ment of mechanical engineering. The course is designed to meet the need for instruction in this method of stress analysis and is expected to be of value to industrial research workers interested in the development of photoelasticity laboratories.

Professor Ralph E. Freeman, head of the department of economics and social sciences, and Professor George F. Wadsworth, of the department of mathematics, will give a joint course on statistical methods from September 4 to September 14.

Graduate courses in chemistry will be offered from June 10 to August 2. This program is in charge of Professor Leicester F. Hamilton, of the department of chemistry.

THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS

(*Continued from p. 423*)

Upward movement of salt in the plant, with special reference to metabolic activities of roots: D. R. HOAGLAND, T. C. BROYER and P. R. STOUT. Previous investigation has proved that accumulation of salt by the plant from the nutrient medium depends on aerobic metabolism of root cells. The relation of root activities in salt accumulation to movement of salt to the shoot has now been studied from several points of view. For certain purposes it has been necessary to conduct experiments over short periods of time with tracer elements, not initially present in the plant. Bromide ions and salts of the radioactive isotopes of Br, Na, P and K have been utilized. One of the authors (P. R. Stout) has developed technique for showing in graphic manner the general distribution of radioactivity in the plant by effects produced on x-ray films. Several general cases of salt movement are recognized: (a) under influence of root pressure, (b) as affected by transpiration, (c) movement under conditions conducive to root injury produced by high salt (*e.g.*, NaCl) concentrations. Xylem exudates may very rapidly build up concentrations of salt much higher than those of the external solution. This may occur even before the roots have attained their maximum capacity for salt accumulation. The phenomenon is related to oxygen supply to roots, concentrations and kind of salt supplied, and indirectly to photosynthesis. Soluble organic nitrogen compounds and organic acid can also move in the exudate dependent on metabolic activities of the root and nature of salt supplied. The effects of $KHCO_3$ are particularly interesting in connection with organic acid metabolism. Young active barley plants may absorb and translocate nutrient ions almost as readily in the dark as in the light, over brief experimental periods. Such plants may grow normally for some time with nutrients supplied only during the diurnal dark periods. With large plants, or those less capable of developing root pressure, rapid upward movement of salt depends on transpiration which may thus indirectly influence absorption of salt by the root. Further evidence was obtained on the path and rate of upward and downward movement of PO_4 by the use of radioactive phosphorus.

Mutations and reversions in reproductivity of Aspergilli with nitrite, colchicine and d-lysine: CHARLES THOM and ROBERT A. STEINBERG. Injury mutants showing loss in reproductive capacity have been obtained thus far with eight species of Aspergilli through the use of nitrite. The interpretation of amino group destruction in proteins of the genetic mechanism is rendered more probable by similar positive results obtained with ninhydrin, chloramin-T, hydriodic acid and hexamethylenamine (formin). Somewhat similar mutants were obtained with colchicine with *Aspergillus nidulans, A. fischeri, A. flavus, A. alliaceus,* and *A. fumigatus. A. variecolor, A. amstelodami* and *A. niger* presumably required higher concentrations of colchicine. Use of excess calcium carbonate to prevent hydrolysis of colchicine to colchicein was found necessary for positive results, though the metabolic effect of neutrality may also be a contributary factor. Partially successful attempts based on theoretical chemical considerations have been made to reintroduce amino groups assumed to have been destroyed by the action of nitrite through the use of high concentrations of d-lysine, and of reducing agents (sodium thiosulfate) in neutral solution. Mutations showing partial to full reversion in reproductivity were obtained with *A. amstelodami* and *A. niger.*

