Meetings

Tropical Oceanography

On the occasion of the dedication of the University of Miami's marine science campus on Virginia Key, Miami, Florida, at the completion of the laboratories of the Bureau of Commercial Fisheries and the Physical Sciences wing of the Institute of Marine Science, an international conference was held in Miami Beach, 17–24 November 1965. The meeting emphasized the tropical environment and covered the sciences from physical, geological, and biological oceanography to the fishery sciences.

The session on equatorial current systems, reviewed the status of research in all three oceans crossing the equatorial region. John C. Swallow (NIO, Surrey, England) and B. Taft (Navy Post-Graduate School) reviewed 2 years' research during the International Indian Ocean Expedition. Using variations in the current pattern, they proved that the existence of the equatorial undercurrent, a subsurface current system discussed by T. Cromwell for the Pacific, depends on the existence of the trade winds on both sides of the Equator. The current disappears, or at least is not clearly defined, during the southwestern monsoon period (June to September), when the water-transports in the southern Indian Ocean are probably compensated by an equal, or nearly equal, east-west transport in the Northern Hemisphere part of the Indian Ocean.

Gerhard Neumann (New York University) used the results obtained during the Equalant Expeditions I and II of the International Cooperative Investigation of the Tropical Atlantic (ICITA) for his explanation of the Atlantic current systems. The northeast and the southeast trade winds provide a transport of surface water to the west. This water piles up against the eastern coasts of the continents, thus providing a downward slope of the sea surface from west to east. At the equator, this slope should produce a current flowing to the east. Neumann also discussed the extension of the undercurrent into the Gulf of Guinea; the undercurrent could be traced as far east as Sao Tome Island. He illustrated the complicated current system in the Gulf. A theoretical model of the undercurrent was presented by A. Robinson (Harvard University). The model is based on the assumption, which seems to be proven by the results in the Indian Ocean, that the wind is the cause of the undercurrent. In his approach to postulate a model, he assumes that a uniform wind is stressing an ocean of finite depth but infinite extent, and further, stable Richardson's numbers are assumed for the vertical momentum transfer. However, for more general wind and pressure distribution, a model is postulated assuming only a constant eddy-viscosity.

Carbonate rocks on oceanic islands can be useful in understanding the processes by which older limestones within the continents were formed from marine carbonate sediments such as those found in some parts of the present-day oceans. There are small hypersaline lagoons on some of the small, low islands in the south-central Pacific. S. O. Schlanger (University of California, Riverside) believes that a similar environment was involved in the formation of the dolomite found in the rocks underlying some of these islands. Isotopically lighter limestones resulting from uplift and recrystallization in meteoric water are well known on the continents and have now been described on Bikini and Eniwetok Atolls by M. Grant Gross (University of Washington, Seattle) and J. I. Tracey (U.S. Geological Survey, Washington, D.C.).

Radiocarbon dating is of great importance in correlating Pleistocene changes in sea level with phenomena believed to require the circulation of meteoric water. The peat found by A. Conrad Neumann (University of Miami) under Harrington Sound, Bermuda, apparently formed about 9000 years ago in a marsh when sea level was about 20 meters below its present position.

It does not follow, however, that recrystallization and cementation of aragonitic skeletal debris by calcite can occur only after uplift. A. G. Fischer (Princeton University) and R. E. Garrison (University of California, Santa Barbara) described calcite cementation of Globigerina-rich sediments from localities with depths of as much as 3300 meters. Indeed, the rates of transformation of the various CaMg carbonate phases to thermodynamically stable assemblages was a principal topic for informal discussion at the meeting. These rates are particularly low in sea water, and monitoring of the associated solutions in short-time experiments suggests that the solids may have become armored with a layer of another phase, too thin to be detectable by available methods. R. N. Clayton (University of Chicago) reported that limestones apparently undergo isotopic exchange with fresh waters at temperatures as low as 30°C, but much longer times are involved in these natural systems.

