected publications:


Selected publications


Selected publications

Selected publications

Mr. Jaume Rucabado (Colaborador Científico). Main actual stream data are: biological acoustics (both vertical [echosounder] and horizontal [sonar]) simultaneously with current measurements (ADCP), CTD vertical profiles and satellite thermal images.

Selected publications:


Selected publications


Selected publications


Dr. Francisco Sardá (Investigador Científico). Decapod crustacean specialist: fishery and ecology. Special attention on biological parameters related to fisheries (moult, growth, reproduction, size at first maturity, morphometry) and dynamics (recruitment, selectivity, movements, seasonality, distribution, density, abundance). Target species: Nephrops norvegicus (Norway lobster) and Aristeus antennatus (rose shrimp). Experience in deep-sea trawl megabenthos sampling (>2000 m).

Selected publications:

Other scientists


Selected publications

Dr. Joan B. Company (Investigador Contratado). Decapod crustacean specialist: biology and ecology. Special attention on life history strategies (recruitment, distribution, abundance, reproductive cycles, size spectrum, sex ratio, related to depth) and ecology (metabolism and energetics). Target species: all deep-sea decapod crustaceans.

Selected publications

Selected publications

Dr. Antoni Lombarte (Investigador Contratado). Ecomorphology of sensorial systems of aquatic animals. Mechanoreception (hearing) and chemoreception (taste) of fishes. Image analysis systems applied to morphometric studies. Otolith studies (biology and growth of fishes). Morphology of cephalopod statoliths. Faunistics and biology of fishes applied to fisheries.

Selected publications

Dr. Francesc X. Maynou (Investigador Contratado). Spatial statistics, population biology, biology and ecology of decapod crustaceans, dynamics of exploited populations.

Selected publications

Dr. Juan-Pablo Pertierra (Investigador Contratado). Pelagic stock assessment techniques, population modelling, new methodologies for biomass assessments, geographical information systems (GIS) applied to fisheries research.

Selected publications

Dr. Laura Recasens (Investigadora Contratada). Application of fish population dynamics models, specifically, analytical models (VPA, pseudocohort analysis, yield per recruit). Fisheries biology of fishes, including demographics (length frequency analysis), reproduction, feeding, relative and absolute growth: calculation of age from modul length distribution models (Bhattacharya).

Selected publications


Selected publications

Dr. Guimars Rotllant (Investigadora Contratada). Crustacean and fish ecophysiology, with special emphasis on endocrinology and reproduction.

262 (30) ICM (CSIC)
Selected publications


Selected publications

**Ph.D. students**


Selected publications


Selected publications

**Mr. Ricardo Bravo** (Becario Predoctoral) (ICM Ph.D. advisor: Dr. D. Lloris). Revision of the Family Bovichtyidae worldwide.

**Mr. Juan Madrid** (Becario Predoctoral) (ICM Ph.D. advisor: Dr. P. Sánchez). Aspects of fisheries ecology and biogeography of fishes in the Meso-American Pacific Ocean.

Selected publications

**Ms. Rosa-Isabel Ochoa-Báez** (Becaria Predoctoral) (ICM Ph.D. advisor: Dr. I. Palomera). Reproductive seasonality and ovary production, fecundity, spawning frequency and atresia of the European anchovy. Reproductive activity and histology of ovaries.

Selected publications

**Dr. Laura Sánchez** (Becaria Predoctoral, 1996) (no ICM Ph.D. advisor). Feeding of some species of Mediterranean fish larvae.


Selected publications

Selected publications


Selected publications

Technicians
Ms. Francisca Calderón (Ayudante de Investigación). Data processing and laboratory assistance.

Ms. Gemma Fuster (Auxiliar de Laboratorio). Data processing and laboratory and cruise assistance.

Ms. Balbina Molí (Ayudante de Investigación). Data processing, laboratory and cruise assistance, and otolith analysis.
TECHNICAL SERVICES UNIT

Head of Unit: Dr. Jordi Camp

LIBRARY

The primary task of the library and documentation service is to furnish the documentary information required to fulfil the Centre’s research objectives. Its services are mainly used by ICM staff and users from other research and academic centres. At the end of 1996, its stocks comprised 4964 books and 1200 periodicals, of which 488 were current publications: 378 from donations and especially exchanges for the journal *Scientia Marina*, the rest subscriptions. The library has a reading room with accessible on-line catalogues, CD-ROM databases for users, and a personal loan and document supply service for ICM personnel.

An inter-library loan service procures requests for documentation not on hand in the libraries own stocks and fills requests from other libraries. Inter-library loan rates are indicative of increasing library activity as a loan centre than as a procurement centre.

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In 1996 cataloguing of the off-print collection of nearly 800 numbers, mostly dealing with crustaceans, from Dr. Zariquiey’s private collection, began for inclusion in the comprehensive computer catalogue at all CSIC libraries.


Librarian in charge: Ms. Marta Ezpeleta (Titulado Técnico).

