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Origins

Since the 18th century, several well-known Cuban naturalists have dedicated much of their work to marine biology. However, none were affiliated with any specific scientific institution until the creation of the Center of Fisheries Research (Centro de Investigaciones Pesqueras) in 1952. This institution soon was closed because of a lack of financial resources and lack of a real scientific program, but it opened up again in 1959. Also in that year, a small aquarium was opened in Miramar (National Aquarium Sibarimar), a neighborhood west of Havana, and it quickly reached great popularity among city residents eager for recreation. The aquarium grew quickly and ultimately becoming an institution of significant national and international prestige.

From the beginning, the National Aquarium's creator and manager, Dr. Darío Guitart Manday, worked to bring together dispersed biologists from several teaching institutions to begin formal research activities in marine biology. On 15 Jan. 1962, the Cuban Academy of Sciences (ACC), was created by government resolution and incorporated several previously dispersed institutions and research groups, most of which were also relatively new. The Laboratory of Marine Biology was also established in this year, as a department of the recently created Institute of Biology, although this department was at the National Aquarium Sibarimar, which offered the best conditions for this type of work (and was under the direction of the same team).

Soon some officers of the Hydrographical Office were added to this department. Much of their initial knowledge in physical oceanography was self-taught. At the same time a few chemists interested in marine chemistry were added. When the spectrum of specialties was enlarged and facing immediate growth, in 1964, the Department of Marine Biology was expanded to the Department of Oceanology, already independent from the Institute of Biology and still located at the aquarium. Also in 1964, thanks to actions promoted by the president of the Cuban Academy of Sciences, Dr. Antonio Núñez Jiménez, a group of 15 graduate students were brought in. The original idea was that those students should continue the department's professional formation through nonconventional methods (marine science specialties didn't exist in the universities of the country at that time), but primary early development came from collaboration with numerous Soviet specialists that would arrive in Cuba by the middle of the year via a recently signed collaboration agreement.

As part of that group of young people, with more enthusiasm than knowledge, I received the first intensive courses on marine sciences, beginning in the first semester of 1964 from the few researchers of the Dept. of Oceanology. Almost immediately we began to participate in some marine expeditions. In July of 1964, at sea east of Havana on board our yacht *Xiphias*, we welcomed the *Research Vessel Academic Kovalevsky*, which brought from Odessa most of the Soviet specialists mentioned, soon to become our counterparts.

By the middle of that year the government provided the Department of Oceanology with facilities for the permanent residence of the future Institute of Oceanology (IdO), which would be inaugurated by the beginning of 1965 (Fig. 1). The facilities that we received, far from being facilities for research, were a building with apartments and three houses, which initially became a provisional school but was abandoned by 1963. We transformed these structures into a research institute in only 5 months (Fig. 2). The available material resources were scanty, and the repair of the buildings and laboratory construction was carried out mainly by the personnel and students of the Department of Oceanology. The task was assigned so that the youths could continue their research and study programs while the buildings were under renovation. It was an intense year for me and my partners. While some were not able to deal with the load, others thrived over the course of the year. Today I find it somewhat incredible, but we achieved it: on 28 Jan. 1965 the Institute of Oceanology was inaugurated. Immediately, another management group was named for the Aquarium, and Darío Guitart and his research team formally transferred to the newly created institution.

In their first stage of development, the institute had two well-defined general objectives: 1) capacity building of its scientific and technical personnel, and 2) the integrated characterization of the marine environment and resources of the Cuban shelf as a baseline for rational use and conservation.

Fig. 1. Aerial photography of site location of Institute of Oceanology, western Havana city.

Fig. 2. Partial view of the main laboratory building of IdO.

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Capacity Building

The Cuban–Soviet expeditions were very important to advance early capacity building. The first expedition included some 20 specialists of the Institute of Biology of the Southern Seas from the Ukraine Academy of Science. Six months later, this group was replaced by a similar group from the Moscow Institute of Oceanology of the Russian Academy of Sciences. Both groups brought all the necessary equipment for the development of previously agreed research plans (laboratory equipment, instruments for at-sea collections, chemical reagents, glassware, scientific information, and office materials). The main base of operations was the vessel *Academic Kovalevsky* (~500 metric tons of displacement), equipped for all types of oceanographic investigation. This ship worked for the institute for more than 1 year and was our primary oceanographic school. This team and vessel executed an intense research program in oceanic waters around Cuba and the Gulf of Mexico, mainly in the Bank of Campeche and other areas, where it operated the recently created Cuban fishing fleet. Investigations in shallow waters of the Cuban platform were carried out in the yacht *Xiphias* (20 m length) and other smaller boats, in all cases with the guidance of the Soviet researchers. When concluding this expedition, the institute had developed the necessary personnel to execute, in an independent and professional manner, the marine investigations that were planned.

