● MARCH 1950

RESEARCH REVIEWS

- THE HUMAN CENTRIFUGE
- EARLY TREATMENT OF FROSTBITE
- ELECTRONS APLENTY
- A MIGHTY MITE
- COSMIC-RAY NEUTRONS
- ON THE NAVAL RESEARCH RESERVE

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

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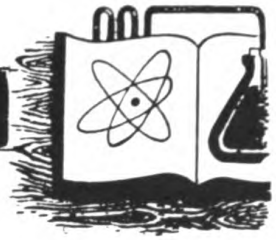
COVER PHOTO: Dr. A.A. Canfield, Jr., former research assistant on an ONR project at the University of Southern California, gives instructions to a subject participating in a perceptual speed test. This test is part of the research program conducted at the University of Southern California on the psychological effects of increased positive radial acceleration using THE HUMAN CENTRIFUGE. See story on page 1.

Approved by Bureau of the Budget, 13 April 1948.

RESEARCH REVIEWS

● Informs the Fleet of ONR-sponsored Research



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Editorial Notes

The value of basic research is constantly being challenged and defended. The efficacy of spending large amounts of money each year for pure research which does not primarily seek direct developments is often attacked. Its defense is this: Basic research provides the bottom layer of knowledge upon which all developments and applications are built. This month, we present the case for basic research by highlighting but a few of the many practical applications which have come out of ONR's basic research program. These applications, although developed during pursuit of a program of fundamental research, are nevertheless the natural outcome of this research.

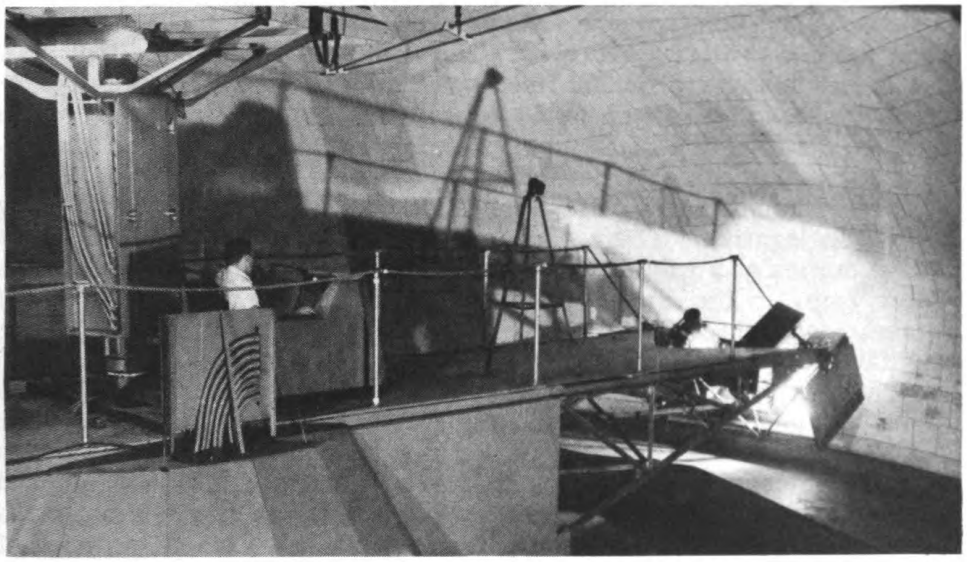
● Veterans of the Naval and other military services are being treated at various hospitals for traumatic injury by new surgical techniques developed through work carried out under ONR research contracts. One of these new procedures is the repair of injured blood vessels by grafting sections of bovine blood vessels preserved in formaldehyde. Another development in the surgical repair of trauma is of great value in the treatment of peripheral nerve injury. It has been found that residual stumps of nerves may be "stretched" to extend their length through an area where the innervation has been completely abolished by a severe shock such as that sustained from projectile or shrapnel injury. Previously, the gaining of innervation in these areas has had to await the slow regeneration of nerve which, if it occurred at all, required a matter of several years for completion.

● A Navy project with the Polaroid Corporation has developed a method of translating ultraviolet absorption, invisible light rays, into photographs, thus making it possible to make photomicrographs of biological specimens such as cancer cells.

● The Harvard Psycho-Acoustic Laboratory has developed a method for improving the intelligibility of voice communications under operating conditions of severe noise and static. The introduction of a series of filters and amplifiers into a radio circuit changes completely the sound of the human voice and at the same time makes it more easily understood. By peak clipping and reamplification of the auditory signal it has been possible to increase the intelligibility of radio voice communications by 20 percent.

● A field study of the probability of detection of visual targets conducted by the University of Michigan has verified laboratory data on the effect of atmospheric attenuation. Sufficient data have been collected to permit the preparation of a field manual for the prediction of ranges of detection of surface targets under various conditions of the atmosphere and for various times of day or night and positions of the sun or moon.

● Studies of the nutrition of disease organisms - "germs" - have developed what may provide a "magic bullet" with which disease germs can be destroyed without danger to the human host. The approach used is that of supplying a chemical substance similar in structure to a substance which the germ needs for its life and growth. In some cases the germ assimilates the unorthodox substance instead of the natural one. The unnatural chemical is known as a "biological antagonist." Studies of the antagonists have pointed the way to what may be a universal solution to problems of infectious disease.



The Human Centrifuge

by
A. A. Canfield, Jr.
Northwestern University

The pilot of modern high-speed aircraft is faced with many stress situations that were unknown to his predecessors. The vital problems of oxygen supply and temperature regulation for high altitude flights have been largely solved; booster mechanisms to aid the human maneuver the aircraft have been supplied; ejection seats have been developed to help the pilot escape from the aircraft at high speeds; the anti-g suit has aided the pilot to withstand those radial accelerative forces encountered in changes of direction of flight. However, a great deal of research is yet to be done in other areas.

It is the purpose of this brief paper to describe the research conducted on the psychological effects upon pilots of increased positive radial acceleration at the University of Southern California during the past two and one-half years, and to indicate present research plans. All of the research mentioned here has been conducted on the U. S. Navy human centrifuge located on the U. S. C. campus. The above picture of the human centrifuge shows the machine in operation at a comparatively low level of rotation speed. As the speed of the boom increases, the radial force applied becomes greater, and the cab in which the subject rides gradually assumes a position almost at right angles to the floor of the building, so that the subject is lying on his side.

Albert A. Canfield, Jr. received his B.S. degree in education from the University of Nebraska in 1942 and his M.A. and Ph.D. degrees in psychology from the University of Southern California. During the war he served two years in the Army Air Forces Psychology Program. Now an instructor in the Department of Psychology at Northwestern University, Dr. Canfield was for two and one-half years research assistant and research coordinator at the University of Southern California for the Office of Naval Research project described in this article.

Increased positive g is a term used to describe the accelerative force applied to the human body under specific conditions. Any body rotating in an orbit around a fixed point is under some degree of centrifugal force. This force tends to accelerate the body away from the center of rotation at a right angle to the tangent along the path of motion. For convenience, the accelerative force imposed is reported in multiples of the normal gravitational accelerative force of the earth. A 2g radial accelerative force would accelerate a free body away from its path of motion at a rate of 64.4 feet per second per second. Sometimes people refer to the normal resting condition as zero g. This is, of course, incorrect. All bodies on the face of the earth are subject to gravitational force. They are drawn toward the center of the earth with a force such that if they were free to move they would be accelerated toward the center of the earth at the rate of 32.2 feet per second per second. This normal gravitational force serves as the g unit used as the base for conversion of other accelerative forces. This unit is used in converting both the radial accelerative forces, as described, and the linear accelerative forces as experienced in sudden starts or stops of bodies. Catapult launchings are familiar examples of linear accelerative conditions. Aircraft crashes involve linear deceleration.

When an accelerative force is applied to the human body in the head to seat direction, such that the body tends to move in the direction the seat is from the head, it is called a positive g force. These forces imposed on the human result in a pooling of bodily fluids in the lower trunk and extremities. Forces applied in the opposite direction, seat to head, involve the pooling of fluids in exactly the opposite body sections and the engorging of the blood vessels in the head and upper trunk. When the forces are imposed at right angles to the long axis of the body they are termed transverse g forces. Catapult launchings of aircraft with the pilot in the seated position involve the application of transverse linear accelerative force.