Inter-library loan manager: Ms. Glòria Medina

PUBLICATIONS: THE JOURNAL, SCIENTIA MARINA

*Scientia Marina* (ISSN 0214-8358) (formerly *Investigación Pesquera*) is an international journal of marine sciences published by the ICM-CSIC since 1955 and, from 1996 in collaboration with the International Centre for Coastal Resources Research (CIIRC). *Scientia Marina* publishes original papers on marine research in the following fields: physical and chemical oceanography, marine geology, marine biology and ecology, marine engineering, coastal zone management, and marine fisheries. Emphasis is placed on articles of an interdisciplinary nature and of international interest. Studies of local interest will be accepted only if they refer to the Mediterranean or other European seas. Papers written in English will be given preference, although papers in Spanish may occasionally be accepted. Papers will be accepted only after receiving a satisfactory report from the Science Editor and at least two reviewers drawn from an international panel of referees. The journal is published quarterly. Four annual numbers make up a regular volume. Supplementary issues include proceedings of symposia and monographs relating to topics falling within the scope of the journal.

For more information: E-mail: scimar@icm.csic.es, ciirc@etseccpb.upc.es, [http://scimar.icm.csic.es/sm](http://scimar.icm.csic.es/sm)

Journal Editor: Dr. Josep-Maria Gili (Jun 91 - Mar 97)

Associate Editors: Dr. Pere Abelló (Jun 92 - Mar 97), Mr. Pedro Rubiés (Jan 89 - Mar 97).

Journal Secretary: Mr. Joan Lambea (Auxiliar Administrativo). Technical processing and editing of texts, data management, journal exchange service, design and editing of figures and text. Computer programs: QuarkXPress and Adobe Photoshop.

CHEMICAL ANALYSIS SERVICE

The main tasks of this service are:
- Preparation of analytical protocols for the analysis of samples supplied by researchers. Chemical analysis of samples collected in-house and/or from outside sources.
- Furnishing advice on problems relating to chemical parameters for research projects. Cooperation by Section staff members in research projects.
- Participation in sample collection on oceanographic surveys.
- Establishment of a local area network (LAN) for the transfer of data and remote link-ups to analytical equipment. The network is in the preliminary stage and will be designed to provide a platform for interchange and control by Section personnel as well as direct access to data by researchers using the Intranet or an in-house network of some sort.

This Section has been subdivided into four operational subsections for the different analytical methods employed:

**Chromatography**: Both High Resolution Gas Chromatography (HRGC) and High Performance Liquid Chromatography (HPLC) are available.

Equipment: DANI 3800HR, SHIMADZU CR-14, and LKB series 2150.

Analysis parameters:
- **Photosynthetic pigments**: Chlorophyll a,b,c, breakdown products, xanthophylls and carotenones, using HPLC with UV-VIS and fluorescence detectors. Analysable matrices: organisms.
**ELECTRON MICROSCOPY SERVICE**

ICM’s electron microscopy laboratory is available for the observation of samples by scanning electron microscopy (SEM) and x-ray microanalysis. It is open to all ICM researchers and researchers of the CSIC and other public and private centres. It has appropriate equipment for sample preparation and provides advice to users on both sample preparation and equipment operation. It is also able to furnish reference material on sample preparation in the different fields, in particular those relating to the marine environment.

- **HITACHI S-570, Scanning Electron Microscope**: Resolution: 3.5 nm; magnification: 20-200000 x; accelerating voltage: 0.5-30 Kv; secondary electron detector.


- **PRINTERFACE for Windows Image Acquisition System**: Image acquisition for scanning electron microscopy at slow scan speeds. Image file format: .TIF, .PCX, .BMP, .WPG, .JPG, .GIF, and others; Computer: Pentium 166 Mhz, 32 MB RAM; Software: Printerface for Windows, Photoshop, Graphics Workshop; Printer: HP Laserjet 5L.

Sample preparation equipment: BAL-TEC CPD 030 critical point drying, POLARON SCS500 Sputter coater, POLARON CA508 carbon evaporation attachment. Development and copies of SEM micrographs is performed by the ICM’S photography service.

Person in charge: **Mr. José-Manuel Fortuño** (Titulado Superior). Ultrastructural studies of phytoplankton. Ichthyoplankton, ultrastructure of fish egg chorions. Microstructural analysis of otoliths and scanning studies of sensory epithelia of the inner ear of fishes. Morphology and ultrastructure of crustacean reproductive systems.

**COMPUTER CENTRE**

The computer centre’s services focus on two main areas, communications and computation.

Communications over the local area network have been extended to the maximum possible number of Institute offices and providing personal computers with e-mail, terminal sessions, and file transfer functions along with sharing of peripherals and other resources. At the same time, communications have been switched from the former hardware to a new central communications processor.
Part of the aforementioned services have also been linked to the global area network and the Internet, and a pilot study for developing an Institute web site is under way.

