effort and interpretability of results which at present are unapproached save in our research uses of certain relatively simple organisms, and which heretofore have commonly been considered unattainable for highly organized creatures like the anthropoid apes and man.

Scarcely less excusable in current practice than the use of inadequately known materials whose variability is extreme is the sacrifice of a valuable animal after employment in a single experiment or investigation. There are times of course when this is fully justified, even essential, but not rarely what amounts to inexcusable wastage of material results from lack of foresight in planning and arranging for sufficient inclusiveness of interest within a given laboratory. Accustomed as we are to sacrificing protozoan, invertebrate or lower vertebrate to a single experiment, we psychobiologists, and many another physiologist, act similarly when far more costly and difficultly obtainable subjects are in use.

The anthropoid ape, whether orang-outan, chimpanzee or gorilla, is the most suitable substitute for man in certain important inquiries. At maturity it represents a relatively huge investment by nature or by man. One might suppose that, dead or alive, every specimen would be highly prized and used in the most varied ways to advance knowledge. The opposite, however, actually is the case. From fairly ample information the estimate is hazarded that of all anthropoid apes captured ostensibly for educational or scientific needs, not one in twenty is ever employed in a really worth-while and well-conducted investigation, while of those which die in captivity not one in a hundred is used effectively for morphological investigations or either wholly or in part finds its way into an institutional collection. The wastage of our most expensive, and from various points of view our most precious, biological materials is unbelievably great. For this reason, among others, these laboratories are attempting to breed and culture chimpanzee so that it shall be as nearly as possible ideally available and useful in biological research.

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THE NATIONAL ACADEMY OF SCIENCES. III.

ABSTRACTS OF PAPERS PRESENTED AT THE AUTUMN MEETING[1]

Anthropological excavations on Kodiak Island[2]*:* A. HRDLIČKA. All studies on the origin of the American aborigines point to Asia as the source of their derivation. The basic identity of the American man, his unquestionable status as a variety of modern man, and the nature of his cultures, all point to a relatively late, post-glacial, peopling of America. The routes practicable for the coming of man from Asia to America, during the time such comings were taking place, were limited to Bering Strait, and possibly the Aleutian Islands. The newcomers must all, therefore, have passed over parts of Alaska, and they must have left there the remains of their stay. Such remains were the kitchen and house refuse with the bones of the fish, birds and mammals the people ate; cultural objects, especially those of stone, bone and ivory; and the skeletal parts of those of the migrants who died there. Such remains, in the Far North, are almost indestructible and should still be preserved in that region. The object of American anthropology and archeology is to locate these remains and learn what information they can give. Preliminary surveys of the regions in question revealed a great number of "dead" sites, some of which had been abandoned far back of the Russian times. But they revealed also serious obstacles to exploration. The main of these is the fact that the coasts, the rivers, the land in western Alaska have changed greatly during the last few thousands of years and are still changing. This means that the location of the earlier remains will be very difficult, in a large measure in fact impossible. The second great obstacle is that the ground over most of the territory is perpetually frozen, which makes excavation exceedingly slow and difficult. The only favorable places for excavation are those on the southern shores of the Aleutians, of the Peninsula and of southeastern Alaska. They include Kodiak Island, and it is on this island that an undisturbed pre-Russian site of much promise was discovered. This site for three years and a half now has been excavated by the Smithsonian, and has yielded astonishing results. The human accumulations are up to 16 feet in thickness. They lie directly on glacial till and a layer of fine loess. They cover the period of perhaps 2,000 years. There were two different human occupations, with two different types of man and culture. The deep old type, while slightly Eskimoid, was in the main Indian. Its counterpart has been recovered from the deep layers of a huge mound on Frazer River, British Columbia. Its culture was both broad and artistic. The people domesticated the fox. They left signs of animism, fetishism and other mythical practises. They knew cannibalism and burnt human sacrifice. They were rather delicate physically, but free from constitutional diseases aside from arthritis. Their medicine men made use of human bones, and knew even the art of trephining. They paved with dressed slate slabs their lower lying habitations, and made slate-paved walks between their houses. They made jar-like receptacles from prepared clay, but

[1] Charlottesville, Va., November 18, 19 and 20, 1935.
[2] Illustrated by motion pictures.

did not bake them. They still used chipped stone implements to quite an extent, but gradually gave these up for polished. The acme of their art in ivory was reached in attempts at bas-relief portraits. They vanished suddenly and completely upon the advent of a physically stronger people of different head type, a few centuries before the advent of the Russians. The "Aleut" people who followed the old stock were a sturdier lot, but with simpler and differing culture. They too eventually vanished from the site, before contact with whites was established. The work on the site, carried on with the help of volunteer students, has yielded on one hand a large store already of original materials, and on the other hand has taught lessons of much importance.