Human tolerance to accelerative forces varies with a number of things. Tolerance to short applications of these forces is, comparatively, very high. Tolerance is lower when the environmental temperature is high than when it is low. Individuals differ markedly in their ability to withstand these forces. The direction of the application of the force is also an important variable. The tolerance to transverse g forces is much higher than that for positive g forces. The tolerance to positive g, similarly, is much higher than the tolerance to negative g. Recent experiments on the prone position for the pilot are directly related to this tolerance difference. At the present time, with the pilot in the familiar seated position, positive g forces are of greater concern than either of the other two, and all of the research reported here has dealt with these positive g forces.

The average blackout threshold for a relaxed subject undergoing increased positive radial acceleration is about 4.5g. Blackout, which usually develops between five and 10 seconds after the onset of the force, is a form of temporary blindness and does not involve unconsciousness. The intra-ocular pressure of the eye is a little higher than the pressure around it and offers greater impedance to the supply of blood to the retina. With continued cerebral blood lack, however, blackout may occur, although consciousness may be maintained. No ill effects have been determined following blackout or unconsciousness for

short periods and they are neither painful nor uncomfortable. The anti-g suit was designed to develop higher blood pressure and hence a longer continued ability to maintain an adequate blood supply to the head.

The orientation of the psychological studies undertaken at the University of Southern California has been toward the determination of the impairment of basic mental abilities (factor abilities), motor skills, and reaction times that might occur while undergoing these accelerative forces. Standard procedure has been to compare their performance at 1g and their performance during a 15-second exposure to higher g levels. In all of these studies conditions of blackout and unconsciousness had to be avoided, since the unconscious or temporarily blind human is quite obviously impaired in all of the aspects mentioned above. In order to subject experimental volunteers to moderate forces and to avoid the undesired blackout and unconscious conditions, the g-suit has been used in the major portion of the research described here.

The earliest studies were directed toward determining the maximum force applicable to an aircraft control stick under normal and increased positive g conditions. All four directions of movement were studied, i.e., fore, aft, left, and right. The results of these studies indicated that there was no simple linear relation between the g level encountered and the force applied to the control column. The effects of the increased accelerative force also varied considerably from one direction of movement to another. Generally, subjects were able to exert greater forces in the left and right directions under the 5g condition than they were at the resting condition. Very little change was found for movements in the forward direction, while significant decreases were found for movements aft. Since the aft movement is the one required in recovering from dives, these results have led to the suggestion that high-speed aircraft should be provided with powerful booster systems to aid the pilot move the stick in those conditions where the most severe g forces, of any appreciable duration, are encountered.

Subsequent studies were concerned with the human factor abilities of spatial orientation and perceptual speed. Spatial orientation deals with the ability to determine the position of objects in space in reference to the observer. Perceptual speed tests determine the person's ability to note minor differences in the detail of objects quickly and accurately. The cover photo shows a subject seated in the centrifuge cab being given the instructions for performing the perceptual speed test. The black box mounted on the cab was the exposure device. A half-silvered mirror on the front made it impossible for the subject to see the items on the inside until the lights on the interior of the box were turned on. Rigidly controlled exposure times could then be attained.

The studies conducted indicated that both of these abilities are apparently unimpaired as long as the human maintains vision. This means that the pilot still possesses those mental abilities up to the point of blackout. These results showed that little concern need be given these aspects of the accelerative situation, and research therefore turned to studies of reaction time.

These studies dealt with the reaction times of subjects undergoing radial accelerative forces. In the first of these experiments subjects' reaction times to simple light and sound signals were obtained for various conditions of accelerative force. In this study it was found that the reaction time to these simple signals increased as the imposed force increased. The reaction times to both light and sound were significantly

longer at 5g than they were at 1g. The reaction time to sound, however, was significantly shorter than that to light at all g levels. This led to the suggestion that emergency signal devices be given the pilot through auditory channels rather than visual ones because he could react to them more rapidly. Also, since the condition of blackout involves the loss of vision but not audition, the use of auditory signals would obviate this temporary disability of the pilot under conditions of blackout.

The second set of experiments on reaction time involved a more complex type of response. First the subject had to interpret a simple set of visual signals and then respond to them. In this case it was found that the reaction times did not differ significantly from one g level condition to another. This apparent contradiction in results between the first and second study was tentatively interpreted as being due to increased motivation and attention in the more complex task. That is to say, the subjects in the more complex task could compensate for the slight decrement in efficiency that is supposed to have occurred. By paying closer attention to the complex signal pattern at the increased g levels and trying more diligently to make rapid responses, compensation not possible with the simpler responses could occur.

An entirely different type of problem has recently been studied on the centrifuge. The intent of the study was to determine what changes in the ability to make reaching movements with the hand and arm might be associated with these accelerative forces. Subjects made reaching movements to a target located at almost arm's length away from them. The target was placed in four different positions in front of them, to the right, left, above, and below their shoulder level. The results of this study indicated quite clearly that these movements are slower and less accurate under conditions of increased radial acceleration than they are at normal conditions. However, movements made to the same side of the body as the preferred hand and those movements made downward (in line with the applied accelerative force) were generally much less impaired than either of the other two directions of movement. In general, all movements tended to fall short of, and below the intended terminal point. It has been recommended that emergency controls be located below the pilot's shoulder level, fairly close to the normal position of the hands, and on the side of the preferred hand. In view of the changes found in the accuracy of the movement, the size of the control should be quite large.

Current research is being directed at the relationship between exposure to these accelerative forces and pilot fatigue. The general approach has been to give the subject a series of tests, then submit him to a rather extended period of exposure on the centrifuge, and then obtain the tests scores again after the experience. These pre- and post-exposure scores will be compared with another group of persons who spend the same amount of time in similar activity on the centrifuge, but without being subject to the accelerative forces. The tasks being used in an effort to detect these changes that might be called fatigue are such tests as color naming, speed of computation, tendencies to make certain types of perceptual groupings, level-of-aspiration changes in view of experimenter-produced frustrations, and changes in attention to detail as in a letter-cancellation test. This research has not progressed far enough to make any general or tentative statements about what results might be forthcoming.

Early Treatment Of Frostbite

by
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Indiana University School of Medicine

It is a popular home-remedy idea that the frostbitten limb should be treated by rubbing it in snow. It has also been fairly generally accepted by the medical profession that the frozen part should be thawed slowly. Some scientific basis for this concept was furnished about 30 years ago by the observations of Lake. Working with tissue cultures, he noticed that cells froze and were destroyed at temperatures below -5°C. This type of injury he termed true frostbite and assigned to it a hopeless prognosis incapable of being altered by any kind of treatment. He further observed that cultures of tissues survived for a longer period when exposed to temperatures ranging between -5° and 5°C than at any other temperature below 15°C. This observation was interpreted as indicating that in this temperature range the metabolic processes in the cells were almost completely inhibited. He felt that the gangrene which follows frostbite, less severe than that associated with irreparable damage to cells, was due to vascular stasis resulting from the edema or swelling which develops when the arteries, intensely constricted during the exposure to cold, relax and deliver blood at high pressure to the capillaries. From these beliefs it was natural that Lake should have felt that all cases of frostbite should be treated by slow thawing, and that if the part were allowed to thaw more rapidly, every effort should be made to maintain some constriction of the blood vessels, for example, by administration of such agents as strychnine or ergot.

Further support of this general method of treatment came from the observations of such men as Greene. To be sure, Greene saw no constant relationship between the degree of edema and the subsequent death of tissue. In the development of gangrene he emphasized the importance of the inadequacy of oxygenation of tissues resulting from the silting out of the red blood cells in the blood vessels. He felt that Lake's explanation was essentially true in cases of frostbite not sufficiently severe to produce such occlusion of blood vessels. Consequently he, too, advised that the frostbitten limb be kept in an atmospheric temperature of from 2° to 5°C in an effort to save the less severely damaged parts. He thought that such treatment might depress the metabolic processes sufficiently to be more nearly compatible with the blood supply and that it would serve the additional useful purpose of maintaining some constriction of the blood vessels and hence decrease the formation of edema.