Computations and the attendant applications employed have also been shifted from the former computer, and at the same time new tools for constructing computational programs and programs for the display of scientific data have been brought on-line. Programs from the public domain helpful for computational and graphics users have also been installed.

Other tasks include advisory activities and user problem support.


Mr. Jose-Manuel Contreras (Titulado Técnico). Network and system administration, computer mapping, statistics, programming, Internet, multimedia.

**BIOLOGICAL COLLECTIONS**

At the present time the ICM biological reference collections comprise four subcollections: fishes, with a total of 6000 specimens catalogued, including 8 holotypes and 35 paratypes from the following geographical areas: Southeast Atlantic (Namibia), Mediterranean deep-sea region (below 1000 m), Central Eastern Atlantic, Beagle Channel (Tierra del Fuego, Argentina), Central and Northwest Atlantic, Western Indian Ocean, Central Pacific; some 800 batches of decapod crustaceans, including 11 holotypes and 25 paratypes from the Southeast Atlantic (Namibia), Central Pacific, and the Mediterranean Sea; the Zariquiey decapod collection containing approximately 10000 specimens, nearly all captured in the Mediterranean; and 200 batches of cephalopods, all from the Mediterranean. The collections constitute a service unit, servicing all types of queries, loans, and exchanges, both national and international. In recent years the collections have grown with the addition of a substantial number of specimens, mainly from the Indian Ocean off Mozambique, but the most important improvement has been implementation of a PVC-based, thermal transfer labelling system, which may be the definitive solution to the problem posed by labels submerged in alcohol. In addition, the preservative customarily used, 3-% formaldehyde, is being replaced by denatured ethanol, thus doing away with the problems attaching to the handling of that preservative.

Person in charge: Ms. Conchita Allué (Ayudante Diplomada de Investigación).

**PHOTOGRAPHY AND DESIGN SERVICES**

**Photography**: Digital reproduction of slides, photographic reproduction of documents, macrophotographic equipment for enlargements of up to 30x, black and white laboratory.

Technical equipment: Computers: PC and Macintosh, Polaroid Digital Palette slide maker, Durst DA - 900 (6X9) enlarger, Nikon FM (35 mm) camera, Nikon F-801 (35 mm) camera, Mamiya RZ-67 (6X7), Lenses: Micro Nikkor, 55 mm. f.:2.8; Vivitar, 70-210 mm. f.:4.5; Tokina, 35-200 mm. f.: 3.5 - 4.5; Mamiya - Sekor 110 mm. F.:2.8.

Auditorium (capacity: 100): Equipment: Kodak Carousel slide projector, 16 mm Elmo projector, S-8 mm Silma projector, 3M (400 w) overhead transparency projector, Mitsubishi VHS video player, 27" Philips viewing screen, microphone and loudspeakers, roving microphones.

Person in charge: Mr. Joan Biosca (Professional photographer).

**Design**: Computer-aided graphic design using the Freehand and Photoshop programs. Poster-making and free-hand design. Text scanning and layout graphic design service for scientific journals.

Person in charge: Mr. José María Anguita (Professional designer).
OCEANOGRAPHIC VESSELS UNIT

Head of Unit: Mr. José-Ignacio Díaz

http://hesperides-bd.icm.csic.es

Objectives

The primary task of the Oceanographic Vessel Unit is technical supervision of the scientific outfitting of the Oceanographic Research Ships HESPÉRIDES and GARCÍA DEL CID and of the main equipment infrastructure on those vessels (winches, compressors, etc.) employed in oceanographic surveys.

Role of the Unit in oceanographic research

Since 1992, with continuous support from the Comisión Interministerial de Ciencia y Tecnología (Interministerial Commission for Science and Technology), ICM personnel have gradually been taking over responsibility for complete technical management - operation, maintenance, and repair - of the scientific equipment on the R/V HESPÉRIDES. The Oceanographic Vessel Unit was formed in 1995 by consolidating the HESPÉRIDES technical support group with the previously existing ICM technical staff for the R/V GARCÍA DEL CID. The Unit has taken part in over 40 oceanographic surveys carried out by the R/V HESPÉRIDES in the Mediterranean Sea and Atlantic, Pacific, and Antarctic oceans. At the present time the Unit affords the first real oceanographic technological assistance in the service of scientific research in Spain.

The Unit provides nationwide service for both ships on their oceanographic surveys and offers full technical and scientific support to researchers of the CSIC, universities, the Instituto Español de Oceanografía (Spanish Oceanographic Institute), and the Spanish Navy. Participation by Unit technicians on the oceanographic surveys carried out by both research ships is now standard. Normally, the R/V GARCÍA DEL CID carries 1 to 3 technicians per cruise, the R/V HESPÉRIDES 3 to 5. After the surveys the Unit’s technicians take charge of maintenance, repair, and calibration of the vessels’ scientific equipment, ensuring that it is ready for use on future surveys. In addition, since 1993 they have been responsible for the procurement of new scientific equipment funded under the National R&D Plan, to ensure that all equipment is suitable for the vessels on which it is to be installed.

