Oceanography

Two Reports on the Recent International Congress in Moscow by R. H. Charlier and R. S. Dietz.

Probing the Ocean

Oceanographic research during the last decade has resulted in numerous practical applications that range from submarine warfare to exploitation of mineral resources, from food production to engineering. Recently, tides have been harnessed in the Rance River, thus opening the way for industrialization in Brittany, France's "forgotten" province. Russia is experimenting with similar plans on the Kislogubskaua (White Sea and Sea of Barentz), while Australia, Great Britain, Argentina, Canada, and the United States are studying the possibilities of tapping tidal power at home.

During the symposium on underwater technology at the second oceanographic congress (Moscow, 30 May–9 June), Jacques Delacour (France) introduced his recently completed "telenaut." All previous submersibles were manned and had varying ranges and different degrees of mobility. The new two-man submarines have barely made their appearance and already the minimal crew of two has been cut to a crew of none! The telenaut is equipped with sonar and can detect obstacles as far away as 91 meters. This unmanned submarine is controlled from the surface by a cable, which also serves as its source of energy. The autonomy of the machine is virtually unlimited. Three propellers, two horizontal and one vertical, control its movement. The ship is midget-sized, measures 4 by 1½ by 1½ meters, and weighs approximately 1 ton. In addition to taking depth measurements, the telenaut can take photographs with a range of about 60 to 100 meters. It is also equipped with a 6-ton electrocorer that is attached to a flexible cable 40 meters long; the corer has a maximum immersion range of 500 meters. The telenaut has been successfully used in both the North Sea and the Mediterranean Sea and has been of outstanding value in medium depth research.

The command-and-energy cable that links the telenaut to the surface is only 300 meters long, but Delacour feels that there would be no problem in extending the cable's length to 1000 meters. He also introduced "telebel," an electric ship with ultramodern coring devices.

The United States, commented Allyn Vine, is also pushing automation in oceanographic research. We are presently working on a telenaut-type engine, to be used aboard the *Silas Bent*.

Major costs are still salaries for the crew and space. Thus, every engineer is trying to reduce the size of the required crew; not only would operational costs be reduced, but there would be space for more scientists. This concept of a computerized ship is, of course, not unique; the trend toward automation is also being pursued in the merchant marine.

By means of the automatic pilot, research vessels can be kept on a straight course. However, scientists have not unanimously accepted this new device. Conversely, on the Mohole project, a device called "automatic maneuvering" keeps the ship in position rather than on a straight course and geologists do not agree that this is an improvement.

Among the latest additions of research ships, the United States launched the "Aluminaut," a 70-ton submarine that accommodates from three to six people. The Aluminaut is designed to scout depths of up to 4000 meters, more than 3.2 kilometers, and has been successfully tested at 2000 meters. The "Alvin" is of course close to Allyn Vine's heart since it was named for him. With a diameter of 2 meters, a length of 7 meters, four windows, and an extraordinary rotation capacity, Alvin was designed for depths down to 200 meters. It performed splendidly at such depths in the summer of 1965.

The Westinghouse Corporation has ordered the construction, in France, of the "Deep Star," while the Electric Boat Company, subsidiary of General Dynamics, has already launched two ships—"Star One" which dives to 400 meters and "Star Two" which reaches about 610 meters.

Vine also underscored the invasion of physical and biological oceanography by electronics; recent sediment studies were made with sounding equipment. Cable-connected instruments are more frequently used, while the increasing number of ships helps make oceanography more global.

This illustrates a trend toward making submarines that can not only go deeper but also be safer, the main purpose being to enable scientists to do selective sampling. However, no matter how impressive the advances in submarine technology, the importance of submersibles can only be told and assessed at the next oceanographic congress. Indeed, buoys are rapidly and steadily becoming more important in oceanography. They may replace ships and limit the work of aquanauts as well. Although there is much enthusiasm for new techniques, we must keep in mind that if one out of four new instruments is actually operational, success and progress are remarkable.

