sential that we should consider how important this aspect really is and whether, in the future, synthesis could be more successfully directed by artificial intelligence and computers. Although not expressly formulated at the Ciba Foundation Symposium in 1972 by the panel of experts in chemical synthesis, these questions were in the minds of many of the participants.

The discussions showed that new developments are not going to change the scene in organic chemical synthesis within the next decade. There is no doubt, however, that an intensive effort will be made to systematize some areas of chemistry, and that such efforts will directly or indirectly stimulate activity in this field.

It is a fact that the analysis of synthesis planning has been neglected for a very long time. Yet such analyses are certainly of tremendous educational value, and Corey himself maintains that, even if the computerized systems do not become operative and useful, the insight they will afford into the obscure, intuitive ways in which synthetic schemes are conceived by the masters of organic synthesis will have a definite and positive influence on the quality of future synthetic work. Certain general principles, such as the concept of pseudosymmetry in chemical intermediates and the principle of convergent synthesis, although very difficult or even impossible to translate into mathematical language, nevertheless have a real meaning to organic chemists. The application of such principles to synthetic problems and the semisystematic evaluation of synthetic schemes will, it may be hoped, become part of a new educational system in organic chemistry. This immediate effect of the project discussed in this article is considered of such importance that the whole effort put into it will certainly have been well worthwhile.

One final point still remains to be stressed (as it was in a postsymposium letter by W. S. Johnson of Stanford University) and that is the importance of distinguishing between two different aspects of accomplishing a synthetic objective, namely between the planning and the execution of a synthetic scheme. As Johnson quite rightly puts it, "the present state of the art of synthesis is such that all well-planned synthetic schemes almost invariably fail to give the envisaged results at one, or more often, several stages. Thus a successful synthesis seldom follows and sometimes diverges dramatically from the original plan. It is this 'fallibility phenomenon' which renders organic synthesis at least as much of a creative challenge at the execution stage as at the planning stage." Thus, even if planning can be fully systematized, the second challenge will remain: that is, basically chemistry is and will always be an experimental science.

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Marine Biological Laboratory: Origins and Patrons

The 50th anniversary of the Main Building recalls that it is a creation of the National Research Council.

Detlev W. Bronk

Fifty years ago, in July 1925, the Main Building of the Marine Biological Laboratory at Woods Hole was dedicated. The events which led to that occasion are significant in the early history of the Carnegie Institution of Washington, the National Research Council, and philanthropic foundations that have had a profound influence in the furtherance of science.

The preceding quarter century had been a period of remarkable change and growth of the scientific endeavor in the United States. During that time two pioneer research institutions were created: the Carnegie Institution and the Rockefeller Institute for Medical Research. The Carnegie Corporation and the Rockefeller Foundation that were established in 1911 and 1913, respectively, enabled universities to expand their facilities for research. Barriers between sciences were being crossed in fields such as biochemistry and biophysics. The National Research Council (NRC) was organized by the National Academy of Sciences because, during the war of that period, the NRC had demonstrated its capacity for large service; it was being critically tested as a useful organization for the cooperative furtherance of science in times of peace. It was during this period and through these institutions that the Marine Biological Laboratory (MBL) developed the resources and status that made possible its phenomenal growth in this past half century.

The Woman's Education Association

Now that the role and rights of women in science are much discussed and the NRC has formed a committee on the Education and Employment of Women in Science and Engineering, it is timely to recall that some energetic, visionary women were largely responsible for creating the MBL. They were members of the Woman's Education Association of Boston, which was founded in 1871. At that time, when the teaching of science for women was in its infancy, the Association persuaded the Massachusetts Institute of Technology to admit women to courses in chemistry. One of

