stand is full, approximates 25 per cent. of the ground area. The moist spots are under all trees where the wind blows up or over the slopes; in some cases moisture has collected fast enough to form puddles and run down the slopes in rivulets. Away from the trees the ground is dry as it usually is in summer.

The trees average 15 feet in height for pines and 20 for eucalyptus, the trunks from 6 to 10 inches thick. Small trees, brush and grass collect relatively little moisture.

The effect of this additional moisture collected from fogs in the dry season is readily noticed in the rapidity of growth. As the trees become larger their collecting area increases.

THOS. H. MEANS

ACTION CURRENTS FROM MUSCULAR CONTRACTIONS DURING CONSCIOUS PROCESSES[1]

IN the course of investigations on the influence of general muscular relaxation[2] upon the occurrence of various types of conscious processes, we arrived at a fairly uniform result. After a period during which relaxation had been sufficiently advanced and generalized, all the subjects (23) who had been adequately trained as judged by certain tests agreed, under controlled conditions, in giving independent reports that there had been for the time a notable diminution or virtually total disappearance of conscious processes. These included not alone so-called kinesthetic activities but also visual and auditory imagery, attention, reflection and emotion. Extreme relaxation of the muscles of the eyes and of speech seemed of conspicuous importance.

When these subjects were requested to engage in reflection or other conscious activity, but at the same time to seek to relax extremely, they reported that they did one or the other but could not do both. Extreme relaxation was found to be incompatible with the simultaneous presence of conscious activities. When the subjects relaxed extremely to a point where they later reported diminution or absence of mental activity, the muscles of the eyes and face assumed a flaccid appearance which gave characteristic photographs. Association time was greatly prolonged or no associations appeared. The subjects, who were highly trained in observing and critically reporting their sensory experiences, agreed in discerning an experience as of a muscular contraction occurring at the moment of conscious activity and appearing to constitute a part of the conscious process. We are reminded of the assertion of Hughlings Jackson that a motor element is involved in every conscious activity.

To test this conclusion from another direction, we have begun to employ the string galvanometer with vacuum tube amplification. Ours is the first application of that instrument (unpublished in 1921), we believe, to the question whether action currents are given off by muscular contractions associated with imagery, reflection, attention and other conscious processes. Early tests in a preliminary way without amplification on imagined flexion of the biceps brachial group have given positive results. It is necessary, however, to control the methods very carefully and to apply the tests to various parts of the musculature during various types of conscious processes, before the foregoing conclusions can be adequately tested or confirmed. This is now being done.

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[1] Preliminary report.

[2] Jacobson, E. 1924. *Jour. of Nerv. and Mental Dis.*, LX, 568. 1925. *Am. Jour. of Psychol.*, XXXVI, 73.

THE NATIONAL ACADEMY OF SCIENCES

AT the annual meeting of the National Academy of Sciences, held in Urbana, on October 18, 19 and 20, at the University of Illinois, the following papers were presented:

Further evidence on the constancy of the light of stars: JOEL STEBBINS. At the Washburn Observatory, University of Wisconsin, tests of the light of different classes of stars have been made by the writer and C. M. Huffer. From the samples studied it is inferred that white and yellow stars are fairly constant in their radiation, but that the red stars are likely to vary in light, particularly the very red and relatively cool bodies. The amount of the change is often ten or twenty per cent. within two weeks or a month. Nearly one third of the red stars in general, and all of the largest stars like Betelgeuse, are variable in this fashion. It is probable that the surfaces of these stars are covered with spots like those on the sun, and that the bodies are in early stages of development.

An attempt to detect the Einstein displacement at the limb of Jupiter: PHILIP FOX (introduced by Henry Crew). The displacement of star images at the limb of the sun observed at the time of total eclipses has been demonstrated by several observers with values closely approximating the amount predicted by Einstein. On April 28, 1923, Jupiter occulted the star BD–14° 4069. The circumstances of this phenomenon were observed at the Dearborn Observatory. A series of plates were exposed successively as Jupiter approached and receded from the star. This note presents the results of the observations and the plans for a similar occultation which will occur on the evening of December 7, 1927.

An after-image of the yellow spot: J. MCKEEN CATTELL. Loewe, Haidlinger, Clerk Maxwell and Helmholtz have described in detail the entoptic phenomena connected with fovea centralis and the yellow spot. If one looks at a blue surface or preferably through a blue glass or a solution of chrome alum, a dark spot appears in the center of the field of vision. Skilled observers may see a dark halo with a bright ring surrounding the spot. The observation here put on record is that after the retina has been fatigued by the blue light, if the eyes are turned to a white surface, say the clouded sky, a bright yellowish after-image of the yellow spot appears, comparable to the sun seen through the clouds. The yellow spot has been protected from the blue light by its pigment and is relatively more sensitive to the white light. Another observation that may be put on record is that about twenty-five years ago I obtained an after-image that still exists. The after-image followed exposure of the eyes for one minute to the clear sky through the cross-bar of a window. This positive after-image, which I can now see with closed eyes, may be due to permanent changes then caused in the retina, or it may be reinforced by attention. Newton describes an after-image of the sun that lasted three years.