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Upon careful scrutiny it is rather surprising that these ideas were not challenged earlier and more vigorously. We often see massive edema in other conditions without the occurrence of gangrene. Limbs may become enormously swollen in cases of heart failure, kidney disease, following occulsion of the veins by clotting, and in conditions of chronic lymphatic obstruction. In none of these conditions does edema of itself cause gangrene. It would obviously be desirable to keep tissue metabolism low when the circulation to a part is reduced to a dangerously low level. We well know, however, that local cooling brings about a reduction in blood flow as well as in tissue metabolism. Whenever a part is cooled there is no means of controlling the relative diminution of metabolic rate on the one hand and of circulation on the other. Obviously only harm would result if cooling should keep the blood flow depressed proportionately more than the metabolic needs of the tissues. Furthermore we know that when blood is chilled sufficiently there is impairment of release of oxygen from the hemoglobin to the tissues.

No one had tried to test the validity of these concepts experimentally and the proper interpretation of clinical results was necessarily difficult because of the difficulty of adequately controlling the extent of the injury. Of the clinical observations which are pertinent, those made during the last war by Davis and his associates seem to me especially significant. In a few instances they treated extremities injured by high-altitude frostbite by prolonged chilling while other limbs similarly injured were treated by exposure of the part to room temperature. They concluded that the results obtained with the second method were as good or better than those obtained with the first. Furthermore, in cases of high-altitude frostbite they observed that (1) the extremities tended to be wet and edematous when there was much damage to the endothelium of capillaries and little arteriolar thrombosis, and (2) that they tended to be dry without edema or vesiculation when considerable vascular thrombosis occurred. Cases of the first kind sustained little or no loss of tissue while those of the second type underwent mummification and eventual loss of tissue in those areas deprived of circulation.

One of the first problems undertaken by my associates and me was an experimental evaluation of prolonged local chilling of the frozen part. It was found that mice could be kept in good health for several days in cylindrical wire cages with the tail in a test tube bathed by a water bath (Figure 1). When the distal six cm of the tail was subjected to a standard cold injury by freezing it for a given period of time in a mixture of ether and carbon dioxide snow kept at -15°C, maintenance of the tail in an environmental temperature of from 1° to 3°C for 72 hours did not decrease the loss of tissue as compared with untreated control animals. Indeed the loss of tissue was definitely greater. The mean loss of tissue was increased from 1.76 cm to 3.7 cm and in no animal was as little as one cm of the tail lost. In contrast, five percent of the untreated mice sustained no loss of tissue and in nearly 30 percent one cm or less was lost. The confinement of the mice was not a factor in the unfavorable response as was indicated by the fact that other animals similarly treated but with maintenance of the water bath at 20° C did somewhat better. The mean loss of tissue was 2.3 cm and about 10 percent had loss of one cm or less. Furthermore, when the frozen tail was thawed rapidly by immersion in water at 42°C and then kept for three days in the same apparatus but with the bath maintained at 40°C, the results were decidedly better than in the untreated group. The mean loss of tissue was

1.4 cm, nearly 30 percent lost no tissue, and about 65 percent lost one cm or less. These experiments appeared convincing that slow thawing and prolonged cooling were not only not helpful but were apparently actually harmful. They made it seem more profitable to pursue other experiments designed to test the worth of measures altogether different—rapid thawing, the production of vasodilatation, the use of anticoagulants, the use of rutin and benadryl. Some limited evaluation of most of these measures had been made in our own preliminary studies and by others. It was our hope that the possible clinical significance of any benefit of treatment might be increased if similar results should be found to obtain in a number of different species and in the treatment of cold injuries to parts varying widely in vascularity and in relative proportion of skin and muscle mass.

Harkins and Harman concluded from their study of rapid thawing of the frozen legs of dogs and ears of rabbits that the method did not increase the damage to tissues. Ariev, and later Crismon and Fuhrman, found rapid thawing effective in minimizing tissue loss after freezing the ears and feet of rabbits. My associates and I have now tested this method with frostbite of the tails and feet of mice, tails and feet of rats, feet and ears of rabbits, and the feet of dogs. The results were excellent. For example, every untreated rabbit's foot developed extensive gangrene while nearly half the treated animals sustained no loss of tissue and in none was the loss of tissue more extensive than gangrene of toes. Similarly no untreated mouse's foot escaped without loss of tissue and in only 5.6 percent was the gangrene limited to toes. In contrast, half the treated group lost no tissue at all and in 76 percent either no gangrene occurred or gangrene was limited to toes.

The ideal temperature for rapidly thawing the frozen part is 42° C or in that vicinity. When the frozen mouse's tail was thawed at 38 °C the results were not as good, though better than those in untreated animals; when 50 °C was used the results were no better than in untreated controls. When the frozen tails of mice and rats were allowed to thaw at room temperature and were then bathed in water of 42° C, the results were no better than in untreated controls. Apparently the transient use of local warmth is effective only as an agent to induce rapid thawing of the frozen part. Apparently, too, the ideal temperature for such rapid thawing is one slightly higher than body temperature.

In 1944, Bramble and Loker had used the anticoagulant agent, dicumeral, along with other therapeutic measures in treating a patient in whom incipient gangrene of toes had developed following frostbite.

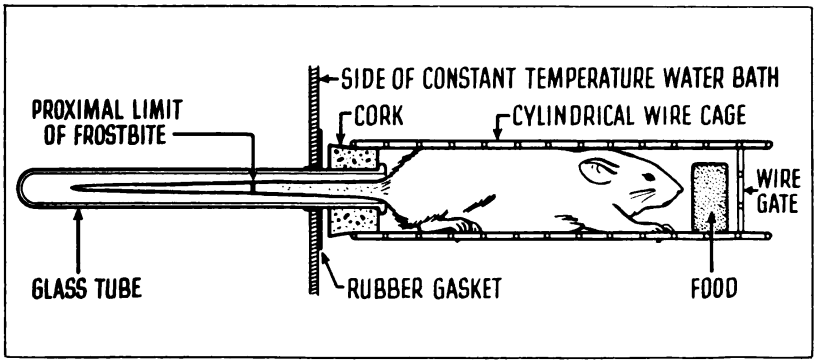

Figure 1. Apparatus used for the direct application of heat or cold to the frostbitten tail of the mouse.

They felt that the anticoagulant therapy might have been responsible for the good result obtained and suggested study of its possible usefulness in other cases of frostbite. In 1945, Lange and his associates reported studies in frostbitten rabbits which were convincing of dramatic efficacy of the anticoagulant, heparin, in the prevention of gangrene and subsequently they reported similarly brilliant results in experimental contact frostbite in human volunteers. No one, however, has subsequently obtained such brilliant results. Indeed, Fuhrman and Crismon did not find heparin effective in diminishing gangrene in the frozen feet of rabbits, nor did Quintanilla and his co-workers find heparin of value in their studies upon the frostbitten rabbit's ear.

In our early experiments we failed to achieve as good results as Lange had reported even though we froze a smaller area of the rabbit's extremity, subjected it to less intense cold and for shorter periods, and used more heparin. Nevertheless, some efficacy of the method was evident. For example, whether the foot was frozen for 10, 30 or 60 minutes, all the untreated animals developed extensive gangrene. With adequate heparinization 40 percent of the first group had no loss of tissue and 50 percent either no loss or only gangrene of toes. These figures were eight and 25 percent in the second group and 18 and 27 percent in the third. In later studies of frostbite of the mouse's tail we found that heparinization decreased the mean loss of tissue from 1.76 to 0.7 cm; the percent surviving with no loss of tissue increased from five to 39 and the percent sustaining no loss of tissue or less than one cm increased from 27 to 72. In frostbite of the rat's tail, heparinization decreased the mean loss from 3.6 to 2.2 cm, the percent recovering with no loss of tissue from nine to 18 and that of those sustaining no loss of tissue or less than one cm from 14 to 28. These changes are not of definite statistical significance. In the rat's foot, a significant increase in the percent sustaining no loss of tissue was noted, zero to 18. No increase in the percent surviving with no gangrene or gangrene limited to toes was noted, the figures being 50 and 58 percent in the two groups. When heparinization in the rat was delayed until three hours after freezing, no significant effect was noted in minimizing loss of tissue in the tail or foot.