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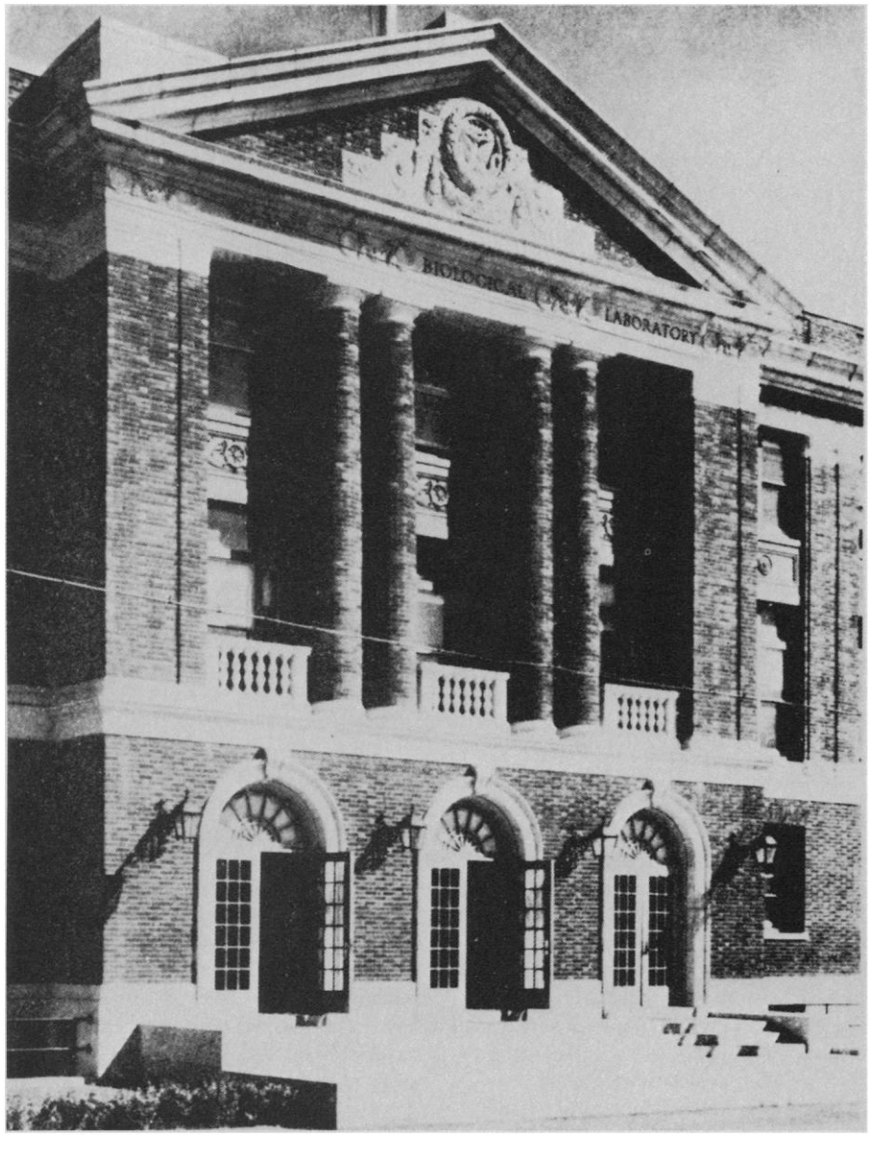
the first to be admitted was Susan Binns, who later became a founding trustee of the MBL.

In 1881, the Boston Society of Natural History announced that "the liberality and cooperation of the Woman's Education Association has enabled us to establish a Sea-side laboratory under the direction of our Curator, Alphaeus Hyatt." This laboratory at Annisquam, Massachusetts, continued until 1886 when 13 women and 13 men were present during the two summer months. The Woman's Association then decided that, because the laboratory they had nurtured had attracted more men and women than could be accommodated, they should encourage the creation of more ample facilities under more representative control by scientists from academic and scientific institutions throughout the country. And so they convened a meeting of biologists who agreed that a permanent laboratory should be established under a board of scientific trustees.

For many years Spencer Baird, secretary of the Smithsonian Institution, had been the unpaid Commissioner of Fish and Fisheries. After studying marine biology at various places along the northeast coast, he decided in 1882 that "Woods Hole is the best place for a permanent laboratory of the Fish Commission." And so, a station was erected there on land bought and given to the government by Johns Hopkins University, Princeton, Williams College, four individuals, and the Old Colony Railroad.

