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PHYSICS.—*The size and shape of the electron.* Arthur H. Compton, Research Laboratory, Westinghouse Lamp Company. (Communicated by G. K. Burgess.)

The radius of the electron is usually deduced from the energy of the electron in motion, assuming its magnetic energy to be identical with its kinetic energy. If the electron is a sphere, its radius must be, according to this assumption, about 1×10^{-13} cm. It is thus sufficiently small to act as a point charge of electricity even with the shortest γ-rays.

Calculating on the basis of such an electron, J. J. Thomson[1] has shown that the fraction of the energy of an electromagnetic wave incident upon an electron which is scattered by it is given by the expression

$$\frac{8\pi}{3}\frac{e^4}{m^2C^4}.$$

This corresponds to a mass absorption coefficient due to a scattering of the primary beam equal to

$$\frac{\sigma}{\rho} = \frac{8\pi}{3}\frac{e^4N}{m^2C^4}, \tag{1}$$

where N is the number of electrons which contribute to the scattering in a gram of the absorbing medium, C is the velocity of light, and e and m have their usual significance. As Barkla has pointed out, there may be absorption due to other causes,

[1] Thomson, J. J. Conduction of Electricity through Gases, 2d ed., p. 321.

such as the production of secondary photoelectrons or beta rays, and for other than waves of short length the rays scattered by the different electrons in an atom are nearly enough in the same phase to produce the phenomenon of "excess scattering," so that the absorption coefficient is in most cases considerably greater than the value given by this expression. If the electron acts as a point charge there is, however, no possible grouping of the electrons which can, according to classical theory, produce a smaller absorption than that calculated according to Thomson's formula.

Barkla and Dunlop[2] have shown that for a considerable range of wave-lengths of X-rays the mass scattering coefficients of the lighter elements are given accurately by equation (1) if the number of electrons in the atom is taken to be approximately half the atomic weight. For elements of high atomic weight the phenomenon of excess scattering occurs, except with the very shortest wave-lengths, and the absorption coefficient due to scattering becomes much greater than this value. For wave-lengths less than 2×10^{-9} cm., however, the absorption coefficient becomes very appreciably less than that theoretically calculated, falling as low as one-fifth as great for the shortest γ-rays. Soddy and Russell[3] and Ishino[4] have shown that for these shortest rays the amount of energy scattered by the different elements is accurately proportional to their atomic numbers, so that all the electrons outside the nucleus are effective in producing absorption. It is therefore impossible to account for this very considerable decrease in the absorption coefficient for very short electromagnetic waves if the electron is considered to be a point charge of electricity.

If, however, the diameter of the electron is comparable in magnitude with the wave-length of the incident wave, the radiation scattered by different parts of the electron will be so different in phase that the energy of the scattered rays will be materially reduced. If, for example, the charge on an electron

[2] Barkla and Dunlop. Phil. Mag., March, 1916.
[3] Soddy and Russell. Phil. Mag. **18**: 620. 1910; **19**: 725. 1910.
[4] Ishino. Phil. Mag. **33**: 129. 1917.

is supposed to be in the form of rigid spherical shell, incapable of rotation, a simple calculation shows that the mass absorption coefficient due to scattering is given by

$$\frac{\sigma}{\rho} = \frac{8\pi}{3} \frac{e^4 N}{m^2 C^4} \sin^4 \left(\frac{2\pi a}{\lambda}\right) \left(\frac{2\pi a}{\lambda}\right)^4, \tag{2}$$

where a is the radius of the spherical shell and λ is the wave-length of the incident beam. For long waves this becomes identical with equation (1), but it decreases rapidly as the wave-length approaches the diameter of the electron, as is shown in curve I, figure 1. Such an assumption is therefore able to explain at least qualitatively the decrease in the absorption for electromagnetic waves of very high frequency.

It would appear more reasonable to imagine the spherical shell electron to be subject to rotational as well as translational displacements when traversed by a γ-ray. The scattering due to such an electron is difficult to calculate, but an approximate expression can be obtained if the electron is considered to be perfectly flexible, so that each part of it can be moved independently of the other parts. On this hypothesis it can be shown that the intensity of the beam scattered by an electron at an angle θ with an unpolarized beam of γ-rays is given by the expression

$$I_\theta = I \frac{e^4 (1+\cos^2\theta)}{2r^2 m^2 C^4} \left\{ \left(\frac{\lambda}{4\pi a}\right)^2 \sin^2 \left(\frac{4\pi a}{\lambda} \sin \frac{\theta}{2}\right) \Big/ \sin^2 \frac{\theta}{2} \right\}. \tag{3}$$

Here I is the intensity of the incident beam, r is the distance at which the intensity of the scattered beam is measured, and the other quantities have the same meaning as before. The mass absorption coefficient due to scattering by such an electron is therefore

$$\frac{\sigma}{\rho} = 2\pi N r^2 \int^{\pi} \frac{I_\theta}{I} \sin\theta \, d\theta. \tag{4}$$

This integral may be evaluated graphically or by expansion into a series. The values of σ/ρ in the case of aluminium, taking the numbers of electrons per atom to be 13, are plotted in curve II, figure 1, for different values of a/λ. The values for a rigid spherical electron which is subject to rotation should lie between curves I and II for the range of a/λ here plotted.