Unit Composition

The Unit consists of a core staff of five university graduates in the fields of geology, physics, chemistry, and biology, with broad experience on oceanographic surveys. In addition, there is a group of 14 qualified technical engineers and trained maintenance personnel specialized in mechanics, electronics, and computing.

The Unit has been structured around various sections covering the following specialized subject areas:

- Oceanography and instrumentation
- Computing, communications, and oceanographic data management
- Mechanical engineering
- Acoustics and telemetry
- Electronics
- Remote sensing

Oceanography and instrumentation: Equipment (physics, chemistry, and marine biology) for use on surveys, such as CTDs, rosettes, thermosalinographs, spectroradiometers, plankton nets, etc., as well as all laboratory equipment on the vessels.

Computing, communications, and oceanographic data management: Local area computer networks on the oceanographic vessels; on-line collection of oceanographic parameter values; peripherals and commercial software; satellite communications to and from the vessels; management and storage of oceanographic parameter values collected on the surveys; design and management of an oceanographic database open to and accessible by the national research community via the Internet; quality control of the information collected before entry into the database; processing of depth data collected using multibeam echo sounders; collaboration and interchange with international databases.

Mechanical engineering: Support infrastructure for research, such as oceanographic gantries and winches, including electric and non-electric cables, hydraulic systems, air compressors, and seabed sampling systems, such as corers or benthic trawls, plankton nets, etc.

Acoustics and telemetry: Acoustic research systems such as multibeam echo sounders, biological and geological echo sounders, and Doppler current meters. This section is also responsible for vertical reference and vessel attitude gauges, gravimeters, and magnetometers.

Electronics: Maintenance of the different electronic equipment cared for and operated by the unit, providing basic support for the other sections.

Remote sensing: Management of the TeraScan TS300 satellite image reception system.
Features of the oceanographic vessels

The R/V HESPÉRIDES, launched in 1990, is an 80 m-long polar exploration vessel with a capacity for 29 scientists, built by the Consejo Superior de Investigaciones Científicas (Spanish Council for Scientific Research - CSIC). It is operated by the Spanish Navy, and scientific management is overseen by a Supervisory Commission presided over by the Director General for Research and Development (CICYT) with members from the different public scientific research bodies. This vessel is the flagship of the Spanish oceanographic fleet and has been designated one of the country’s major scientific research facilities. It has been outfitted with a full complement of sophisticated, state-of-the-art, multipurpose equipment and has appreciably raised the level of scientific research, extending the research areas from the Mediterranean Sea and Atlantic Ocean to the Antarctic and the Pacific Ocean. Every year the ship also carries out logistic support duties for the Juan Carlos I Antarctic Base and the Gabriel de Castilla Station.

The R/V GARCÍA DEL CID, launched in 1977, is a coastal vessel 37 m long, with a capacity for 12 scientists, built by the Consejo Superior de Investigaciones Científicas. Scientific management is the responsibility of the CENCIMAR Commission, presided over by the Director of the Instituto de Ciencias del Mar (ICM). The ICM administration is also responsible for the economic and administrative management of the vessel. It too is a multipurpose ship, it is adequately equipped for research in the field of physical oceanography, marine biology and fisheries.

Scientific equipment

The total value of the scientific equipment on the two ships comes to around 1,500 million pesetas and includes the equipment listed below:

Scientific equipment on the R/S HESPERIDES

- Computer system comprising:
  - PC compatible computers (Intel) and Macintosh
  - Local area network with printer nodes (B/W and colour)
  - Real-time acquisition, storage, and pre-processing of information
    (Meteorology, navigation, probes, temperature, and surface salinity)
- Mk5 and Mk3C-WOCE CTDs
- G.O. 24-bottle 1015 rosette
- G.O. 24-bottle 1016 intelligent rosette
- 5, 10, 12, and 30 l-capacity Niskin bottles
- Reversible thermometers
- Sippican MK12
- Continuous and sampling fluorimeters
- Continuous on surface thermosalinograph
- AUTOSAL salinometer
- Continuous and/or sampling nutrient autoanalyser
- Spectrofluorimeter
- Culture oven
- Drying oven
- Muffle oven
- Freezers (-70 ºC)
- Incubation chamber
- Thermostatic bath
- Metrohm titroprocessor
- Kontron UVICON 941 spectrophotometer
- Shimatzu spectrophotofluorimeter
- Beckman LL6000 scintillation counter
- Coulter counter
- Laminar flow chamber
- Autoclave
- Cooled centrifuge
- Microcentrifuge
- Analysis-type water distillation systems
- E-Pure ultrapure water system
- Binocular microscope
- Epifluorescence inverted microscope
- LHPR plankton net
- BIONESS plankton net
- Bongo nets
- Aanderaa automatic meteorology station
- TS300 satellite image reception system
- Non-toxic system
- Multicorer
- Kasten gravity corer
- Gravity corer
- Box corer
- Double spade dredge
- DFS-5 2400 m. multichannel seismic streamer
- PROMAX multichannel seismic processing system
- Air cannons
- High-resolution hydrophone
- High-resolution seismic acquisition and digital processing system
- G-876 magnetometer
- Bell BGM-3 gravimeter
- WORDEN Master Geodetic portable gravimeter
- EM12 multibeam echo sounder
- EM1000 multibeam echo sounder
- TOPAS geological echo sounder
- EK500 biological echo sounder
- EA500 hydrographic echo sounder
- MERLIN acquisition system
- NEPTUNE II processing system
- B1500 acquisition system
- BIOSONICS towed biological echo sounders
- RDI VM150 Doppler current meter
- Benthos 2216 pinger