Nevertheless, the theoretical development of most of the investigators and technical personnel was still limited, and it was very difficult to incorporate new graduates from Cuban universities due to the strong competition resulting from the creation and growth of many other scientific institutions in the country. Some of these other institutions were highly prioritized by the government as a result of their high value to the immediate economic development needs of the country. Therefore, it was necessary to continue the nonconventional capacity building of personnel.

The IdO director, Dr. Guitart Manday, always maintained his other professorial positions in biology at the University of Havana, and he created opportunities at IdO (courses, projects) for training biology students in the marine specialties. In this way, by 1970 an enthusiastic and creative group of young graduates was able to create the Center of Marine Investigations within the Faculty of Biology, University of Havana. This new institution would play an important role in the education of marine biologists with advanced qualifications for the whole country, and later on for Latin America.

Nevertheless, the incorporation of graduate-level personnel was still poor, so IdO organized a course for technicians (1969–1971), which included students who had recently completed intermediate levels of training. These youths were incorporated as assistants for the few functioning researchers at IdO. Some of them continued studying at the University of Havana, mainly in the faculties of biology and geography, where they had already had some specialized training in marine sciences. This course for technicians was repeated throughout the decade of the 1970s, and it ultimately produced more than 60 investigators and a similar number of technicians and research assistants.

Scientific Collaboration

The collaboration with several institutions of the former Soviet Union [Institute of Biology of the Southern Seas, Institute of Oceanology, Institute of Zoology, Institute of Evolutionary Morphology and Animal Ecology, Institute of Biological Active Agents (currently Pacific Institute of Bioorganic Chemistry)] continued until the end of the 1980s, reinforced by specialists from other socialist countries (Romanía, Bulgaria, East Germany). Many investigators of IdO received training and carried out joint research in the Soviet institutions, usually using field samples collected in Cuba. Many prominent Cuban specialists obtained doctorate degrees in the Soviet Union or associated countries, among them Dr. Guitart Manday, the first Cuban scientist to obtain a Ph.D. in a socialist country (1967).

Beginning in 1968, the IdO carried out several short projects financed by the United Nations (UN) Educational, Scientific, and Cultural Organization and the UN Food and Agriculture Organization, and advised by advanced specialists that contributed substantially to the development of several specialties in Cuba (including plankton biology, hydrochemistry, hydrology, mariculture, taxonomy and ecology of algae, and marine geology). Since 1975, various important projects were developed, including the study of pollution in Havana Harbor. In the 1990s, the first phase (of three) of a Global Environmental Facility (GEF)/UN Environment Program project for the study and management of biodiversity in the huge Archipelago Sabana-Camagüey on Cuba's north coast was initiated originally by the IdO and later with multi-institutional participation coordinated by the Environmental Agency,

at the Ministry of Science, Technology and Environment.

Since 1978, during the Carter administration in the United States, a productive scientific collaboration began with the Smithsonian Institution, Washington, DC. This resulted in oceanographic expeditions that included jurisdictional waters of Cuba organized by the National Oceanographic and Atmospheric Administration (NOAA) and Woods Hole Oceanographic Institution, with Cuban personnel as observers. Nevertheless, such collaborations were interrupted by the Reagan and first Bush administrations.

Since approximately 1991, during the Clinton administration, contacts were restarted with the Smithsonian Institution, and there was also important support from a US nongovernmental organization now known as the Ocean Conservancy. In the early 2000s, the Environmental Defense Fund began several research projects with the IdO and also contributed hundreds of books and journals to modernize the IdO and other Cuban institutional libraries. As the 2000s proceeded, other exchanges and joint investigations were carried out with scientists from other United States institutions, including the Harbor Branch Oceanographic Institution, the University of South Florida, the University of Miami, and the National Marine Fisheries Service (part of NOAA). A significant relationship also developed with the Harte Research Institute at Texas A&M University—Corpus Christi for future research in the Gulf of Mexico.

However, since the second term of the Bush administration, many of these relationships have not been able to fully develop due to the political differences among the governments of both countries. There is some discussion of potential openings with the Obama administration but, functionally, many challenges still remain.

