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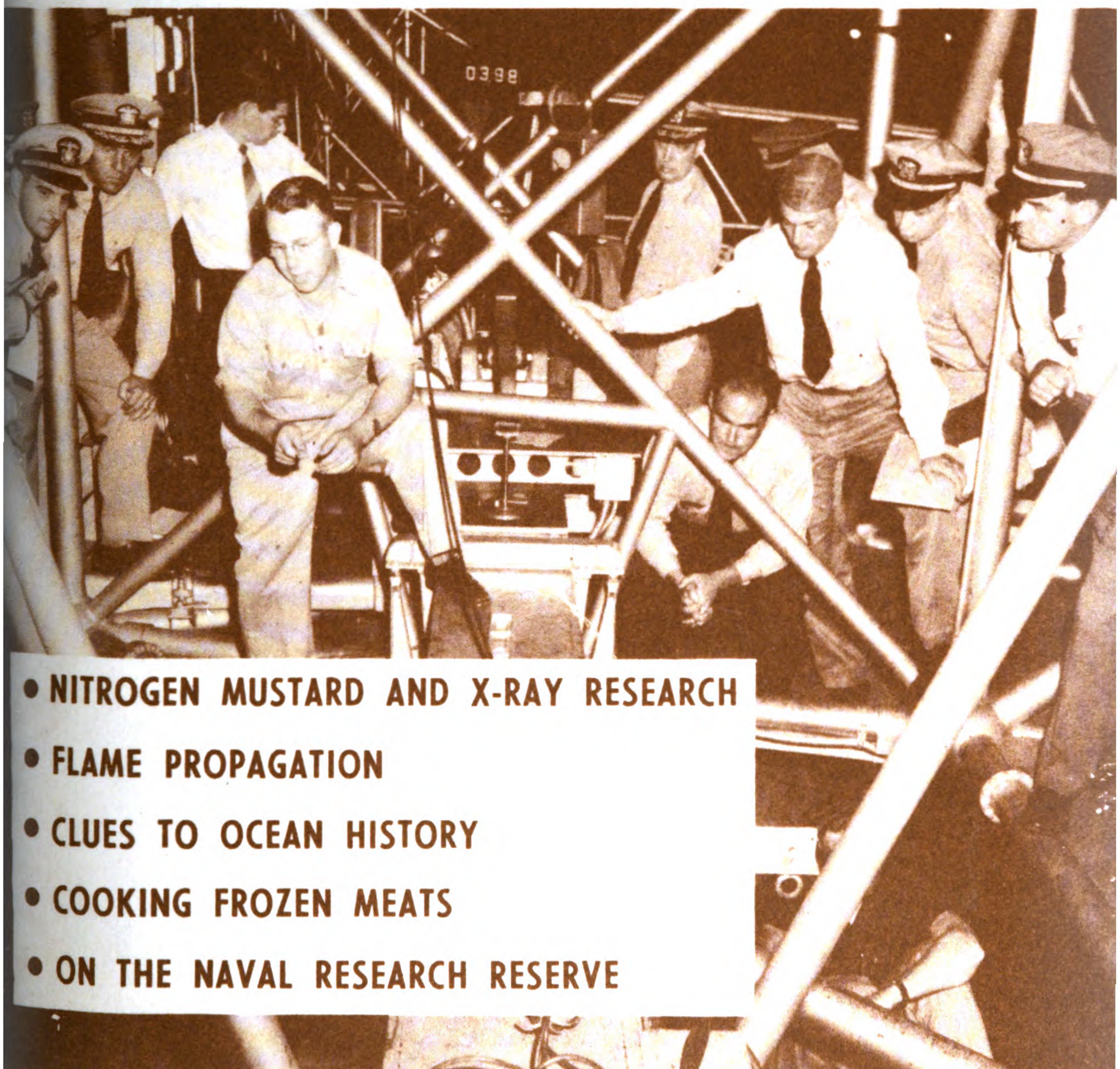
RESEARCH REVIEWS



- NITROGEN MUSTARD AND X-RAY RESEARCH
- FLAME PROPAGATION
- CLUES TO OCEAN HISTORY
- COOKING FROZEN MEATS
- ON THE NAVAL RESEARCH RESERVE

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

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COVER PHOTO: Naval Research Reserves are pictured on board one of the ship model towing carriages in the Basin Building at the David Taylor Model Basin — one of the laboratories visited by the Reserve officers during the scientific seminar held in Washington, D. C. last June. Advance details on the third scientific seminar to be held in Washington this June 7-20, can be found in the section ON THE NAVAL RESEARCH RESERVE. See page 23.

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Approved by Bureau of Budget, 13 April 1948.

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RESEARCH REVIEWS

Informs the Fleet of ONR-sponsored Research

Contents

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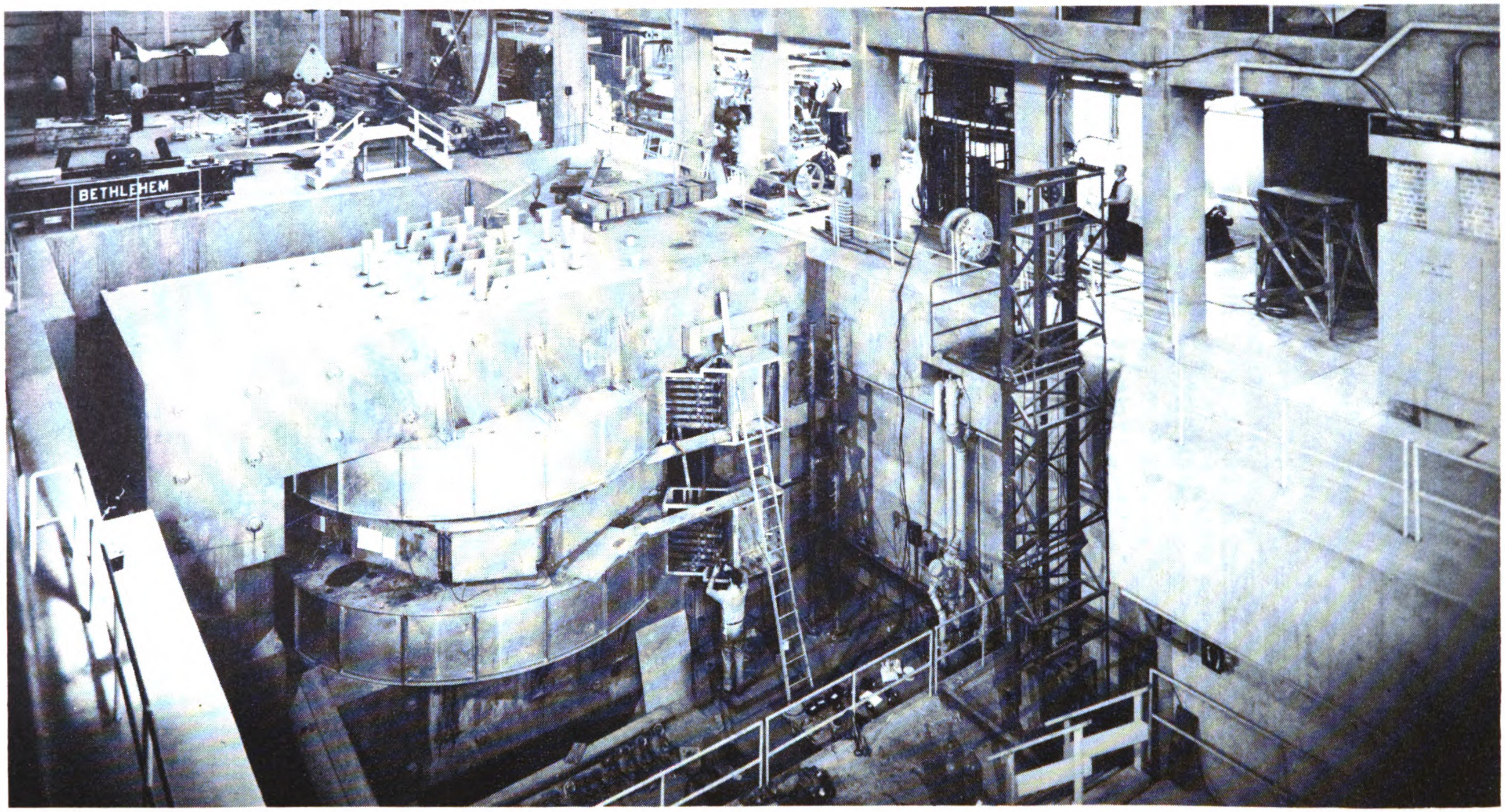

Nearing completion under ONR contract at the University of Chicago is this 350-Mev cyclotron. The builders of future science are here constructing the largest man-made accelerator in the world.

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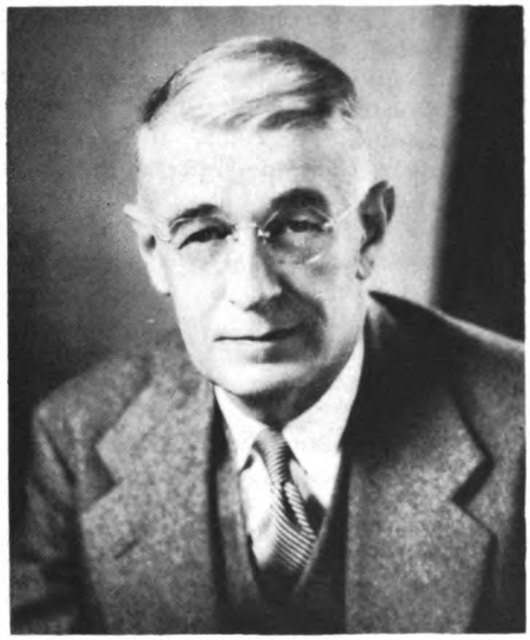
Dr. Vannevar Bush, president of the Carnegie Institution of Washington, D. C., was formerly director of the Office of Scientific Research and Development. In 1940, he was appointed by President Roosevelt as Chairman of the National Defense Research Committee. Dr. Bush served also as Chairman of the Joint Research and Development Board of the War and Navy Departments, and as Chairman of the R & D Board of the NME. His notable report to the president on recommendations for fostering peacetime scientific effort, was issued in July, 1945 under the title "Science, the Endless Frontier."



The Builders

by

VANNEVAR BUSH

The process by which the boundaries of knowledge are advanced, and the structure of organized science is built, is a complex process indeed. It corresponds fairly well with the exploitation of a difficult quarry for its building materials and the fitting of these into an edifice; but there are very significant differences. First, the material itself is exceedingly varied, hidden and overlaid with relatively worthless rubble and the process of uncovering new facts and relationships has some of the attributes of prospecting and exploration rather than of mining or quarrying. Second, the whole effort is highly unorganized. There are no direct orders from architect or quarrymaster. Individuals and small bands proceed about their businesses unimpeded and uncontrolled, digging where they will, working over their material, and tucking it into place in the edifice.

Finally, the edifice itself has a remarkable property, for its form is predestined by the laws of logic and the nature of human reasoning. It is almost as though it had once existed, and its building blocks had then been scattered, hidden, and buried, each with its unique form retained so that it would fit only in its own peculiar position, and with the concomitant limitation that the blocks cannot be found or recognized until the building of the structure has progressed to the point where their position and form reveals itself to the discerning eye of the talented worker in the quarry. Parts of the edifice are being used while construction proceeds, by reason of the applications of science, but other parts are merely admired for their beauty and symmetry, and their possible utility is not in question.