According to Unesco representative Feodorov, the future of oceanography lies in international collaboration. In reminding the members that Unesco is publishing a volume of tables of oceanographic data, he asked that suggestions be sent to the congress, that a system of intergovernmental oceanographic information be implemented, and that the number of expeditions be reduced. Only necessary, requested expeditions should be given support. The publication of new oceanographic tables should be speeded, special frequency bands should be allocated to meteorologists, and special legislation should be enacted for buoys in international waters.

Roger Charlier discussed the progress in oceanographic education on the U.S. campuses at undergraduate and graduate levels. Ten years ago only 26 universities offered courses in oceanography and today there are 66 schools. According to reports from the National Science Foundation and the Interagency Com-

mittee on Oceanography, about 6000 oceanographers must be found by 1972. Although the number of students has doubled since 1960, there are not enough graduates to fill the demand. The shortage is alleviated to a certain extent by transfers from other fields. In response to the recent appeal by Abel and Lindquist for nurturing oceanographic interest at the precollege level, Bernard Gordon (U.S.) spoke of expanding high school efforts in that direction.

Academician Vinogradov, president of the congress, disclosed a surprising number of Russian views that clash with ideas held by large numbers of scientists from other nations. He dealt a flat "no" to the continental drift theory. He also challenged the belief that the earth's mantle is easier to reach by boring through the bottom of the ocean. This fall U.S. scientists, in operation Mohole, were going to start such boring operations off the coast of Hawaii had Congress not voted down the appropriations. Vinogradov announced that Soviet teams are boring on land in the Caucasus and on the Kola Peninsula where they hope to reach the mantle at a depth of 10 kilometers.

In a symposium on ocean circulation, several scientists held that the so-called seventh sea, the Antarctic Ocean, is not a separate ocean but a continuation of the Atlantic, Indian, and Pacific oceans. This brought down Russian fireworks from A. F. Treshnikov in his paper on the water and ice circulation in the southern Ocean. Wholeheartedly disagreeing with the preceding speakers, he insisted that many characteristics observed in the Antarctic are proper to that ocean. He concluded with the plea that any decisive statement ought to be reserved until a more thorough study of the characteristics of water mass dynamics is completed. He also pointed out that his recent measurements indicate that the Antarctic continental shelf is 500 meters deeper than any other because of the ice load. If the climate near the South Pole were modified, tremendous changes in sea level and in land-sea relationship would naturally ensue.

Whether the ocean can provide substantial help in solving the rapid overpopulation of the earth was a much debated topic. Papers read at the congress indicate the wide gap between the death rate in the actual oceanic environment and in a laboratory experiment. Indeed, 99.99 percent of all fish born in the sea die rather rapidly. This incredibly high death rate does not occur in the laboratory as proven by experiments just concluded by James Shelbourne in Ardere Loch (Scotland). However, as soon as fishes reared in the laboratory were freed, two-thirds of them fell prey to carnivorous sea dwellers in less than a week.

The world population is badly in need of more protein. Undoubtedly it is easier to get more protein from the sea than from the land, yet we overlook the problem of manpower and even more its cost. The latter is perhaps a lesser problem in a Socialist economy, although I could not elucidate this point. When I asked what amount of money is spent annually by the U.S.S.R. for fisheries research, statistics were not available.

But, assuming that manpower and financing would be both available, the danger of overfishing would be a threat within 10 years. K. Banse (formerly Hamburg, now Seattle) stated that the amount of fish that can be retrieved from the sea depends on economics, costs of fishing operations, and technology, that is, the fishing methods and equipment. To give a picture of the economy of the sea, Banse explained that if 100 kilograms of phytoplankton are available, 10 kilograms of zooplankton could survive, resulting in the possible growth of 1 kilogram of herring. These would sustain either 100 grams of small tuna or 10 grams of large tuna.