The presence of the Fish Commission Laboratory and Baird's reasons for its location there persuaded the Woman's Association to transfer all of the equipment, apparatus, and boats of the Annisquam Laboratory to Woods Hole. They then raised many of the funds for the new undertaking and graciously relinquished responsibility for what they had started and had become the MBL. Three members of the association were among the seven founding trustees and were active in the early days of the laboratory of which Hyatt was president and C. O. Whitman the director. Never again has there been so large a percentage of women among the trustees.



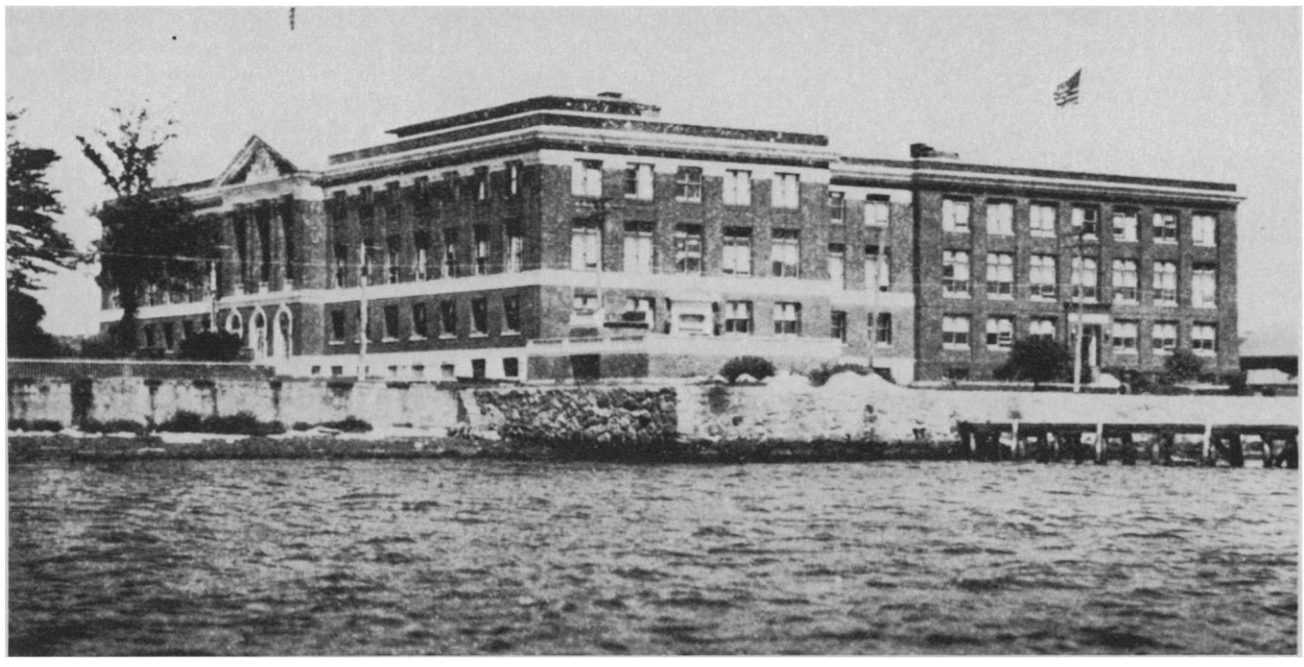
Entrance to the Main Building of the Marine Biological Laboratory.

Crisis and Salvation by Carnegie Institution

During 10 years the MBL flourished under Whitman, who had studied under Agassiz at the short-lived Penikese Laboratory. Attendance increased from a score to several hundred investigators and students; a new temporary wooden building was erected every other year on a small plot of land adjoining the Fisheries Laboratory. Then in 1896 a long and bitter crisis evolved from the director's proposal to build a fifth "temporary" building. It was indeed built and lasted more than 50 years, but its creation gave rise to schisms in its board of trustees and between the board and the director. The crisis continued for 5 years until a wise and generous action of the newly founded Carnegie Institution of Washington gave a stable, lasting peace.