The soil as a source of microorganisms antagonistic to disease-producing bacteria: SELMAN A. WAKSMAN and H. BOYD WOODRUFF (introduced by Charles Thom). Fresh field and garden soils contain a large number of microorganisms which are antagonistic to disease-producing bacteria. When these bacteria are introduced into the soil, as in the excreta of patients suffering from various diseases, as well as in the dead bodies of men and animals, they are rapidly destroyed by the corresponding antagonists. As a result of this, the soil can hardly be considered as a source of epidemics and as a carrier of the more common infectious diseases. A special method was developed for demonstrating the presence and abundance of antagonistic microbes, based upon the use of living bacteria as the sole nutrient. It was established by means of this method that the introduction of large numbers of disease-producing bacteria into the soil leads to their rapid disappearance and is accompanied by a rapid multiplication of antagonists. Particular attention was paid to certain gram-negative bacteria, especially members of the coli-aerogenes group and *Brucella abortus.* Two specific bacteria and several actinomycetes were isolated from the soil and shown to possess the property of antagonizing these gram-negative bacteria, as well as various gram-positive forms. By the use of three bacteria of varying degrees of sensitivity (*Sarcina lutea, Bacillus mycoides* and *Escherichia coli*) as standards of measurement of inhibition, it was found that the active substance

produced by the above antagonists was largely thermostable, passes through a bacterial filter, is absorbed by charcoal and is soluble in ether. The active substance obtained by ether extraction prevented the growth of the three bacteria in concentrations of 1: 250,000, 1: 50,000 and 1: 12,500, respectively. The inhibitory effect of the active substance against *B. abortus* fell between *B. mycoides* and *E. coli*. The substance also possesses a strong bactericidal action.

Respiratory metabolism of the porpoise: LAURENCE IRVING, P. F. SCHOLANDER and S. W. GRINNELL (introduced by C. E. McClung). As a species of small-toothed whale the porpoise, *Tursiops truncatus*, encounters the respiratory difficulties common to all whales. We have examined in nine porpoises the characteristics of breathing and internal respiration in order to see how the respiration of whales proceeds and to gain light on how mammalian respiration operates when breathing is infrequent. During the course of our observations the porpoises usually breathed from two to four times a minute and during each respiratory pause the heart gradually slowed to about 40 beats per minute and then increased to about 80 a few seconds after taking a breath. Heart records were taken with the electrocardiograph. During a two-minute dive in the open sea the heart slowed to about 30 and remained retarded during active swimming under water. It appears likely that the bradycardia is associated with the elective control of the circulation which is known to exist in several mammals during apnea. For comparison with the cardiac response in man it was found that the heart rate of a practiced and able diver at Silver Springs, Florida, slowed while he stood quietly under water to about 30. Even while swimming vigorously under water the bradycardia persisted. Measurements of the respiratory metabolism of porpoises weighing about 180 kg by means of a large Krogh spirometer showed that each inspiration took in from 6 to 10 liters and about 10 per cent. of that volume of oxygen was utilized. The resting oxygen consumption was about one liter per minute. At each expiration the lungs were almost completely emptied, the residual air being determined at about 20 per cent. of the inspired air. The alveolar CO_2 was between 7 and 10 per cent. It appears that porpoises are like several other diving animals which are relatively insensitive to CO_2. During or after a forced dive of two or three minutes' duration it was remarkable that the alkali reserve of the blood changed very little, and scarcely any increment of lactic acid appeared either in blood or muscles. Although fatal asphyxia could be caused in three minutes the absence of the acid as a sign of anaerobiosis was surprising. These observations point out the mechanics and dimensions of the respiratory system in the porpoise. They also show how certain typical mammalian respiratory mechanisms operate under the peculiar conditions in which an aquatic mammal lives.

Fats and oils as protective repositories of neurohumors and other chemical activators: G. H. PARKER. The color changes in catfishes are controlled by three chief neurohumors, intermedin from the pituitary gland, acetylcholine and a concentrating neurohumor probably adrenaline from the dispersing and the concentrating nerve-fibers, respectively. Of these three the two from the nerves, acetylcholine and adrenaline, are soluble in fats and oils. Acetylcholine induces a dispersion of melanophore pigment and consequently a darkening of the fish. Adrenaline on the other hand concentrates this pigment and blanches the fish. When acetylcholine has been discharged for some time from the dispersing nerves it accumulates in the fatty or lipoid constituents of the tissues about the melanophores and in consequence continues the dispersion of pigment for some time after the dispersing nerves have ceased to act. It can be extracted in measurable amounts from dark fish skins. This substance, very important for nerve action generally, escapes destruction by choline esterase by its retreat into fatty materials where it is temporarily stored. The same appears to be true of adrenaline, another important general nerve activator. Thus the fatty or lipoid substances in the animal body may serve as storage reservoirs for agents that may be of first consequence in the animal economy. This storage activity of lipoids for important activating agents has not received the attention of biologists that it probably deserves.