Unfortunately the experimental data are too meager to submit these formulae to accurate quantitative test. There are,

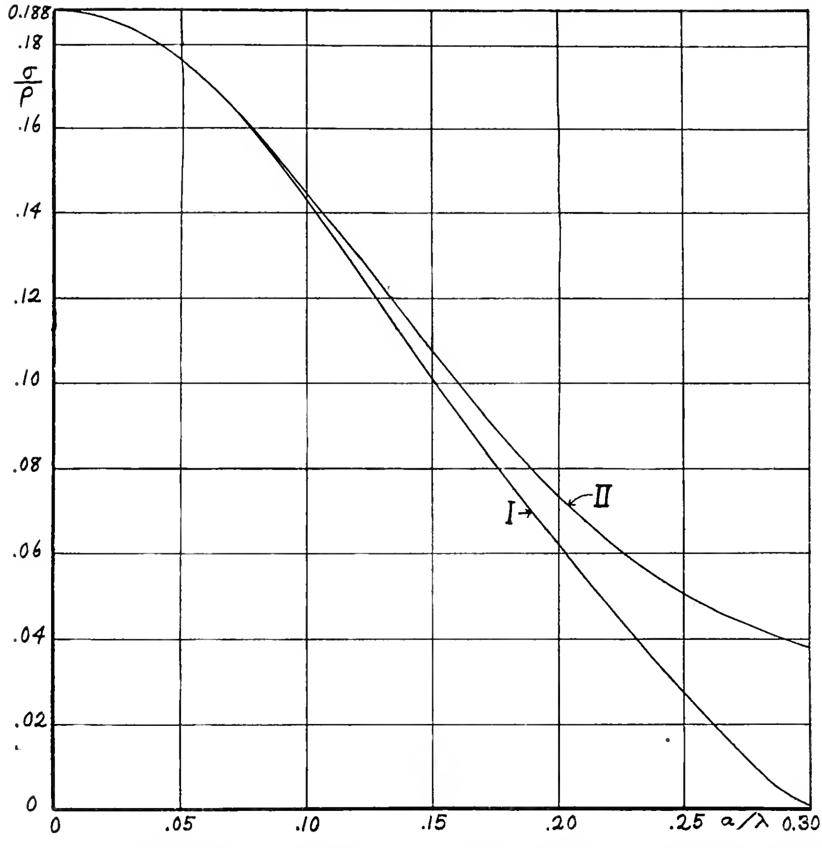

Fig. 1. Mass absorption coefficient for electrons (I) in the form of rigid spherical shells incapable of rotation, and (II) in the form of perfectly flexible spherical shells. The number of electrons per atom is taken as 13.

however, three points on the curve which are established with some accuracy. Barkla[5] has found that for relatively long X-rays the light elements scatter accurately according to equation (1), so that the part of the curves where a/λ is small is verified.

[5] BARKLA and DUNLOP. Phil. Mag.

Hull and Rice[6] have shown that for wave-lengths in the neighborhood of 0.17×10^{-8} cm. the value of σ/ρ for aluminium is about 0.12. From curve I this corresponds to an electronic radius of 2.2×10^{-10} cm., while curve II gives 2.3×10^{-10} cm. Ishino[7] finds that the value of σ/ρ, using the hard γ-rays from radium-C, is about 0.045. Taking the effective wave-length to be[8] 0.093×10^{-8} cm., curve I gives $a = 2.1 \times 10^{-10}$ and curve II gives $a = 2.5 \times 10^{-10}$ cm. Using either formula the agreement between the two values of the radius is within the limits of probable experimental error. The unusually low absorption coefficient for γ-rays can therefore be quantitatively explained on the hypothesis that the electron is a spherical shell of electricity of radius about 2.3×10^{-10} cm.

Another difficulty that is found in J. J. Thomson's simple theory is that it predicts that if a beam of X-rays is passed through a thin plate the intensity of the scattered rays on the two sides of the plate should be the same. It is well known, however, that the scattered radiation on the emergent side of the plate is much more intense than that on the incident side, both in the case of relatively soft X-rays and in the case of hard γ-rays. Barkla and Ayres[9] have shown that for rather hard X-rays and for those substances of low atomic weight whose absorption coefficient can be calculated accurately by equation (1) this prediction of Thomson's theory is also valid. In the case of the heavier atoms and the longer waves, however, the rays scattered at a small angle with the incident beam by the different electrons in the atom are so nearly in the same phase that the intensity is considerably increased, while at large angles the phase difference is much greater, and the intensity is much smaller. This explanation cannot, however, be applied to the excess scattering of γ-rays of short wave-length, since experiment shows[10] that for longer waves the light elements show no

[6] Hull and Rice. Phys. Rev. **8**: 326. 1916.
[7] Ishino. Phil. Mag. **33**: 129. 1917.
[8] Rutherford and Andrade. Phil. Mag. **28**: 263. 1914.
[9] Barkla and Ayers. Phil. Mag. **21**: 271. 1911.
[10] Barkla and Ayers. Phil. Mag. **21**: 271. 1911.

excess scattering on the emergent side, indicating that the electrons act independently, while for hard γ-rays the excess scattering is the same as for the heavier elements.

The same difficulty is present if instead of considering the electron as a point charge it is assumed to be a rigid spherical shell incapable of rotation, as this assumption also makes the scattered radiation symmetrical on the incident and the emergent sides. If, however, the electron is a spherical shell of electricity which can be rotated by a passing electromagnetic wave, it is

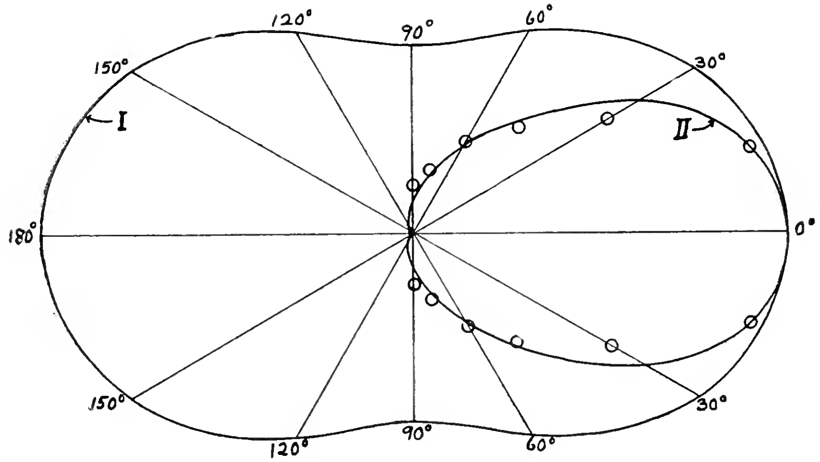

Fig. 2. The intensity of the radiation scattered at an angle θ with the incident radiation, the electron being a perfectly flexible spherical shell. I, radius of electron = 0; II, radius = $3\pi\lambda/4$.