Presbyota and the causes of deficient hearing: J. MCKEEN CATTELL. Presbyopia is well-known, but in so far as there is an analogous condition of the organ of hearing it has been so little considered that a new name must be invented for it. Oliver Wendell Holmes noted that in old age tones of high pitch, as the chirping of a cricket, can not be heard, and the upper limit of audible pitch is now measured by the Galton whistle and other methods. In the Bell Telephone Laboratories Dr. Harvey Fletcher, following work of Professor Seashore and others, has recently perfected an audiometer for measuring acuity of hearing for tones of different pitches, records from which are exhibited. Attention is here called to the fact that deficiency of hearing is due not only to failure to respond to the energy of the stimulus as measured by the audiometer, but also to the fusion of successive stimuli and that this condition may be normal after middle-life. Vision is a space sense; hearing a time sense. The inertia of eye and the fusion of visual sensations have been thoroughly investigated, but we have no corresponding information in regard to the fusion of auditory sensations. Sounds separated by one five-hundredth of a second can be discriminated, but with speech sounds given at longer intervals are fused. We can speak about as rapidly as we can hear—some twenty changes a second—and this may have evolutionary significance. In order to be heard by one of deficient hearing, or by an audience, it is necessary to speak not more loudly, but more distinctly and more slowly. The conditions are analogous to the loud speaker of the radio or to transmission on the telephone line, where increased loudness increases the distortion and blurring of the waves. As the muscular system of the eye controlling the curvature of the lens becomes flaccid with age, so the receptor in the ear may be expected to lose its elasticity with age. It does not respond to the more rapid vibrations and has greater inertia, so that a longer period is required to set it in motion and the motion may subside more slowly. There is consequently fusion of successive sounds, which are besides less distinctive because the higher overtones are lacking. A loss of acuity of hearing of 30 per cent. is a small matter, for one can hear a conversation as well at six feet as at three, but the fusion of successive stimuli makes close attention necessary and explains the difficulty that older people experience in listening to an address or theater performance.

The correlation between intelligence and speed in conduction of the nerve impulse: LEE EDWARD TRAVIS (introduced by C. E. Seashore).

The collection of Negro songs by phonophotography: MILTON METFESSEL (introduced by C. E. Seashore).

Environment and context: MADISON BENTLEY (introduced by S. A. Forbes).

The beginnings of cerebral cortex: C. JUDSON HERRICK. The lowest vertebrates have no fully differentiated cerebral cortex, that is, superficial gray matter in the forebrain. This appears first in reptiles. In the Amphibia cortical territory can be recognized, but true cortex is not differentiated within it. An analysis of this territory reveals the physiological factors operating in a phylogenetic stage just antecedent to the appearance of true cortex. The intrinsic functions of association, so characteristic of human cortex, here provide the physiological motivation for the actual differentiation of cortex as we see it in reptiles. Yet no cortex appears in Amphibia. The reason is that a certain measure of anatomical localization of function in cortical territory is prerequisite for the appearance of cortex in this territory. The Amphibia have three local fields of "primordial cortex," but only two of these have specific connections through projection fibers with distinctive subcortical reflex centers. In reptiles the third field also has acquired its own system of such projection fibers. Cortex never appears in a single isolated field, but at least three fields with distinctive subcortical connections are necessary for its differentiation, which occurs simultaneously in all of them.

Studies on the thyroid: A. J. CARLSON.

The effect of raised intrapulmonic pressure upon the knee jerk, arterial blood pressure and state of consciousness: ARNO B. LUCKHARDT (introduced by A. J. Carlson). In the dog raised and maintained intrapulmonic pressure leads to a sharp drop in the general arterial blood pressure accompanied by a diminution of the knee jerk or its complete abolition. The effects on the knee jerk center are due, for the most part, to changes in the circulation through the brain and cord (anemia and asphyxial depression). The diminution of the knee jerk may in part be due to reflex inhibition of the knee jerk center as a result of stimulation of the sensory fibers of the pulmonary vagus. A similar drop in general arterial

pressure results in man from a forced and maintained increase in intrapulmonic pressure. The drop in pressure in man and dog under conditions of raised intrapulmonic pressure is due to an interference with the filling of the left heart. Depending on the extent of the drop in the general arterial blood pressure, there ensues giddiness or arterial unconsciousness. The compensatory after fling in the blood pressure (on release of the intrapulmonic pressure) is responsible for the symptoms of nausea, fullness of the head and general discomfort.