Also from the early 1990s important collaborations were developed with institutions in Europe (ORSTOM—France, Center of Tropical Marine Ecology; University of Bremen, Germany) and in Latin America (Center of Investigations for Quintana Roo; Department of Ecology of the University of Guerrero; Institute of Marine Sciences and Limnology, National Autonomous University of México; some other agencies from the National Autonomous University of México; National University of Costa Rica, Institute of Applied Mathematics of Brazil, Federal University of Río Grande do Sul; Central University of Venezuela [Caracas], University of Oriente, Venezuela). Of particular importance was the collaboration of IdO in the ''Program for integrated management of the coastal zone of Venezuela.'' Many of these and other collaborations still continue.

Primary Research Goals

The first objectives outlined from the creation of the Department of Marine Biology in 1962 were the study of the biosystematics, ecology, and life cycles of selected marine resources and ecosystems of the Cuban platform. Soon other discipline-specific objectives were added regarding associated environmental drivers including physical oceanography, hydrochemistry, marine pollution, and marine geology. Also an important Marine Organism Collection has been created and maintained for research and teaching. Since 1964, research has occurred on the physiology of marine organisms, mainly in relation to the development of mariculture, as well as fishery biology and ecology, in support of the rapid growth of fishing on the Cuban shelf and international waters.

Concomitant with the Cuba–Soviet expedition in 1964, we also began to carry out open ocean research, mainly in the Gulf of Mexico, especially Campeche Bank. These included physical, hydrochemical, and biological oceanography (primary and secondary production, plankton, larval development of fish) in ocean waters around the Cuban Archipelago and the Gulf of Mexico. From 1965 combined investigations were developed with Soviet scientists from the Russian Institute of Oceanology, for the geologic and geomorphologic characterization of the Cuban insular shelf. In 1968 we started the installation of equipment for sea level measurements in different areas of the country, the first step for the creation of the National Sea Level Network, which reached full development in 1971 in collaboration with the Cuban Institute of Hydrography and the Hydrographic Institute of the Soviet Union. Information initially collected was used to support the development of the first Cuban nautical charts and, in a second stage, allowed the development of the Annual Tide Forecast Tables for Cuban ports, of high importance for maritime trade. The long-term information obtained is now of great importance to assess sea level changes as a result of global warming.

During the 1970s and 1980s most of the disciplines reached a significant level of development, comparable in many cases with those in other countries with more economic and scientific resources. Scientific disciplines diversified, and many environmental services began to be offered, with an increased focus on coastal

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ecosystem management and the conservation of marine resources.

Some Research Results of the Cuban Institute of Oceanology

It is not possible in so short a paper to summarize even the most important scientific results at IdO over more than 45 years. By way of example I would like to mention only a few activities, which illustrate some representative products.

The initial characterizations of the Cuban marine shelf mentioned above (López-Baluja and Lluis Riera, 1980) provided useful baselines of primary biological, oceanographic, and geological processes that can be used to assess changes in biodiversity and other features as a result of anthropogenic impacts and climate change. These investigations continue through today, producing important environmental information on Cuba's shallow marine ecosystems, particularly on coral reefs, seagrass beds, mangrove environments, and estuarine environments. Most of the data are summarized in several books, two atlases of Cuba, and many other papers of great importance for the evaluation and conservation of the coastal marine resources of Cuba.

As part of the general characterization of the Cuban shelf, in 1965 in collaboration with the prestigious scientists of the Moscow Institute of Oceanology, we carried out studies on the geological, relief, and sediment distribution of the marine platform, summarized in the book *Geology of the Cuban Shelf* (Ionin et al., 1977).

Since the creation of IdO, a large number of environmental studies have been conducted to assess the design and management of many businesses that need to use seawater for cooling (e.g., thermoelectric industries in Mariel, Matanzas, and others) and also to evaluate impacts and assess cleaning and control of marine fouling organisms that affect the efficiency of these industries. IdO has carried out many consulting projects and impact assessments in relation to pollution produced by different industries (hydrocarbon refineries, cement factories, distilleries and so on), and ecological evaluations of the technological processes of saltworks to improve their efficiency, as well as many other environmental services.

In the 1970s, IdO played an important part in studies of the contamination of Havana Bay, the most polluted port in the country at this time. The project was initially proposed by IdO and executed by several national institutions with financial support and expertise from the UN Development Program (UNDP). The project evaluated the environmental situation in detail and established baselines for a rehabilitation and integrated management program. As a parallel result, a new scientific institution was created that would take charge of harbor and port research issues around the country, the Center for Environmental Management of Bays and Coastal Zones, within the Ministry of Transportation.