capable of producing excess scattering on the emergent side for short γ-rays in much the same manner as groups of electrons in the atom produce excess scattering in the case of the longer X-rays. For purposes of calculation it is again simpler to consider the nearly equivalent case of the electron which is a flexible spherical shell. The intensity at any angle is then given by equation (3). When $a = 0$, this expression becomes identical with that calculated on Thomson's theory, and the corresponding values are plotted in curve I of figure 2. In curve II, I_θ/I is plotted for different values of θ, using the value $a = 3\pi\lambda/4$.

The circles are experimental values determined by D. C. H. Florance[11] using the γ-rays from radium bromide scattered by a plate of iron. Inasmuch as these rays are heterogeneous, and as the softer rays are scattered relatively more strongly at larger angles, the agreement of the experimental values with curve II is as good as can be expected.

A better quantitative test of this explanation is afforded by Ishino's observation[12] that the radiation scattered on the incident side of a plate struck by hard γ-rays from radium-C is about 15 per cent of that scattered on the emergent side. On the hypothesis of the electron as a flexible sphere this ratio is given by the relation

$$\frac{I_i}{I_e} = \int_{\pi/2}^{\pi} I_\theta \sin\theta \, d\theta \bigg/ \int_{0}^{\pi/2} I_\theta \sin\theta \, d\theta \qquad (5)$$

The values of this ratio for different values of a/λ are plotted in figure 3. This curve explains beautifully the observation of Florance that the "incident" scattered rays are softer than the "emergent" and the primary rays, since it shows that the relative amount of the rays scattered backward is much greater for soft, or long wave-length, γ-rays than for hard rays. Rutherford and Andrade[13] have found the hard γ-rays from radium-C to consist of a strong line, $\lambda = 0.099 \times 10^{-8}$, and a weaker line, $\lambda = 0.071 \times 10^{-8}$ cm. Taking into account this selective effect, we may take the effective wave-length to be 0.095×10^{-8} cm. On this basis, and using $a = 2.3 \times 10^{-10}$ as determined above, the calculated value of the ratio of the incident to the emergent scattered radiation is 8 per cent. The agreement is hardly within the probable experimental error, but the calculated value is at least of the proper order of magnitude, which is a strong verification of a flexible or a rotatable electron.

According to electromagnetic theory it is obvious that the mass of an electron cannot be accounted for on the basis of a uniform distribution of electricity over the surface of a sphere

[11] Florance. Phil. Mag. **20**: 921. 1910.

[12] Ishino. Phil. Mag. **33**: 129. 1917.

[13] Rutherford and Andrade. Phil. Mag. **28**: 263. 1914.

of the size here assumed. Much the same effect, so far as the scattering of γ-rays is concerned, results from the conception of the electron as a ring of electricity of diameter comparable with the wave-length of the incident beam. It has been shown by

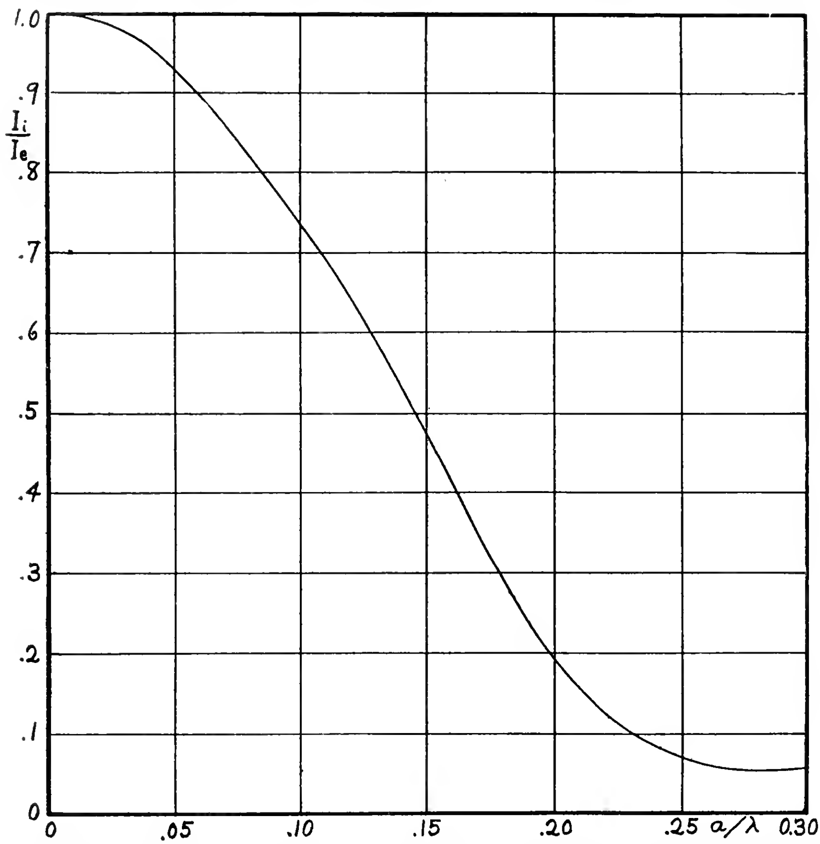

Fig. 3. Ratio of the intensity of the radiation scattered on the incident side to that of the radiation scattered on the emergent side of a plate. The electron is assumed to be a flexible sphere.