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In these circumstances it is not at all strange that the workers sometimes proceed in erratic ways. There are those who are quite content, given a few tools, to dig away unearthing odd blocks, piling them up in the view of fellow workers, and apparently not caring whether they fit anywhere or not. Unfortunately there are also those who watch carefully until some industrious group digs out a particularly ornamental block, whereupon they fit it in place with much gusto and bow to the crowd. Some groups do not dig at all, but spend all their time arguing as to the exact arrangement of a cornice or an abutment. Some spend all their days trying to pull down a block or two that a rival has put in place. Some, indeed, neither dig nor argue, but go along with the crowd, scratch here and there, and enjoy the scenery. Some sit by and give advice, and some just sit.

On the other hand there are those men of rare vision, who can grasp well in advance just the block that is needed for rapid advance on a section of the edifice to be possible, who can tell by some subtle sense where it will be found, and who have an uncanny skill in cleaning away dross and bringing it surely into the light. These are the master workmen. For each of them there can well be many of lesser stature who chip and delve, industriously, but with little grasp of what it is all about, and who nevertheless make the great steps possible.

There are those who can give the structure meaning, who can trace its evolution from early times, and describe the glories that are to be, in ways that inspire those who work and those who enjoy. They bring the inspiration that all is not mere building of monotonous walls, and that there is architecture even though the architect is not seen to guide and order.

There are those who labor to make the utility of the structure real, to cause it to give shelter to the multitude, that they may be better protected, and that they may derive health and well-being because of its presence.

And the edifice is not built by the quarrymen and the masons alone. There are those who bring them food during their labors, and cooling drink when the days are warm, who sing to them, and place flowers on the little walls that have grown with the years.

There are also the old men, whose days of vigorous building are done, whose eyes are too dim to see the details of the arch or the needed form of its keystone; but who have built a wall here and there, and lived long in the edifice, who have learned to love it and who have even grasped a suggestion of its ultimate meaning; and who sit in the shade and encourage the young men. (Reprinted by permission from The Technology Review, January 1945, edited at the Massachusetts Institute of Technology.)

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Nitrogen Mustard and X-Ray Research

by
Mary A. Russell
University of Delaware

Much attention has been given to mustard compounds since 1941, when Charlotte Auerbach's discovered that the compounds could be used to produce mutations similar to those produced by X-rays. Further studies have shown more points of similarity between the action of these compounds and the effects of radiation. One of the more significant is that both agents stop cell division without interfering immediately with cell elongation and differentiation. In addition, both X-rays and mustard compounds produce comparable changes in chromosome structure and behavior as well as other cytological abnormalities. And still another relationship of the supposed similarity between the action of these agents is exemplified by the work of V. Bryson who found that a strain of bacteria (Eschericha coli) which was resistant to radiation was also relatively resistant to the action of a mustard. These and other observations may indicate the existence of a common mode of action of these agents on living tissue.

Since the mustards were found to have a pronounced effect on actively growing tissues, it was logical to test their possible therapeutic usefulness in controlling the lawless multiplication of cells in cancer and allied diseases. The most successful results in the application of these compounds have been obtained with conditions involving the abnormal growth of lymphatic tissue. In some cases of Hodgkin's disease and lymphosarcoma, nitrogen mustard has had a palliative effect when used after X-rays had lost their power to control the disease. Occasionally, patients who have failed to respond to radiation treatment initially, have been treated with small amounts of a mustard compound to serve as a sensitizing agent so that subsequent radiation treatment became effective.

These considerations indicate that any further information concerning the action of mustard compounds on living tissue should have both practical and theoretical value. This laboratory is doing research on a project involving a comparison of the effects of mustard compounds and X-rays on the growth and development of the corn seedling. This test medium is an easily obtained source of embryonic tissue, and observations of its behavior may have direct bearing on certain aspects of the cancer problem since cancerous tissue simulates embryonic tissue development.

The compound used in these experiments was methyl-bis (Beta-chloroethyl) amine hydrochloride, furnished through the courtesy of the Army Chemical Center. The accepted symbols for this chemical are

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Mary A. Russell received her A. B. from Goucher College and the degree of Ph. D. from the University of Pennsylvania. She was a Research Assistant at the Biochemical Research Foundation from 1928 to 1942. Since 1942 Dr. Russell has been a member of the Department of Biological Sciences at the University of Delaware, Newark, Del.

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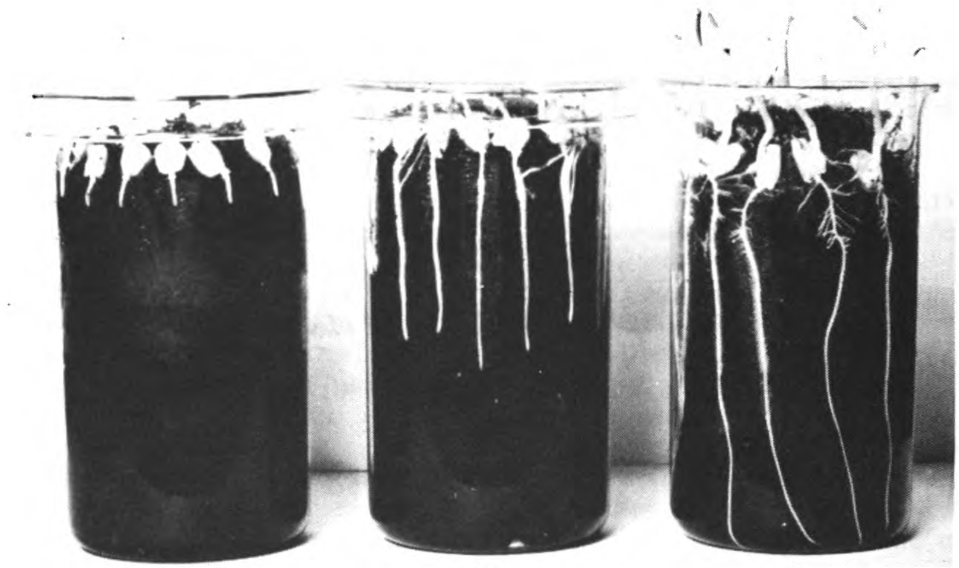

Figure 1. Normal growth of corn seedlings. (a) Appearance when first placed in beakers of moss. (b) After 36 hours, no laterals formed. (c) After three days, laterals are well developed.

MBA or HN2. Since this compound is water soluble, it is more convenient for test material than other forms. When this work was started, the only guides to techniques were a few papers by Gillette and Bodenstein describing the effects of MBA solutions on amphibian larvae. The importance of using freshly made solutions of MBA was stressed. One experiment, for example, indicated that a solution made up at pH 6.8 was inactive after standing for 45 minutes. An organic chemist advised that if solutions were made with distilled water at approximately pH 5.7, the compound would remain more stable for a longer period of time. A 0.001 percent solution of MBA was prepared in this manner, having an initial pH of 5.3 which changed to pH 4.9 by the end of six hours. At this time seedlings were treated with the solution, and subsequent observations of their growth showed that they were damaged to the same degree as seedlings similarly treated with a fresh solution.

Corn of the "U.S. 13" strain is being used in these experiments. The seed is routinely treated for five minutes with 0.05 percent mercurophen solution to kill mold spores. It is then soaked in water for one hour, spread between layers of wet paper towels in germinating dishes and put into an incubator. A temperature of 30°C is used during the entire experiment. After about 30 hours, seedlings with roots of from five to 10 mm length are selected for use. Tall 600 ml beakers are lined with filter paper and loosely packed with moist sphagnum moss. They are covered with petri dishes and sterilized to prevent growth of mold. After immersion in the MBA solution for the required length of time, the seedlings are washed thoroughly with tap water and then placed between the glass and the paper, about 15 plants to each beaker. (See Figure 1.) Thirty seedlings are used in each series. Controls are soaked in distilled water for the same period of time as that used for

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the MBA solutions. The beakers are marked so that each seedling has its own number, and its individual record is kept for the duration of the experiment. Measurements of the length of the primary roots are made twice daily, and more frequent observations are made to determine the time of appearance of the lateral roots.

The behavior of the primary roots after exposure to one concentration of MBA (0.0001 percent) for different periods of time is shown in Figure 2. After treatment for five minutes, the growth rate was almost identical with that of the controls, but the lateral roots were slightly delayed. This example illustrates the fact that delay in the appearance of laterals indicates some degree of damage to the organism as a whole which is not shown in the behavior of the primary roots. The same is true after exposure to X-rays. After 15 minutes' exposure, the growth was generally good, but one very sensitive root died. The roots treat-

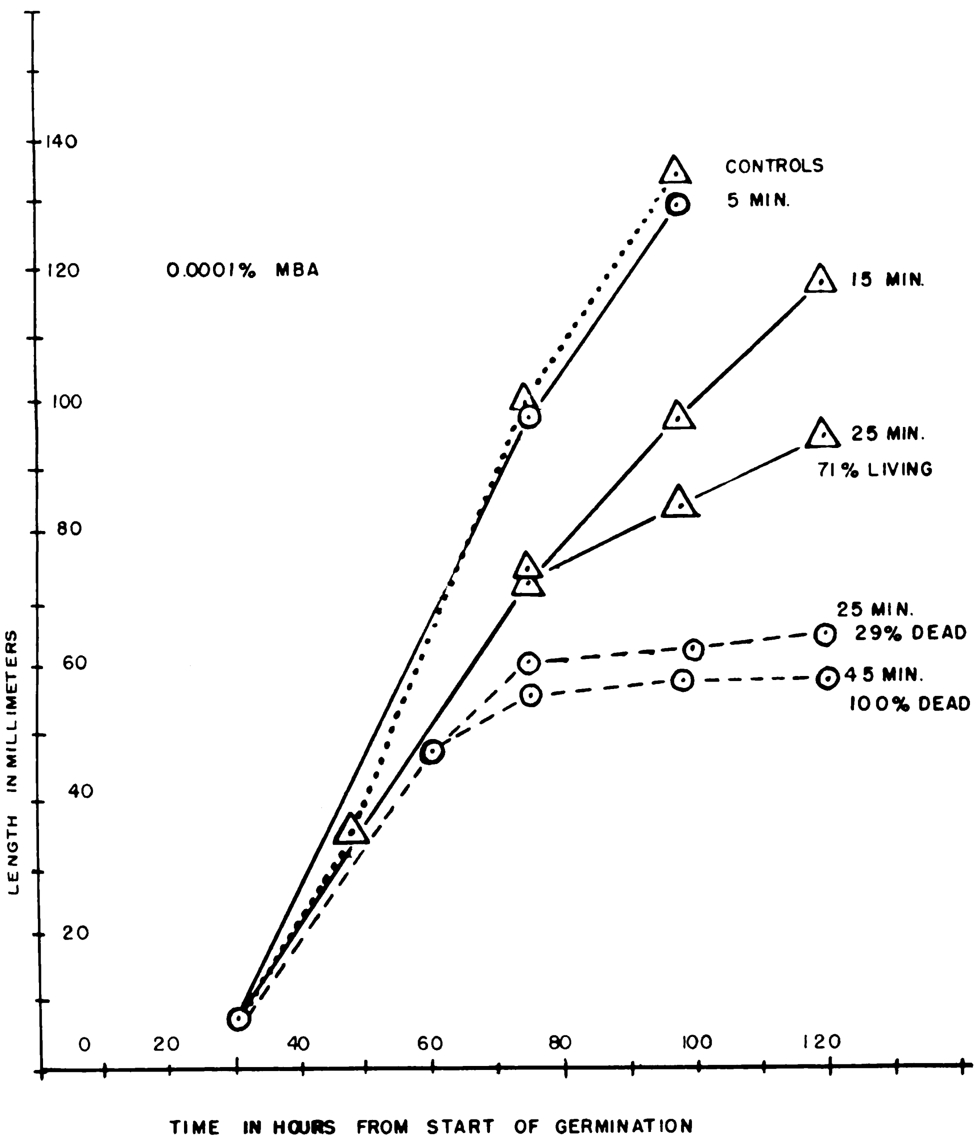

Figure 2. Behavior of primary roots after exposure to 0.0001 percent solution of MBA for different periods of time.