Although Whitman had personally secured much of the money needed to provide laboratories and apparatus for investigators and students, he was ungraciously criticized for his financial management during that period of rapid expansion. To ensure good management and more adequate financial resources, it was proposed by some of the trustees that the MBL be incorporated within the Carnegie Institution which was established in that year, 1902. In making this suggestion, Henry Fairfield Osborn, president of the MBL Corporation, and Edmund B. Wilson, chairman of the executive committee, wrote to fellow trustees: "If the Laboratory is placed under the control of the Carnegie Institution, its future is assured on a splendid and permanent basis. We would have the opportunity to develop the Laboratory into one of the highest rank and to render a great and lasting service to the cause of American science. . . . This action of the Carnegie Institution would, however, be contingent upon the transfer of the Laboratory property to the Carnegie Institution, so that it shall be incorporated within the Institution as 'one of the special features' of their proposed plan for the encouragement of scientific research." The executive committee of the Carnegie Institution indicated that it would recommend $80,000 for land, a new building, wharf and vessel, and $10,000 a year for maintenance.

During that summer a deed conveying



The Main Building of the Marine Biological Laboratory with the Crane Building at the right.

all the property of the MBL to the Carnegie Institution was read at a meeting of the MBL Corporation and discussed. Sixty voted in favor of the transfer; only three opposed. Thus the MBL was about to become a part of the Carnegie Institution, which was at that time being organized by Daniel Coit Gilman, retired president of Johns Hopkins. Formal acceptance by the Carnegie trustees had been promised.

While waiting for that final action, Whitman, the persistent advocate of complete autonomy, pled for Carnegie financial assistance to an independent MBL with its own board and corporation of scientists. He published, in *Science*, "The impending crisis in the history of the Marine Biological Laboratory." It began: "The act of the Corporation of the Marine Biological Laboratory at its recent meeting leaves the fate of the Laboratory to be decided by the trustees of the Carnegie Institution. It was not a welcome step to surrender the Laboratory, but the financial situation seemed to offer no other solution." Whitman wondered what would be the form and character of the Carnegie Institution "that is still *in ovo*. . . . Hitherto we have been independent. We could follow our own ideals to the extent of ability and means."

Whitman admitted that the trustees of the Carnegie Institution had not proposed the acquisition of the MBL. "They were told that the Laboratory was in dire financial stress." He might have added that the very first appropriation made by the newly created Carnegie Institution had been $4000 to the MBL for the summer of 1902 so that the MBL Corporation might have ample time to choose their future course.

Led by Whitman and encouraged by argumentative McKeen Cattell, controversial discussion regarding the relations of the MBL and the Carnegie continued in private and in *Science*. Finally, in October, the executive committee of the MBL decided that the MBL should retain its independence. Immediately, the Carnegie Institution graciously granted the MBL $10,000 a year with which to conduct its own affairs. After 3 years, the Carnegie established their own laboratory of marine biology at the Dry Tortugas.

At the end of that tumultuous time of divisive indecision, Whitman wrote to the trustees of MBL: "Whether for better or for worse, we are left with our humble possessions all our own, with all the vexatious responsibility of independence, with all the agony of our old incentives to pull and sweat and pray together, with little hope of ever moulting our restless anxieties."

Following his victory, Whitman gradually withdrew from active direction of the MBL. Frank Lillie, who had been assistant director during the years of crisis, assumed leadership and was director until completion of the Main Building in 1925 assured the MBL a viable future. While chairman of the Division of Biology and Agriculture of the NRC and president of the National Academy of Sciences, he used the Academy and NRC and the assistance of Carnegie and Rockefeller philanthropies to make Woods Hole a great center of marine biology and oceanography as had been envisioned by Whitman, his predecessor. In this great endeavor he was aided by his brother-in-law, Charles Crane, the philanthropist.

Crane's interest in marine science began while a youth on long ocean voyages in merchant sailing ships; that interest continued throughout his life as manufacturer, diplomat, and president of the MBL for 20 years. During the years of crisis, Crane was among those who argued for independence of the MBL and gave generous financial assistance. Ten years later in 1912, he supported the biologists' cooperative endeavor by contributing more than $100,000 for a small, brick laboratory building.

The Role of the National Research Council

The NRC had been organized in 1916 and served as a department of science and research of the Council of National Defense until 1919. Then, at the request of President Wilson, it was perpetuated "as a special agency of the National Academy of Sciences." During the first meeting of the NRC Division of Biology and Agriculture, "Lillie spoke briefly regarding the character of the MBL at Woods Hole and the opportunities which it offers as an institution in the hands of some 450 members. . . . Dr. Lillie hopes that the Council will be able to aid the organization." At the close of the meeting, C. E. McClung, chairman of the division, appointed a committee to consider that request.