Davisson[14] and Webster[15] that this conception is compatible with the electromagnetic theory of the mass of the electron. I have not as yet been able to solve completely the problem of the scattering produced by such ring electrons. Approximate

[14] Davisson. Phys. Rev. **9**: 570. 1917.
[15] Webster. Phys. Rev. **9**: 484. 1917.

methods show, however, that if the electron is a rigid ring whose plane is invariable, the scattered energy follows equation (2) rather closely, and is symmetrical on the incident and the emergent sides. If the electron is a flexible ring, or one capable of rotation about any axis, the scattering is more nearly that given by equation (4), but should be somewhat greater for large values of a/λ. The ratio of the incident to the emergent scattered radiation should also be appreciably larger than that given by expression (5). It seems probable, therefore, that the scattering of γ-rays and X-rays may be completely explained on the hypothesis that the electron is a ring of electricity of radius about 2×10^{-10} cm., if the ring is capable of rotation about any axis.

This hypothesis makes it possible to explain also the effect noticed by A. H. Forman[16] that the absorption coefficient of iron for a beam of X-rays is greater when the iron is magnetized parallel with the transmitted beam than when the iron is unmagnetized or magnetized perpendicular to the X-ray beam. Using an effective potential of 27,000 volts the effect was about 0.4 per cent, and with a potential of 81,000 volts it was 0.6 per cent. From X-ray spectra obtained under similar circumstances it can be shown that the effective wave-length used in the two cases was about 1.0×10^{-8} and 0.5×10^{-8} cm. respectively. If the ring electron acts as a tiny magnet, as suggested by Parson,[17] it may be turned by the magnetic field until its plane is perpendicular to the incident beam of X-rays This will make the rays scattered by the different parts of the electron more nearly in the same phase, so that the absorption due to scattered radiation will be increased. Moreover, since the incident rays can get a better hold on the electron in this position, its displacement will be greater than when unorientated, and absorption due to transformation of the X-rays into other types of energy will be greater. For the relatively long waves used by Forman the ratio of the absorption coefficient when

[16] Forman. Phys. Rev. **7**: 119. 1916.

[17] Parson, A. L. Smithsonian Misc. Collections. Nov. 1915. Parson estimates his "magneton," or ring electron, to have a radius of 1.5×10^{-9} cm.

magnetized to that when unmagnetized should be approximately

$$k\left(\frac{2\pi a}{\lambda}\right)^2 \sin^2\left(\frac{2\pi a}{\lambda}\right)$$

where a is the radius of the ring electron and k is the fraction of the electrons which are oriented by the magnetic field. Using the value $a = 2.3 \times 10^{-10}$ cm., this means that the change in the absorption due to magnetization for $\lambda = 1.0 \times 10^{-8}$ cm. is 0.7 k per cent, and for $\lambda = 0.5 \times 10^{-8}$ cm. is 2.8 k per cent. From the observed values of this difference we find that the fraction of the electrons oriented by the magnetic field is 0.6 and 0.26. The experimental basis of the latter value is much the more certain. Taking the number of electrons in the iron atom to be 26, this means that in order to explain Forman's effect in terms of ring electrons a number $0.26 \times 26 = 7$ of the electrons must be capable of being oriented by the magnetic field. This is what would be expected if it is the 8 valence electrons of iron which are responsible for its ferro-magnetic properties. Our hypothesis of a ring electron of radius 2.3×10^{-10} cm. is therefore capable of explaining satisfactorily Forman's effect.

It should be noted that Forman explains his effect as being due to an orientation of the *molecules* in the iron. The experiments of Rognley and the writer[18] on the effect of magnetizing a crystal on the intensity of the beam of X-rays reflected by it have shown that any orientation of the molecules, if it occurs at all, must be extremely small. It was found further that unless it is very nearly isotropic the atom also is not rotated by magnetization. Thus Forman's explanation of his effect is inadequate. The fact that his experiments can be explained in terms of an orientation of the electrons must be taken as a confirmation of the conclusion arrived at by Rognley and the writer that it is not the atom as a whole, but the electron itself that is the ultimate magnetic particle.

[18] COMPTON and ROGNLEY. Science (N. S.) **46**: 415. 1917.

Summary. Ishino's experiments, showing that the scattering of hard γ-rays by different materials is strictly proportional to the number of electrons and is not proportional to the masses, proves that the electrons are responsible for practically all of the scattering, and that for these wave-lengths they act independently of each other. According to the classical electrodynamical theory, this means that if the electrons are sensibly point charges of electricity, the absorption coefficient due to scattering for these rays must be given by equation (1). Since this equation does not hold for these wave-lengths, we cannot consider the electron to be a point charge. In order to account for the small absorption coefficient of γ-rays *the electron must have an effective radius of about* 2.3×10^{-10} *cm.* In order to explain the fact that the emergent scattered radiation is more intense than the incident radiation, it is necessary to assume further that *the different parts of the charge of the electron can possess certain motions independently of each other.* It appears that these phenomena, together with the electromagnetic mass of the electron, can be quantitatively explained on the hypothesis that the electron consists of a ring of electricity subject to rotation about any axis and of radius about 2.3×10^{-10} cm. This hypothesis is confirmed by the fact that it explains satisfactorily Forman's effect of magnetization of iron upon its absorption coefficient, for which there is no other apparent explanation.

CHEMISTRY.—*A silica-glass mercury still.* J. C. Hostetter and R. B. Sosman, Geophysical Laboratory.

Although numerous electrically heated mercury stills have been described and are doubtless being used with satisfaction, nevertheless there is one undesirable feature that is common to all vacuum mercury stills and that is avoided in the one about to be described: namely, that a still made of ordinary glass or even of combustion glass will, when slightly overheated, collapse under the pressure of the atmosphere.[1]

[1] The form of failure of such a tube is of some interest in itself. One of our ordinary glass stills that collapsed one night when the voltage on the power line became too high yielded symmetrically around its vertical axis, instead of flattening out, producing a figure with three cusps separated by angles of 120 degrees.