This concern about the kinetics of carbonate solution and deposition has led to a growing interest in nucleation mechanisms, the structure of solutions, and the development of cation-specific electrodes for measuring activities. K. M. Wilbur and N. Watabe (Duke University) are attempting to evaluate the mechanisms of carbonate deposition in living molluscs and marine algae, by varying temperature and deposition rate and monitoring such parameters as crystallite size and the content of particular organic compounds in solids and in body fluid.

Very interesting was the wide coverage of the tectonics of the Caribbean. H. H. Hess (Princeton University) gave a summary of the discussion outlining the main problems and what was not known about the Caribbean. Most significant among the contributions was G. Pardo's synthesis of the work done by Gulf Oil in Cuba over a long period of years. Very careful field mapping with drilling and trenching conclusively show structures analogous to Alpine nappes. As many as four such nappes, one above the other, were found; each having rocks ranging in age from Late Jurassic to Paleocene based on paleontological work by P. Bronnimann. Each successive nappe has different lithofacies of these ages of rocks. The sliding took place from south to north in Eocene time.

A. Menendez (Venezuela) described the geology of the central portion of the Caribbean mountains in the area from Caucagua to Tinaco in Venezuela.

He, too, described enormous gravity slides which displaced the Villa de Cura group of volcanic rocks from the Caribbean Sea southward to the southern margin of the range. This was particularly interesting in light of the northward movement of sheets, also away from the Caribbean, reported by Pardo.

Ewing, Talwani, and Ewing (Lamont Geological Observatory) described a large number of seismic reflection profiles crisscrossing the Caribbean. In all of them, except the Yucatan Basin, they found two prominent reflecting layers which, in the Venezuelan and Colombian basins, were horizontal and only disturbed at one site, a fault east of Beata Ridge. Here the bottom of the first layer was sampled by dredging and found to be Eocene, suggesting that the bottom of the second layer is well into the Cretaceous. The conclusion is drawn that the floor of the Caribbean was undisturbed for a long period of time, perhaps 100 million years, whereas the margins suffered comparatively intense deformation.

T. Donnelly (Rice University) analyzed the gravity field, seismic data, topography, and geology of the Virgin Island Bank and was able to draw a number of tentative conclusions on its history and structure. Particularly intriguing was his identification of very recent faults cutting the deposits on the surface of the bank and his analyses of seismic data which showed a pronounced change in character south of the Anegada Passage.

G. Dengo (Guatemala) summarized what is known of the tectonic history of Central America. The northern part has cratons with Paleozoic cores and has a continental type of crust, whereas the southern part, the Isthmus of Panama, may be of young island-arc type structure with a crust intermediate between oceanic and continental.

The session on nutrient cycles in tropical waters covered mainly the relationship between particulate and dissolved nutrients and the first trophic level (microalgae) in the tropical and subtropical regions of the oceans. E. J. Ferguson Wood (University of Miami) discussed profiles of phytoplankton distribution. Except in areas of upwelling or turbidity currents, the phytoplankton maximum is normally below, or associated with, the thermocline, where the light is about 1 percent of that on the surface. Wood also referred to the presence of chlorphyll-bearing microalgae below the photic zone to a depth of at least 5000 meters. Included in these are zooxanthellae associated with radiolarians. He pointed out that the presence of these organisms must be associated with dissolved or particulate organic matters which, presumably, they require as food. J. Krey (Kiel, Germany), discussing the distribution of biomass of particulate organic matter in the Arabian Sea, could show three peaks with depth. He believes that the particulate organic matter does not sink by gravity but rather is staged downward and excreted by vertically migrating animals feeding at the surface during the night. H. Rotschi (ORSTOM, New Caledonia) discussed the differences in remineralization rates of nitrogen, phosphorus, and carbon in the tropical South Pacific. He showed that the apparent mechanisms of remineralization are characteristic of specific water masses and that the rates of mineralization are different from the theoretical values expected from the quantity of consumed oxygen.