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ed for 25 minutes were divided into two groups, so that one curve could be prepared to show the progress made by those which survived for four days (71 percent), and another curve made for those which died. The latter curve closely parallels the curve obtained from roots exposed for 45 minutes. This period of exposure was found to be lethal to 100 percent of the roots at the consentration of 0.0001 percent MBA. (See Figure 3a, b and c.)

After testing the effect of exposing seedlings to a single concentration of MBA for various time intervals, experiments were set up to test a series of concentrations as shown in Table I.

The results indicate that a solution of 1:1000 inhibited all growth if seedlings were exposed for 37 minutes, but a solution of 1:100,000,000 had no lethal effect even when exposed for five hours. When the 1:100,000 solution was used, our results were similar to those obtained with the amphibian larvae exposed to the same concentration, in that exposure of five minutes produced nearly as much damage as exposure for 45 minutes. However, we are quite certain that our solution was still active after 45 minutes, and that little more damage appeared because the maximum effect was reached in five minutes at this concentration. Using a large volume of solution made no difference in our results. This was done to test the possibility that all of the active MBA present in the solution may have been used up during the first five minutes. Experi-

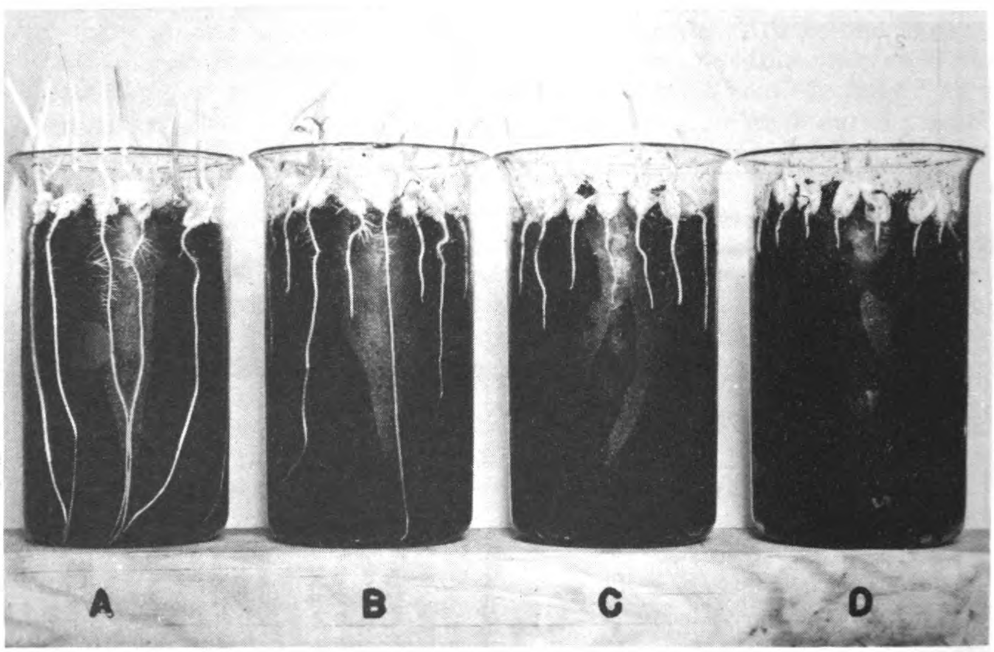

Figure 3. Photo taken three days after treatment of seedlings. (a) Control. (b) Exposed to 0.0001 percent MBA for 25 minutes, showing some roots similar to those in the control beaker (a), while other roots have stopped growing. (c) Exposed to (b) solution for 45 minutes. This dose killed all of the primary roots and prevented formation of lateral roots. (d) Exposed to 0.01 percent $CuSO_4$ for two hours. Compare with Figure 1(a) and notice that these roots are the same length as they were at the time of exposure.

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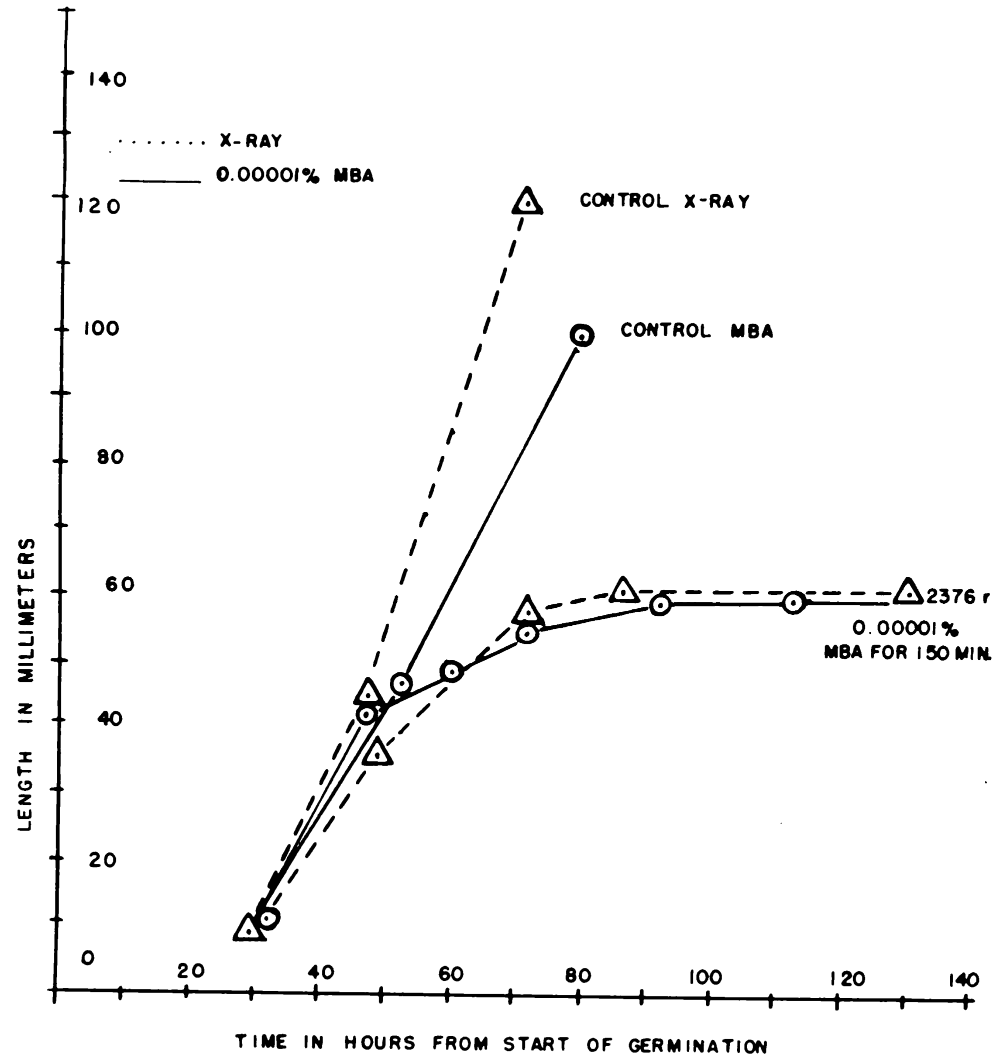

Figure 4. Similarity between the growth of roots following lateral doses of MBA and physical X-rays.

CONCENTRATION OF MBA		TIME OF EXPOSURE	AVERAGE LENGTH OF ROOT AT DEATH	% OF ROOTS SHOWING LATERALS
%	MOLAR			
1×10^{-1}	5.2×10^{-3}	37 MIN.	8 MM.	0
1×10^{-2}	5.2×10^{-4}	5 - 45 "	52 ± 1.97 "	0
1×10^{-3}	5.2×10^{-5}	5 "	60 ± 2.15 "	0
		15 - 45 "	51 ± 2.1 "	0
1×10^{-4}	5.2×10^{-6}	45 "	57 ± 1.76 "	50
1×10^{-5}	5.2×10^{-7}	180 "	57 ± 2.09 "	100
1×10^{-6}	5.2×10^{-8}	300 "	NONE DEAD	100

Table I. Relation between duration of exposure and concentration of MBA solutions.

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ments are underway testing the length of time solutions will remain active at various temperatures.

The table further shows that after treatment with concentrations of solution greater than 1:1,000,000 there were no laterals formed, regardless of the time of exposure required to kill all of the seedlings. When this concentration was used for 45 minutes, laterals appeared on about 50 percent of the roots. Laterals were present in all cases when higher dilutions were used for the times indicated, but they always appeared much later than those in the controls. While the primary roots were about the same length at the time of death either when the 1:100,000 solution was used for five minutes or when the 1:10,000,000 solution was used for three hours, the presence of laterals in the latter case indicates a lesser degree of damage. When the logarithms of time and concentration required for the LD_{100} dose are plotted against each other, the resulting straight line shows a direct correlation between these two factors. Early in 1949 a paper appeared by Novick and Sparrow describing the effect of MBA on mitosis after roots had been exposed to solutions of that compound. They reported no effect on roots of Lilium if a concentration of 5×10^{-4} solution was used for 10 minutes. It is likely that if they had used a longer time there would have been some effect, especially if they had made up the solution at a pH well below 7.

Since there is no common unit of dosage for the chemical MBA as compared to the physical X-rays, any comparison between these agents must be based on a standard effect such as the minimum dose which will kill a certain percent of the roots. Figure 4 shows the similarity between the growth of roots following lateral doses of these two agents. In both cases the data for the curves was selected from experiments in which at least 10 percent of the roots survived. The well known "latent period" during which X-rayed seedlings fail to show much damage lasts about 30 hours in this case, and the same phenomenon is exhibited by the MBA treated roots.

This similarity between the behavior of seedlings following exposure to radiation and MBA solutions is even more striking when one observes the great difference between the behavior of seedlings exposed to minimum lethal doses of MBA in one case and a typical plant poison, such as copper sulphate, in another. After treatment with the copper sulphate (1:10,000 for two hours) there is no further growth of the root, which is in marked contrast to the growth of at least 40 mm after MBA is used. (See Figure 3d).

In summary, the experimental data presented in this paper may warrant the following conclusions:

(1) In gross appearance the corn roots behave much the same after exposure to lethal doses of X-rays and MBA. In both cases lateral roots are either delayed in their time of appearance or are suppressed entirely, while the primary roots grow to a considerable length before death occurs.

(2) Solutions of MBA may remain active for a considerable time if prepared from acid distilled water of about pH 5.7. This permits a longer exposure time and thus might cut down errors arising

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from slight variations in the time involved in a given experiment. Furthermore, seedlings may be exposed to high dilutions of the solution for relatively long periods of time, and the results then compared with those obtained by using a high concentration for a short time.