A readily demonstrated physiological difference between the red blood cells of different species: M. H. JACOBS. The red blood cells of different species of vertebrates differ in a striking and apparently constant manner both in their normal permeability to dissolved substances and in the manner in which this permeability is altered by external conditions. For specific distinctions among the mammals by the permeability method glycerol is a particularly useful substance, but it has the disadvantage of requiring rather long times for the necessary measurements. The related substance, ethylene glycol, of lower molecular weight and greater penetrating powers, has been found to give almost equally reliable results in times which for the individual observations are measured in seconds rather than in minutes. Curves obtained by plotting against pH (between 4.2 and 8.2) the times of hemolysis in 0.3 M ethylene glycol solutions buffered with a phosphate-phthalate mixture have proved to be satisfactorily constant and characteristic for each of the 12 species of mammals so far studied, including the commonest laboratory mammals and man. In the examination of approximately 100 samples of blood distributed among these species no case has so far been encountered in which the origin of the blood in question could not be correctly determined by this test alone. Even such closely related species as the albino rat and the albino mouse are readily distinguishable, as are the dog and the cat, the rabbit and the guinea pig, the ox and the sheep, etc. The observed differences are associated in part with differences in permeability and in part with other properties of the cells; a distinction between these various factors can be made by studies of non-hemolytic volume changes of the cells. Cell permeability must be regarded as highly specific both with respect to the cell and to the penetrating substance, and any satisfactory theory of the nature of

the cell surface and of its permeability to solutes must take this specificity into account.

Modification of the human-eye potential by dark and light adaptation: WALTER R. MILES. The human eye, measured under standard conditions previously described, for well-relaxed young adult subjects (33 men), shows an average potential of about $1.10 \pm .03$ mv. Under conditions of constant illumination of 5 millilamberts the potential holds very steadily for a given subject. Reducing the illumination to a value of about .001 ml. it is found that after 5 minutes of dark adaptation the potential has dropped to $0.99 \pm .03$, and after 10 minutes to $0.88 \pm .02$ mv. Changing back to the 5 ml illumination it is found that after 5 minutes in this light the potential has risen to a value of $1.26 \pm .04$ mv. This change from 0.88 to 1.26, a difference of 0.38 mv., proves to be a statistically reliable difference since it has a critical ratio of 5.2. A second experiment showed 0.85 and 0.76 mv for 5 and 10 minutes respectively in the dark, followed by 1.14 mv 5 minutes after the 5 ml light had been turned on. The difference here is also 0.38 mv and gave a critical ratio of 5.9. The eye in adjusting from dark to light (.001 to 5 ml) increases its polarity potential scarcely at all or very slowly in the first 3 minutes. The rise is accelerated in the 4th and 5th minutes and probably continues still longer and then falls to an equilibrium value. These modifications in eye potential appear to depend upon retinal functions and thus offer promise of an objective measure of retinal states and activities that may supplement the subjective threshold methods long used in scientific studies of vision.