Within a few months the committee, of which Lillie was chairman, recommended that the NRC provide for construction of a

new building. A. G. Mayor, director of the Department of Marine Biology of the Carnegie Institution, was one of the most vigorous advocates and urged that the MBL be the first consideration of the NRC because "the Laboratory has become the most remarkable example of the successful application of broad principles of cooperation in scientific work in the world of science today." Thus the Carnegie Institution gave the MBL timely aid as it had done 20 years before.

Mayor and the other members of the committee were supported by letters from 24 leading biologists. Typical were comments such as those of T. H. Morgan: "If the young NRC is looking around to see how it can most advantageously advance the needs of biology in America . . . there is no more efficacious way . . . than by giving greater facilities to the Woods Hole Laboratory without interfering with the democratic spirit that pervades the Laboratory." The greater facilities desired were a new laboratory, equipment, and land, for all of which $200,000 was required.

The committee recognized that their request for support of an institution was presenting a precedent in those formative years of the NRC that should be carefully guarded. But they emphasized the unique character of the MBL, that it was a cooperative research agency of many scientists from many universities; it was different from any other education or research institution. "Its purpose," they said, "is that of the NRC itself as directed by President Wilson: 'To promote cooperation in research . . . in order to secure concentration of effort . . . but in all cooperative undertakings to give encouragement to individual initiative.' "

James Rowland Angell, chairman of the NRC, informed the committee that his executive board would support the MBL as a democratic scientific enterprise by securing financial aid from outside agencies. He added, "the NRC is not a disbursing agent simply and has no general funds to be used for such purposes." Vernon Kellogg, permanent secretary of the NRC, was then authorized to solicit funds for the project. A year later, early in 1921, he wrote to McClung, "I am inclined to see a little gleam of sunshine. I'll tell you about things when you get down to Washington."

The National Research Council and the Foundations

During the period in which the NRC was evolving, close relations developed with the great philanthropic foundations that had recently been incorporated. Angell had resigned as chairman of the NRC to become president of the Carnegie Corporation. The president of the Rockefeller Foundation was George Vincent, who had been a colleague of Angell, Kellogg, and Lillie at the University of Chicago. John C. Merriam, the first chairman of the NRC, was a trustee of the Carnegie Corporation as well as president of the Carnegie Institution. Vernon Kellogg, besides being permanent secretary of the NRC, was also a trustee of the Rockefeller Foundation. And so it was natural that, under the leadership of this group of friends, the foundations became strong supporters of the natural sciences. That postwar period was a good time for the beginning of a new era in American science.

These associations and interrelations are shown in a 1921 letter from Kellogg to the secretary of the Rockefeller Foundation.

> I found Angell very well disposed in the matter of the MBL. He would be specially interested in considering the possibility of some sort of 50-50 arrangement on the part of the Carnegie Corporation and the Rockefeller Foundation by which the Foundation would help in the construction and maintenance of the Laboratory for biochemistry and biophysics and the Corporation in the construction and maintenance of the other more general building. Angell was surprised to learn that the estimates of needs had increased considerably over the ones made while he was chairman of the NRC; but, on the other hand, feels that if his board would be interested at all, it might be more interested in doing a big thing rather than a small thing. The opportunity of making this Laboratory the leading thing of its kind in the world appealed to him as something that might appeal to his Board.

That reference to a laboratory for "biophysics" reflected a growing interest in bridging a gap between the physical and biological sciences although at the time there was no university department of biophysics. This new emphasis also appeared in a conflict of interests that involved the MBL, the Cold Spring Harbor Biological Laboratory, three foundations, and the NRC. Kellogg wrote to McClung:

> The Commonwealth Fund have been applied to for a sum of money to build a bio-physics laboratory at Cold Spring Harbor for Davenport in connection with the Brooklyn Institute of Arts and Sciences. . . . It seems to me that while your Division of Biology and Agriculture would probably be willing to favor any appropriation by any foundation for a bio-physics laboratory, yet as the Division is strongly urging through the Council the appropriation of means for building a first class biochemistry-physics laboratory at Woods Hole, it should not lessen the strength of that recommendation by recommending miscellaneous appropriations for other lesser laboratory of the same general kind. The President of the Commonwealth Fund would like some kind of statement from us just as soon as he can have it.