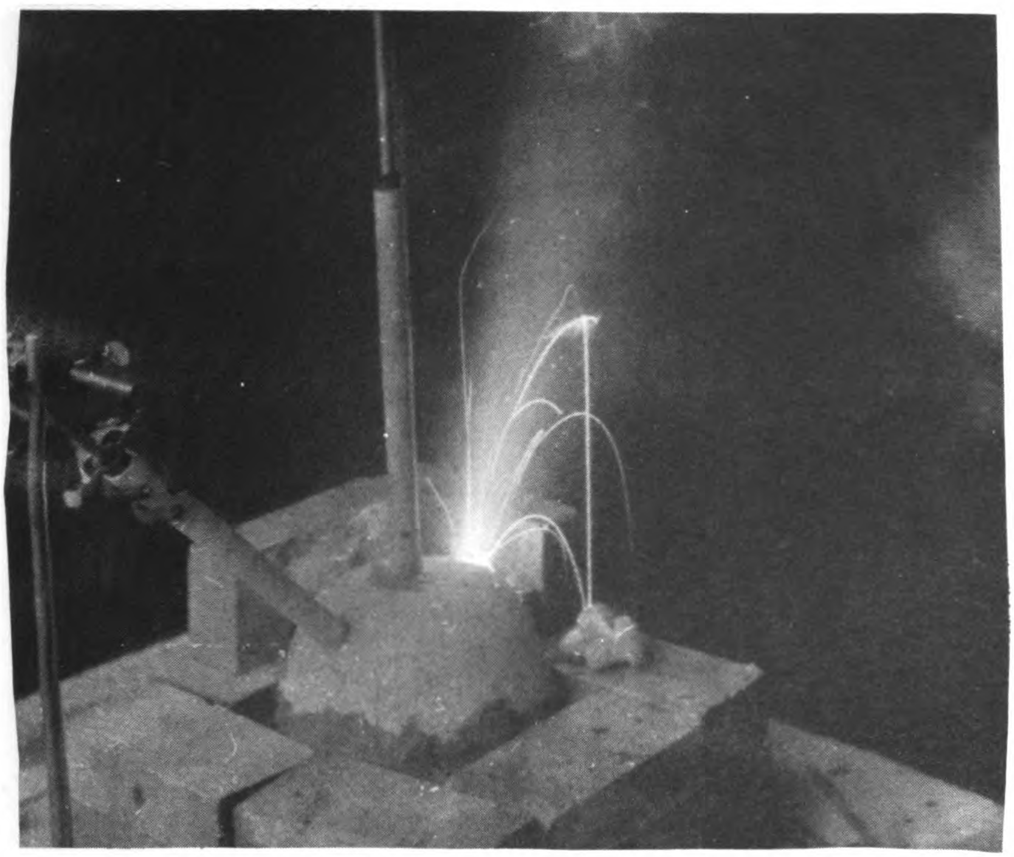
This work is being supported by Contract N8 onr 78300 through the joint sponsorship of the Office of Naval Research and the U. S. Atomic Energy Commission.

The author gratefully acknowledges the assistance of F. J. Michelini.

* * *

The Hottest Furnace Known

Last month ONR scientists visited the Temple University high-temperature furnace at Philadelphia where scientists have been able to create heats up to 5,000°C (about one-fifth the temperature of the sun) in a small aluminum-oxide globe. This furnace, shown below, is unique because, by enabling such high temperatures to be maintained, it permits researchers to study the characteristics of superheats. Oxygen pours into the globe through the vertical tubes causing the pure powdered aluminum to give off its tremendous flame. After ignition pure aluminum is fed into the flame to maintain its combustion.



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Flame Propagation

by
George H. Markstein
Cornell Aeronautical Laboratory, Inc.

The advent of jet and rocket propulsion has greatly stimulated the interest in combustion and flame propagation phenomena. Man has utilized flames and combustion since the dawn of civilization, long before many other physical phenomena became useful or even known to him. Yet our knowledge about fundamental aspects of combustion is still surprisingly sketchy. This may be due in part to the fact that through our long practical experience with combustion we have taken for granted things which are really quite complicated or even puzzling; undoubtedly the main reason, however, is that combustion constitutes an intricate tangle of physical and chemical phenomena, which defies a clear-cut separation into such special fields as thermodynamics, fluid dynamics, acoustics, and chemical kinetics.

Systematic studies of flame propagation in gases date back to the pioneer work of Bunsen, Gouy, Mallard, and Le Chatelier during the latter part of the nineteenth century. These and many subsequent investigations showed that, in general, the speed with which a flame spreads through a combustible gas mixture varies between wide limits, even in the course of a single experiment, depending greatly on the particular experimental conditions. It is possible only in certain special cases, notably in a stationary flame burning in a laminar gas stream issuing from an orifice (Bunsen flame), to measure a velocity of flame propagation which is determined by the composition and state of the combustible gas mixture only. This speed, defined as the velocity with which the flame front moves normal to its surface and relative to the unburned gas at initial conditions, is generally called the burning velocity. A large part of past and current studies of flame propagation are concerned with experimental determinations of burning velocities for various combustible mixtures, initial pressures and temperatures, mostly by means of the Bunsen burner method.

Many attempts have been made to develop a theory of the burning velocity which would make it possible to predict it accurately for any mixture and initial state, taking into account the simultaneous occurrence of chemical reactions, heat conduction, and diffusion in the flame front. This problem is still far from a satisfactory solution, not only because of mathematical difficulties, but chiefly because too little is yet known about the complicated chain reactions, involving many unstable inter-

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George H. Markstein, head of the combustion section at Cornell Aeronautical Laboratory, received his Ph. D. in Applied Physics at the Technische Hochschule in Vienna, Austria, in 1937. After nine years of industrial research in Austria and South America, Dr. Markstein joined the research staff of Cornell Aeronautical Laboratory, Inc., in September 1946, and since then has been working chiefly on fundamental problems of flame propagation for ONR and the Air Force under Project SQUID.

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mediates ("chain carriers"), which take place within the narrow reaction zone of flames. Considerable progress in this branch of combustion research may be expected when the results of many current investigations of flame reaction mechanisms, employing such varied techniques as emission and absorption spectroscopy, mass spectrography, and others, will be available.

Figure 1. Undisturbed Bunsen flame.

It has already been mentioned that flames propagate with the burning velocity only under rather special conditions. In practically all applications of combustion, the "effective" flame speed is much higher than the burning velocity. This is of particular importance in the field of jet and rocket propulsion; in fact it would be quite impossible to burn the necessary amounts of fuel within reasonably short combustion chambers and tail pipes if the burning velocity were not exceeded by a large factor. On the other hand, fluctuations of flame speed may be responsible to a considerable extent for the undesirable phenomenon of "rough burning" and other troublesome instabilities of burning in propulsive devices.

Unfortunately, flame propagation studies performed in the past do not provide sufficient information, either for an understanding of the fundamental phenomena involved or as a basis for predicting flame behavior in practical applications. Little is yet known about what causes the increase of flame speed above the burning velocity apart from the generally accepted view that it is due mainly to an increase of flame surface area, and possibly also to increased heat conduction and diffusion rates, both caused by flow disturbances which are usually called somewhat loosely "turbulence".

Recent studies have shown that the level of turbulence already present in the unburned gas is of minor significance for flame speed; the predominant part of flow disturbances responsible for increased flame speed appears to originate in the immediate vicinity of the flame front. This result suggests that the older approach, which regarded the problem merely as one of effect of turbulence on flame speed, should be replaced by one which takes into account the mutual interaction of flame propagation and flow disturbances.

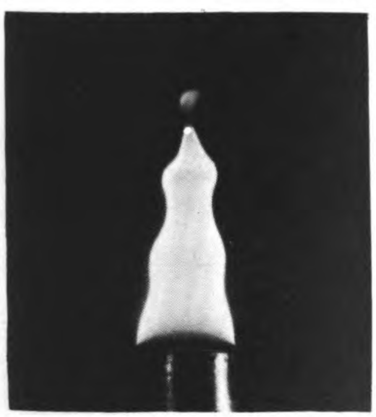

Figure 2. Stroboscopic photograph of Bunsen flame under the influence of an acoustical disturbance.

Flame studies now underway at Cornell Aeronautical Laboratory under the sponsorship of Project SQUID have already provided strong support for this view. In one group of experiments, an originally steady Bunsen flame in a laminar gas stream was subjected to

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periodical disturbances and the distortion of the flame front was analyzed by means of stroboscopic observation or high speed photography and cinematography. The effects of such varied disturbances as sound waves, alternating electric fields, and vibrating wires, were found to be surprisingly similar. In all these cases, the distortion of the flame front consisted of waves which travelled upward along the flame cone with the flow velocity of the unburned gas. Figure 1 shows a typical undisturbed Bunsen flame; Figure 2 is a stroboscopic photograph showing the effect of sound on this flame. Figure 3 is a stroboscopic photograph of a flame under the influence of an alternating electric potential applied between the nozzle and a spherical electrode. The spark schlieren photograph, Figure 4, shows the effect of a vibrating wire touching the flame front near the base.

A remarkable feature, common to all cases investigated and well visible in the figures, was the increase of amplitude during the upward travel of the waves. (The increase in time appears of course as an increase in space in the photographs.) Since it seems obvious that the observed distortion of the flame front must be due to flow disturbances present both in the unburned and burned gases, the phenomenon may be quite analogous to the well-known amplification of periodical disturbances in a laminar boundary layer and may thus be of fundamental importance for an understanding of the generation of turbulence in flames.

This interpretation is necessarily of a tentative nature, since the distortion of the flame front does not provide sufficient information for deducing the disturbance velocities, even in its immediate vicinity. In order to explore the flow patterns in disturbed flames further, titanium tetrachloride vapor, which hydrolizes upon contact with the moisture

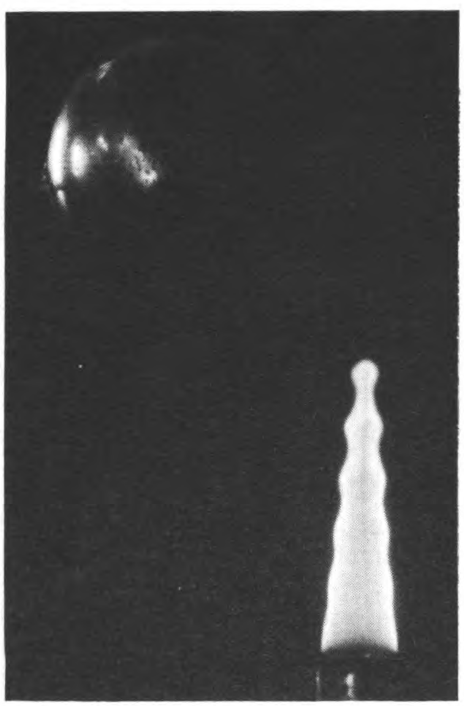

Figure 3. Stroboscopic photograph of Bunsen flame under the influence of an electrical disturbance.

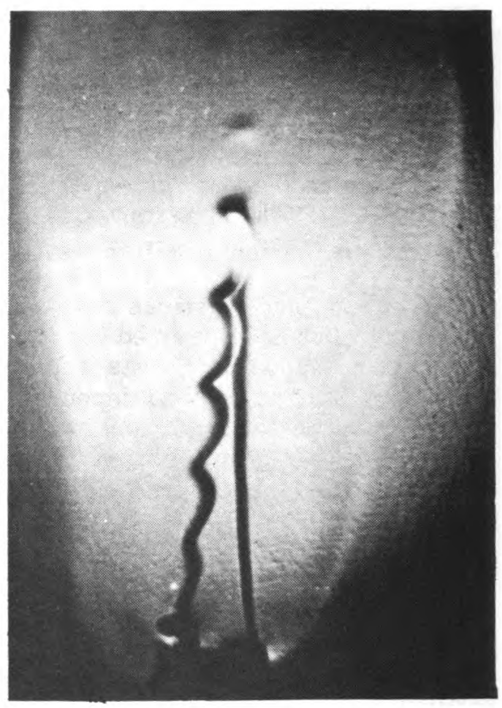

Figure 4. Spark schlieren photograph of Bunsen flame disturbed by a vibrating wire.