A small number of human cases of frostbite have been treated by anesthetizing or operatively resecting the sympathetic nerves. Such procedures produce local dilatation of blood vessels. The results in these cases in general were felt to be good, contrary to the point of view presented in the beginning of this discussion. Nevertheless, most of these cases were treated relatively late in the course of the frostbite when gangrene had developed or definitely been averted. It seemed important to us to investigate the possible usefulness of such methods in controlled animal experiments. Two methods were used, operative removal of the sympathetic nerves, and the administration of tetraethyl ammonium chloride, a drug which tends to block the sympathetic nerves throughout the body and to produce some vasodilatation though not to such an extent as is produced by sympathectomy.

In mice with frozen tails, tetraethyl ammonium chloride did not decrease the mean loss of tissue but did increase the percent surviving with no loss of tissue from five to 30 and that of those sustaining no loss of tissue or less than one cm loss from 29 to 70. Administration of the drug did not improve the results in rabbits with frozen ears but did lessen the extent of damage after frostbite of the rat's tail and foot. The percentage of rats, for example, which sustained no loss of tissue

was increased from zero to 11, and that of those with no gangrene or gangrene limited to toes from 50 to 93.5. Treatment seemed efficacious when begun an hour after freezing.

Sympathectomy performed either beforehand or immediately after freezing did not alter the outcome in frostbite of the rabbit's ear. When sympathectomy was performed after freezing, the extent of damage in the dog's foot was decreased. The percent which survived without any loss of tissue rose from 15 to 35 while the percent with no loss or gangrene limited to toes rose from 20 to 45. If the few animals in which no gangrene developed in either the control or the sympathetically denervated foot are eliminated from consideration, the percent increased from zero to 23 and from six to 35; these results are statistically significant.

Fuhrman and Crismon recently reported that the development of gangrene was favorably influenced in a few rabbits given rutin before and after experimental frostbite, and in a few given rutin after experimental frostbite. The precise mode of action of rutin is not completely understood, but it is clear that it has some influence upon capillaries. In certain conditions in which the capillaries are abnormally fragile, rutin apparently decreases their fragility and diminishes the tendency to bleeding. In large numbers of experimental animals we have found this agent to have a variable influence upon the tissue damage resulting from frostbite. In the mouse it diminished remarkably the gangrene following frostbite of the foot, but had no significant effect upon frostbite of the tail. In the rat it did influence favorably frostbite of the tail. In rabbits no effect upon the outcome of frozen feet was noted but tissue damage after frostbite of the ear was significantly diminished. In frostbite of the mouse's foot, the drug was effective when treatment was delayed until three hours after freezing.

Macht and his associates recently reported that the histamine antagonists, benadryl and pyribenzamine, lessened the edema which developed after mild contact frostbite in human volunteers. Histamine is thought to be released locally in frostbite as in other conditions of tissue injury. Among other effects, histamine produces dilatation of capillaries. The histamine antagonists have a variable effect in counteracting the action of histamine. In our experiments, benadryl was found to have no favorable effect upon frostbite of the mouse's tail. It did, however, influence very favorably the results of frostbite in the mouse's foot. In rats, the drug decreased remarkably the damage following frostbite of the tail.

Fuhrman and Crismon reported that plaster casts and other pressure dressings altered favorably the outcome in rabbits with frozen feet. In our experiments, plaster casts proved of no aid whatsoever in preventing gangrene after frostbite of the rat's and the mouse's foot.

There is no experimental basis for the assumption that slow thawing is effective in diminishing tissue damage after frostbite, nor that vasoconstriction should be encouraged and vasodilatation avoided. Rapid thawing of the frozen part is remarkably effective. The production of vasodilatation, the use of anticoagulant agents, rutin and benadryl, though yielding more variable results, seem to be of some benefit; they never appear to be harmful. Since these possible therapeutic measures have now been studied in a number of different animals and in frostbite to parts differing widely in vascularity and tissue structure, it would seem justifiable to study cautiously their effect in cases of human frostbite.

Electrons Aplenty

by

Albert S. Eisenstein
University of Missouri

The oxide cathode, to an average layman, is the thing that in a radio tube "lights up" or "burns out," but to the electronics specialist it is the source of a copious supply of electrons and is thus the "heart" of most electronic devices. At the normal operating temperature of the oxide cathode (a dull red), this source provides a billion times as many electrons as are emitted by a typical metal like tungsten. Only when tungsten is heated to near its melting point (a dazzling white), are electrons emitted in an equal profusion. The oxide cathode stands head and shoulders above other materials as an efficient source of electrons.

Except for mechanical breakage, failure of nearly all electron tubes, and thus the equipment depending on them, can be attributed to the oxide cathode. Low cathode emission and excessive grid emission in radio tubes, reduced phosphor efficiency in cathode ray tube screens and fluorescent bulbs, and gas clean-up in hydrogen filled thyratrons are all traceable to a misbehaving oxide cathode. Although oxide cathode technologists are concerned primarily with securing increased electron emission for longer cathode life, particular applications often impose unusual conditions for which special cathodes are required. Back bombardment by electrons in magnetron operation and ion bombardment in gas discharge tubes are examples of this. Problems arising in the improvement and development of oxide cathodes are of considerable interest in the fields of both fundamental and applied electronics research. Although the oxide cathode was discovered some 45 years ago, our present day understanding of the emission mechanism is far from complete. By following a set of "cookbook" techniques, this type of cathode can be made reproducibly and as such has reached a fairly high degree of perfection. However, it is generally recognized that further advances in the art of cathode making will come only through a more complete knowledge of the cathode itself.

As the name implies, compounds in the form of oxides comprise the chief constituents of the cathode; they are barium oxide, strontium oxide, and sometimes calcium oxide. Of the many thousands of compounds tested only these three have been found to be efficient electron emitters. Since these oxides are chemically unstable in air, they must be formed in vacuum in the electron tube by heating the respective carbonates. This conversion of the carbonates to the oxides is one of the

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Albert S. Eisenstein received his Ph.D. in Physics from the University of Missouri in 1942. He was staff member at the Massachusetts Institute of Technology Radiation Laboratory until 1945. Dr. Eisenstein held a Frank B. Jewett research fellowship for one year at M. I. T., where he was also a research associate at the Research Laboratory for Electronics. He returned to the University of Missouri in 1947 as associate professor of physics.

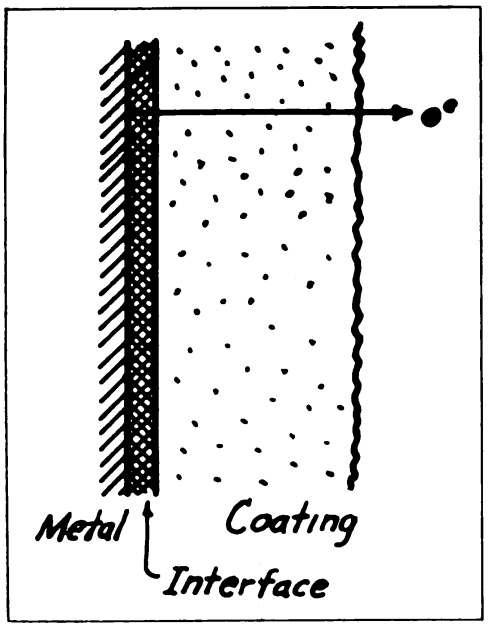

Figure 1. A conception of the physical structure of the oxide cathode. Impurities in the base metal react chemically with the oxide coating, forming an interface compound.

major steps carried out in the processing of the electron tube. The finished cathode consists then of a thin layer of oxide, about 5/1000 of an inch thick, covering a base metal support which is usually nickel. Only within the past decade was it suspected that this simple two-component system, the oxide coating and the base metal, was actually considerably more complex. Five tools of modern science have been used to examine in detail the physical structure of the cathode. The spectroscope serves to identify foreign atoms which are present in the oxide coating and base metal, often as an unsuspected impurity. X-ray diffraction techniques, although less sensitive for the detection of minute traces of impurity, provide information not only about the foreign atoms present but also about compounds of these. Changes which occur in the oxide coating composition and thickness can be studied using this technique. Electron diffraction methods allow a detailed analysis of the emitting surface layer of the coating which results in information concerning the composition of the topmost 20 atom layers. Electron microscope emission pictures of the cathode show that all points on the surface do not emit electrons with the same proficiency. Mass spectroscopy studies indicate that atoms and ions, both positive and negative, are emitted from the cathode along with electrons.