Everyone agrees that modern fishery cannot afford to overlook the fact that the sea is not an inexhaustible supplier. While there is no doubt that the catch can be increased, there are still no indications of the magnitude of that possible increase.

According to David Cushing the average catch was from 23 to 46 million tons during the decade 1953–63. The catch reached about 50 million tons in 1965. This total could still be upped but the top limit seems to have been reached in both the Atlantic and Pacific oceans. Since 1958, the Peru current has been fully exploited; it has yielded 7 million tons of anchovies which have been used as fish meal. The catch is now stabilized.

Can more fish be caught in other upwelling areas?—probably so and to the extent of 5 million tons from each area. Summarizing and adopting the most optimistic views, we may foresee that with more capital, better equipment, and the tapping of new areas, the total catch can be doubled within the next 10 to 20 years.

Banse's views were not entirely shared by his British and Russian colleagues. Reporting on Shelbourne's work, David Cushing predicted a fourfold rather than a twofold increase in the present catch. He pointed out that artificial rearing has already been attempted. The British dammed a river estuary and successfully reared 300,000 baby plaice by protecting them from their natural enemies, but upon release 200,000 were promptly devoured by eels and crabs. This leads to the conclusion that "fishing is an expensive way of catching food!"

Soviet scientist T. S. Rass made the startling statement that the present catch of 60 to 80 million tons can be increased to 200 million tons. Such divergent views lead one to speculate about the sources of both his statistics and the basis for his projections. It was suggested that Westerners may lack information available to Rass; he disclosed that some fishing grounds in the Far East will be exhausted within a few years. In 1937, 517,000 tons of sardines were caught off the California coast; in 1966, the catch will not exceed 26,000 to 35,000 tons. This decline was caused by climatic changes, irrational fishing methods, and a change in the stock of the resources.

Increased harvest of fish in the Pacific Ocean is the result, according to Rass, of the expansion of the Russian and Japanese fleets, the exploration of currents, and a steadily growing demand for more fish meal. In order to accommodate larger consumption, it seems appropriate to start a fish breeding industry, using Shelbourne's results, which would involve, for instance, fry and milk fish on the coasts and attempts to acclimatize shad throughout the Atlantic and the Pacific oceans. In a more spectacular view, Rass revealed his project of establishing one-way locks between the Sea of Japan and the Sea of Okhotsk, which would redirect the Kuro-Shio current and thus bring up organic matter from the cold layer of water.

K. Sugawara (Japan) drew the balance sheet of chemical oceanography. The marine chemist should consider the sea as a chemical whole and analyze its components from a chemical point of view. Through study of the dis-

tribution of marine biochemical elements, the output of the ocean could and would be substantially enhanced. The chemistry of sediments has been neglected too long and it is imperative that the content of organic matter in sea water be determined. This, in turn, will lead to proper use and conservation of the resources of the sea. We cannot wait for the sea to come to us with gifts, we must take these gifts from the sea. Sugawara showed that, in the Japanese language, there is little difference between the symbol for the sea and that for mother. This is perhaps because the sea is, in some ways, a mother to us. Since "mother sea" is generous with her gifts, we must protect her, as we would protect our own mother, against irresponsible exploitation and equally against pollution!

The theme "ocean and life" was developed by L. A. Zenkevitch (U.S.S.R.). The interests of the marine biologist point toward virtually all branches of oceanography, and since all facets of oceanography are interconnected, the biologist must be informed on the age of deposits, origin of structures and of seas, salinity, circulation, air-ocean interactions, and other factors. Great advances have been made in the study of the Antarctic and Indian oceans since the first oceanographic congress. However, it has become increasingly evident that the major oceanographic problems cannot be solved by a single team nor by a single nation. Intense, close, and unrestricted collaboration is necessary.