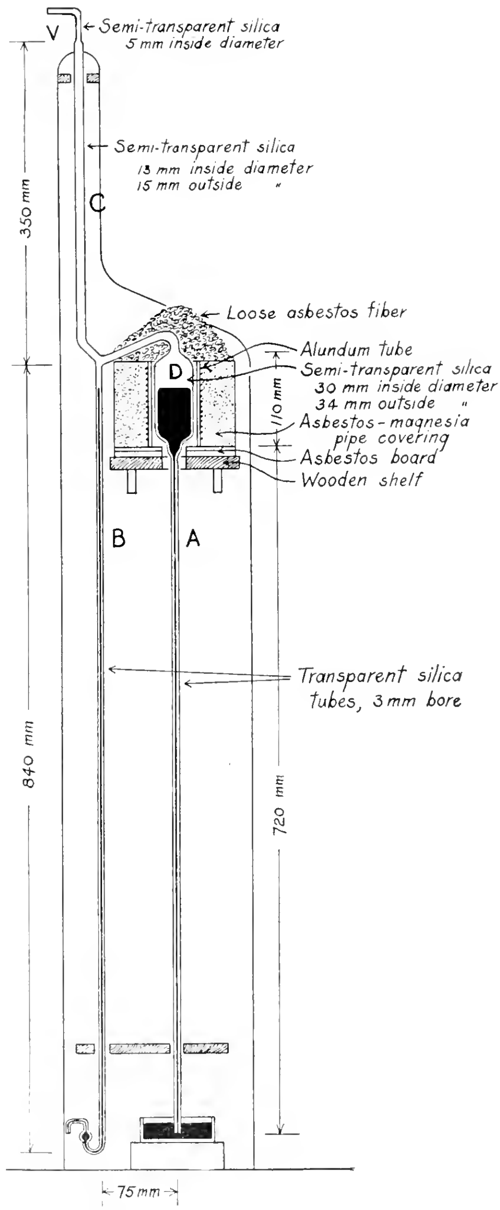

Fig. 1. Silica-glass mercury still

After several such exasperating experiences with glass stills—the overheating being caused by rising voltage on the power line—we had our still remade of silica glass (fused quartz, or "quartz glass"), and it has been in use more or less continuously for several years. The additional cost of the silica-glass still is well expended in the insurance thereby secured against interruption of the distillation. We have been requested to put on record a brief description of the still, having had a number of inquiries for information concerning its design.

Design of the still. The construction is shown in detail in figure 1. An effort has been made to simplify the still as much as possible in order to minimize the difficulties connected with the working of silica glass. No originality is claimed for the design: an inspection of the diagram will show that the essential points of any continuously acting still have been embodied, some having been taken from one still and some from another.

The distillation chamber (*D*) has an inside diameter of 30 mm. and a length of 110 mm. The condenser (*C*) has an inside diameter of 13 mm. Both of these parts of the apparatus are made of the semitransparent inexpensive variety of silica glass. The smaller vertical tubes, *A* and *B*, however, are made of the transparent variety, thus enabling one to observe readily the rate of condensation and to see whether the vacuum is being maintained. At *V* the still is connected to a suction pump that gives a pressure of 1 cm. of mercury or less. This joint is made with hard De Khotinsky cement and is located where it will be air-cooled as thoroughly as possible. The lengths of the small vertical tubes must be such that at ordinary atmospheric pressure the distillation chamber is about half filled: the length of *A* is 720 mm. to the bottom of the distillation chamber, while *B* has a length of 840 mm. The inside diameters of *A* and *B* should not be too small; the tubes on our still have a bore of 3 mm., but 5 mm. might be better.

The furnace. The furnace is wound so as to go directly on the 110-volt circuit (alternating or direct current) without any external resistance. The power consumption is about 60 watts. Since the temperature required is comparatively low, various designs for the furnace might be safely employed; such, for instance, as winding the resistance wire on an asbestos-covered metal tube. Having at hand, however, an alundum tube of suitable size, we found it convenient to wind the wire directly upon this tube, and to hold the wire in place with alundum cement. The alundum tube has an inside diameter of 1½ inches (38 mm.) and is 4½ inches (114 mm.) long. The winding consists of 51 turns (12 to the inch) of No. 30 nichrome wire (diameter 0.010 inch, or 0.25 mm.), giving a total of approximately 24 feet (7.3 meters) of wire. Its resistance is about 160 ohms cold and 200 ohms hot, and the current is about 0.6 ampere. The furnace rests on a disk of heavy asbestos board and is jacketed with ordinary asbestos-magnesia pipe covering. The neck of the still is covered with loose asbestos fiber.

Preliminary treatment of the mercury. As here constructed this still is intended for the final distillation of mercury that has been previously treated to remove the gross impurities. This may be done (a) by the well-known process of Lothar Meyer[2] since modified by Hildebrand[3] and by Desha,[4] in which the mercury is allowed to pass in a fine stream through a long column of dilute nitric acid; (b) by making the mercury the anode in a nitric acid bath and electrolyzing;[5] (c) by passing air through the slightly heated mercury;[6] (d) most thoroughly of all, by the method of Hulett and Minchin,[7] consisting in subjecting the mercury to a preliminary distillation during which a stream of air is bubbled through it. The first three methods have recently been combined and developed into an automatic process.[8]

Another very simple but surprisingly effective method of removing impurities, which is not generally known and which has been ascribed to Henry Leffman, is to shake up the con-

[2] Meyer, Lothar. Z. Anal. Ch. **2**: 241. 1863.

[3] Hildebrand, J. H. J. Am. Chem. Soc. **31**: 933–935. 1909.

[4] Desha, L. J. Am. Chem. J. **41**: 152. 1909.

[5] Wolff, F. A., and Waters, C. E. Bull. Bur. Standards **3**: 624–625; **4**: 9–11. 1907.