Scientific equipment on the R/V GARCÍA DEL CID

- Computer system comprising:
  - PC-compatible computers (Intel)
  - Local area network with printer nodes (B/W and colour)
  - Real-time oceanographic data acquisition and storage
    (Meteorology, navigation, probes, data, temperature and surface salinity)
- Mk3B CTD with G.O. 12-bottle rosette
- 2, 5, 10, and 12 l-capacity Niskin bottles
- Seabird 25 CTD
- SeaTech 25 transmissometer
- Seabird 21 continuous-on-surface thermosalinograph
- RDI VM-150 Doppler current meter
- EA500 hydrographic echo sounder
- Aanderaa automatic meteorology station


Company J.B. and F. Sardá.- (in press). Reproductive pattern and aspects of deep-seaandalid shrimp life-


Palomera, I.- 1996. Actions for Coordinated Research on European Anchovy. *Comission of the European Com-


Rojas, P., M.A. García, J. Sospedra, J. Figu, J. Puig de Fábregas, O. López, M. Espino, V. Ortiz, A. Sánchez-


Dr. Albert Calbet, 1997. Marine zooplankton production: effects of abiotic and biotic variability scales (Polytechnical University of Catalonia).
Ph.D. advisor: Dr. M. Alcaraz (ICM).

Dr. María-José Cardell, 1996. Structure and dynamics of benthic macrofauna from marine sediments affected by domestic and industrial wastes: effects of residual waters and sediments from a sewage farm located in Sant Adrià de Besòs (Barcelona) (University of Barcelona).
Ph.D. advisors: Dr. R. Sardá and Dr. J.-M. Gili (ICM).

Ph.D. advisor: Dr. F. Sardá (ICM).

Ph.D. advisors: Dr. J. Font (ICM) and Dr. J. Candela.

Ph.D. advisors: Dr. F. Sardá (ICM) and Dr. G.Y. Conan.

Ph.D. advisors: Dr. H. Güde and Dr. D. Vaqué (ICM).

Dr. Bernardo Shirasago, 1996. Applications of the ERS-1 synthetic aperture radar to the study of the surface mesoscale dynamics of the western Mediterranean Sea (in Spanish) (University of Barcelona).
Ph.D. advisor: Dr. J. Font (ICM).


Ph.D. advisors: Dr. G. Ercilla (ICM) and Dr. M. Canals.

Ph.D. advisors: Dr. B. Alonso (ICM) and Dr. G. Fierro.

OCEANOGRAPHIC CRUISES 1995-96

**KAVALA IV**
O/V: Capetan Stratos
28 Jan. - 9 Feb. 95
Area: W Thracian Sea (E Mediterranean)
Scientist in charge: Dr. E. Lefkaditou (Teuthis, Greece)
ICM participants: Dr. P. Sánchez

**DRAKE 95**
Feb.95
O/V: BIO Hesperides
Area: Drake Strait and Bransfield Strait
Scientist in charge: Dr. M. Garcia (Politecnic University of Catalonia, Spain)
ICM participants: Dr. A. Palanques, Mr. P. Puig.

**KAVALA V**
O/V: Capetan Stratos
3 - 17 Apr. 95
Area: W Thracian Sea (E Mediterranean)
Scientist in charge: Dr. E. Lefkaditou (Teuthis, Greece)
ICM participants: Dr. M. Demestre

**U.S. JGOF'S ARABIAN SEA PROSPECT. Prospect cruise #2**
O/V: Thomas G. Thompson
Mar-Apr. 95
Area: Arabian Sea
Scientist in charge: Dr. J. Marra (Lamont Doherty Earth Observa-tory of California University, USA)
ICM participants: Dr. M. Latasa.