The photodynamic effects of vital dyes on fertilized sea urchin eggs: D. H. TENNENT. The dyes used effectively in this work were Neutral Red, Brilliant Cresyl Blue and Auramine O. The experiments were done on the eggs of the sea urchin *Lytechinus variegatus*. Neutral red in concentrations of 1: 150000, used on eggs 5 minutes after insemination, was non-toxic in diffuse light and on cultures exposed to sunlight for 2 minutes or less, while it was increasingly toxic to cultures sunned from 2 to 8 minutes and fatal to all normal development if the cultures were irradiated beyond 8 minutes. Following irradiation of from 12 to 20 minutes there was uniformly complete cytolysis, the surface of the egg forming a mass of colorless blisters. If the eggs were placed in the neutral red solutions after the nucleus had begun its processes of mitotic division and sunned from 2 to 8 minutes the eggs completed their division, but later development was abnormal. The effective light in the production of the photodynamic effect of neutral red was found to lie in the short waves of the visible spectrum. Cultures protected by a Wratten A No. 25 (Red) filter, and sunned, developed perfectly, and those that were screened from ultraviolet light alone were killed by an exposure of 20 minutes to sunlight. The action of brilliant cresyl blue is similar to that of neutral red. After irradiations of shorter duration both produce abnormalities in the phases of mitotic division. After longer irradiations both produce cytolysis. Auramine O in concentrations of 1: 300000 and 1: 600000 was toxic both in the diffuse-light and the irradiated cultures; in concentrations of 1: 1200000 the eggs in the diffuse light cultures developed abnormally, while those in the sun-treated cultures failed to develop; in concentrations of 1: 2400000, development of eggs in diffuse light approached normal. In concentrations of 1: 4800000 development in the diffuse-light cultures was approximately normal, but was highly modified in those that were irradiated. The photodynamic effect of Auramine O was on the processes of mitotic division. The spindle was greatly reduced in size, was usually multipolar, and division of the nucleus was usually not followed by division of the cytosome. The multinucleate cell finally divided (fragmented) irregularly and cytolized. In concentrations that were on the border line between toxicity and non-toxicity in diffuse-light cultures, irradiation stopped all processes of development instantly.

The earliest responses of vertebrate melanophores: G. H. PARKER. Most fishes and amphibians begin to show color changes immediately after they hatch from the egg. No observations on this subject have been made on ovoviviparous vertebrates such as the dogfish, *Mustelus*, whose young at birth may be as long as 33 cm. These young dogfishes when born are moderately dark, due doubtless to the influence of the maternal body in which they have been lodged. Immediately after birth they respond to their environment by changing light or dark through a concentration or a dispersion of their melanophore pigment. Pale bands can be produced by cutting the nerves in their fins and they blanch when adrenalin is injected into them and darken to an injection of pituitrin all as in the adults. They show no primary phase of color change, but are born with a melanophore system in the second phase, that is, in adult reactivity. The primary phase in them is apparently suppressed.

The manipulation of Hydra's nematocysts by Microstomum: W. A. KEPNER, W. C. GREGORY and R. J. PORTER. The polyp, *Hydra*, and the Turbellarian, *Microstomum*, feed upon each other. *Hydra* wounds or captures *Microstomum* only when the latter approaches it unawares. The *Microstomum* discharges from its pharynx a secretion that acts as a local anesthetic so that the polyp seems not to be disturbed when the worm is feeding upon it. The *Microstomum* eats the polyp primarily for its defensive structures, the nematocysts. The tissues of *Hydra* are digested within the enteron of *Microstomum*, leaving the three types of nematocysts (penetrants, glutinants and volvents) behind free of their cnidoblasts. These nematocysts are taken up by the endoderm and delivered to the mesenchyme. Here phagocytes ingest and digest the lasso-type of nematocysts (volvents) which would be of no use to the *Microstomum*. The penetrants and glutinants (stinging threads) are carried by phagocytes to the epidermis where, in cooperation with epidermal cells, the attending phagocytes (cnidophages) orientate the nematocysts and retain them indefinitely (for three or more generations). These orientated nematocysts are used by the *Microstomum* in wounding other animals that disturb it. So many cells of *Microstomum* cooperate in the manipulation of the nematocysts that one is tempted to remark that a *Microstomum* is all cooperation; as Weismann said that "a whale is all adaptation."