Studies of conditioned reflexes: N. KLEITMAN. Dogs with salivary fistulae were placed in a stand for a period of time varying from 15 minutes to two hours, and were then given an injection of morphine subcutaneously. Daily repetition of this procedure resulted in the development of a conditioned salivation starting as soon as the animals were put in the stand. The curve of development of this conditioned reflex is S-shaped, showing first a positive acceleration and then a negative one. The extinction of the conditioned reflex when the daily injections are discontinued follows a concave curve, which in some dogs is a second degree parabola. The abolished conditioned reflex may be reestablished by resuming the injections of morphine, and it reaches its height of development in less time than it takes to establish it for the first time. The establishment, extinction and reestablishment of the conditioned reflex resemble closely learning, forgetting and relearning nonsense syllables. Starvation acts deleteriously on the course of the fully established reflex or prevents its proper development. This is not due to a decrease in water consumption observed in fasting, nor to a decrease in size of the salivary glands. It is probably due to a depression of the activity of the centers in the nervous system resulting from starvation.

The action of trypanolytic sera in vivo: WILLIAM H. TALIAFERRO (introduced by S. A. Forbes). Mice infected with *Trypanosoma equinum* exhibit a progressive infection with a constant increase of the parasites in the blood until death which occurs on the fifth or sixth day in our strain. If, however, a suitable dose of trypanolytic serum (serum obtained from guinea pigs, rabbits or sheep after a natural trypanolytic crisis) be injected into an infected mouse, there is a lysis of the parasites (crisis) in about one hour, then a period of several days in which no parasites can be found in the peripheral blood and eventually a relapse during which the parasites increase steadily until the death of the mouse. The length of life of such treated mice is prolonged over that of untreated controls about as long as the crisis lasts. A peculiar anomaly sometimes appears when a series of infected mice at the same stage of infection are given different amounts of lytic serum. Doses of lytic serum greater than the minimal effective dose instead of all producing lysis of the parasites show recurrent zones of effectiveness and non-effectiveness. This zonal phenomenon is superficially similar to the animal experiments of Pfeiffer (1895) and others on the protective (as distinguished from the present curative experiments) action of antibacterial sera and to the so-called Neisser-Wechsberg phenomenon in test-tube experiments. Such peculiarities in the action of immune serum in the animal body, besides its theoretical interest, may have a distinct bearing on the use of immune sera in the treatment of disease. In *T. equinum* the occurrence of zonal phenomena is directly correlated with the number of trypanosomes present in the blood at the time the immune serum is administered. In one strain (experiments of T. L. Johnson) if there are from 1 to 5 parasites per microscopic field when the lytic serum is given there is no zonal phenomenon, but all doses greater than the minimal effective dose are similarly effective. If, however, there are from 9 to 33 parasites per field doses greater than the minimal effective dose show alternate zones of effectiveness and non-effectiveness. Finally, if there are from 45 to 50 per field no dose of immune serum so far used has been found effective. The absolute number of trypanosomes per field necessary for the occurrence of zonal phenomena is constant for each single-cell strain, but varies with different strains. Although the present series of experiments has not offered an adequate explanation of zonal phenomena they throw considerable doubt on various explanations which have been offered in bacteriological literature. Thus, it is impossible to assume that the phenomenon is dependent upon inactivation because we have obtained it repeatedly with active as well as inactivated serum. In the protective experiments with bacteria there is considerable evidence that even where a large dose of serum does not protect the animal, the serum actually kills the bacteria and the assumption is made that the animal dies as a result of the consequent liberation of endotoxins. In our work, however, where a large dose of serum is ineffective the trypanosomes are not killed. Recent investigators have postulated two substances in immune serum—one protective and the other antagonistic to the host's resistance and explained the ineffectiveness of large doses as due to the increased amount of antagonistic substance. This is untenable because it would imply a point after which all larger doses would be non-effective and would not explain the recurring zones found in our work. Finally, variability in the host's reaction can not be the basis because the phenomenon is directly dependent upon the number of trypanosomes present when the serum is injected. That the final explanation of the results both in bacteriological as well as trypanosome work will have to include the relation of the number of organisms present when the serum is given is indicated by the fact that the zonal phenomena in the protective action of antipneumococcus serum is also dependent upon the amount of virus injected with the serum. (Unpublished work of F. A. Coventry.)