Combining the results of these and many other investigations, the following sort of physical structure for the oxide cathode emerges. Reducing impurities present in the base metal, such as silicon, aluminum, or titanium, react chemically with the oxide coating forming an interface layer sandwiched between the metal and the coating (see Figure 1). This interface compound may be barium silicate, barium aluminate, barium titanate, or others, depending upon what impurities were initially present in the base metal. The thickness of this interface layer increases with time and may easily become one-fifth as thick as the coating. Due to the more rapid evaporation of barium and barium oxide from the coating than strontium and strontium oxide, the external surface of the cathode rapidly becomes more deficient in barium than the underlying bulk of the coating thus causing the formation of nearly pure strontium oxide surface layers. The original two-component "simple" cathode has now become a "complex" system of at least four components all of which must be considered, since an electron emitted from the surface of the cathode must traverse the base metal, the interface, the barium-strontium oxide bulk, and the pure strontium oxide surface layers.

A considerable portion of current research activities on oxide cathodes is directed toward an understanding of the role played by each

of these components of the cathode. The base metal serving both as a mechanical support and as the electrical connection to the cathode, acts also as a reservoir for the reducing elements which react chemically with the coating to form the interface. Studies are being carried out at the University of Missouri to evaluate the effect of different reducing elements and their concentration on the type of interface formed and the rate at which its thickness grows. Some interfaces are formed during the initial processing of the tube and change little in thickness during the normal life of the cathode. Other interfaces grow with increasing life of the tube and may alter its operating characteristics. Two examples of this have been established. When an interface forms due to the presence of silicon in the base metal, the electron current which can be drawn from the cathode in short pulses is seriously limited. Due to the high electrical resistance of the interface cathode, "sparking" occurs when high peak currents are drawn. Cathodes made on pure nickel have no interface and may not "spark" until over 100 amperes/cm^2 are drawn, but silicate interface cathodes pass only 20A/cm^2 before "sparking" limits the emission. This problem is particularly serious in magnetrons and other pulsed tubes containing oxide cathodes. The second example concerns the effect of the interface on the amplification obtainable in receiver type tubes. When the interface develops, it behaves as a parallel resistance and capacitance in the cathode lead causing the amplification obtainable from the tube to decrease with decreasing frequency and with increasing tube life. The same mechanism causes the plate current passed by the tube to decrease during the first few microseconds of pulsed operation and thus to fail to faithfully reproduce signals applied to the grid. An obvious solution to these problems is the elimination of silicon from the base metal, but it is not quite as simple as that. The silicon was introduced intentionally since the chemical reaction producing the interface also releases barium, considered essential for easy processing of the oxide coating. The detailed study of these chemical reactions, the growth of interface thickness and the electrical properties of the interface formed are problems of both academic and applied interest.

No theory yet proposed adequately accounts for all of the observed electronic properties of the oxide coating. For example, a theory dealing with the thermionic emission of electrons from the oxide cathode should also be able to predict certain features of the photoelectric emission and electrical conductivity—for these are closely related phenomena. Two current theories consider the coating to be: (1) an electronic semi-conductor through which electrons may flow and eventually be emitted from the external surface; and (2) a porous structure of loosely packed crystals each capable of emitting electrons, but with such a high internal resistance that the electrons prefer to pass between the crystals in an electron gas. Although the working models which these theories propose are quite different, both have very similar electronic properties. Experiments have been conducted to test the two models but the results obtained have never been decisive. It seems unlikely that studies of thermionic emission only will point to the correct mechanism of oxide cathode operation. However a comprehensive examination of many properties of the cathode may yield conclusive evidence for one all-inclusive theory. Only when this is achieved will the making of oxide cathodes have completely emerged from the "cookbook" stage. It is hoped that the results obtained from experiments at the University of Missouri and from other research laboratories will enable oxide cathodes always to provide electrons aplenty.

Cosmic-Ray Neutrons

by
C. G. Montgomery
Sloane Physics Laboratory
Yale University

One of the reasons why the study of cosmic rays is valuable is that it leads to a better understanding of the forces which hold the nuclei of atoms together. Atoms are composed of three entities: electrons, protons, and neutrons. Most of the volume of an atom is occupied by the electrons which move rapidly in a complicated manner. At the center of the electronic cloud is the very dense core, or nucleus, of the atom. Here the protons and neutrons are bound tightly together by the strong forces which are characteristic of nuclear matter. A measure of the strength of these forces is the energy which must be supplied to remove one of the neutrons or protons from the nucleus—the "binding" energy. Roughly this energy is eight million electron volts, expressed in the units convenient for atomic or nuclear processes. On the other hand, only about one millionth part of this energy is required to remove an electron from the atom.

To study the structure of atomic nuclei, it is necessary to reach into the nucleus with test particles that have energies of the same order as the binding energy. These test particles may be electrons or gamma rays, but more often they are nuclei of simple atoms: the proton, which is the nucleus of ordinary hydrogen; the deuteron, the heavy hydrogen nucleus which consists of one neutron and one proton; or the alpha particle, the nucleus of helium. These particle "probes" must be accelerated and, in the laboratory, cyclotrons, synchrotrons, and other devices are used for this purpose.

The cosmic radiation, however, is a natural source of high-energy particles of all kinds. Although these particles are fewer in number than those produced by man-made machines, the energies of cosmic-ray particles, and of the secondary particles that the cosmic rays produce, cover a much wider range. There are some which cover the same energy range as cyclotron particles, but there are also others with energies far in excess of any artificially accelerated particles. At the Radiation Laboratory of the University of California, alpha particles of nearly 400 million electron volts have been produced; in the cosmic rays there are particles with energies of a million times this value and more. Nature, however, makes it difficult for the nuclear physicist, because the higher the energy, the fewer cosmic-ray particles there

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C. G. Montgomery, associate professor of physics at Yale University, received his B.S. and M.S. degrees from California Institute of Technology in 1927 and 1928 respectively, and his Ph.D. degree from Yale in 1930. Before joining the faculty at Yale in 1941, he was engaged in cosmic-ray research at the Bartol Research Foundation of the Franklin Institute. During the war he was engaged in microwave research at the Radiation Laboratory at M.I.T. Currently he is directing cosmic-ray work under an ONR contract at Yale.

are to be found. Moreover, the beam of cosmic rays cannot be controlled, and those who wish to use cosmic rays to study the nucleus must travel to high mountain altitudes, fly in airplanes, and even send balloons and rockets to the top of the earth's atmosphere to find these rare but energetic particles.

When a particle moving with high energy strikes the stationary nucleus of an atom, its energy is transferred to the stationary nucleus, causing its particles to fly apart. The neutrons and protons act in much the same way as a group of billiard balls broken up by the fast-moving cue ball. Thus, when a heavy cosmic-ray particle strikes the nucleus of an air atom, the nucleus is torn apart and many neutrons and protons are set free. These collisions are, of course, not exactly like those of billiard balls: a high-energy neutron may go right through the stationary nucleus without effect, or, more spectacularly, new and different particles may be created in the collision. The details of all these processes are many and complex, and we are only beginning to understand the mechanisms involved.