The growth of Mount Mazama and the formation of Crater Lake: HOWEL WILLIAMS (introduced by John C. Merriam). Mount Mazama, one of the volcanoes of the High Cascade Chain in southern Oregon, was built during Pleistocene and Recent times. It grew to a height of approximately 12,000 feet, mainly by the outpouring of flows of andesite from a number of vents whose positions changed from time to time. During growth, the volcano was almost wholly covered by glaciers. At their maximum extent, the largest of these spread between 10 and 17 miles from the summit and filled the canyons to a depth of more than 1,000 feet. The moraines left by these glaciers are interbedded with lavas on the caldera wall and the oldest extend even to the edge of the lake. After the period of maximum glaciation, a semi-circular arc of vents opened on the north slope of Mount Mazama, along what is now the north rim of Crater Lake. From these, viscous flows of andesite and dacite were erupted. About the same time, many cones of basaltic cinders were active farther down the sides of the main volcano. Finally, after a long period of quiescence, eruptions of pumice began on an unprecedented scale. At first, the explosions were mild and the ejecta, rising high above the volcano, were dispersed toward the east and northeast by winds. Five thousand square miles of country were covered to a minimum depth of 6 inches. Thereafter the eruptions became more violent and voluminous. The pumice was no longer projected high above the vents but rushed down the mountain sides in the form of glowing avalanches or *nuées ardentes*, some of which raced down the canyons for no less than 35 miles, burning the forests in their path. The rapid eruption of this enormous mass of pumice from the magma chamber removed support from beneath the summit of the volcano and led to profound engulfment, forming a caldera between 5 and 6 miles wide and 4,000 feet deep. This catastrophe dates back less than 10,000 years, to a time when this part of Oregon was already inhabited by man. It was followed by the formation of the cinder cone of Wizard Island, the final activity of which occurred only about 1,000 years ago.

Nodal points on crystallization curves of solid solutions: N. L. BOWEN. The crystallization curves in solid solution systems characterized by a valley curve (Tallinie) on the fusion surface have been treated by Schreinemakers for the case of crystallization with perfect fractionation. He did not examine the case of crystallization curves with perfect equilibrium, but a number of other investigators have done so, and they agree that the curves of perfect equilibrium crystallization have points of inflexion where they intersect the valley curve. On the other hand, there is no agreement among them as to the manner of location of the point of intersection with the valley curve. This confused condition suggested a new analysis of the problem which shows that the point of intersection of valley curve and crystallization curve is determined by a simple construction, that a crystallization curve has no unique properties at this point, that some crystallization curves have nodal points but the locus of nodes is a curve which is independent of the valley curve.

General symmetry: EDWARD KASNER. Symmetry in elementary geometry and art is usually defined with respect to a straight line or point as base. One method of generalizing to any basic curve leads to conformal symmetry and functions of an ordinary complex variable. Another method, explained in the present paper, leads to *equilong symmetry* and functions of a dual variable. Equilong symmetry preserves distances, just as conformal symmetry preserves angles. In equilong symmetry, corresponding lines are parallel and the mid-line is tangent to the base curve. The lines touching the base curve remain fixed. In the equilong theory, parallel curves become parallel curves. No analogue of this phenomenon appears in the conformal theory. Also while the equilong theory is capable of generalization to space of any dimensionality, the conformal theory is essentially restricted to two dimensions. If we compare a general curve C_1, the transformed curve C_2 and the base curve C_0, we find that the radii of curvature are related by $R_1 + R_2 = 2R_0$. A like relationship is valid for derivatives (with respect to inclination) *of all orders.* This is in contrast to the conformal theory where the average value theorem (for curvature) is valid only up to the second order. The group generated by all symmetries is discussed. The case where the base curve is a circle is elaborated. Any such transformation is *not* a Laguerre inversion, but may be expressed as the product of three Laguerre inversions. It has been shown by De Cicco in my seminar that a reverse equilong trans-

formation of period two is either an equilong symmetry or of a certain new type (equivalent to line symmetry) without a base curve.