Virus concentration in relation to acquired immunity from tobacco ring spot: W. CONWAY PRICE. Tobacco plants infected with ring spot, a virus disease, invariably recover and become immune from the disease. Leaves from recovered plants, although difficult to distinguish from healthy leaves, continue to carry the ring spot virus. In the present study it was found that the virus of ring spot multiplies in recovered plants but never reaches as high a concentration there as it does in diseased plants. Leaves from diseased plants have, on the average, from 5 to 10 times as much virus as leaves from recovered plants. The decrease in virus concentration occurs suddenly since the healthy-appearing portions of partly recovered leaves

contains much less virus than the diseased portions of the same leaves. The virus concentration of leaves from recovered plants was not increased by inoculating them heavily with ring-spot virus. Roots of recovered plants likewise contain somewhat less virus than roots of diseased plants. Stems of recovered and diseased plants, on the other hand, were not found to differ significantly in virus content. The virus concentration of different leaves of both recovered and diseased plants was found to show a rather wide variation, whether such leaves were taken from the same or from different plants.

Increased mutation rate from aged Datura pollen: A. F. BLAKESLEE, J. L. CARTLEDGE and M. J. MURRAY.

Studies of the nature of rust resistance in beans: S. A. WINGARD. The results of studies conducted over a period of several years clearly show that varieties of beans, *Phaseolus vulgaris* L., differ greatly in their reaction to infection by the rust fungus, *Uromyces appendiculatus* (Pers.) Fries. On varieties commonly classed as rust susceptible, inoculation is followed by infection and the development of normal sori and spores. This, however, is not the case with the so-called rust-resistant varieties. On these, infection occurs, but the parasitized cells collapse as a rule before sori and spores are developed, thus producing sterile flecks in the tissues of the bean leaf. Hence, the so-called rust-resistant varieties owe their ability to resist the rust disease to their hypersensitiveness rather than to the property of true resistance or immunity. For all practical purposes, this type of resistance is satisfactory because the rust fungus can not produce spores in sufficient quantity on such plants to cause severe damage. Hypersensitive plants, however, can be killed by artificial inoculation with heavy doses of spores. In the case of the susceptible varieties, the invaded host cells are not destroyed by the rust fungus, but on the contrary are stimulated as a result of a symbiotic relationship formed with the fungus at the expense of the surrounding uninvaded host tissues. The rust hyphae spread from the point of infection through the tissues of the bean leaf and thus form circular colonies very similar in appearance to fungous colonies produced on artificial culture media. The colonies of invaded leaf cells, together with the invading rust hyphae, form the parasitic units which live at the expense of the other host cells. This symbiotic relationship between rust hyphae and invaded host cells continues until after spore production and the surrounding tissues are too much impoverished to continue to nourish the parasitic units. The rust hyphae then lose their ability to take the stain as if completely exhausted, whereas the invaded host cells seem to be invigorated as shown by the production of a green island surrounding the sorus. It seems that the invaded host cells prey upon the contents of the rust hyphae after the hyphae are weakened and partially exhausted by spore production.