[6] Crafts, J. M. Bull. Soc. Chim. Paris **49**: 856. 1888.

[7] Hulett, G. A., and Minchin, H. D. Phys. Rev. **21**: 388–398. 1905.

[8] Patten, H. E., and Mains, G. H. J. Ind. Eng. Chem. **9**: 600–603. 1917.

taminated mercury with cane sugar. After such a treatment and a filtration through a pin hole the mercury comes out remarkably clean.

Unless the mercury has been partially purified in some manner the tube *A* may become clogged by the accumulation of foreign metals which concentrate in the tube as the mercury distils.

If a wet process of purification has been employed, it is best to dry the mercury by bubbling air through it for several hours before introducing it into the still.

After a distillation from this apparatus the mercury should be given a filtration through a pin hole in a filter paper in order to remove a slight film of oxide produced by the oxidation of metal impurities by the small amount of air remaining in the still. After such a distillation and filtration the mercury may be safely used in vacuum gages and in thermoregulators, and for other purposes requiring a reasonably pure product.

The yield of distilled mercury is about 400 cc. per twenty-four-hour day, when the still is operated with a vacuum of approximately 1 cm. of mercury.

PHYSIOLOGY.—*Sensory fibers in the mesencephalic root of man and the guinea pig.* WILLIAM F. ALLEN, Department of Anatomy, University of Oregon Medical School, Portland, Oregon.

As a result of Marchi stained serial sections of the brain stems of a five year old girl and two guinea pigs, in which the left V-roots of the guinea pigs were previously severed behind the semilunar ganglion and the V-sensory root of the girl had been destroyed by a large glioma in the pons region, the following preliminary statement can be made: A number of sensory fibers arising from cells in the semilunar ganglion follow the ventral surface of the sensory root of the trigeminal nerve into the brain stem to pass dorsally between the V-motor and the V-sensory (substantia gelatinosa) nuclei to end in considerable numbers in the motor nucleus. Other fibers continue dorsad and cephalad in the V-mesencephalic root to terminate in the locus coeruleus. Degenerated fibers were fairly abundant in the mesencephalic root as far cephalad as the point of crossing of the IV-nerve root. A few of these sensory fibers apparently continue farther cephalad in the mesencephalic root to end in the V-mesencephalic root nucleus lateral to the central gray mass above the IV and III nuclei. Additional experiments are in progress to determine the distribution of the nerve fibers arising from the V-mesencephalic nucleus and the locus coeruleus.

CONCHOLOGY.—*The land mollusks of the genus Obba from the islands of Bohol and Panglao, P. I.*[1] PAUL BARTSCH, U. S. National Museum.

The United States National Museum has recently received a lot of shells belonging to the genus *Obba*, collected by Gilbert S. Perez on the islands of Bohol and Panglao, which made a revision of the group necessary. This has resulted in the recognition of a number of new forms, brief critical diagnosis of which are presented herewith. A fuller account and figures of these will be published in a monograph on the Philippine members of the genus, which is in preparation.

Obba rota Perezi, n. subsp.

The present race differs from *Obba rota rota* Broderip, which is at home on the island of Siquijor, in being decidedly more elevated and in having the peripheral keel less upturned at the edge, and situated about half way between the base and summit, while in *Obba rota rota* it is at the anterior extremity of the upper third.

The type, Cat. No. 216983, U. S. N. M., comes from Bilar, Bohol, and measures: altitude, 10.2 mm.; greater diameter, 27.6 mm.; lesser diameter, 22 m.

Obba rota panglaoensis, n. subsp.

This race is much smaller and darker than *Obba rota rota* Broderip. It is elevated like *Obba rota perezi* B. and has the keel similarly situated, but the sculpture is rougher in the present race.

The type, Cat. No. 216984, U. S. N. M., comes from 'Panglao Panglao Island, and measures: altitude, 9.7 mm.; greater diameter, 23.5 mm.; lesser diameter, 18.7 mm.

[1] Published by permission of the Secretary of the Smithsonian Institution.

Obba moricandi hernandezensis, n. subsp.

The present race is more elevated and narrower than typical *Obba moricandi moricandi* Sowerby which comes from Jacna, Bohol. The pronounced characteristic color bands of the spire in the typical form are completely absent and only a faint narrow light-brown thread encircles the base. Our specimens come from Garcia Hernandez, Bohol.

The type, Cat. No. 216980, U. S. N. M., measures: altitude, 19.3 mm.; greater diameter, 33.2 mm.; lesser diameter, 25.2 mm.

Obba scrobiculata valenciensis, n. subsp.

The rought axial sculpture, characteristic of *Obba scrobiculata scrobiculata* Pfeiffer, is reduced to a minimum, while the color bands on the upper surface of the typical form are merely indicated by obsolete lines in the present race. The upper surface is marked by broad, light and dark oblique axial zones, which lend it a watered-silk effect. A color band is present on the base.

The type, Cat. No. 216986, U. S. N. M., comes from Valencia, Bohol, and measures: altitude, 13 mm.; greater diameter, 29.3 mm.; lesser diameter, 23 mm.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Notes on the geology and iron ores of the Cuyuna district, Minnesota.* E. C. HARDER and A. W. JOHNSTON. U. S. Geological Survey Bulletin 660–A. Pp. 26, with maps, sections, and illustrations. 1917.

The Cuyuna iron-ore district is near the geographic center of Minnesota, about 90 miles west of Duluth and 55 miles southwest of the western part of the Mesabi district. In contrast with some of the other Lake Superior iron-ore districts, it is without marked topographic relief. It is mainly a region of low, irregular morainic hills interspersed with lakes and extensive swamps and marshes.

The productive part of the Cuyuna district is commonly divided into two ranges—the north range, including the part lying north of the Northern Pacific Railway, and the south range, including the belt lying south of the railway. The discovery of iron ore in the Cuyuna district was entirely due to the existence of abnormal magnetic attractions in the region.