What happens, though, to the nuclear fragments produced in these processes? The pieces collide with other atoms, producing still more fragments if their energy is high enough, or simply losing energy and slowing down gradually until their speed is reduced to values near the speeds of air molecules executing the usual thermal motions. The protons find electrons and pair together to form hydrogen atoms and molecules. The slow neutrons are captured by nitrogen nuclei of the air, a proton is emitted, and the nitrogen atom becomes an atom of radioactive carbon. Thus, the net effect of nuclear disintegrations of this sort produced by cosmic rays is to change the chemical composition of the earth's atmosphere. This is an unimportant process, however, since the radioactive carbon eventually changes back into nitrogen, and the hydrogen and other nuclei are formed in altogether negligible amounts.

The cosmic-ray group at Yale, working under the Joint Research Program of the Office of Naval Research and the Atomic Energy Commission, have recently measured the rate of production of neutrons in several substances at sea level and at an altitude of 11,500 feet in Climax, Colo. The technique employed was similar to that used for the production of plutonium. To slow down the neutrons, a "pile" was constructed of paraffine blocks, and of blocks of the substance in which the neutron production is to be measured. A detector for slow neutrons was placed at the center of the "pile." Cosmic-ray particles strike this "pile" and nuclear reactions with the emission of neutrons occur. These neutrons are slowed down by the paraffine and are measured in the detector. For example, it was found that for every thousand cosmic rays passing through a centimeter of lead, three neutrons are produced at sea level. At high elevations, many more neutrons are produced.

Although the energies of the individual particles involved in these phenomena are extremely high, their incidence is comparatively rare so that the total energy involved is negligibly small and such a "pile" is useful only in obtaining information about these particles and the nuclear reactions which they cause. Information of this kind, although apparently not directly connected with practical matters, should aid materially in our understanding of the nucleus. As this understanding increases more useful and efficient applications of nuclear energy as a source of power can be developed.

A Mighty Mite

by
Louis J. Lipovsky
University of Kansas

What are chiggers? Chiggers are tiny mites, often called redbugs, which cause viciously itching bites much more painful and persistent than those of mosquitoes. They belong to the family Trombiculidae and are related to ticks but are much more like spiders than they are true insects. In their six-legged larval stage, chiggers attack man and other vertebrates. Later in their nymphal and adult stages, they are eight-legged and non-parasitic; they are then free-living, soil-inhabiting creatures which prey upon small insects and their eggs, as well as on other minute invertebrate forms. In this eight-legged stage, chiggers are difficult to find in their natural habitat.

The larval chigger mites, however, are all too familiar to people of the South, the Atlantic states, the Midwest, and scattered areas elsewhere in the country. In the United States three species in particular cause much discomfort. The most common species are Eutrombicula alfreddugesi and E. splendens; the third species, E. batatas, has been found in Florida and the adjacent states.

It has been only in the past decade that man has become actively concerned about chiggers and their developmental life histories. There are many kinds of chiggers in the world; in the Americas alone there are well over a hundred known and many remain to be named. Only about six kinds have been studied in all stages; the rest were mostly described from larvae removed from vertebrate animals and the other stages are unknown. The necessary impetus for research on this important group of mites was provided by the medical needs of World War II. Chiggers became a serious problem to the armed forces during maneuvers in the southern United States and were responsible for the loss of many man days. From the point of view of disease transmission, they were even more important, for in many parts of the Pacific from Australia to India and Japan chiggers are the vectors of "tsutsugamushi" or scrub typhus, a serious and frequently fatal disease. Because of our inadequate knowledge and the inability of investigators to grow chiggers in numbers under controlled laboratory conditions, medical research on scrub typhus transmission was difficult.

Louis J. Lipovsky received his A.B. in entomology in 1940 from the University of Kansas. He was appointed Teaching Fellow at the State College of Washington where he received his M.S. in 1942. During the summers of 1941 and 1942, Mr. Lipovsky was collaborator with the U.S. Department of Agriculture's Bureau of Entomology and Plant Quarantine at Yakima, (Union Gap) Wash. He served with a Malaria Survey Unit in Guadalcanal in 1943 and 1944. In 1946, he was appointed assistant entomologist to study mites at the State College of Washington, Tree Fruit Branch Experiment Station, at Wenatchee, Wash. Mr. Lipovsky is now working under the ONR-sponsored contract, discussed in this article, at the University of Kansas, Lawrence, Kan. - of which Dr. Charles D. Michener is principal investigator.

With "tsutsugamushi" disease as a stimulus, the Japanese were the first to attempt life cycle investigations on Trombicula akamushi in 1917. But it was not until 1946 that Wharton and Carver, working in Guam on Ascoschoengastia indica, discovered that insect eggs were satisfactory food for the nymphs and adults. Thus, the rearing of the free-living stages has presented the most difficult aspect of culturing chiggers.

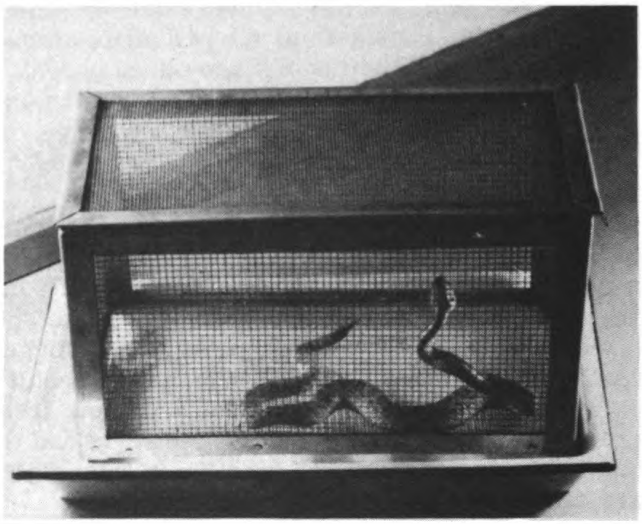

Figure 1. Rattlesnake caged over pan of detergent solution. Chiggers falling from the snake fall in the solution, from which they can be collected for rearing.

Since larval chiggers do not bite man or animals at intervals, as a mosquito does, it is usually impossible to get a chigger to bite a diseased rat and later a healthy one to see if the disease is transmitted. Ordinarily, unless disturbed, a chigger attaches to its host in some moist place, as in the ear of a rat, and engorges, sucking up dissolved skin tissue, not blood, as food. After a few days, when full, it drops off to change to the harmless soil-inhabiting nymphal stage. This means that unless there is some disturbance, such as the death of the host animal when the chiggers are partly engorged, the chigger must suck up disease organisms, carry them in its body through the nymphal and adult stages, and transfer them through its eggs to the larvae of the next generation which must then bite other hosts in order to transmit the disease. It is for this reason that knowledge of life-histories and rearing methods are so important for a study of scrub typhus.

A main objective of the present research on chiggers has been the development of satisfactory methods of culturing as many species of chiggers as the investigators could collect. Some host species such as wood rats may have as many as six species of chiggers on them at one time. These must be recovered from the living or dead rat, and the larvae thus collected must be handled individually at least four times before they can be placed in culture tubes. It has been found that for the most satisfactory results the different species must be isolated and transferred to individual culture containers for further development. This is only one of the phases of chigger biology for which new techniques for collecting and handling the parasitic form of the mite had to be developed. (See Figure 1.)

In all, about 25 species belonging to eight genera have been reared in our laboratory. In many instances it has been necessary to recover from host animals several hundred specimens of a species of chigger in order to obtain a sufficient quantity of fully engorged and healthy ones

with which to start cultures. In a few instances the less common species were present with a common chigger at a ratio of 1 to 100. If all the chiggers recovered from all hosts had been preserved, the number would exceed 200,000 specimens, and an equivalent number were purposely disregarded. Obviously, the task of selecting rearing material of the less common species from the bulk of the commoner ones has been very great. Some 20,000 fully engorged living chiggers have been handled to obtain the nymphs and adults of the cultured species. Some of these cultures have been maintained for over a year; the majority were maintained for from six to nine months. The two common species of summer chiggers, E. alfreddugesi and E. splendens, under ideal conditions, go through their life cycle from larva to larva in three to four months. There are a number of species which are normally active in winter (some remain active at temperatures as low as freezing). Although eggs of these species have been laid in the laboratory at temperatures of 70° and 80° F., they have failed to develop. Recently, a few larvae of these winter chiggers were obtained after prolonged exposure of eggs and adults to temperatures below 40° F. What these species do in summer remains a mystery.