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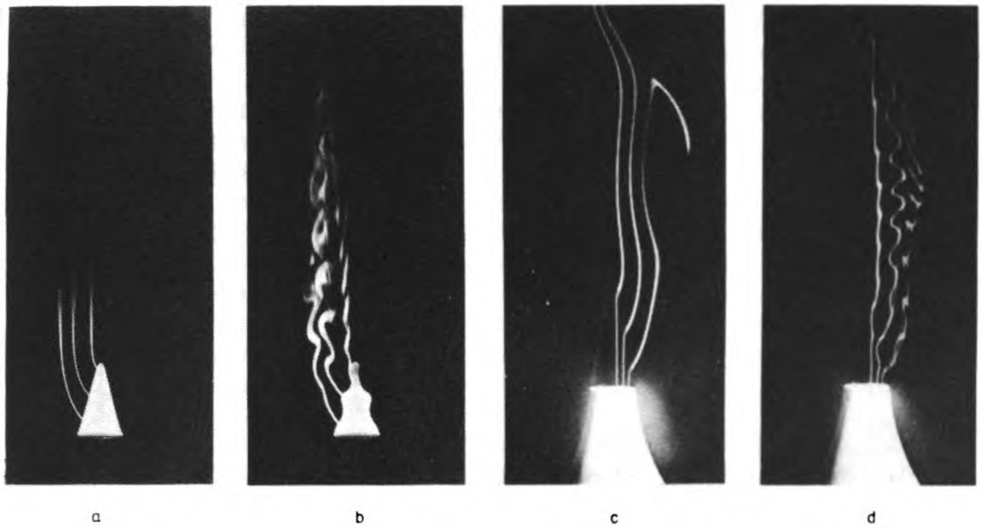

Figure 5. Flow visualization in Bunsen flames by means of $TiCl_4$ smoke traces: (a) undisturbed flame, (b) stroboscopic photograph, acoustically disturbed flame, (c) flash photograph, undisturbed flame, (d) flash photograph, acoustically disturbed flame.

in the air, forming a dense white smoke, was injected into the unburned gas stream in several thin traces. Since the fine smoke particles follow the gas motion practically without any inertia effects, the presence and nature of flow disturbances can be deduced from the shape of the traces. Examples are shown in Figure 5; Figure 5a, and the stroboscopic photograph 5b are taken in the own light of the smoke, which becomes brightly luminous in the hot burned gas; 5c and 5d are taken with electronic flash illumination. Figure 5b and 5d show the effect of sound disturbance on the flow pattern; 5d in particular demonstrates strikingly the penetration of the disturbances into the unburned gas. At present work is continuing on a modification of this technique to enable a quantitative evaluation of the flow pattern.

Another group of experiments at Cornell Aeronautical Laboratory is concerned with flame propagation in tubes. Numerous investigations of this subject have been carried out in the past; but while it was recognized that flame speed depends decisively on flame surface area and thus on flame shape, few previous attempts were made to study flame structure in tubes systematically.

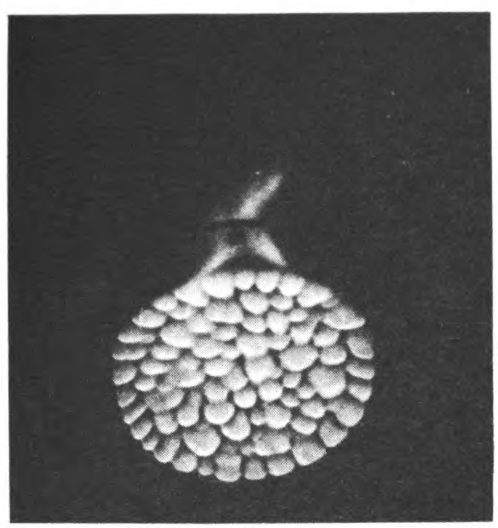

Figure 6. Cellular flame burning in 10-cm i.d. tube

In order to separate the the various factors which may have an influence on flame shape, all disturbances which may affect it are eliminated as completely as possible in one type of

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experiment of the present study. This condition is realized best for an almost stationary flame burning near the upper open end in a vertical tube, with the premixed gases entering near the bottom at such low speed that laminar flow in the tube is insured. Contrary to what might be expected, it was found that even under these conditions in certain mixtures the flame front disintegrated into a number of roughly hemispherical cusps of fairly uniform size. These cusps, which were always convex toward the unburned gas, and separated by narrow ridges, filled the whole cross-section of the tube in a single horizontal layer moving about continuously in irregular fashion. A typical example of such a "cellular" flame, burning in a rich mixture (i.e., containing more fuel than necessary for complete combustion) of isobutylene, air and nitrogen in a tube of 10-cm inner diameter, is shown in Figure 6.

There can be little doubt that this flame structure is caused by flow disturbances, generated by the flame itself. Like the amplification of artificial disturbances in flames described above, the phenomenon has the character of an instability. Unlike the former, however, cell structure was observed only in certain mixtures; it did not appear at all in methane-air mixtures, and only in rich mixtures of higher hydrocarbons. Recently it was found that cells appeared in lean mixtures of hydrocarbons, including methane, when small amounts of hydrogen were added. The size of the cells was found to depend markedly on the type of fuel and on pressure and other variables determining composition and state of the gas mixture, but not on tube diameter and gas flow velocity.

In another type of experiment the flame is no longer kept almost stationary, but left to flash down more or less rapidly from the open to the closed end of the tube. It was already known to Mallard and Le Chatelier that under these conditions an initial "uniform" motion of the flame is followed by a "vibratory" motion which generally is accompanied by a marked increase of flame speed and which may assume a violently explosive character. This phenomenon, which is of great practical as well as fundamental importance, has been extensively studied in the past. It has been established that the vibration frequencies correspond to organ-pipe oscillations of the gas column in the tube; however, the cause of their excitation, and of the simultaneous increase of flame speed has never been fully established.

Important clues for a better understanding of vibratory flame motion may be provided by studying the hitherto neglected role of flame structure. Because of the extremely rapid changes of flame shape occurring under these conditions the only possible method of attack consists of high speed cinematography combined with schlieren or shadowgraph techniques. With a tube of circular cross-section this can be done only by means of a parallel beam of light traversing the tube axially and passing through a glass window at the closed end. A sequence of frames of a high-speed movie taken in this way during the vibratory part of flame motion is shown in Figure 7. Cells can be seen to appear and disappear periodically in the rhythm of the oscillation. Thus, flame surface area and therefore heat release of the flame will vary in the same rhythm. As Rayleigh had already shown, periodic heat addition, if applied in proper phase, causes excitation of oscillations of a gas column. It seems most likely that the resulting periodic accelerations of the gas column affect flame front stability and thus cause the observed

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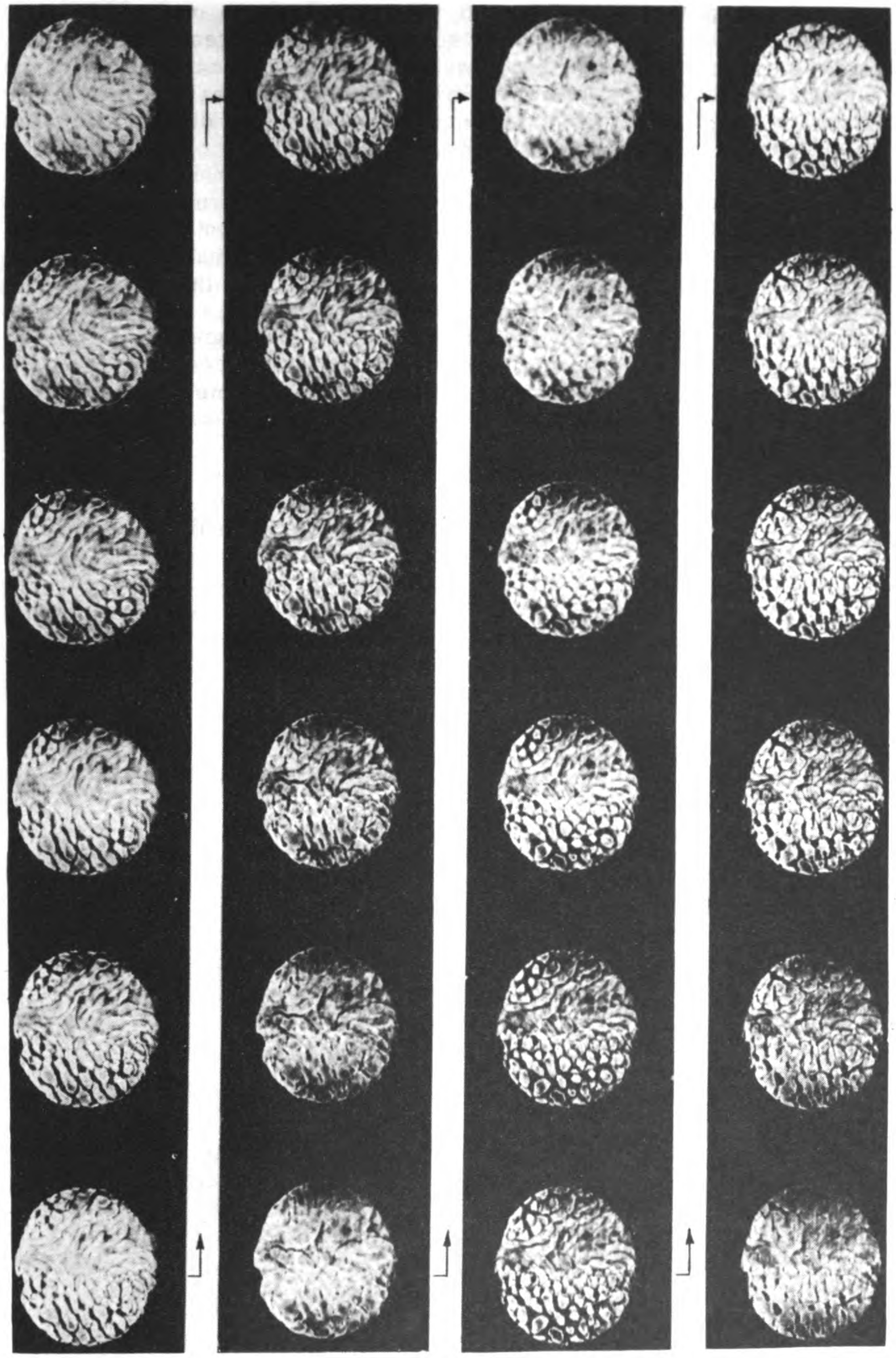

Figure 7. Shadowgraph high speed movie (approximately 1500 frames per second) of flame structure in tube during vibratory flame motion.