Marine biogeography has failed to keep pace with its terrestrial counterpart and has been principally zoological in nature. The zoogeography symposium demonstrated varied approaches to the problem of marine zoogeography by concentrating on a single group of organisms, fishes, for which a knowledgeable base line has been established. In keeping with the theme of the conference, the single broad area of the tropics was discussed. J. C. Briggs (Florida Atlantic University) established the main provinces of the marine tropical regions and the relative historic effectiveness of the various land and water barriers in keeping apart the faunas. This effectiveness was based on the percentage of species shared between faunas. R. H. Rosenblatt (Scripps Institution of Oceanography) focused attention on the distribution of fish near shore in the American tropics, a study which nearly 60 years ago led David S. Jordan to propose the term germinate species. Only in recent years have sufficient numbers of midwater and deep sea fishes been collected to permit evaluation of their ecological and geographic parameters. Alfred W. Ebeling (University of California, Santa Barbara) discussed various aspects of this problem, using as a primary basis his own detailed studies of the beryciform family Melamphaidae. G. S. Myers (Stanford University) indicated how the zoogeography and paleontology of continental vertebrates may contribute information on the dating of major geophysical changes in the ocean basins and continents. The primary freshwater fish family, Characidae, restricted to South America and Africa and older in origin than most scientists have believed, supports well the recent treatments of continental drift by Runcorn and his colleagues.

The session on ecology of tropical organisms included an interesting account of man's influence on nature. The water current through the Suez Canal flowing during 10 months of the year to the Mediterranean has gradually reduced the salinity in the Bitter Lakes and, during the last years, finally dissolved the salt "harsh" on the bottom. Consequently, the high salinity barrier between the Mediterranean and the Red Sea has now disappeared. The reduced influx of Nile water caused by the Aswân Dam has increased the salinity in the southeastern corner of the Mediterranean and the migration of the Red Sea fauna has thus been greatly accelerated. G. Thorson (Elsingore, Denmark) pointed out that the study of this drastic biological change is most urgent since it will give the clue for the changed food chain and that change may upset the economical balance in this fishing area when predators penetrate from the Red Sea. D. Magnus (Darmstadt, Germany) could show on two echinoderm species that they actively improve their food uptake by utilizing environmental factors. Since the amount of organic particles sinking would be insufficient, one species by directing its 20 arms into the current can filter 40,000 liters per night, at a current speed of only 2 centimeters per second. Thomas F. and N. I. Goreau (Kingston, Jamaica) and C. M. Yonge (Glasgow, Scotland) proved that, in the symbiosis of zooxanthellae and the bivalve *Tridacna elongata*, zooxanthella produce during photosynthesis a soluble factor which is quickly distributed throughout the body of the bivalve and preferentially taken up by some tissues. The high turnover rate of the labeled substance in the bivalve indicates that the soluble organic factor is of metabolic importance. As T. Goreau stated, the bivalve looks at zooxanthella as a dairy man looks at the milk cow.

Although somewhat outside of the tropical theme of the conference, a

symposium on deep sea biology was included, since it has been rather neglected in the United States during the last few decades. It covered a wide variety of aspects, however, with a common denominator—adaptation to the deep sea. N. B. Marshall (London, England) discussed the variation of the anatomy with depth. Swim bladder and firm skeleton are characteristic for mesopelagic fishes. However, the disappearance of swim bladder and reduction of skeleton weight seem to be related to a food-poor environment. These classic types of deep sea fishes do not undertake vertical migration. The development of drumming muscles on the swim bladder seems to be restricted to benthic fishes populating the depth from 150 to 1000 meters, since mesopelagic and benthic fishes from great depths do not produce sound using the swim bladder.

G. L. Voss (University of Miami) pointed out the decrease of muscle tissues with depth and their replacement by gelatinous material. The light organs increase and are more specialized, and the feeding mechanism changes. It was pointed out that the larvae live in the surface layers, squids in the surface, and octopods close to the thermocline. Thus size increases with depth. Donald F. Squires (Smithsonian Institution) also pointed out the reduction of skeleton in corals with depth. He studied the specification and dispersal from the Cretaceous period and pointed out the tendency toward greater depth during development.