Perhaps the most useful technique developed during the course of chigger investigation is a washing method of chigger recovery from small mammals and birds. The washing agents used are dilute solutions of the detergents, Aerosol O. T. and Vatsol O. T. There is no evidence that these wetting agents are deleterious to the chiggers. The washing method is simple. The dead host animal is chilled for a few hours, then warmed and washed in the detergent solution. With minor variations, this method of obtaining healthy chiggers for cultures has proved extremely useful. Chiggers recovered in this manner can be easily sorted under a binocular microscope by using a medicine dropper for transferring the chiggers from dish to dish and finally into culture jars. It has also been found that animals can be successfully infested with chiggers, directly from solution, with a medicine dropper. Many of the routine problems of isolation and culturing of species would have been extremely difficult were it not for these wetting agents.

Concerning the biological methods and techniques of culturing chiggers, the procedures have been considerably simplified although individual cultures require much attention. The culture dishes now used require no special substrate other than a mixture of plaster of Paris and powdered charcoal. These culture dishes and their contents may easily be observed at any time. It has been this factor of knowing the state of the cultures that has made the success of the life history studies possible, for previously it has been necessary to keep nymphs and adults in soil where they are out of sight most of the time.

Much work remains to be done on food, temperature, and humidity requirements with particular reference to the nymphs and adults. Some evidence now available indicates that food acceptable to a species in one culture may not be acceptable to the same species in another culture. As yet one can only speculate as to the factors which govern the food intake of the free-living forms of chiggers. In any case, the most satisfactory culture conditions for the majority of nymphal and adult chiggers have been found to be a moist culture dish containing, in addition to the chiggers, a culture of Collembola or spring-tails.

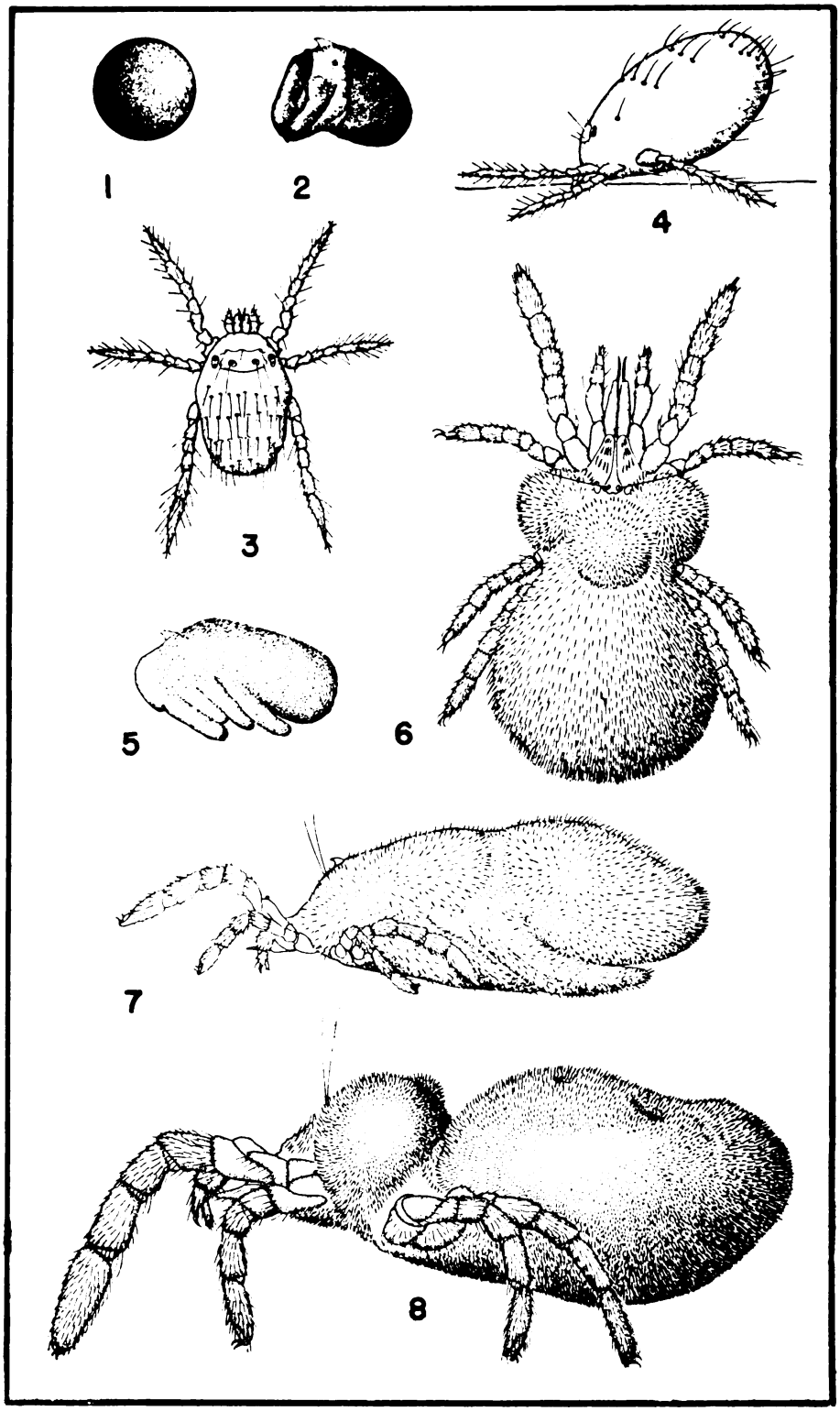

Figure 2. (From a study of Eutrombicula batatas by C. D. Michener) 1. Egg. 2. Lateral view of deutovum with broken egg shell. 3. Dorsal view of unengorged larva. 4. Lateral view of engorged larva prior to transformation. 5. Lateral view of nymphochrysalis without larval integument. 6. Dorsal view of nymph. 7. Lateral view of imagochrysalis within nymphal integument. 8. Lateral view of large adult.

Collembola are tiny soil insects whose eggs may be used for food by the chiggers. Some Collembola eggs hatch to produce more spring-tails. A few kinds of chiggers do not eat eggs at all but require molting, sick, or dying spring-tails. It will be seen that here is a very interesting balance of nature adapted to a useful laboratory technic.

In all the species of chiggers studied, the adults lay their eggs singly in the culture dishes. The eggs are very small and round, 0.09 to 0.15 millimeters in diameter. They vary with the species from almost white, to pale yellow, orange or red. After an egg is laid it starts to "grow" until the egg shell finally bursts revealing the developing deutovum between the two halves of the split egg shell. At this point the egg is no longer round; it is irregular and more than a third larger than the newly laid egg. It is from this deutovum or "second egg," that the white, yellow, orange, or red chigger larva emerges. It is this six-legged stage which seeks to attach to a host, be it man or some other vertebrate. Man, however, is not a natural or suitable host, for it would be a rare chigger that could complete its feeding or engorgement on a human being without being scratched and killed within the first 24 hours of attachment. The minimum time of engorgement on the "chigger-digested" tissue of a host is two days. Individuals of the same species may require as much as a week or more on the same host; on the other hosts engorgement may require a month or more.

After the larva has completed its feeding, it drops off wherever its particular host may be at the time. This larva may crawl around for a few days, finally coming to rest, perhaps in a sheltering crevice. There it remains motionless while it reorganizes its internal anatomy, again swelling and gradually becoming a recognizable nymphochrysalis, or protonymph, inside the much enlarged and now fragmenting larval skin. The original contents of the six larval legs are withdrawn into the body of the developing nymphochrysalis to form new parts, thus leaving only the shells of the original appendages. The conversion of the larva into the nymph requires a week or more.