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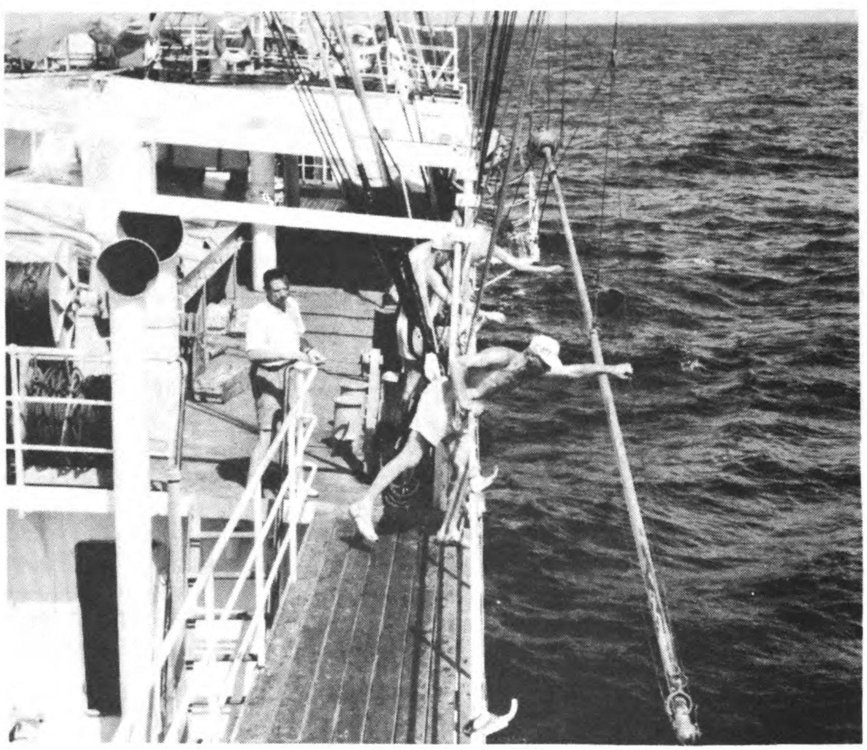
periodic changes of flame structure, thereby providing the "feedback" necessary for spontaneous oscillations. Further work is being done, correlating oscillographic records of the pressure oscillations at the closed end of the tube with high speed motion pictures of flame structure for various mixture compositions, in order to arrive at a more complete understanding of these matters.

It is hoped that the field of jet and rocket propulsion will eventually benefit greatly by these and many other studies of flame propagation now underway. While remarkable progress has been made in this field in recent years, it should not be overlooked that this has been achieved to a large extent by costly and time-consuming trial-and-error methods. It is to be expected that a better understanding of flame propagation will ultimately lead to more straightforward design procedures comparable to those customary in other fields of engineering.

* * *

Searching The Ocean Bottom

This summer-clad scientist is assisting in retrieving a Kullenberg coring tube from the ocean floor. The tube, one of the instruments used last summer in the trip of the ATLANTIS through the North Atlantic, scrapes bottom samples of the ocean for later study in the laboratory. "Clues to Ocean History," which appears on the next page of this issue tells the story of one of the investigations made during this voyage. The August 1949 issue of the Reviews carried the story of "North Atlantic Oceanography," which documents the procedure of the ATLANTIS during one of her voyages.



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Clues to Ocean History

by
Frances L. Parker
Marine Foraminifera Laboratory

Although the Foraminifera have engaged the curiosity of a few for a century and a half, it is only in the last hundred years that they have interested the geologist, in the last thirty the oil geologist, and in the last fifteen the oceanographer.

Foraminifera are microscopic marine protozoans, averaging about one-half millimeter in diameter. They secrete calcareous or chitinous tests, the latter often encrusted with a coating of cemented sand grains. They are found on the bottom of all the oceans and in bays and marshes. They are found, too, in the plankton, or floating life, of all the seas. The planktonic forms, falling to the bottom of the water

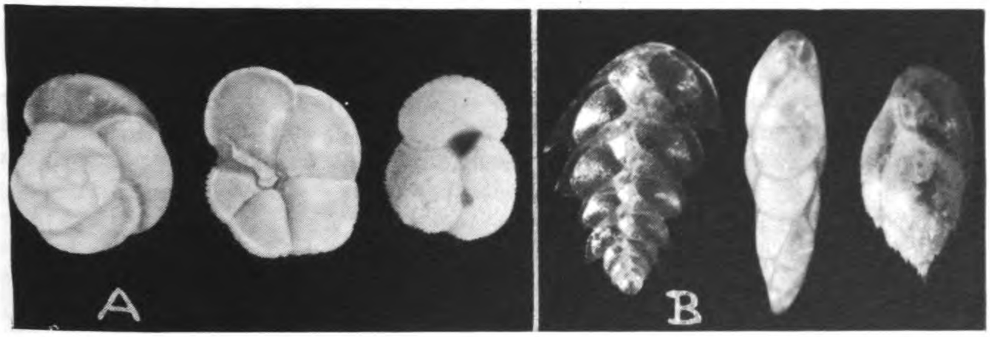

Figure 1. (A) Planktonic Foraminifera; (B) Benthonic Foraminifera

after death, form an appreciable percentage of the sediments--sometimes as high as 99 percent in the so-called Globigerina oozes. This is true only of the deeper water sediments. In the shallow water sediments, the bottom-living forms are the more abundant. It is a natural corollary that these forms should also be found in the marine sediments and rocks of the land.

For a long time the Foraminifera occupied scientists only in an objective sense. "Here", they said, "is a new shell to describe". Later they said, "Here is a clue to the age of this geologic formation". Still later they began to say, "This species appears only in shoal water and this one in deep". Now the Foraminifera are being used as "tracers" in deciphering ocean history.

Frances L. Parker is a research associate at the Marine Foraminifera Laboratory. Miss Parker received an A.B. degree from Vassar College in 1928 and an M.S. degree in geology from Massachusetts Institute of Technology in 1930. She was associated with the Cushman Laboratory of Foraminiferal Research, Sharon, Mass., from 1930-40, and was a senior paleontologist with Shell Oil Co., from 1943-45. Miss Parker has been associated with the Marine Foraminifera Laboratory since 1947, working under the direction of Fred B. Phleger, chief investigator on an Office of Naval Research contract.

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It has become apparent to the geologist that here is an instrument for the interpretation of the processes of the past insofar as they concern marine rocks. What were the conditions under which this rock was formed? What is the life history of this area in terms of ocean depths, bay, or marsh conditions, ocean currents and water masses? And to the oil geologist: Where can we expect to find ideal conditions for the accumulation of oil?

It is evident that the only way to interpret past phenomena is by an intensive study of the present. Foraminifera are known to be sensitive to the conditions of their environment as other animals are. Temperature, salinity, availability of food, character of the bottom sediments, and many other factors all play an important part in the environment of Foraminifera. Since these animals are small, large quantities can be easily obtained and statistical analyses made of the sequences found under different environmental conditions. A study of the bottom-living or benthonic forms shows that relatively small depth changes can be recognized. The faunas living in low-salinity water of rivers and marshes have definite characteristics and are quite different from those of the open sea. Faunas from calcareous sediments differ greatly from those living in sand or mud. The floating, or planktonic, forms also show considerable variation in different parts of the oceans. These, too, appear to be greatly influenced by temperature. For example, great differences may be observed between planktonic forms from the North Atlantic Ocean and those from the Caribbean Sea.

In order to pursue such studies, the Marine Foraminifera Laboratory was established. Its first project, carried on partly under contract with the Office of Naval Research, was a reconaissance study of the northwest part of the Gulf of Mexico. This area was chosen partly for its immediate interest to the oil geologist and partly for its suitability as a field of investigation. The Woods Hole Oceanographic Institution ketch ATLANTIS made three cruises in the early months of 1947. (See "North Atlantic Oceanography," by C.O'D. Iselin, Research Reviews, August, 1949.) It covered the area by means of 12 traverses starting near shore and extending out to the Sigsbee Deep. Five hundred samples of bottom sediment were collected by means of a simple device which obtains undisturbed samples of sediment. In addition, one hundred cores, averaging eight feet in length, were taken and 27 plankton tows were made at various depths below the surface. Frequent bathythermograph records were taken to establish the temperature conditions and hydrographic stations were made to collect data on salinity and deep water temperatures.

In the laboratory an extensive examination was made of the sediment samples. The upper layer of each sample was examined for living forms as well as for the dead, empty tests. These were tabulated quantitatively by species. Since the floating and the bottom-living forms represent different environments, they were tabulated separately. An analysis of the results reveals that the constitution of the bottom-living faunas shows a definite progressive change with depth. Six of these changing faunas, called faunal facies, can be recognized in the area. There is, of course, some overlap but in rough figures the changes occur at 50, 100, 300, 500, and 900 fathoms. These changes can be correlated in part with the temperature pattern. An example of this can be

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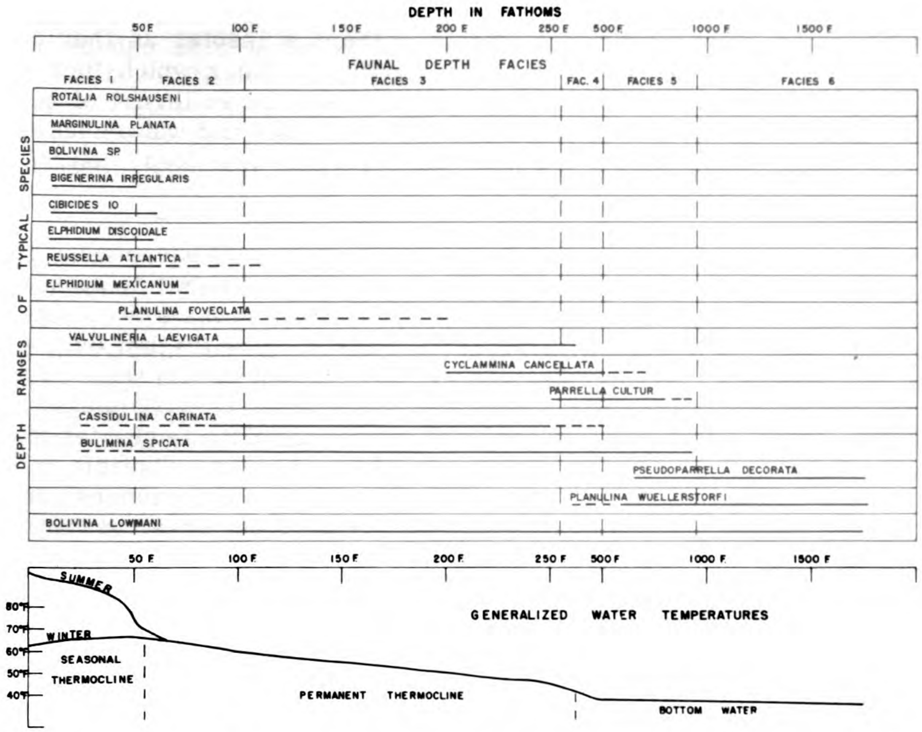

Figure 2. Generalized chart showing depth ranges of Foraminifera species and relation of faunal depth facies to temperature.

seen at the 50-fathom depth change which coincides with the top of the main thermocline.

The percentage of living forms to dead ones gives a possible clue to the relative rates of sedimentation in the region. A much higher percentage of living forms was found in the shallow, near-shore area, and hypothetical calculations show that the sedimentation is 60 times as rapid there than farther off shore.

The analysis of the foraminiferal faunas of the cores throws an interesting light on the past history of the area. Study of the planktonic faunas shows, that there were alternating periods of relatively colder and warmer water. These may perhaps be correlated with glacial and interglacial stages of late Pleistocene age. The benthonic faunas of the cores are also of great interest. In some of the cores taken in deep water, layers occur containing faunas from considerably shallower environments. These faunas give evidence of the slumping or sliding of material from near shore areas--in some cases for a considerable distance. A study of the plankton tows shows that living planktonic Foraminifera are present in some abundance in the off-shore water. These represent only a small fraction of the total planktonic population. The average content is five or six specimens per cubic meter. This figure is many times higher in parts of the area. The specimens are found at all depths sampled down to 1000 fathoms. The relative numbers found at different depths are variable and, contrary to previous belief, in some places they are found to be more abundant at considerable depths than near the surface.