Motion pictures showing some of the effects of alcohol on nerves in living frog tadpoles: CARL CASKEY SPEIDEL. Practically any degree of neuritis may be induced in living frog tadpoles if these are immersed in dilute solutions of alcohol for suitable periods of time. The minute structural changes in single nerve fibers have been directly observed and photographed in the living animals during both irritation and recovery. Myelinated fibers irritated by alcohol exhibit vacuolation, fibrillation, swelling and globule formation. Severe prolonged irritation causes complete degenerative metamorphosis of the more distal myelin segments of a fiber. Mild daily intoxication of brief duration, even though continued for many weeks, causes little damage to nerves. The slight irritative changes that appear each day during treatments are quickly repaired. Under these conditions nerve growth continues, including myelin ensheathment of fibers and the origin and extension of new nerve branches. Growing nerve tips of regenerating fibers, as well as resting nerve endings supplying the skin, undergo definite retraction in alcoholized animals. Such retracted nerve endings grow out again soon after normal conditions are restored.

Conformal geometry: EDWARD KASNER. Just as projective geometry is based on the group of linear transformations, so conformal geometry is based on the group of all regular analytic functions of a complex variable. A single curve has no invariants, but a pair of curves at a point (curvilinear angle) has as fundamental invariant the angle θ between the tangents of the curves. The author has shown the existence in certain cases (namely θ a rational part of 360° or 2 π) of differential invariants of higher order. In the case of $\theta = 90°$, two relative invariants of third and fifth orders are found, and thus an absolute invariant of fifth order is determined. If, in hydrodynamics, we are given one stream line and one level line (of course meeting orthogonally), these two curves are not independent, but form a special type of curvilinear right angle, subject to an infinity of conditions. Three fourths of all the coefficients in the two power series are arbitrary. In the historically important case $\theta = 0$, giving a *horn angle* (two curves with a common initial tangent line), relative invariants of second and third order arise, and thus a unique absolute invariant of third order exists.

This invariant, which is defined as the "natural or conformal measure of the horn angle," is

$$M = I_3 = \frac{\frac{d\gamma_1}{ds_1} - \frac{d\gamma_2}{ds_2}}{(\gamma_1 - \gamma_2)^2} = \frac{r_2^2 \frac{dr_1}{ds_1} - r_1^2 \frac{dr_2}{ds_2}}{(r_1 - r_2)^2}$$

$$= \frac{\frac{d^2\theta_1}{ds_1^2} - \frac{d^2\theta_2}{ds_2^2}}{\left(\frac{d\theta_1}{ds_1} - \frac{d\theta_2}{ds_2}\right)^2} = \frac{\tan \delta_1 - \tan \delta_2}{(\gamma_1 - \gamma_2)^2}$$

where γ is curvature, r is radius of curvature, ds is element of arc, and δ is deviation. A concrete interpretation is obtained by drawing the two circles of curvature and the two osculating parabolas (or conics). For all circular horn angles the measure M obviously vanishes. If M does not vanish the horn angle can not be converted conformally into a circular angle. New invariants are obtained for higher order contact. Thus we obtain an intrinsic non-Archimedian classification of all horn angles.

For an orthogonal angle the simplest relative invariant is $\frac{d\gamma_1}{ds_1}+\frac{d\gamma_2}{ds_2}$, as contrasted with $\frac{d\gamma_1}{ds_1}-\frac{d\gamma_2}{ds_2}$ and $\gamma_1-\gamma_2$ for the horn angle. The bisection and multisection of curvilinear angles is studied in detail. It is shown that any one of these relative or absolute invariants completely characterizes the conformal group, and that the results can be extended to any surface. New theorems are found concerning conformal symmetry with respect to any curve (Schwarzian reflexion), a process fundamental in the theory of functions (analytic prolongation). Finally families of curves are studied conformally. The entire theory is then extended dually to equilong geometry, where many analogies and certain distinct features are displayed.

Continuous transformations on certain manifolds: G. T. WHYBURN.

On the computation of $\frac{1}{n!}$ *to 400 decimal places, together with associated numbers:* H. S. UHLER.