It is doubtful that the fertility of the ocean can be determined by primary production; its fertility must be determined by utilization. "My compatriot and colleague T. S. Rass has discussed the perspectives of fisheries, but I would like to go a step further," Zenkevitch continued. "The water of the ocean is an élixir de Jouvence, a life-giving and sustaining fluid, creating organic substances, antibiotics, vitamins and so on, varying however according to location, as shown for instance by the Italian B. Battaglia in his paper on the geographic differentiation of the marine copepods." And he joined Sugawara in concluding that oceanography must lead to the rational use of the ocean's resources.

K. Pawnikar (India) stated that much progress has already been made, between the first and the second oceanographic congresses, in the study of the resources of the ocean. He praised the results of the Indian Ocean Expedition for the new trends it had inaugurated in oceanographic and fisheries cooperation.

In Chicago, 5 years ago, perhaps one or two universities offered a course in oceanography; today there are at least half a dozen. In Moscow there is a chair of oceanography at the State Institute of Fisheries, a chair of oceanography at Lomonosov State University, and a chair of oceanography at the Institute of Oceanology of the Soviet Academy of Sciences. All teach courses in the various oceanographic disciplines and all conduct research and expeditions, seemingly without consulting the others.

The Institute of Oceanology was created 20 years ago; Arctic ocean research led to its founding, orginally as a home for the materials connected with the 1937 Soviet expedition. It now includes three branches as onshore locations and operates several 400-ton vessels that conduct research in the Baltic and the Mediterranean seas. At present housed in the former palace of Count Durask on the Moskva River bank, it will move in 1967 to Lenin Prospect, near the seat of the Soviet Academy of Science. The new site will house the 400 members of the institute including the 80-man faculty, the 93 students enrolled towards degrees in oceanography, and the land-based technicians. The institute is totally separate from Moscow (Lomonosov) State University which is more academically oriented while the institute emphasizes applied research. Its activities are coordinated by the academy. A forthcoming expedition is slated to go to the Indian Ocean and study rift-valleys.

A spectacular reception in the old formal (Czarist) style underscored the opening of the congress and so did a widely acclaimed concert by the Moscow University Students' Orchestra and soloists. This informal occasion gave the vice-rector an opportunity to brief the congress on the Soviet system of education—which explains why Ivan can read—and announce that the 40-story university building is bursting at the seams and new buildings are planned. Russian participation in the establishment of Mediterranean oceanographic stations at Villefranche, Banyuls, Marseilles, and, to a certain degree, Monaco, was underscored.

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Our Deep and Wide Ocean

The 2nd International Oceanographic Congress was convened in Moscow, 30 May–9 June 1966, at the Moscow Lomonosov State University. There were 1800 registrants, including 600 foreign of which 200 were American. More than 500 papers were read; they included invited plenary reports and contributed papers to various sections and subsections covering all of the many disciplines within the general framework of oceanography. In addition there were seven symposia covering nearshore processes, biogeochemistry, primary production, oceanographic instruments, radioecology and radioactivity in the oceans, bioacoustics and aspects of upwelling.

Foreign oceanographic ships were invited to visit Leningrad during the congress but only those of the surrounding Baltic countries came. This program was marred by the cancellation of the *Silas Bent*, perhaps the most sophisticated research vessel presently operational, of the Navy Oceanographic Office. Permission was withdrawn at the last moment on the basis that the *Silas Bent* was a naval ship.

This meeting took place 7 years after the first such congress met in New York in 1959. It seemed generally agreed that the results presented at Moscow revealed a vast growth in the raw data of oceanography and a decline in the validity of Murphy's Law, which states that the optimum number of electronic parts in any piece of oceanographic equipment is less than one. On the other hand, there was a general failure to fully digest and analyze the vast quantities of data now pouring in from the world's growing oceanographic fleet, and a dearth of new ideas or concepts. Or at least so it seemed, but can we be sure? Many good new ideas are discredited at first and only obtain acceptance by slow realization, while oddball concepts draw the attention of the press—for example, the expanding earth theory of the first congress, about which we thankfully heard nothing this time.