In addition to this work in the Gulf of Mexico, many other projects are now under way at the Marine Foraminifera Laboratory. A study is

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being made of the Portsmouth area of the Gulf of Maine where a detailed study of the population changes in a relatively small area can be analyzed. A study of the region extending from Long Island Sound to Buzzards Bay is revealing the effect of rapid change of salinity and the more gradual changes resulting from the shift from bay conditions to an open sea environment. Arctic faunas from the neighborhood of Greenland are also being analyzed.

Another important study in progress is the analysis of deep sea cores collected by the Swedish Ship ALBATROSS in 1948. Cores up to 60 feet in length were obtained and a detailed study of the Foraminifera should yield a great deal of information concerning the history of the sea during the last million or more years. It should be possible, eventually, to reconstruct the details of an ocean for any time during the recent geologic past. This may aid in long range predictions of variables in the oceans.

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Cooking Frozen Meats

by
Faith Fenton and Kathryn Causey
Cornell University

The effect of several thawing and cooking methods on the palatability and nutritive value of frozen ground pork, beef, and lamb was one phase of the Office of Naval Research project on frozen foods at Cornell University.

Few studies have been reported on the cooking of frozen meats. During this study, bacterial plate counts were made before freezing, before and after thawing, and after cooking. To minimize sampling errors, the pork used in all of the studies was obtained from one lot which had been ground, mixed, and frozen at one time; the beef and lamb were selected in the same manner. Before being frozen the meat was weighed and shaped in one-fourth pound patties, each two and one-half inches in diameter, and five-eighths of an inch thick.

The patties were cooked both from the frozen state, (-24° to $-29^{\circ}C$), and after thawing at room temperature to $2.8^{\circ}C$, by several methods: pan-broiling, oven-broiling, dielectric cooking without pre-browning, and dielectric cooking with pre-browning. Five replicates of each study were made and in each study, thawing and cooking procedures were standardized. Thawing and cooking times were recorded continuously with a potentiometer except in the dielectric cooking. Since it is impossible to use thermocouples in dielectric heating, stainless steel expansion-type thermometers were used.

Palatability was determined by a panel of eight to ten men and women, all experienced judges, who scored each sample for external color, crust quality, internal color, tenderness, juiciness, and flavor, according to a graduated scale of from 1 (very poor) to 10 (excellent). The judges also gave their order of preference for the three meats.

Bacterial plate counts were made by the procedure of the Committee on Microbiological Examination of Foods, while the thiamine and riboflavin contents were determined in all meats by chemical methods. Microbiological methods were used to determine niacin in pork,

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Faith Fenton, professor of Food and Nutrition in the State College of Home Economics and School of Nutrition at Cornell University, obtained her Ph.D. degree from the University of Chicago in 1938. She received the War and Navy Department certificate of appreciation for her contribution to the work of the Office of Scientific Research and Development during World War II for research on the retention of palatability and nutritive value during processing and large-scale cooking of foods.

Kathryn Causey is a research associate in the School of Nutrition and College of Home Economics at Cornell University. She received her B.S. at the University of Illinois in 1947 and her M.S. in February 1949 at Cornell University where she held a Philco Fellowship in frozen foods.

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and lysine in beef and lamb. Statistical treatment was made using Student's "t" method.

In the studies described, it was found that pork and beef patties thawed at room temperature in 90 minutes, while the lamb took 105 minutes. Thawing prior to cooking shortened the cooking time for conventional methods (pan-broiling and oven-broiling) from three to eight minutes and for dielectric methods by two minutes or less. It was noted that the dielectric cooking of meat patties in units of five required only one-seventh to one-third the time necessary in the other methods.

Table I below shows that palatability scores for thawed and unthawed meat fell within the same ranges. The maximum possible score was 10. The pan-broiled, and pre-browned, dielectrically cooked patties all received similar high scores in each of the six quality characteristics. The patties cooked dielectrically without pre-browning, on the other hand received lower scores in external color, crust quality, and flavor. These patties, however, received scores similar to the others in internal color, tenderness, and juiciness, except the lamb, which was scored consistently lower in juiciness. Note that cooking methods giving scores in the same ranges are grouped together.

Table I. Effect of Cooking Methods on Palatability of Frozen Ground Meats

Meat	Cooking Method	Ranges of Average Palatability Scores						
		External Color	Crust Quality	Internal Color	Tenderness	Juiciness	Flavor	Average
Pork	Pan-broiling, oven-broiling, and dielectric with pre-browning	8.1-8.7	8.0-8.9	7.6-8.4	8.2-8.6	8.2-8.7	8.2-8.7	8.2-8.5
	Dielectric without pre-browning	4.8-5.0	4.7-4.9	7.2-7.8	8.4-8.4	8.4-8.7	7.7-7.8	6.9-7.0
Beef	Pan-broiling, oven-broiling, and dielectric with pre-browning	8.0-8.8	8.2-9.0	7.8-8.5	7.7-8.8	7.6-8.7	8.1-8.6	8.0-8.6
	Dielectric without pre-browning	7.0-7.5	7.1-7.4	6.8-7.3	7.1-7.2	6.6-7.0	7.3-7.6	7.0-7.3
Lamb	Pan-broiling, oven-broiling, and dielectric with pre-browning	7.6-9.3	7.5-9.2	8.1-8.7	8.4-9.0	8.0-8.7	8.5-8.8	8.1-8.9
	Dielectric without pre-browning	7.0-7.4	7.0-7.4	8.1-8.7	7.8-8.0	7.4-7.8	8.2-8.3	7.7-7.8

In order of preference, pan-broiling ranked first with all meats. Pork and lamb patties thawed during cooking were preferred over the pre-thawed; this preference did not exist with beef. The judges may have preferred well-done pork and lamb, and medium or rare beef. For example, frozen pork patties required 29.6 minutes for pan-broiling and thawed patties 26.2 minutes for the same method. The thinness of the patties may also have been a factor.

Weight loss from beef and lamb was larger during dielectric cooking than during conventional cooking, but this difference did not occur with pork. No explanation is given. The drip loss from all three meats was greater during dielectric cooking than during conventional cooking, although the difference in the drip from pork was not statistically significant.

The bacterial plate counts for the raw meat averaged 16,000 organisms per gm for pork, 263,000 for beef, and 63,000 for lamb. After

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cooking, all counts were low—30-720 per gm. No differences due to either thawing or cooking methods occurred in the final count, although the plate count was doubled during thawing.

The average thiamine content of the frozen raw pork was 0.50 mg per 100 gm; beef 0.08 mg; and lamb 0.07 mg. No losses occurred during pre-thawing. The average retention of thiamine in the drained patties, based on original content, was practically the same in all three meats; 85 percent in the pork, 84 percent in the beef, and 86 percent in the lamb. With all three meats, there was two to three times as much thiamine in the drip from the dielectrically cooked patties as in the drip of the patties cooked by conventional methods. This was probably directly related to the greater amount of drip formed during dielectrical cooking.

The average riboflavin content in mg per 100 gm of the frozen raw meat was similar for all three meats: 0.19 for pork, 0.20 for beef and 0.18 for lamb. Retentions in the drained patties averaged 85 percent in pork, 79 percent in beef, and 55 percent in lamb. The drip of all three meats contained an average of seven percent of the original riboflavin. No consistent trend of improved retention in any one of the cooking methods was observed.

The average niacin content of the frozen raw pork was 2.64 mg per 100 gm. Probably little of the niacin was lost, since an average retention of 97 percent was found in the drained cooked patties, and the rest was found in the drip. In general, the drip from the dielectrically cooked patties contained more niacin than did the drip in the other methods. No other significant differences were observed.

Lysine in the frozen raw beef averaged 3.08 gm and in the lamb 2.30 gm per 100 gm. The drained cooked beef patties contained an average of 89 percent of the original lysine, and the lamb patties 92 percent. Negligible amounts (0.02 percent or less) were found in the drip. No differences due to thawing or cooking methods were observed.

Frozen ground pork, beef, and lamb patties were cooked both before and after thawing by (1) pan-broiling, (2) oven-broiling, (3) dielectrically without pre-browning and (4) dielectrically with pre-browning. Palatability, bacterial plate counts, and nutrient content and retention were determined.

The slight decrease in cooking time due to pre-thawing of these relatively small masses of meat was of little, if any, practical advantage.

Dielectric methods decreased the cooking time of the five one-fourth-pound patties by one-seventh to one-third that required by oven or pan-broiling.

Pan-broiled, oven-broiled, and pre-browned dielectrically cooked patties were superior to the unbrowned dielectrically cooked patties in external color, crust quality, and flavor.

The bacterial plate counts after all four cooking methods were similar in each meat, and were always low.

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The retentions of thiamine were similar for the three meats, 84 to 86 percent, and for each of the four cooking methods. The percent of thiamine in the drip, and the volume of drip, were slightly, but consistently, greater for the dielectrically cooked patties than for those cooked by other methods.

The retention of riboflavin varied with the kind of meat; it averaged 85 percent in pork, 79 percent in beef; and 55 percent in lamb. The thawing and cooking methods used, however, had little, if any, effect on the retention of riboflavin in either the drained patties, or in the drip of any one kind of meat.

The retention of niacin in the pork patties was 97 percent; the rest was found in the drip.

The retention of lysine in the beef patties averaged 89 percent, and in the lamb patties 92 percent; traces were found in the drip.

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On the Naval Research Reserve

Third Annual Scientific Seminar To Be Held June 7-20

A total of 100 specially qualified Naval Reserve officers will observe and study Naval research programs first-hand during the third annual scientific seminar to be held in Washington, D.C., from June 7 to 20, 1950.

The seminar, sponsored by the Office of Naval Research, will feature visits to various laboratories in the Washington, D.C. area and lectures by outstanding scientists and engineers closely identified with the scientific, research, and development activities of the Naval Establishment.

A number of the Naval Reserve officers who will attend the seminar are presently working as civilians on Navy research projects in university and college laboratories throughout the country.

Rear Admiral T. A. Solberg, USN, Chief of Naval Research, will welcome the Reserve officers at the opening seminar session at 2:00 p.m. Wednesday, June 7, in the Navy Department. He will introduce Admiral Forrest P. Sherman, USN, Chief of Naval Operations, who will give the opening address.

Lecturers during the seminar include Dr. Lowell T. Coggeshall, Dean, Division of the Biological Sciences, University of Chicago; VADM Russell S. Berkey, USN, Navy Chief of Information; RADM C. B. Momsen, USN, Assistant Chief of Naval Operations for Undersea Warfare; RADM T. B. Hill, USN, Director, Atomic Energy Division, Office of the Chief of Naval Operations; RADM H. A. Hauser, USN, Head, Legislative Branch, Department of Defense; CAPT Arleigh A. Burke, USN, Navy Secretary, Research and Development Board; CAPT J. R. Ruhsenberger, USN, Commanding Officer and Director of the Special Devices Center, Office of Naval Research, Sands Point, Long Island, N.Y.; CAPT J.H. Schultz, USN, Assistant Chief for Naval Reserve, Bureau of Naval Personnel; and CAPT C. G. Pendill, USNR, Navy Sectretary, Civilian Components Policy Board.

The two-weeks' seminar program calls for visits to the Naval Research Laboratory; the Naval Ordnance Laboratory, White Oak, Md; JHU Applied Physics Laboratory, Silver Spring, Md; the Naval Medical Research Institute, Bethesda, Md; the Engineering Experiment Station and the United States Naval Academy, Annapolis, Md.

Naval Reserve Commissions Now Open

Appointments to commissioned rank as line officers in the Naval Reserve are currently being made in several categories, according to information from the Bureau of Personnel.