Minimal surfaces of unstable ring type: MARSTON MORSE and CHARLES B. TOMPKINS, II. We are concerned with a generalization of theorems concerning minimal surfaces which go back to Newton. Minimal surfaces are surfaces which are locally curved away from the tangent plane in equal degree on both sides. Stable minimal surfaces are those of least area. Soap films assume the shape of minimal surfaces to a very high degree of approximation. Let there be given two circles with distinct parallel planes and with centers on the same axis of rotation. These circles will bound two minimal surfaces of revolution each generated by a segment of catenary, provided the two circles are not too far apart. One of these surfaces will be of minimizing type and stable, and the other non-minimizing and unstable. These surfaces are "ring surfaces"; that is, they are continuous images of a plane circular ring. Our theory includes the following generalization of this classic result. Let the two circles be replaced by two simple closed curves g_1 and g_2 of class C^1. Instead of being planar, suppose g_1 and g_2 have convex projections on suitably chosen planes. Instead of having distinct containing planes suppose g_1 and g_2 are separated by a plane. *If g_1 and g_2 bound a "ring" minimal surface of minimizing type, g_1 and g_2 also bound a ring minimal surface of non-minimizing type.* In developing this theory it was necessary to reinvestigate many portions of the classical theory and in particular to obtain new and stronger theorems concerning the first variation. In general, the work is based on the topological theory of critical points of functionals as developed by Morse. One of the technical details depends upon results recently obtained by Professor A. E. Pitcher concerning "Sum functions on product spaces." An essential characteristic of the methods is the replacing of classic concepts such as that of a critical point by broader topological concepts involving no derivatives. This analysis in the small is combined with the appropriate group theoretic analysis in the large.

(*To be concluded*)

SPECIAL ARTICLES

ALLEGED GONADOTROPIC EFFECT OF ROYAL JELLY

FEMALE larvae of the honeybee (*Apis mellifera* L.) develop into members of the queen or worker caste depending upon the food and care received during larval development. The mature queen is nearly twice as large as the worker and has highly developed ovaries which nearly fill the abdomen.

It is not uncommon for workers to lay unfertilized eggs, although such individuals may have not more than 8–10 ovarioles compared with upward to 340 for the queen. All newly hatched female larvae have rudimentary ovaries capable of developing into the functional organs of the queen caste. However, the number of ovarioles decreases during the late larval and pupal stage of the worker.[1]

Heyl[2] recently suggested that royal jelly, or larval food, secreted by the honeybee "might contain an active principle that would behave like a gonadotropic or growth hormone." In support of this idea he reported that the injection of dilute sodium hydroxide and aqueous pyridine extracts of royal jelly had resulted in a precocious development of the Graafian follicles in immature rats.

In connection with investigations under way on the physiology of reproduction of the honeybee, royal jelly has been assayed for gonadotropic activity, with results that are not in line with those of Heyl. The data from two assays are presented in Table I. Aqueous extracts of acetone-dried royal jelly were used for one assay, and aqueous pyridine extracts for the other. Eight immature female rats, 21 days old, selected from a closely inbred strain, were used as the experimental animals, four for each assay, one of each group serving as a control. The rats in each group were litter mates. The injections were made twice daily for 3 days, and the animals were autopsied 24 hours after the last injection.

TABLE I

ASSAY OF ROYAL JELLY OF THE HONEYBEE FOR GONADOTROPIC EFFECT ON RATS

Rat No.	Equivalents royal jelly injected	Weight of rat		Weight of ovary	Weight of thymus	Weight of adrenal
		Initial weight	Final weight			
	mg	*gm*	*gm*	*mg*	*mg*	*mg*
	Acetone-dried royal jelly					
1	100	38.6	51.0	15.0	182.1	15.2
2	200	38.5	50.0	15.3	144.9	14.5
3	400	36.5	48.5	14.7	172.3	10.8
4	Control	39.5	53.5	18.9	250.9	12.8
	Aqueous pyridine extracts of royal jelly					
5	1000	34.0	41.1	11.4	93.6	16.1
6	2000	31.0	39.8	12.7	86.7	11.0
7	3000	33.0	34.5	11.0	21.5	15.6
8	Control	41.0	54.1	14.6	219.5	13.2

It will be noted that all animals increased in weight during the period of the injection. The ovarian weights of the animals injected with extracts were not greater than those of the controls; furthermore, upon microscopic examination little, if any, follicle stimulation was observed. Histological study of the vagina showed no effects of theelin. The thymus weights of the experimental animals were reduced, whereas the adrenals showed little effect of the injections of royal jelly.

It is concluded from these preliminary assays that

[1] E. Oertel, *Jour. Morph. and Physiol.*, 50: 295, 1930.
[2] H. H. Heyl, SCIENCE, 89: 540, 1939.