The congress amply served its first purposes, meeting and becoming personally acquainted with our Soviet oceanographic colleagues, exchanging information, and observing Soviet science and general culture. Tours to selected institutes and cultural trips around Moscow were an integral part of the program. The building crane, and not the traditional bear, would

seem to be the appropriate symbol for contemporary Russia. Like Americans the Soviets revel in superlatives and certainly we must credit them with the world's biggest queue, winding through Red Square and waiting to pass through Lenin's mausoleum. Among the congress exhibits were two new Soviet publications of great interest, a Eurasian tectonic map and the Soviet Antarctica atlas prepared by the Arctic and Antarctic Research Institute of Leningrad.

Communication was, of course, hindered by the language barrier and by many poorly prepared slides and presentations. On the other hand, we were most thankful for the ready acceptance by all participants of the use of English. Perhaps the tenor of the times is marked by the new Eurasian tectonic map which has both English and Russian legends. Would that it were so for the Antarctica atlas.

Breakthroughs in research are paced by new techniques. Sub-bottom acoustic profiling is one of these which is revolutionizing marine geology by revealing structure of the sedimentary layers of the ocean-floor; such results were the subject of several important papers. On the other hand, deep research vehicles (DRV's) seem to be having little impact as yet upon our science. Their research role, especially in physical oceanography, seems to remain as yet not clearly defined. No results were reported from the highly vaunted Soviet research submarine, *Severyanka*, although it has operated for a decade.

The Soviets continue to excel in Arctic research, a new example being the studies of R. Demenitskaya *et al.* (Arctic and Antarctic Research Institute, Leningrad) on the morphology and structure of the Arctic Basin. A striped, zebra-like pattern of magnetic anomalies has now been found running parallel to the presumed Arctic mid-ocean rift. By the concept of Vine and Matthews (Cambridge), this may be interpreted as evidence for the spreading of the seafloor with the generation of new ocean bottom growing out from the rifts. The zebra pattern would be interpreted as due to periodic reversals of the earth's magnetic field which induce a polarity, now one way and then the other, as the new sea floor is formed at a rate of a few centimeters per year. However, the origin of the great nonmagnetic Lomonosov Ridge, which divides the Arctic Ocean, remains completely unknown.

The massive, stalinesque Moscow Lomonosov State University, completed in 1953, was the site of the second International Oceanographic Congress.

E. C. Bullard (Cambridge) cited as significant recent discoveries the numerous transcurrent faults offsetting the mid-ocean ridges, the probable salt domes beneath the Gulf of Mexico, and the radiometric Precambrian age of the Seychelle Islands granites, with the implication that they may be continental drift fragments from a continental shield. He noted that the sixties have been so far devoid of the great surprises of sea-floor geology of the 1950's (the youth of the sea floor, the absence of any sialic lining, and other discoveries). But one might ask that, if he had been a continental drifter in the 1950's rather than a believer in continental fixity, would these discoveries have been surprises? Surprises may be defined as discoveries which disagree with preconceived notions or intuitive models. Bullard called for a great effort in deep-sea-floor drilling and for the application of several, as yet little-tried, geophysical techniques to the study of the ocean floor.

In the past decade new additions have been made to the complex of vast planetary currents. Especially significant are the great equatorial undercurrents of the Pacific, Atlantic, and Indian oceans, which have maximum speeds of 150 cm/sec, 120 cm/sec, and 60 m/sec, respectively. The 5000-ton research ship *Lomonosov*, of the Marine Hydrophysics Institute of Sevastopol, has devoted much attention to the Atlantic Equatorial ("Lomonosov") Undercurrent (A. G. Kolesnikov *et al.*). This current is a narrow, lens-shaped subsurface stream, 200 to 250 miles wide and with a maximum thickness of 250 meters. The axis of this 2500-mile-long, eastward-setting stream lies along the equator. Flowing year around and without any reversal of direction, it carries fully half the water volume of the Gulf Stream or the Kurishio. An outstanding feature of this current is its high salinity, but it may also be recognized by its temperature structure and by the distribution of dissolved oxygen, phosphorus, and other chemical elements.