The bedrock in the district and adjacent region is largely concealed by a mantle of glacial drift that varies in thickness from 15 feet to about 400 feet. No rock exposures are known in Crow Wing County, in which most of the district is situated. The rocks that have been found up to the present time in the district can all be grouped under three classes: (1) sedimentary and igneous metamorphosed rocks interlayered with each other in beds and lenses and usually having steep dips due to extensive folding, (2) igneous rocks intruded into the metamorphosed rocks subsequent to their metamorphism and deformation, and (3) younger rocks which lie horizontally on the eroded surfaces of the rocks of the other two classes. The age of the various rocks is not definitely known.

The iron-bearing formation of the Cuyuna district presents a variety of lithologic types. Among the more common rocks composing it are hematitic and limonitic chert and slate, cherty and slaty iron carbonate, siliceous magnetitic slate, amphibole-magnetite rock, jaspilite, dark-blue, red, brown, black, and yellow iron ore, black, red, and brown manganiferous iron ore, green chloritic schist, and dark-red hematitic schist.

It is generally supposed that the original rock from which the present hematitic and limonitic chert and iron ore have in large part been formed is a banded cherty iron-carbonate rock.

The ore bodies are as a rule roughly tabular in shape, with the longer axes parallel to the bedding of the inclosing rocks. As the beds of rock generally dip steeply, the ore bodies are shown at the surface as bands that extend for considerable distances along the strike of the beds. They range in width to several hundred feet and are usually very long, some of the known ore bodies being more than a mile in length. The Cuyuna ore shows all stages of hydration from pure reddish-blue hematite to ocherous yellow limonite, and both argillaceous and siliceous phases are common. R. W. Stone.

PARASITOLOGY.—*A further note on the life history of* Gongylonema scutatum. B. H. Ransom and M. C. Hall. Journ. Parasit. **3**: 177–181. June, 1917.

Seurat in recent publications has questioned certain conclusions reached by the writers in former papers relative to the life history of the nematode *Gongylonema scutatum*. In the present paper these conclusions are upheld, namely that dung beetles and croton bugs fed upon the eggs of *G. scutatum* become infested with an encysted larval stage of the parasite and that it is quite evident that sheep, cattle, and other suitable mammalian hosts become in turn infested as a result of swallowing infested insects (under natural conditions various species of dung beetles). Certain larval nematodes found by Seurat (1916) in several species of *Blaps* in Algeria are not *G. scutatum* and it is not improbable that those which he found in various Algerian beetles and identified as the larvae of *G. mucronatum* Seurat in reality belong to the species *G. scutatum*. B. H. R.

MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The 113th meeting of the Academy, the nineteenth annual meeting, was held at the Cosmos Club at 8.30 p.m., Thursday, January 11, 1917. In the absence of the Recording Secretary, the chair appointed F. E. Wright acting secretary. The minutes of the last annual meeting were read and approved.

The reports of the Corresponding Secretary, the Recording Secretary, the Treasurer, and the Auditing Committee were read and accepted. William R. Maxon presented the report of the editors, which was accepted.

The tellers reported that the mail ballot had resulted in the election of the following officers for the year 1917:

President: W. H. Holmes.
Non-resident Vice-Presidents: E. W. Morley and W. S. Thayer.
Corresponding Secretary: F. E. Wright.
Recording Secretary: William R. Maxon.
Treasurer: William Bowie.
Managers, Class of 1920: Paul Bartsch, C. S. Scofield.

Nominations for Vice-presidents from the affiliated societies were then presented, and the following Vice-Presidents were elected:

Anthropological: Walter Hough.
Archæological: Mitchell Carroll.
Biological: W. P. Hay.
Botanical: A. S. Hitchcock.
Chemical C. S. Hudson.
Electrical Engineers: R. H. Dalgleish.
Engineers: A. L. Baldwin.
Entomological: W. D. Hunter.
Foresters: George B. Sudworth.
Geographic: O. H. Tittmann.
Geological: A. C. Spencer.
Historical: Allen C. Clark.
Medical: G. Wythe Cook.
Philosophical: E. Buckingham.

The meeting was then adjourned for five minutes, after which the Academy met in joint meeting with the Chemical Society, with C. L. Alsberg in the chair. R. B. Sosman presented his address as retiring president of the Chemical Society, on the subject: *Some problems of the oxides of iron.* The address has been published in the Journal of the Academy (7: 55–72. 1917).

R. B. Sosman, *Corresponding Secretary.*

The 114th meeting of the Washington Academy of Sciences was held in the auditorium of the Natural History Building of the National Museum the evening of February 1, 1917. The retiring president of the Academy, Dr. L. O. HOWARD, delivered an illustrated lecture entitled *The carriage of disease by insects.* The address has since been published in abridged form in the Journal of the Academy (**7**: 217–222. April 19, 1917).

The 115th meeting of the Academy was held in the Assembly Hall of the Cosmos Club the evening of March 15, 1917, the occasion being the presentation of the first of a series of public lectures on Heredity. Prof. H. S. JENNINGS, Johns Hopkins University, Baltimore, delivered an address entitled *Observed changes in hereditary characters in relation to evolution.* This has since been published in full in the Journal of the Academy (**7**: 281–301. May 19, 1917).

The 116th meeting of the Academy was held in the Assembly Hall of the Cosmos Club the evening of March 29, 1917, the speaker being Dr. OSCAR RIDDLE, of the Department of Experimental Evolution, Cold Spring Harbor, New York. Doctor Riddle's lecture, entitled *The control of the sex ratio,* has been published in full in the Journal of the Academy (**7**: 319–356. June 4, 1917).