**MEDITS 95**
O/V: B/O Cornide de Saavedra
21 April - 23 May 95
Area: Western Mediterranean (Spanish coasts)
Scientist in charge: Mr. L. Gil de Sola (Instituto Español de Oceanografía, Spain)
ICM participants: Dr. D. LLoris, Dr. P. Abelló, Dr. P. Sánchez, Ms. L. Recasens

**LATITUD-95A**
O/V: BIO Hesperides
1 Mar. - 22 Apr. 95
Area: Equatorial and Subequatorial Atlantic
Scientist in charge: Dr. S. Agustí (CEAB, CSIC, Spain)
ICM participants: Dr. D. LLoris, Dr. P. Abelló, Dr. P. Sánchez, Mr. E. Vázquez

**TOBI**
O/V: TOBI
15 May - 1 June 95
Area: Catalan-Balearic Sea
Scientist in charge: Dr. M. Canals (University of Barcelona, Spain)
ICM participants: Dr. B. Alonso, Dr. G. Ercilla, Dr. J. Baraza, Mr. F. Estrada, M. F. Pérez, Mr. M. Farrán, Ms. G. Bozzano
MESO’95
O/V: B/O García del Cid
31 May - 17 June 95
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Mr. J. Salat, ICM Cruise

BATMAN 2
O/V: B/O García del Cid
4 - 7 June 95
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Dr. F. Sardá, ICM Cruise

SOFARGOS 95
O/V: Urania
4-13 July 95
Area: NW Mediterranean
Scientist in charge: Dr. M. Astraldi (Stazione Oceanografica CNR La Spezia, Italy)
ICM participants: Dr. J. Font, Mr. A. Juliá

VARIMED 95
O/V: BIO Hespérides
June 95
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Dr. M. Alcaraz, ICM Cruise

LATITUD-95B
O/V: BIO Hespérides
3 Oct. - 20 Nov. 95
Area: Equatorial and Subequatorial Atlantic
Scientist in charge: Dra. S. Agustí (CEAB, CSIC)
ICM participants: Dr. D. Vaqué, Dr. J.M. Gasol, Mr. E. Vázquez

FRUELA 95-96
O/V: BIO Hespérides
18 Nov. 95 - 13 Feb. 96
Area: Bransfield Strait
Scientist in charge: Dr. R. Anadón (University of Oviedo, Spain)
Mr. P. Masqué.

ANT/3
O/V: RV Polarestern
26 Feb. - 15 Mar. 96
Area: Weddell Sea, Antarctica
Scientist in charge: Prof. W. Arntz (Alfred-Wegener-Institut for Polar and Marine Research, Germany)
ICM participants: Dr. V. Alvà, Ms. C. Orejas.

MEDIT’S96
O/V: B/O Cornide de Saavedra
1 - 23 May 96
Area: Western Mediterranean (Spanish coasts)
Scientist in charge: Dr. L. Gil de Sola (Instituto Oceanográfico, Spain)
ICM participants: Dr. D. LLoris, Dr. P. Abelló

PALEOPAC
O/V: BIO Hespérides
9-25 Mar. 96
Area: SE Pacific
Scientist in charge: Dr. A. Palanques, ICM cruise

CNL-0596
O/V: B/O García del Cid
13 - 18 May 96.
Area: Balearic channels
Scientist in charge: Dr. J.M. Pinot (Universitat de les Illes Balears, Spain)
ICM participants: Dr. J. Font, Mr. A. Juliá, Mr. A. Cristobal, Mr. S. Ruiz, Mr. M. Lloret, Mr. M. Moll

GALAPAGOS’96
O/V: B/O Hesperides
28 Mar.-10 Apr. 96
Area: Galápagos Islands (Central Pacific)
Scientist in charge: Dr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán, Mr. F. Estrada.

CORTES’96
O/V: B/O Hesperides
12 Apr.-2 May 96
Area: California Gulf
Scientist in charge: Dr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán.

CAIMAN-96
O/V: B/O García del Cid
28 May - 16 June 96
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Dr. M. Alcaraz (Instituto Oceanográfico, Spain)
ICM participants: Dr. I. Palomera

VARIMED-96
O/V: B/O García del Cid
2 - 5 June 96
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Dr. M. Alcaraz, ICM Cruise

PUPPIS
O/V: R/A Las Palmas
June 96
Area: El Hierro Island (Canary Archipelago)
Scientist in charge: Dr. M. Canals (University of Barcelona, Spain)
ICM participants: Dra. B. Alonso, Dr. J. Baraza

MESO 96
O/V: B/O García del Cid
18 - 25 June 96.
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Mr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán, Mr. F. Estrada.

IMPACT-96
O/V: B/O García del Cid
6 - 12 June 96
Area: Barcelona coast
Scientist in charge: Dr. P. Sánchez, ICM Cruise

CORTES’96
O/V: B/O Hesperides
12 Apr.-2 May 96
Area: California Gulf
Scientist in charge: Dr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán.

CAIMAN-96
O/V: B/O García del Cid
28 May - 16 June 96
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Dr. M. Alcaraz , ICM Cruise

PUPPIS
O/V: R/A Las Palmas
June 96
Area: El Hierro Island (Canary Archipelago)
Scientist in charge: Dr. M. Canals (University of Barcelona, Spain)
ICM participants: Dra. B. Alonso, Dr. J. Baraza

MESO 96
O/V: B/O García del Cid
18 - 25 June 96.
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Mr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán, Mr. F. Estrada.