A measure of fortitude is needed to cruise northward and stormward in the search of scientific discovery, but such determination was needed to catch a water mass in the act of being born. J. Reid (Scripps Institution of Oceanography) reported on the origin of North Pacific Intermediate Water (300 to 600 meters down in the North Pacific). This discovery was made during a recent winter cruise aboard the R.V. *Argo* to the Kamchatka, Kurile, Aleutian region. This water mass is not formed by the cooling and sinking of the surface waters at high latitudes (north of 50°N), but rather is created by subsurface mixing in the pycnocline 150 meters down. Thus convective overturn, limited to the upper layer of the ocean above 200 meters, is sufficient to account for the formation of this water mass.

Many papers were concerned with results from the recently completed International Indian Ocean Expedition which, oceanographically at least, has opened up this *mare incognito*. J. Swallow (National Institute of Oceanography, England) remarked that a striking feature of the circulation of the Indian Ocean is the variability of the equatorial undercurrent. Swallow noted that close international collaboration was not, in fact, achieved but this was just as well for any closely-knit program would have missed the variability of the current systems which seem not to be related to any yearly cycle. He called for the use of oceanographic buoys to collect long-term observations. He also urged the study of deep-sea tides and of deep currents.

G. M. Belyaev (Institute of Oceanology, U.S.S.R.) discussed the ultra-abyssal bottom fauna of trenches with the *Vityaz* results of the past decade. About 300 species are now known. Of this number 68 percent are endemic, and there is only a 6 percent over-

lap between these "hadal" and abyssal faunas. The great hydrostatic pressure is a factor restricting the diversity of the hadal fauna while intensive sedimentation creates favorable feeding conditions. Holothurians dominate in both number and biomass, with bivalve mollusks and polychaetes ranking second. Belyaev concluded that, owing to narrow specializaton, the hadal fauna has no further evolutionary prospects and is incapable of evolving into higher taxons.

R. Hessler and H. Sanders (Woods Hole Oceanographic Institution) reported on an elegant and intensive study of the deep-sea benthic fauna and arrived at some rather unorthodox conclusions. About 100,000 specimens were collected along a transect from New England to Bermuda. They found that great diversity in fauna is characteristic of deep-sea assemblages and suggest that the deepsea is not the harsh environment it usually is assumed to be. By the very constancy of the regime, they suppose that the abyss can and does support a highly diversified fauna. They find no diminution of species with depth. The fauna is strongly layered with depth but there is a continuum of change. An abrupt break was observed only at the shelfbreak where eurythermal shallow-water forms are almost entirely replaced by deep stenothermal species.

G. L. Clarke (Harvard) reported that bioluminescence is a virtually universal oceanic phenomenon both geographically and in depth. This living light is constantly present, but variable in its manifestations. The maximum display is in the upper 100 meters (because of dinoflagellates), with a secondary display at about 900 meters. However, even at a depth of 3740 meters, bioluminescence was detected by a sensitive bathyphotometer. Flashes occur at rates from 1 to more than 100 per minute. It was inferred that in the clearest water deep-sea fish can detect ambient daylight down to 1300 meters. Similar results were presented by I. I. Guitelson (U.S.S.R.), who noted that the role of luminescence remains undetermined and not at all clear.

In the euphoric, popular mind the ocean is a vast cornucopia, an untapped reserve of food and mineral resources. J. Strickland (Scripps Institution of Oceanography) took issue with this rosy-hued view. He seriously doubts that we will have the requisite ability to describe, or sufficient understanding to manipulate, the marine environment by the time mankind is faced with the ultimate need for large-scale aquaculture and waste disposal, unless we bring about a revolution in our approach to the study of the ecology of the open sea, both in technique and the magnitude of manpower and financial resources.