To this McClung replied: "While the Division would wish to see facilities of this kind multiplied, it would not wish to urge support of a second institution of this character while its request for one at Woods Hole is still undecided." And so, the Cold Spring Harbor proposal was not encouraged by NRC.

On the other hand, NRC support of MBL gradually aroused the interest of the Rockefeller Foundation as well as the Carnegie Corporation. Throughout a year the representatives of the NRC carried on complicated, interrelated negotiations with the two foundations. How could they get most without risking loss of all.

The Rockefeller Foundation suggested a grant of $500,000 if this were matched by others. "That promised support should move the Carnegie Corporation if they understand that the Foundation will not move without their concurrence," said Lillie. But the Carnegie funds were tied up for some time, and so there was danger that the whole project would be balked. On the other hand, if the Rockefeller Foundation agreed to proceed independently with a biophysics half of the building, NRC would lack the pressure which the cooperative form of action would exert on the Carnegie Corporation. Kellogg advised the whole building: gamble for all or nothing.

A few months later, early in 1922, the Rockefeller Foundation agreed to give one-half a total sum of $1,000,000 for a building containing laboratories, library, and auditorium, with endowment for its maintenance. There was no further mention of the "biophysics building."

Hopes for the other half of the fund then rested in the Carnegie Corporation. Unfortunately, however, Angell, who was a strong advocate for the MBL project, had just left the Carnegie Corporation to become president of Yale. And so, a month after the favorable Rockefeller action, it was Henry S. Pritchett, the temporary president, who informed McClung that only $100,000 had been appropriated provided the total amount of $1,000,000 was secured. "This is something of a shock," said Kellogg. "Now that we are $400,000 short of meeting the requirement for both the Rockefeller and Carnegie grants, we are in a pretty bad boat."

As hopes faded, tempers flared, and the efficacy of the NRC was questioned. McClung complained to Kellogg:

> With both corporations desirous of helping the Laboratory, it does seem as if some way should be found of getting action. I am not favorably placed to do anything and have merely carried on the correspondence because it started here in the Division. Cannot you and Merriam take hold of this and put it through? *This is NRC's big opportunity to demonstrate to the biologists its effectiveness in promoting fundamental research.*

Kellogg replied, "I hardly need to say, in the light of the history so far of this undertaking, that we shall do the best we can."

And to Merriam he wrote: "I don't like McClung's way of instructing us to get the money. As a matter of fact, the more we do for the biologists, the more they want done for them." Kellogg had indeed been active in his efforts and was an influential trustee of the Rockefeller Foundation. As a trustee of the Carnegie Corporation and president of the Carnegie Institution, Merriam was constant in his efforts to aid the MBL as others at the Carnegie Institution had been during 20 years.

During this time that was critical for the future of the MBL and for the prestige of the NRC, Lillie succeeded McClung as chairman of the NRC Division of Biology and Agriculture. This was fortunate and appropriate. McClung could be querulous in his demands for support of science and thus irritate potential donors. Lillie, on the other hand, was gently tactful and persuasive. If the project were to succeed, it would be appropriate that Lillie be chairman at the time of success, for it was he who first proposed that the NRC create the building and thus secure the future of the MBL. His term as chairman started well with a letter from Vincent.

> The offer of the Rockefeller Foundation will hold good for any reasonable length of time. . . . I have talked with Pritchett at the Carnegie about the project. He is heartily in sympathy with it and may, I think, be counted upon to do all in his power to get a revision of the original action. There are some difficulties with which he finds it hard to cope. . . . If I can manage to drop in at Woods Hole this summer, I shall certainly make a point of doing it. In case I can make a visit, it will be "unofficial."

The personal interest aroused by that and other visits had far-reaching influence in the later development of the MBL and the Woods Hole Oceanographic Institution by Rockefeller philanthropies.