IMPACT-96
O/V: B/O García del Cid
6 - 12 June 96
Area: Barcelona coast
Scientist in charge: Dr. P. Sánchez , ICM Cruise

CORTES’96
O/V: B/O Hesperides
12 Apr.-2 May 96
Area: California Gulf
Scientist in charge: Dr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán.

CAIMAN-96
O/V: B/O García del Cid
28 May - 16 June 96
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Dr. M. Alcaraz , ICM Cruise

PUPPIS
O/V: R/A Las Palmas
June 96
Area: El Hierro Island (Canary Archipelago)
Scientist in charge: Dr. M. Canals (University of Barcelona, Spain)
ICM participants: Dra. B. Alonso, Dr. J. Baraza

MESO 96
O/V: B/O García del Cid
18 - 25 June 96.
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Mr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán, Mr. F. Estrada.

IMPACT-96
O/V: B/O García del Cid
6 - 12 June 96
Area: Barcelona coast
Scientist in charge: Dr. P. Sánchez , ICM Cruise

CORTES’96
O/V: B/O Hesperides
12 Apr.-2 May 96
Area: California Gulf
Scientist in charge: Dr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán.

CAIMAN-96
O/V: B/O García del Cid
28 May - 16 June 96
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Dr. M. Alcaraz , ICM Cruise

PUPPIS
O/V: R/A Las Palmas
June 96
Area: El Hierro Island (Canary Archipelago)
Scientist in charge: Dr. M. Canals (University of Barcelona, Spain)
ICM participants: Dra. B. Alonso, Dr. J. Baraza

MESO 96
O/V: B/O García del Cid
18 - 25 June 96.
Area: Catalan Sea (NW Mediterranean)
Scientist in charge: Mr. J.J. Doñabeitia (Instituto Jaume Almera, CSIC, Spain)
ICM participants: Mr. M. Farrán, Mr. F. Estrada.
**OMEGA - ALGERS**  
30 Sep. - 21 Oct. 96  
O/V: BIO Hespérides  
Area: Alboran Sea and western Algerian Basin  
Scientist in charge: Dr. J. Font, ICM cruise

**PROVA’96**  
O/V: B/O García del Cid  
11 - 14 Oct. 96  
Area: Catalan Sea (NW Mediterranean)  
Scientist in charge: Dr. F. Sardá, ICM Cruise

**MAYC-95**  
4 - 15 Oct.96  
O/V: BIO Hespérides  
Area: Agadir area (Atlantic Ocean)  
Scientist in charge: Dr. B. Alonso, ICM cruise

**QUIMERA-I**  
O/V: B/O García del Cid  
16 - 28 Oct. 96  
Area: Balearic Sea (NW Mediterranean)  
Scientist in charge: Dr. D. Lloris, ICM Cruise

**MAYC-96**  
O/V: B/O García del Cid  
1 - 6 Oct. 96  
Area: Alboran Sea  
Scientist in charge: Dr. G. Ercilla, ICM cruise

**FANS**  
O/V: B/O García del Cid  
1 - 8 Nov. 96  
Area: Ebro Delta region (NW Mediterranean)  
Scientist in charge: Dr. A. Palanques, ICM Cruise

**OMEGA-1B**  
23 - 27 Nov. 96  
O/V: B/O García del Cid  
Area: Alboran Sea  
Scientist in charge: Dr. J. Lanoisellé (LODYC, Univ. P. et M. Curie Paris VI, France)  
ICM participants: Mr. M. Moll, Mr. C. García

**CANIGO**  
O/V: RV Meteor

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**GUEST SCIENTISTS 1995-96**

**Prof. Wolf Arntz** (Alfred Wegener Institut für Polar und Meeresforchung, Germany) (Von Humboldt-Mutis Award) (Oct.95-Jan. 96; Oct.96-Jan. 97).  
Topic: Ecology of Antartic benthos.

**Prof. Jean Bouillon** (Université Libre de Bruxelles, Belgium) (Apr.-May and Sep. 96)  
Topic: Systematics and Evolution of deep sea Hydromedusae collected by sediment traps.

**Prof. Thomas Kiorboe** (Danish Institute for Fisheries Research, Denmark) (Oct. 96)  
Topic: Zooplankton behaviour.

**Prof. Wim Vervoort** (National Natuurhistorisch Museum, The Netherlands) (Mar. 96)  
Topic: Taxonomy of benthic hydroids.

**Prof. Fan Zhengang** (Institute of Oceanology, Chinese Academy of Sciences) (Jan.-Feb. 96).  
Topic: Ecology of several species of Crustacea Decapoda.