The congress ended at the Palace of Congress, within the Kremlin walls, with a summing up of impressions and results by a dozen or so leading scientists in the various oceanographic disciplines, a sumptous Russian banquet, and a presentation by the Bolshoi Ballet in which the rising ballerina was, of all things, the daughter of a professor of geophysics. A third congress will be convened about 5 years hence. Many of us prodded the British to host this meeting to suitably commemorate the 100th anniversary of the sailing of the Challenger Expedition (1872–76) which founded scientific oceanography. The only offer announced at the meeting, however, was an invitation to meet in Valparaiso, Chile.

Field trips after the congress included visits to Leningrad, the Black Sea region or the Lake Baikal area. The highpoint of the Baikal trip was the visit to the Limnological Institute on Lake Baikal at the southern toe of this great crescent-shaped lake. Lake Baikal is the deepest (1620 meters) lake in the world and, although smaller in surface area than Lake Superior, Lake Michigan, or Lake Huron, it contains more water than all of the Great Lakes combined. It contains 23,000 km^3 of fresh water, or about 20 percent of the world supply.

Geologically, Baikal is a rift valley like the rift valleys of Africa and is presumably related to some type of mantle activity which has placed the sialic crust under tension. One wonders if this isolated rift may somehow be an extension of the world-wide, mid-ocean rift system, as the African rifts seem to be. However, the Soviets are inclined to regard the Baikal rift as a portion of a closed system in central Siberia only 1000 kilometers in length.

The ecology of Lake Baikal is exceedingly interesting, for it is an ancient lake formed in the Miocene about 20 million years ago. Two-thirds of its 1800 animal species are endemic. There is an especially rich collection of endemic gammarid amphipods; 230 species are found here, or more than one-half of all those known in the

world. Especially famous is the herd of 30,000 endemic Siberian seals or nerpa (*Foca siberica*). The geologic setting of Baikal is much like that of Lake Tanganyika in Africa, but the ecological situation of the oligotrophic lake offers a strong contrast.

The congress was organized by the U.S.S.R. Academy of Sciences through special agreement between Unesco and the Soviet government. It received financial support from the scientific Committee on Oceanic Research, the Food and Agriculture Organization of the United Nations, the World Meteorological Organization, and the International Atomic Energy Agency.

We may hope, and even expect, that with the next congress we will see more input from sophisticated theory, more problem-oriented rather than survey-oriented ship programming, and better and more thorough data reduction, all of which should yield a more perceptive insight into our deep and wide ocean.

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Forthcoming Events

October

16–20. **Planned Parenthood** Fed. of America, annual mtg., New York. (Planned Parenthood—World Population, 515 Madison Ave., New York 10022)

17–18. **Bioengineering Education**, symp., Rose Polytechnic Inst., Terre Haute, Ind. (R. M. Arthur, Rose Polytechnic Inst., Terre Haute)

17–18. **Systems Science and Cybernetics**, conf., Inst. of Electrical and Electronics Engineers, Washington, D.C. (J. E. Matheson, Stanford Research Inst., Menlo Park, Calif. 94025)

17–19. **Automation in Analytical Chemistry**, intern. symp., Technicon Corp., New York, N.Y. (J. E. Golin, Technicon, Ardsley, N. Y.)

17–19. Chemical Inst. of Canada, 16th Canadian **Chemical Engineering** conf., Windsor, Ont. (P. M. Reilly, Polymer Corp., Sarnia, Ont., Canada)

17–19. **National Acad. of Sciences**, autumn mtg., Duke Univ., Durham, N.C. (Home Secretary, NAS, 2101 Constitution Ave., Washington 20418)

17–19. **Plastics**, intern. congr., "Processing Polymers to Products," Amsterdam, Netherlands. (Congress Bureau Royal Netherlands Industries Fair, Vredenburg 49, Utrecht)

17–20. **Cellular Chemistry**, intern. symp., Ohtsu, Japan. (S. Seno, Biwako Hotel, Ohtsu)