A limited number of vacancies now exist for Navy and Coast Guard Veterans of World War II, who are members of the Naval Reserve, for appointment to commissioned rank in the Volunteer Reserve. This program has been established for the benefit of certain highly qualified

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veterans who were not eligible for commissioning during the war years but who now qualify and desire an active part in the peacetime Reserve.

In general they will be appointed ensigns for limited general service in the line (aviation, deck, engineering and communications classifications). Qualifications are:

(1) Must have honorably served in an enlisted or warrant status between 7 December 1941 and 24 June 1948.

(2) Must have been separated from the service with an honorable discharge.

(3) Must be a native born male or female citizen of the United States or naturalized for at least 10 years; (10-year requirement may be waived by the Bureau of Naval Personnel for otherwise highly qualified candidates).

(4) For males, be not less than 19 nor more than 30 years of age; for females, be not less than 21 nor more than 30 years of age.

(5) Have satisfactorily completed a four year course (at least 120 semester hours) at an accredited college or university. One year of college may be waived for each year of active duty not in a student status (V-5, V-12, V-12a, Class A Service Schools and Recruit Training) in the Naval Service or Coast Guard during the period 7 December 1941 to 24 June 1948, providing the candidate is of the four year college educational level (indicated by percentile score of 50 on the Officer Selection Test). Not more than two years of the four years of college may be waived on a full year for full year's basis. Less than one full year may not be counted.

(6) Be physically qualified by standards set forth for Reserve Officers in the Manual of the Medical Department, U. S. Navy.

(7) Be enlisted in the Naval Reserve for inactive duty. Active participation in periods of Naval Reserve Training or drilling subsequent to 1 July 1946 and recommendation for commission by the appropriate officer conducting the training will be given strong consideration.

(8) Establish mental, moral and professional fitness for the Naval Service by means of interviews and investigation of his employment and Naval Records.

In a second category, officers appointed will be assigned specialist classifications appropriate to their education and experience. Since there is no indoctrination or training program available at this time for training officers after their appointment, they must be professionally qualified prior to appointment. The basic professional qualification is a college degree in the specialty concerned plus five years of progressive and acceptable experience in the specialty. High school graduates who have not attended college may be processed, provided they have at least 10 years of acceptable progressive experience in the specialty. Applicants less than 32 years of age must have the professional experience described above. For each year the candidate is over 32 an addi-

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tional year of experience is required. The maximum age is through 40. The general qualifications previously listed also apply to this group.

Commissions in a third category are for men between the ages of 19 and 27, but individuals eligible for the draft are not eligible for commissions under either this category or the preceding one. Officers procured under this classification are potential specialists in some field of experience of value to the Navy. The basic professional qualification is a degree from an accredited college or university. Degrees most desired are in the various engineering and technical fields. Applications are not desired from candidates with degrees in the liberal arts unless the candidate has other outstanding qualifications.

Further information on these three programs may be obtained from the nearest Office of Naval Officer Procurement, usually found as part of the Navy Recruiting Station.

Undersecretary Speaks to Princeton Unit

Undersecretary of the Navy Dan A. Kimball spoke before a meeting of VRR Unit 4-1 in the engineering lounge at Princeton University on March 22. Mr. Kimball devoted most of his discussion to the research aspect of the preparedness program. He explained that the serious decline in the amount of research during the period between the two wars left this country in a precarious position when World War II began.

"The most important thing we can do now is to keep the research strong and active," the Undersecretary said. He added that "research would receive a grant of $600,000,000 toward achieving this goal."

Unit Commanding Officers Meet

Commanding Officers of Volunteer Research Reserve Units in the First Naval District held a meeting on March 3, 1950, in the ONR Boston Branch Office. They were addressed by CDR A. B. Cook, USNR, Director of Naval Research Reserve, Washington, D. C., who was introduced by CAPT A. L. Pleasants, USN, Commanding Officer, ONR Boston Branch Office. A round-table discussion was held on mutual problems of the units and the program for the coming year.

Commanding Officers who attended the meeting included: CDR George Z. Dimitroff, USNR, VRU 1-7, Hanover, N.H.; CAPT Joseph W. Hammond, USNR, VRU 1-1, Boston, Mass.; CDR Charles J. Fish, USNR, VRU 1-2, Providence, R.I.; LTJG Joseph B. Masaschi, USNR, VRU 1-6, Lowell, Mass.; LT Francis J. Sullivan, USNR, VRU 1-4, Orono, Maine; and LCDR Edward D. Emerson, USNR, VRU 1-3, Amherst, Mass.

Radio Interview

On a recent radio program sponsored by the American Chemical Society over Station WMDN, LTJG Donald D. McCollister, USNR, Commanding Officer of VRR Unit 9-15, Midland, Mich., was interviewed by ENS Thomas E. Werkema, USNR, a member of the Steering Committee of the unit. Both are members of the ACS Society. LT McCollister answered questions on ONR and the Research Reserve Program.

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Research Reserve Unit W-5 Activated

The Commandant, Potomac River Naval Command, has authorized the activation of Volunteer Research Reserve Unit W-5 (Bio-Sciences) as a component of Battalion W-1 of the Volunteer Research Reserve. The formal activation ceremony for Research Reserve Unit W-5 was held on Thursday, March 9, 1950, at the Officers Mess, National Naval Medical Center, Bethesda, Md.

CAPT C. W. Shilling, MC, USN, Deputy for Bio-Sciences, Office of Naval Research, was the principal speaker. He described the organization and operation of the Office of Naval Research and the purposes of peacetime training under the Naval Research Reserve program.

Among the invited guests, Navy and civilian, were: RADM T. A. Solberg, Chief of Naval Research; RADM Lamont Pugh, MC, Deputy and Assistant Chief of the Bureau of Medicine and Surgery; RADM George W. Calver (Ret.)(Capitol physician); CAPT W. L. Gates, Volunteer Reserve Program Officer, Potomac River Naval Command; CAPT A. R. Behneke, MC, Executive Officer, Naval Medical Research Institute; CAPT C. C. Shaw, MC, Research Division, BuMed; Dr. H. T. Karsner, Medical Research Advisor to the Surgeon General of the Navy. CDR Barry King, MSC, USNR, is the Commanding Officer of the new Research Reserve Unit W-5.

Admiral Pugh spoke to the group and paid a tribute to the Reserve component of the Navy, emphasizing its importance and observing the major role played by Reserves in the late war.

Research Reserve Unit W-5 is one of 85 ONR research units that have been established throughout the United States. The new unit has an enrollment of 30 members all of whom are Naval reserve officers now returned to civilian life.

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The Inside Story on Training Duty

by
LT Olen A. Nance, USNR

If you are curious about the functions of the peacetime Navy, the operation of the Volunteer Research Reserve, the progress of ONR, or even about the customary hubbub of Washington, here is a "first endorsement" of training duty.

In order to present a picture of the pleasant and profitable duty awaiting the Reservist with a sincere interest in ONR and its program, let me give you a first-hand account of my own experiences during two weeks in the ONR Research Reserve office.

When I arrived, quarters were available upon presentation of orders at the B.O.Q. in Anacostia, and it was possible to get "squared away" and begin work on Monday. The quarters are comfortable and there are several lounges in the building equipped with all of the usual conveniences, including television. The B.O.Q. is 20 to 30 minutes from the ONR offices by bus depending on the rush hour traffic, but the parking problem is acute in the neighborhood of any government office building, and it requires at least that long to travel to and from work in your own automobile. Laundry service, at present, requires three days but there is also a special, 24-hour service available. I have mentioned this because there is some change in these conditions from time to time and the rest of the procedure of establishing oneself in Washington is covered clearly in a briefing letter from the Research Reserve office.

Duty effectively begins with a conference with the Director of Research Reserve and the Training Officer. I, like other trainees, was offered an opportunity to find the most suitable schedule of activities consistent with the program currently in progress.

The directors of the divisions of the Office of Naval Research have prepared a series of memoranda which have been distributed to VRR units and these, together with the Quarterly Project Summary, provide an excellent overall picture of the research activities of the Navy.

I was able to obtain a number of items of valuable information as well as a conviction that the VRR program and ONR should have valuable correlative functions. Conferences were held with Dr. Ralph Roberts and Mr. Leo A. Shinn of the Chemistry Branch and with Dr. Elliott Montroll, Dr. Frank B. Isakson, and several other members of the Physics Branch. Without exception, they were cordial and cooperative and were happy to make all possible unclassified information available to trainees.

I was particularly interested in spectroscopy and instrumentation. Reading and the conferences at ONR naturally led to visits with Dr. Donald C. Smith and Mr. Lester W. Daasch of the Naval Research Laboratory. Dr. Smith took me to the Crystal Branch of the Metallurgy Division to see the apparatus for growing and working crystalline materials of optical interest. Dr. Paul Egli and the group there are an excellent example of the enthusiasm one may expect to encounter. As a matter of fact, every visit I made was so interesting that my schedule

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was thrown somewhat out of its original plan. One of the crystals grown at NRL was that of titanium dioxide (rutile), a material which has created great interest because its refractive index is higher than that of a diamond, hence yielding very brilliant gems. The disadvantage of the material lies in the fact that it is softer than a diamond and subject to wear; it is also somewhat difficult to have synthetic gem stones processed by jewel cutters.

In general, the trainee is welcome at institutions which have a regular training program or in the administrative sections of those activities, but one should, of course, remember that the results of the visit should justify the interruption of the work of the activity. The VRR office will arrange an appropriate number of contacts and the individual trainee should not attempt to make individual arrangements without prior advice from one of the administrative officers. On that basis, my own trips and contacts were very profitable.

An off-duty activity that had enthusiastic support was the customary "shop talk" session. Almost every night found several groups in the lounge and quarters comparing notes or digressing into traditional topics of conversation. Groups with which I was associated included: LT C. G. Templeton, chemistry, University of Michigan; LTJG A. R. Thomson, fluid mechanics, Michigan; LCDR E. D. Harrison, mechanical engineering, Virginia Polytechnic Institute; LTJG F. F. Stecker, mechanical engineering, Iowa State University; LT B. C. Horne, mathematics, V.P.I.; LTJG A. N. Smolelis, microbiology, Purdue University; LT C. C. Ijams, physics, Memphis State College. From my own experience, contacts of this type are among the major advantages of training duty, not only for the exchange of information but for the growth of mutual interests in Naval research as well as in the scientific specialties.

One afternoon was spent at the Bureau of Standards. I talked with Dr. E. R. Smith of the physical chemistry section, with Dr. M. M. Davis who was working on an oscillator-titrimeter, and with Dr. William S. Meggers and Mrs. Charlotte M. Sitterly of the spectroscopy section. The spectroscopy section has released a volume of atomic energy levels wherein the information available on atomic spectra from hydrogen through vanadium is collected and summarized. The present volume is the first of a series which will be completed and maintained as a reference library on this material.

A "must" for the training period is attendance at one of the meetings of the Washington Research Reserve units; our choice was a meeting of W-1. The meeting opened with introductory remarks and announcements by the C.O. CDR W. M. Richardson, USNR, and the introduction of the speaker, Dr. R. D. Reid of the microbiology branch of the Office of Naval Research. Dr. Reid spoke on the general aspects of biological warfare and the contribution that information gained during the period 1917 to date has made in meeting the public health problem. A movie on a modern laboratory devoted to medical research was shown. Our group enjoyed the meeting immensely.

At this point in my writing, it is time to begin the checkout period, and the brevity of two weeks becomes apparent. I would like to express my appreciation to the entire staff of Research Reserve, who invariably found time to aid and encourage the efforts of all of the trainees. LTJG T. E. Hargett deserves special mention because of the pleasant relationship with the Military Personnel Office, which was enjoyed by all of the transient officers.

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