Periodic solar variation and associated weather phenomena: C. G. ABBOT. Stations 7,000 miles apart in opposite hemispheres agree to within an average daily difference of one third per cent. in values of the sun's intensity of radiation outside our atmosphere, and agree in showing the solar radiation to be variable. The solar variation, seemingly altogether irregular, is comprised of 12 regular periodicities ranging in length from 7 months to 23 years. These sum up to within an average difference of one fifth per cent. of the observed solar variation curve. These 12 periodicities are all aliquot parts of 23 years, which also is the sun's magnetic cycle. These solar periodicities are found in the temperature and precipitation of 6 widely separated cities of the northern and southern hemispheres during the past 100 years. Reversals of phase occur in these weather periodicities, and hitherto have obscured them. But these reversals occur abruptly at intervals which are integral multiples of $11\frac{1}{2}$ or of 23 years from the year 1819. The 23-year cycle has been traced in the Pleistocene and Eocene geologic formations, in the widths of tree-rings, in the catch of ocean fishes and in the levels of the Nile River and the Great Lakes. A 46-year cycle is even more marked in Great Lake levels, and clearly associates itself with drought conditions. The 23-year cycle has been used to make test forecasts of temperature and precipitation for more than 30 cities in the United States for the years 1934, 1935 and 1936. The percentage results in 1934 were as follows: Excellent, 27; Good, 42; Half good, 17; Bad, 14. Publication of forecasts is withheld pending further tests.

The national mapping plan of the National Resources Board: WILLIAM BOWIE. To be published later.

Prismatic deviation as a function of cosmical orientation: F. L. WHIPPLE, T. E. STERNE and D. NORMAN. Measurements of the total deviation of light in a rigidly constructed 2-prism astronomical spectrograph were made to detect any possible changes produced by azimuthal rotation of the instrument in its optical plane at various sidereal times. The deviation was found to be constant within the accuracy of its measurement. The determination of each "change" (due to a 90° or 180° change in azimuth) involved two least squares solutions, each depending upon 12 measurements of spectral lines on a photographic plate. The probable error, as determined from the least squares solutions, of a single "change" in the refractive index of the prisms should be 0.000000077 from errors of measurement. The observed probable error of a single "change" is 0.000000078. Thirty-six (36) "changes" were measured, and do not appear to be correlated with sidereal time, in any obvious manner. The mean of all the "changes" in the refractive index is $0.000000022 \pm 0.000000013$.

The proportion of dwarfs among tenth magnitude stars: P. VAN DE KAMP and A. N. VYSSOTSKY. Frequency distributions of the transverse motions of 3,000 faint stars with known spectra were investigated in order to obtain additional information concerning the relative frequencies of giants and dwarfs among tenth magnitude stars. This was especially desirable in view of the fact that the results recently obtained by Bok and van Rhijn and Schwassmann were contradictory to the conclusions of Schilt. The method used differed from those used by other investigators. It consisted of a very simple analysis of the frequencies of motions (H functions) corrected for the errors of observation. It was found in essential agreement with Bok and van Rhijn and Schwassmann that in both high and low galactic latitudes about 50 per cent. of the 10th magnitude G stars are dwarfs, while among the K stars the percentage of dwarfs is 19 per cent. in low latitudes and 35 per cent. in high latitudes. Grouping all stars together irrespective of their spectral class, it was found that 18 per cent. are dwarfs in low latitudes, whereas in high latitudes 35 per cent. are dwarfs.

New velocities of extra-galactic nebulae: M. L. HUMASON. During the past four years the apparent velocities of 100 extra-galactic nebulae have been obtained at Mount Wilson. They include velocities from 6 clusters, 5 groups and 56 isolated nebulae. As found in previous investigations they are predominantly velocities of recession ranging from only a few hundred km/sec. for the nearer and brighter objects, to velocities of the order of +40,000 km/sec. in the Boötes cluster and in the second Ursa Major cluster. Both clusters are estimated to be at distances of about 70 million parsecs. The observations cover a range about forty times that available in Hubble's first formulation of the velocity-distance relation and indicate that the relation is still sensibly linear out to the distance of these clusters. The constant of the linear relation, $v = 560$ km/sec. per million parsecs, remains essentially unchanged. In the Virgo cluster 25 new velocities have been obtained. These, with velocities previously known, show an average range of 500 km/sec.