In this decade, coral reef research and assessment projects were begun (Zlatarski and Martínez-Estalella, 1982); these have been very productive. Research on the taxonomy of a number of invertebrate taxa has been similarly productive (including Porifera, Scleractinia, Octocorallia, Polychaeta, Crustacea, Mollusca, Tunicata, etc.) and fishes. This work has been of particular significance because of the high regional biodiversity and the many taxonomic challenges of the complex Cuban marine biodiversity. Many papers have been published on the biosystematics of the Cuban marine flora, fauna, and microorganisms, in domestic journals such as *Serie Oceanológica*, *Reporte Científio-Técnico*, *Reporte de Investigación*, *Avicennia*, *Revista de Investigaciones Marinas*, *Ciencias Biológicas*, and many international journals and books (Guitart, 1974–1978; Campos, 1993).

In the 1980s an extensive and highly productive research project on the benthic ecology of the huge marine shelf of the Golfo de Batabanó of Southwest Cuba was carried out. This project concluded with the publication of a major book, *El bentos de la macrolaguna del Golfo de Batabanó* (Alcolado ed., 1990).

IdO has had important roles in the three phase UNDP/GEF project ''Protection of Biodiversity and Establishment of Sustainable Development of the Sabana-Camagüey Ecosystem,'' also originally proposed and developed by IdO for the massive array of lagoons and reefs on Cuba's north-central coast. Most of the scientific and technical staff of IdO have contributed to the success of the first two phases and still work on the current one. IdO has participated in the production of two books reporting results of each phase and many subject maps and other reports on species richness of the coastal flora and fauna, distribution of seagrass beds, commercial and ecologically important species, ecologically sensitive areas, habitat distribution and quality assessment, pollution topics, coral reef assessments, fisheries impacts, hydrological regimes, training of personnel in the five provinces covered by the project, and many other research and management activities (Alcolado et al., 1999; González, 2004).

Detailed investigations on the ecology and fishery biology of fishes were initiated in the 1970s. This research focused primarily on the huge Golfo de Batabano in southwest Cuba, later on the archipelago Sabana-Camagüey, and produced many research products on commercially and ecologically important snappers, groupers, grunts, jacks, and other species. Research was coordinated to produce many contributions on age and growth, reproductive physiology, spawning areas, food habits, ecological monitoring, and associated topics. This research was summarized and expanded by reviewing all of the reef fish literature in all languages for the Greater Caribbean in the Smithsonian Institution Press book *Ecology of the Marine Fishes of Cuba* (Claro, 2001), winner of a National Prize for 2002 by the Cuban Academy of Sciences. Collectively, work published in domestic journals and international journals, including *Revista Biologia Tropical*, *Marine Ecology Progress Series*, *Gulf & Caribbean Research,* and *Fisheries Research*, has contributed to the establishment of diverse management regulations by the former Ministry of Commercial Fisheries and Marine Reserves by the National Center for Protected Areas.

The National Study of Biological Diversity of the Republic of Cuba, published by the UN Environment Program (Vales et al., 1998), summarizes and integrates an inventory of the national biodiversity of Cuba, uses, and conservation status up through 1995. IdO produced the compilation and integrated the information regarding freshwater and marine ecosystems. After that, IdO assembled the most advanced specialists in the country to prepare a more detailed and specialized version, ''The Marine Biodiversity of Cuba'' (Claro ed., 2007), which contains an updated summary on the ecological and species diversity. This work integrates the main results on biodiversity issues obtained by IdO over more than 40 years, as well as many results obtained by other marine institutions of the country. It includes a paleo-geographic analysis of the origin and evolution of the biota and marine ecosystems of Cuba, a detailed description of ecological characteristics of the Cuban shelf, descriptions of marine habitats highlighting their natural and economic values and social importance, a summary of the existing information about each taxon of the fauna, flora, and microorganisms, a summary of the main products and services of the marine biological diversity (fisheries, tourism, sources of biologically active substances, etc.), and selected assessments of the current state of conservation. The work also identifies the main threats to marine biodiversity; summarizes the existent jurisdictional framework for biological diversity conservation, the institutional capacities for assessment and management, and the national subsystem of marine protected areas; and, finally, offers recommendations for the protection, rehabilitation, and sustainable use of the marine biodiversity of Cuba. In addition, it presents updated lists of all marine species recorded in Cuba until Dec. 2006, with information about their relative abundance and their presence in the nine ecological zones of the Cuban shelf.