In appealing to those philanthropies such as the General Education Board and the Laura Spellman Rockefeller Memorial, Lillie and Kellogg enlisted the aid of Raymond Fosdick, who was, in a sense, the personal representative of the Rockefeller family in all the Rockefeller boards. Lillie also had the personal assistance of Crane who was a friend of John D. Rockefeller, Jr. And so it was through Crane, Fosdick, and Vincent that Lillie was able to interest Rockefeller in the MBL.

In December 1923, the secretary of the Rockefeller Foundation wrote to Kellogg: "The additional $400,000 needed for the Woods Hole project, *which came to our attention through the National Research Council*, has been pledged by Mr. Rockefeller personally." Crane then endowed his annual contribution of $20,000.

As chairman of the NRC Committee on the Marine Biological Laboratory, Lillie wrote: "Thus this project initiated through the Division of Biology and Agriculture has gone through to completion. The Committee accordingly recommends that it now be dismissed." Encouraged and inspired by the success of the endeavor, Lillie began at once to plan the Committee on Oceanography of the National Academy of Sciences, from which was born the Woods Hole Oceanographic Institution.

Notes

1. This account is mostly based on letters and documents in the archives of the National Academy of Sciences and on recollections of conversations with E. G. Conklin, F. Lillie, and C. E. McClung. For early history I am indebted to *The Woods Hole Marine Biological Laboratory* by Frank R. Lillie (Univ. of Chicago Press, Chicago, 1944). I am grateful for much assistance in searching records to my assistant Mabel Bright and to Jean St. Clair and Paul McClure, the Academy archivists.

NEWS AND COMMENT

Caspar Weinberger: Beware of an "All-Pervasive" Federal Government

His friends call him Cap. Others refer to him as Cap the Knife. As director of the Office of Management and Budget (OMB) and, then, as Secretary of Health, Education, and Welfare (HEW), Caspar W. Weinberger has been in a special position to influence the federal budget. He earned his sobriquet from his consistent efforts to drive federal spending down, or at very least, to keep it from expanding exponentially. He singled out programs that had, in his opinion, outlived their usefulness or proved to be ineffective. He suggested they be "knifed" out of the budget. But, as he noted a couple of years ago, one of the hardest things for the federal government to do is to *stop* doing something it has started. And, in fact, Weinberger's knife has not really cut very deeply at all, not nearly as deeply as he wishes it had.

This spring, Weinberger announced his resignation as HEW secretary and on 8 August officially left government service. In an interview with *Science* shortly before he departed HEW, Weinberger reflected on his years in office and his philosophy of government. He thinks government is getting out of hand. "My single overriding observation after all these years in Washington is of the growing danger of an all-pervasive federal government," he said, reiterating a statement made in his last major address as secretary.* "Unless checked, that growth may take from us our most precious personal freedoms. It also threatens to shatter the foundations of our economic system."

During the 5½ years that Weinberger was in Washington, the federal budget increased by 83 percent, from $196.6 billion in 1970 to $358.9 billion now. Weinberger wants everyone to know it is not his fault. He dislikes being thought of as Cap the Knife, he said, because it has a "negative" connotation, whereas he believes his position should be seen in a more positive light. "The unreasoning, automatic expansion of *all* programs simply can't work," Weinberger told *Science* in a tone that sounded more like a plea than a declaration. "There is a great reluctance in government to make choices. Look at New York City, staring into the abyss. It may be forced to do what we in the federal government ought to be doing."

As director of OMB, Weinberger had a budgetary hand in every aspect of government, but, as he admitted, from that vantage point it is hard to penetrate deeply into any single one. The view from HEW is more focused, but hardly more manageable. HEW comprises one-third of the federal budget, a sum larger than the budgets of many countries, and it keeps getting bigger. Weinberger is worried about it. "There is an overriding danger inherent in the growth of an American welfare state. The danger simply is that we may undermine our whole economy. If social programs continue growing for the next two decades at the same pace they have in the last two, we will spend more than half of our whole gross national product for domestic social programs alone by the year 2000. Should that day ever come, half of the American people will be working to support the other half."

During his tenure in office, Weinberger made a number of specific suggestions about how the government should save money. One area that he believed suitable for reductions in federal spending is in

* "A View of the Federal Government," delivered 21 July before the Commonwealth Club of San Francisco.