The creature which now emerges from the sac-like nymphochrysalis stage is the eight-legged nymph. Like the larvae, nymphs of the various species are of different colors. Our common pest chigger nymphs, like their larvae, are either red-orange or red. They have now attained a length of about one-half millimeter. After the nymph has eaten several satisfying meals of insect eggs or minute insects, it behaves much as the engorged larva. It remains motionless, withdraws within its own skin, and transforms into the imago-chrysalis, or "pre-adult" stage, swelling and enlarging in the process. It is from this stage that the adult emerges. This adult may be a full millimeter long in our largest species!

For many years and even to the present time most persons, including many authorities, have supported a few popular misconceptions about the habits of chiggers. One of the most common and persistent of these misconceptions is that chiggers burrow under the skin. They do not. It is also erroneously stated that chiggers suck blood. Actually, the chigger injects a digestive fluid, dissolves the host's tissues, and then sucks up these tissues. It is undoubtedly the effect of the digestive fluid which makes the bite itch for two weeks or more after the chigger has been scratched off the surface of the skin. It is this long itching, combined with the fact that the chigger is so small it is not usually seen, which has probably led to the burrowing myth.

On The Naval Research Reserve

VRR Units Invited To U.S. Naval Shipyard, Brooklyn, N.Y.

In the December, 1949, issue of Research Reviews, we announced an invitation from the Director of the U. S. Naval Experiment Station, Annapolis, Md., for scientific personnel of Volunteer Research Reserve Units to visit the station. A similar invitation has been received from CAPT D. C. Redgrave, Jr., USN, Director of the Material Laboratory at the New York Naval Shipyard, Brooklyn, N. Y., who feels that such visits would be interesting and instructive to members of the reserve units.

The mission of the Material Laboratory is to provide essential scientific support for the research, development, and engineering procurement programs of the Bureau of Ships and other military activities. This work is accomplished in eight Branches encompassing the following major fields of endeavor: Electronics, Mechanics, Electricity, Optics and Radiology, Chemistry, Metallurgy, and Gyro-Dynamics. Two Electronics Branches are concerned with work on electron tubes, components, communication equipment and acoustics, radio interference measurements, and microwave instrumentation. The Mechanics Branch is active in the fields of shock, vibration and engine dynamics, noise reduction in machinery and ventilation systems, stress analysis, structural mechanics, hydrodynamics, heating, ventilating, air conditioning, rubber, plastics and constructional materials. The Electricity Branch is primarily concerned with work in the fields of electrical cables, batteries, instruments, insulation, and electrical power equipment. The work of the Optics and Radiology Branch includes work in the specialized fields of geometric optics, optical design, photometry, spectrophotometry, radiometry, and optical communications, in addition to pioneer work in radiological detection instruments and radiological decontamination. The Chemical Branch carries on work ranging from devising methods for reclaiming oil from hydraulic recoil gun systems; to molecular distillation procedures; to electron microscopy; to studies of electron diffraction patterns; to ultracentrifuging. In the field of metallurgy, work is underway on investigations in welding, radiography, spectroscopy, X-ray diffraction, and foundry control and development. The Gyro-Dynamics Branch is engaged in work on specialized equipment such as gyro compasses, fire control equipment, synchro and servo mechanisms, stable elements, ship's motion recorders, and automatic target plotters. Among the unique features of the Laboratory are complete submarine battery evaluation installations; two high power short circuit stations; facilities for the investigation of ship and engine vibration and fatigue; facilities for the evaluation of electronic components and tubes for joint use by the Services; a complete microwave laboratory; photometric ranges adapted to development of optical communication and searchlight equipment; anechoic and echoic sound chambers; a high altitude, all-weather test station under construction; 80-foot-high velocity impact equipment and other specialized high impact facilities; high attenuation areas for high-frequency investigations; high pressure hydraulic equipment; free space acoustical measuring facilities; ventilation test chambers; electron microscope and vacuum diffusers; and facilities for the development of gyro compasses and gyro stabilizers.

Commanding officers who would like to arrange such a field trip for their units or for groups within units should write the Commander of the New York Naval Shipyard, Brooklyn 1, N. Y., via the Chief of the Bureau of Ships (Code 330). Groups should not exceed more than 16 members.

Inspection of Pasadena Unit 11-2

Annual military inspection of Pasadena's U. S. Naval Volunteer Research Reserve Unit 11-2 was conducted Thursday evening, January 19 by an inspecting party from the headquarters of the Eleventh Naval District, San Diego, Calif. Inspection preceded a regular bi-weekly scientific meeting of the Unit.

The unit, 40 strong, donned their wartime blues for the occasion and formed ranks reminiscent of their days of active service for Uncle Sam. Personnel, training, and administration formed the basis of inspection. Following inspection, the group was addressed by Dr. Fred W. Brown of the Naval Ordnance Test Station, who spoke on atomic energy.

The Unit, one of 70 throughout the United States sponsored by the Office of Naval Research, has an enrollment of 73 members, all of whom are former Naval or Marine Corps officers. Attendance by members is voluntary and unpaid, with each meeting attended being credited toward Naval Reserve service.

The general purpose of the Research Units, according to CAPT T. C. Thomas, USN, commanding the Pasadena Branch of the Office of Naval Research, is to maintain a reserve of up-to-date, scientifically trained civilians who can be readied on a moment's notice to step into uniform and effect the Naval development so vital to success in modern warfare. Through these Units, the Navy maintains close liaison with the researchers whom it must call upon in the event of future mobilization. LT H. D. Strong, Jr., commanding the Unit, invites all former Naval personnel now on inactive duty who are qualified in research and development or administration of research, and who wish to join the Unit to inquire at the ONR Branch Office, 1030 E. Green St., Pasadena, Calif.

LCDR A. F. Medberg, Research Reserve Program Officer for the Pasadena Branch Office, leads the inspection of Pasadena's VRR Unit 11-2. At the right is CAPT William A. Rice, USNR, a member of Unit 11-2 and head of the Contract Branch of the Pasadena Branch Office of ONR.

News And Notes

● Twenty-four retirement points may be earned by completing the correspondence course in the new U.S. Navy Regulations. The latest revision of the 1920 edition of Navy Regs. became effective on 20 January 1949. These basic assignments are recommended both for those who have not previously enrolled in the course as well as for officers who desire refresher training in the revised and up-to-date Navy regulations. Apply to the Navy Correspondence Course Center, New York, via your commandant. Completion of this course will also count two credits toward promotion requirements.

● NavPers 15805 authorizes promotion to LTJG for all Ensigns appointed prior to 31 December 1945. Ensigns commissioned on or after 1 January 1946 serving on active duty (under the 21 or 12 months programs) will be notified via their Commanding Officers of their promotion to LTJG effective on the third anniversary of their original date of appointment as Ensign. Ensigns appointed after 1 January 1946 not on active duty or on active duty under "appropriation Naval Reserve" will likewise be promoted after three years' service in the grade of Ensign, but, for administrative reasons, these promotions to LTJG will be announced annually on 31 December or more often if deemed necessary in subsequent lists similar to the NavPers 15805.

Bethlehem, Pa., and Brookhaven, N.Y., VRR Units Activated

VRR Unit 4-6 was formally activated at the USNR Training Center, Bethlehem, Pa. on January 11. Activation of Brookhaven, L. I., N. Y., Unit 3-9 took place on January 25 at the Brookhaven National Laboratory.

Dr. Urner Liddell, head of the Nuclear Physics Branch at ONR-Washington, addressed both groups of reservists. Dr. Liddell discussed the origin and history of ONR and the part which the research units play in the program of the Navy.

CDR Joseph H. Graham, director of Research Reserves for the Third and Fourth Naval Districts, also attended both activation meetings and read the activation orders for the Brookhaven Unit.

LCDR George W. Petrie III, Commanding Officer of the New Bethlehem Unit, read the activation orders for Unit 4-6. CDR John S. Medd is Commanding Officer of the new Brookhaven Unit 3-9.

Welcome Aboard, Units 4-6 and 3-9.

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