**Dra. Margarida Cristo** (Universidade do Algarve, Portugal) (Nov. 96)  
Topic: Feeding of *Nephrops*.

**Dr. Benni Hansen** (Roskilde University, Denmark) (Oct. 96)  
Topic: Zooplankton behaviour.

**Dr. Michel E. Hendrickx** (Instituto de Ciencias del Mar y Limnologia, UNAM, Mexico) (Jan.-Jul. 95)  
Topic: Biology of Decapoda Crustacea.

**Dr. Sigrún Jonásdottir** (Danish Institute for Fisheries Research, Denmark)  
Topic: Zooplankton behaviour.

**Dr. Per Jonsson** (Tjärnö Marine Biological Station, Sweden)  
Topic: Zooplankton behaviour.
Dr. Michael J. Kaiser (Ministry of Agriculture, Fisheries and Food, UK) (Apr. 96, Jul. 96)
Topic: Impact of bottom trawl on benthic communities. Participation on cruise IMPACT 96.

Dr. Pablo López (Laboratory of Marine Biology, Univ. of Sevilla, Spain) (Sep. 95, June 96).

Dr. Paolo Sartor (University of Pisa, Italy) (Programa de cooperación entre el C.S.I.C español y el C.N.R. italiano) (Oct. 95, Apr. 96)
Topic: Analysis of the interaction of fishing gears in the *Mullus barbatus* fisheries in the Western Mediterranean.

Dr. Mario Sbrana (University of Pisa, Italy) (Programa de cooperación entre el C.S.I.C español y el C.N.R. italiano) (Apr. 96)
Topic: Analysis of the interaction of fishing gears in the *Mullus barbatus* fisheries in the Western Mediterranean.

Dr. Erik Thuesen (Marine Science Institute, University of California, USA) (Sep.-Dic 96)
Topic: Metabolismo en animales bentónicos de profundidad.

Dr. Peter Tiselius (Kristineberg Marine Research Station, Sweden) (Oct. 96)
Topic: Zooplankton behaviour.

Dr. Jorge Vázquez (Jet Propulsion Laboratory, Caltech/NASA, Pasadena, USA) (June. 95)

Dr. Markku Viitasalo (University of Helsinki, Finland) (Oct. 96)
Topic: Zooplankton behaviour.

Ms. Graziela Bozzano (University of Genova, Italy) (Sep.-Oct. 95, Feb.-Apr. 96))
Topic: Sedimentological study in Alboran Basin.

Mr. Constantin Cazacu (University of Bucharest, Romania) (July 96)
Topic: Copepod production.

Ms. Emma Cebrián (Universidad de La Laguna, Canarias, Spain) (July - Dec. 96)
Topic: Trophic ecology of benthic suspension feeders.

Mr. Bouchta El Moumni (University of Tanger, Morocco) (Sep. 95, Apr.-May 96)
Topic: Recent sedimentation in the Alboran Basin.

Ms. Alessandra Ferrá (University of Pisa, Italy) (Erasmus student) (Feb.- Sep. 95)

Ms. Patricia Filipe (University of Lisboa, Portugal) (Erasmus student) (Sep. 95-Sep. 96).
Topic: Trophic ecology of carnivorous macrozooplancton.

Ms. Rosemary J. Frankland (Coventry University, School of Natural and Environmental Sciences, UK) (Erasmus student) (Sep. 95 - June 96).
Topic: Ecology of Decapod Crustaceans.

Ms. Annike Galimont (University of Perpignan, France) (Apr.-July 96)
Topic: Geochemical study in the Gulf of Rosas.

Mr. Antoni Garcia-Rubies (Universidad de Barcelona) (Jan. 95-July 96)
Topic: Ecology of littoral fishes.

Mr. Omar Kheddaoui (Service Hydrographique, Marine Nationale, Alger) (Oct.-Nov. 96)
Topic: Instability of ocean currents along Algerian coast.

Ms. Vasiliki Koumandou (Massachusetts Institute of Technology, USA) (Feb.-June 96)
Topic: Phytoplankton physiology.

Ms. Imma Llobet (Universitat de Barcelona, Spain) (Jan.-Dec. 96)
Topic: Feeding and prey capture of Antarctic anthozoans.

Ms. Kristine Lysnes (University of Bergen, Norway) (Erasmus student) (Nov.95 -July 96).
Topic: Ecology of viruses attacking marine bacteria

Mr. Emilio Ortega-Casamayor (Universitat Autònoma de Barcelona, Spain) (Apr.-Dec.96).
Topic: Low molecular weight RNA as an indicator of bacterial diversity in natural samples.

Mr. Jakob Pernthaler (University of Innsbruck, Austria) (Sep. 96).
Topic: The use of fluorescent phylogenetic probes for specific groups of bacteria in marine samples.

Ms. Eulalia Roger (Universitat de Barcelona, Spain) (Jan.-Dec. 96)
Topic: Trophic ecology of benthic hydroids and reproduction of anthozoans.

Mr. Aïssa Zabat (Service Hydrographique, Marine Nationale, Alger) (Oct.-Nov. 96)
Topic: Instability of ocean currents along Algerian coast.