In the session on the behavior patterns in tropical waters W. Wickler (Germany) made understandable the meaning, in many cases, of highly conspicuous and varied colorations, as well as the bizarre structural forms found among many tropical marine fishes. Wickler's report was greatly enhanced by a number of films which stressed various points covered during the presentation. Neil R. Foster (Academy of Natural Sciences, Philadelphia) reported his studies on the behavior pattern of killifishes. He could show that the male of 35 killifish species have three components in their reproductive behavior: head flicking, contacting, and visual display. Of these visual display seems to be most important, since it is the only component in some extremely sexually dichromatic and dimorphic species. Foster's study pointed to an important shift in the behavioral evolution of the group. This shift was from expelling and fertilizing all ovulated eggs during a single clasp to expelling and fertilizing eggs singly. This apparently increased courtship behavior and thereby the importance of sexual selection in the evolution of these fishes.

The increased effort in fisheries in tropical areas was the topic for two sessions which the conference held jointly with the annual meeting of the Gulf and Caribbean Fisheries Institute.

The high seas fisheries session centered on the world's most important fisheries, namely tuna and anchovy. T. Kamenaga from Japan and A. V. Freyre from Peru accounted for the remarkable developments these two leading nations had experienced in the last decade. Among the attributable growth factors are the relaxation of government regulations, exploitation of new fishing grounds, technical improvements, and market expansion. H. Kasahara (Special Fund of the United Nations, New York) pointed to the west coast of Africa as the area promising greatest expansion, while W. B. Chapman (Van Camp Foundation, San Diego) predicted substantial future exploitation of the eastern Pacific and the world, based on the calculation of a possible yield of 2 billion tons, only 51.6 of which are harvested today. M. Ruivo (FAO, Rome, Italy) conservatively substantiated this theory, stating that fish catches might double by the year 2000.

Complimenting this session was a discussion of the economics of tropical fisheries. The vast potential of the developing African West Coast and the eastern Pacific having been forecast, J. L. Dibbs (FAO, Rome, Italy) and J. A. Storer (U.S. Bureau of Commercial Fisheries, Washington, D.C.) analyzed the many problems, such as the difficulties in moving traditional fishing tribes into industrial fishing operations. A solution appears to be creation of a new fishing fleet and, in some cases, additional modernization of the small-boat fisheries. However, J. Crutchfield's paper, read by A. D. Scott, stressed the importance of marketing methods. The problems seem to be to find the best way between acceptance of the undeveloped status of these fisheries and a rapid economic development of them where the fishing industry underwrites the burden of the overhead costs of roads, storage, and refrigeration. Storer also stressed the point that easy entry into marine fisheries seems to have undesirable effects which are generally felt too late, that is, when the fishery is fully developed. In synthesizing the fishery economics, Scott postulated that although fisheries in general provide useful contributions to food supplies and to exports, they are unlikely to provide the foundation for national economic development, having rarely served as catalysts that have initiated or sustained economic growth of an area.

The International Conference on Tropical Oceanography was a most appropriate addition and climax to the dedication of an important oceanographic research center. The proceedings of this meeting are to be published as part of the series of *Studies in Tropical Oceanography* of the Institute of Marine Science. The volume is expected to be available during the summer of 1966, and requests should be directed to the Proceedings Editor. (Travel support from NSF grant GP-4773, Office of Naval Research.)

F. F. Koczy
Institute of Marine Science,
University of Miami, Miami, Florida

Speleology

The present-day pursuit of knowledge in cave-related phenomena by scientists of many disciplines has many roots in the 18th century study of Yugoslavian caves and karst. The very word karst derives from the Kars district of Slovenia and has become an international term describing many limestone landscapes. It was therefore especially appropriate that the Fourth International Congress of Speleology met in Ljubljana, Yugoslavia for a full program of excursions, special lectures, and technical sessions. The official period of the congress, 12–26 September, was preceded by excursions which gave participants an opportunity to inspect in detail several karst areas of Slovenia having special interest. One excursion consisted of a three-day walking trip into the Julian Alps; another, largely a bus tour, visited the Classic Karst between Postojna and Triest. For the more adventuresome, trips were also conducted into some of the large river cave systems.

The congress was officially opened in a chandelier-lit chamber of the famous and beautiful Postojna cave