around a mean of +1,200 km/sec. The apparent photographic magnitudes of the objects observed range from 10.0 to 15.0 and the mean velocity of the fainter members is approximately the same as that of the brighter. Velocities of isolated nebulae, including those previously known, have been used by Hubble and Humason to derive the velocity-distance relation for isolated nebulae. The relation parallels that for the clusters but is displaced one magnitude toward the brighter side. This displacement occurs because the nebulae observed were selected on the basis of apparent magnitude, a selection which favors the systems of high luminosity if the spatial distribution is considered. It is in the direction and of the order expected. Only six nebulae have negative velocities. Three of them, NGC 247, 253 and IC 342 are large and relatively near objects. The spectra of two others, NGC 4569 and NGC 6207, may be those of stars projected on the nuclei. Comparison of the spectral type with the nebular type shows that late-type spirals are decidedly bluer than E, Sa or Sb nebulae. The mean spectral types for these groups are: E0-7, G3.6; Sa, G3.4; Sb, G1.6; Sc, F8.8. The mean spectral type of faint nebulae is approximately the same as that of the brighter nebulae. The mean spectral type of the 100 objects observed is G2.5.

The magnitudes of 6284 stars in 350 regions of long-period variables: S. A. MITCHELL. The American Association of Variable Star Observers have under constant observation a large number of stars whose magnitudes are changing with periods fairly well known. The stars with periods greater than one hundred days are called long-period variables. Our own sun is a variable star with a period of eleven years. Long-period variables are ordinarily observed visually by comparing the magnitude of the variable with two stars, one slightly brighter and one fainter than the variable. After the originator, this plan of observation is known as the Argelander method. To obtain the magnitude of a variable with accuracy it is necessary to have for each variable a sequency of comparison stars covering the whole range in brightness of the variable and to have accurately known magnitudes for each star of the sequence. The magnitudes of 6,284 comparison stars have been determined from visual observations with the 26-inch McCormick refractor both by observations with a wedge photometer and by visual sequences. By plotting the latter against the former an accordant series of magnitudes is derived. Comparisons of the magnitudes derived at the Leander McCormick Observatory, where the observational work was done chiefly by S. A. Mitchell, with similar magnitudes derived at the Vatican Observatory, show a high degree of accuracy. Comparisons of the visual magnitudes with those made by photographic processes and known as photovisual magnitudes, derived mainly at Harvard and Mt. Wilson, show a splendid agreement between the visual and photovisual magnitudes.

Biographical memoir of Eliakim Hastings Moore: G. A. BLISS and L. E. DICKSON.

Biographical memoir of John Ripley Freeman: VANNEVAR BUSH.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ILLUMINATOR FOR CRITICAL MICROSCOPY UTILIZING AUTOMOBILE HEADLIGHT LAMPS

CRITICAL illumination for microscopy with high-power objectives requires a small (3 mm) source of both uniform and high intensity. This condition may be met admirably and economically by using a fine ground glass as a secondary source and focussing the light from a 6–8 volt automobile headlight lamp upon it. Replacement costs are almost trifling compared to the expensive ribbon filament, projection and other type lamps commonly used, while savings effected through decreased power consumption are considerable. Although a 32 candle power lamp will generally prove sufficient, both 50 c.p. and the double 32:32 c.p. bulbs are available where still greater intensity is needed as, *e.g.*, for photomicrography and dark-field illumination.

Certain types of commercial microscope illuminators have optical systems which are adaptable to the use of these headlight lamps, but when the light is concentrated to a small spot on the ground glass for the high power objectives, it no longer suffices to fill the low power field. This problem can be solved by the insertion of a supplementary lens below the substage condenser,[1] by lowering the substage condenser or by the special feature incorporated into the optical arrangement in Fig. 1. The ground glass K (dashed line in

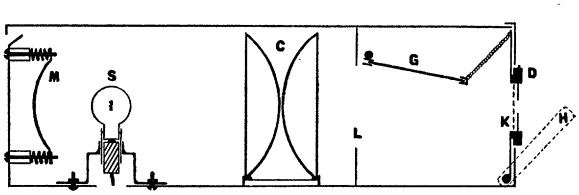

FIG. 1. Microscope illuminator in longitudinal section. Scale approx. ⅙.

Fig. 1) for the small intense source and the iris diaphragm D are mounted in such a manner that their rotation from the vertical plane lowers a second ground glass G to intercept the converging light beam at L. Thus, merely by a quarter-turn of the handle H, a source of proper size and intensity for the low power field is obtainable. This extreme simplicity is dictated by the experience that accessories operated by more complicated motions are soon relegated to a state

[1] I. I. Kornhauser, *Stain Tech.*, 10: 91, 1935.