The long-term assessment of erosion processes on Cuban beaches has allowed the development of methods for their restoration and control, even for the construction of new beaches using large dredge and fill projects. Our specialized team of coastal engineers at the IdO is developing solutions to many problems created by natural erosion, tropical storms, or nonsustainable urban development, not only in Cuba, but in several Caribbean countries; these solutions allow the maintenance of high-quality beaches for tourism development (Fig. 3).

Important results have been obtained on the hydrology of oceanic waters around Cuba (Lluis-Riera, 1983a, 1983b; Victoria et al., 1997), particularly the straits to the east and west of Cuba, some of them in collaboration with Mexican researchers. Many other operational oceanographic studies have been developed at the local level for the solution of problems related to coastal development. Researchers at IdO are working on and have completed studies regarding sea level rise as a result of global warming and other climatic changes that are of great social and economic importance.

Screening of biologically active substances in marine organisms for biomedical application has been carried out since 1972, initially with the collaboration of the soviet Institute of Marine Bioactive Compounds (Vladivostok) and continued in collaboration with some Cuban Institutions for many years. Among them, we have obtained substances with anti-inflammatory, analgesic, antioxidant, anticarcinogenic, or neuropharmacological properties, as well as some extracts that act as cholinergic receptors, toxins with action on Na+ channels, regenerators of collagen fibers, and dermal regenerators (for the production of cosmetics). IdO has also been involved in the evaluation of medicinal creams for application in several hospitals, as well as consultations and some other actions to develop medical services for the Cuban public.

Marine microbiological studies have substantially contributed to coastal assessments and the evaluation of sanitary conditions of inshore waters. In addition, active compounds have been

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Fig. 3. Restoration of Varadero beach. Left: before. Right: restored beach.

obtained from marine bacteria by fermentation (completely innocuous for humans) that are usable for degradation of hydrocarbons, applicable to increasing petroleum flows in oil wells, and particularly effective for the remediation of hydrocarbon spills in coastal habitats. These compounds have already been applied in several areas. The investigations related to these last two points are now done by a new institution (Center for Marine Bioactivity) largely nurtured by personnel from IdO.

Most of the above results have been partially or completely published in more than 1,200 articles in specialized journals in Cuba or in other countries, in addition to diverse books, monographs, and online digital publications.

Projection

Although the research specialties and services of the institute are similar to those from its early years, at various stages the specific objectives were adapted to changing socioeconomic and environmental conditions. For the near term, IdO is planning on developing the following research objectives and services:

1. Ecological assessment and monitoring of coastal habitats (mainly coral reefs, seagrass beds, mangroves, and estuaries) in economically important areas for the design and management of marine protected areas
2. Ecological assessments of environmental change as a consequence of natural disasters (hurricanes, climate changes) and negative anthropogenic activities
3. Studies on the systematics, taxonomy, and biology of diverse organisms (flora, fauna, and microorganisms) to complete the basic inventory of species diversity of Cuban marine ecosystems
4. Development of ecological bioindicators of environmental quality of marine ecosystems
5. Integrated ecological studies to support management, rehabilitation, or mitigation of degraded habitats, species, and populations
6. Selected coastal species biology and stock assessments to provide science-based information for managing living marine resources
7. Environmental impact assessments, according to identified needs around the country
8. Studies on coastal and marine connectivity processes to support fishery management, ecosystem conservation, and the design and management of marine protected areas
9. Contributions to the processes of integrated coastal management for the sustainable use of marine ecosystems and resources
10. Studies on coastal geomorphology and sediment dynamics, particularly of calcareous beaches
11. Rehabilitation and maintenance of beaches in Cuba and the Greater Caribbean
12. Assessment and monitoring of marine physical and hydrochemical processes (sea level changes, temperature, circulation regimes) in relation to global changes and their influences on coastal ecosystems
13. Contributions to sustainable uses of marine organisms for the production and industrialization of energy, foods, pharmacological products, and others resources derived from the development of biotechnology
14. Capacity building of researchers, students, and technicians for the implementation of the investigations and services related to the mission of the institute
15. To promote and undertake environmental education activities that increase knowledge and understanding of the marine environ-

ment and its conservation in the face of climate change and other factors

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