Concerning certain ecological methods of the Illinois Natural History Survey: S. A. FORBES. It is the object of this paper to describe and illustrate by examples some of the uses of statistical ecology in determining relative frequencies of the several species of animals in the various ecological situations of an area which they inhabit, thus ascertaining the ecological preferences of species and their

organization in communities on the basis of an identity, or at least similarity, of such preferences. By a comparison of these ecological preferences, in species so closely allied in classification as to suggest their relatively recent differentiation, some evidence is found of the existence of ecological barriers separating such species, and of the possibility of the influence of ecological segregation in promoting their specific differentiation. The Illinois distribution and ecological relations of three species of fishes are used as an example. Ecological affiliations among the species of birds are shown by determining the numbers per square mile of each species found in each ecological situation of an area surveyed, and examples are given of the use of data so obtained in studying the movements of birds in complete or partial migration. The northern flicker, the common crow and the prairie horned lark are used as examples of a partial seasonal redistribution of species which are classed as permanent residents in Illinois. Finally, a more complex method is presented of distinguishing ecological communities, ascertaining their limits and evaluating the strengths of the affiliations of the several species of a community by determining for each pair of species a coefficient of association, based on the actual frequency of their joint occurrences in collections, the calculus of probabilities being used to distinguish joint occurrences attributable to random distribution from those due to ascertainable ecological causes. Through a comparison, tabulation and grouping of such coefficients, community relations are readily recognized, details of ecological relationship across definite community boundaries are made evident, and the intricate web of the relations of all the inhabitants of a complex area to their physical environment and through this to each other are disclosed.

Influence of a power dam in modifying conditions affecting the migrations of the salmon: HENRY B. WARD (introduced by S. A. Forbes). The migration routes of the Pacific salmon are determined by external conditions which have been recognized in part at least. The streams which they frequent are peculiarly adapted for utilization as sources of water-power. The installation of high dams has modified natural conditions in ways affecting conspicuously the movements of the fish. First of all the dam offers a physical obstacle to the movements of the fish; this has not been satisfactorily overcome by installations yet devised—other less evident changes are wrought in the environment. The newly formed lake replaces a rapid, broken stream by a large body of still water. The current which has exerted a directive influence is eliminated. The water is less highly oxygenated —though in many cases not seriously changed. Temperature conditions are most radically altered and apparently affect the movement of the salmon conspicuously.

Morphologcial changes in the nuclei of the subcuticula in the Acanthocephala: H. J. VAN CLEAVE. In tracing the embryological development in Pomphorhynchus, Hamann, in 1891, showed that the subcuticular nuclei are first recognized as giant spherical or ovoid bodies. Later in development these become progressively more amoeboid until finally each nucleus fragments into a large number of small rounded bodies scattered through the subcuticula of the adult. Recently there have been frequent references to peculiarities in nuclei of adult acanthocephalans with no attempt at correlation observations on the different forms. On the basis of the subcuticular nuclei alone, the genera of Acanthocephala may be arranged in a phylogenetic series following the same progressive changes in nuclear form outlined in the ontogenetic series by Hamann. In all members of the family Neoechinorhynchidae, the subcuticular nuclei of the adult are rounded giant nuclei, essentially like those of the larvae throughout the group. In adults of the genera Pandosentis, Quadrigyrus and Leptorhynchoides there is progressive emphasis of the amoeboid tendency of these nuclei, culminating in Leptorhynchoides. Many other genera, including Acanthocephalus, Echinorhynchus and Pomphorhynchus, enter the adult state with numerous small rounded nuclear masses scattered throughout the subcuticula.

The development of individuals from aggregated cells in Corymorpha: C. M. CHILD (introduced by F. R. Lillie). In the course of work at the Scripps Institution, La Jolla, California, during the past summer the methods used by H. V. Wilson were applied to the large tubularian hydroid, *Corymorpha palma*. The naked stalk regions of these animals were ground with moist sand in a mortar, water was then added and the fluid strained through bolting cloth, 150 meshes to the inch. The somewhat milky fluid passing the cloth was then allowed to settle in tubes. During the first two to three hours following dissociation aggregation of the cells and small cell masses into larger masses and sheets occurs rapidly, the surfaces adhering to each other when they come into contact, but the capacity for aggregation is gradually lost. All aggregates approach or attain spherical form and those 2 mm or more in diameter usually die, but smaller aggregates or pieces cut from the larger may live and give rise to new individuals or partial individuals in 4 to 5 days or more slowly. The environmental differential to which the aggregate is exposed on the bottom of the container is a factor in determining the polarity of the new individual. The upper, freely exposed surface or some part of it tends to develop into the apical region and the region in contact with the bottom, into a more proximal level or a basal end. Aggregates frequently turned over and moved about develop basal ends less frequently than those allowed to remain undisturbed. That physiological polarity originates in a quantitative gradation in physiological activity or condition of protoplasm is shown by many lines of evidence for both animals and plants. In the present case the environmental differential between the freely exposed region of the mass and that in contact with the bottom apparently serves to establish this gradation and so to determine the order of parts along the axis.

(*To be continued*)