The 117th meeting of the Academy was held in the Assembly Hall of the Cosmos Club the evening of April 13, 1917. The speaker, Prof. W. E. CASTLE, of Harvard University, delivered an address entitled *The rôle of selection in heredity.* This lecture, which concluded the series on Heredity, has since been published under a slightly different title in the Journal of the Academy (**7**: 369–387. June 19, 1917).

WILLIAM R. MAXON, *Recording Secretary.*

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 513th meeting of the Society was held at the National Museum, October 2, 1917, at 4.30 p.m.

Dr. ALEŠ HRDLIČKA, Curator of Physical Anthropology, U. S. National Museum, addressed the Society on *Bohemia and the Bohemians,* illustrating his address with lantern slides.

"Bohemia," said Dr. Hrdlička, "is not a large country but one with a great history; and while among the oldest in Europe and one of the most battered by fate it is struggling vigorously to regain its freedom which it lost in the dark period of the seventeenth century. Its people have been endowed with an unquenchable love of liberty and its free sons are now fighting in every Allied army."

The speaker then noted the geographic position of Bohemia in the center of Europe, surrounded by a natural boundary of hills and mountains. Its area is about one-fourth greater than that of Switzerland, with a density of population nearly twice as great as that of France, and one-seventh greater than that of Germany. Ethnically the Bohemians are Slavs. The names Bohemia and Bavaria are both of Roman origin, derived from the name of the Keltic tribe of Boii, the forefathers of the Bavarians who may have extended over, or claimed a part of, Bohemian territory at one time. The name Czech (applied to the Bohemians) is, according to old tradition, derived from that of a leader or chief of the people.

Archaeological excavations have shown that the Slavs were in Bohemia long before the beginning of the Christian era. The earliest historical mention of them occurs in the second and third centuries. They were never subject to Rome, and the Germans were their eternal enemies. At the beginning of the seventh century they were a strong political unit and in 630 were powerful enough to severely defeat the Germans. Thus began historically the marvelous life-and-death struggle of the Czech people with the voracious German flood that would engulf them, a struggle of thirteen centuries, which has lasted until the present day.

The rich Bohemian literature and archives were repeatedly destroyed by the enemy, but enough has been saved to show that those early times were both idyllic and magnificently barbaric. The people were agriculturists and soldiers. Their organization was patriarchal, their government constitutional, almost republican. The religion of Bohemia was naturalistic and poetic. The priests worshiped under great oaks. There was a supreme deity, beside which there are series of bělobozi, or good gods, černobozi and dăsi or demons, víly (fairies), vodníci (water-spirits), etc. The burials were by cremation.

From the eighth to the fourteenth centuries the Bohemians were ruled by kings of a strong native dynasty. In 1526 the last of the Bohemian kings perished in a battle with the Turks, and soon afterward Bohemia as well as Hungary joined Austria for mutual protection against the common peril. This was the beginning of Bohemia's misfortunes. During the Thirty Years War the life of Bohemia was nearly extinguished; not until the nineteenth century came the time of a revival and restitution. Today the nation stands at the head of all those comprised in the medieval conglomerate of Austria-Hungary in education, industry, and practically every other respect. It is still shackled and persecuted by Austria but hopes and works for an early victory of the Allied arms and with this its liberation. In 1918 Bohemia will have with the Allies two small armies of its own, one in France and one in Russia.

The 514th meeting of the society was held in the National Museum, October 16, 1917 at 4.30 p.m.

Dr. Mitchell Carroll, Secretary of the Archæological Institute of America, delivered a lecture on *The story of Greece.* The lecture was richly illustrated with lantern slides portraying the principal centers of Greek life, such as Olympia, Delphi, Sparta, and Athens, with the monuments of architecture and sculpture that have been most influential in the development of art.

Dr. Carroll, in introducing his subject, noted our indebtedness to Greece as five-fold, comprising (1) democracy, (2) obedience to reason, (3) love of beauty, (4) letters, and (5) art. The history of Greece was outlined in seven divisions: (1) The Prehistoric and Heroic Ages to the Dorian migration, 2000–1000 B.C.; (2) the Greek Middle Ages, 1000–500 B.C.; (3) from the Persian Wars to Alexander the Great, 500–386 B.C.; (4) from Alexander the Great to the Roman conquest, 336–146 B.C.; (5) the Roman, Byzantine, and Latin supremacies, 146 B.C.–1453 A.D.; (6) the Ottoman supremacy, 1453–1832; (7) the modern Greek kingdom, 1832.

The racial life of Greece was emphasized by Dr. Carroll, who said "The central fact of all Greek history, from prehistoric times to the present, is the unbroken life of the Greek race. This racial unity rests on common blood, common language, and common institutions."

1. *Race.* From 650 to 850 the Slavs in Greece outnumbered the Greeks, but the Greeks, being superior in civilization, gradually absorbed them. The process of Hellenizing the Slavonians went on steadily until in about 200 years it was practically complete. Thus, between 850 and 1050 was formed the basis of the modern Greek nation. It contains a large infusion of Slavonic blood, but the strain of Hellenic blood has been perpetual and this has determined the type of the modern nationality.

2. *Language.* Greek, though for many centuries crude and ungrammatical, never lost its vitality. In organic matters of structure and syntax Greek has never made a compromise with any foreign language. Briefly, its story has been this. About 300 A.D. the spoken Greek language began to diverge from the literary language, but until 750 Old Greek was generally understood by the people. Then came the breach of Greek tradition, due to the Slavs, and by 900 A. D. classical Greek had probably ceased to be generally understood. Between 1100 and 1200 popular Greek began to have a literature of its own, the popular Greek of the thirteenth century differing little from the popular Greek of today. The chief difference between Old and Modern Greek is that one is synthetic and the other analytic.

3. *Character.* National characteristics of ancient and modern Greeks are: (1) aptitude for city life; (2) ability in commerce; (3) love of mental culture; (4) cleverness. The real core of the Greek nation throughout its history is the agricultural population of Greece proper. The Greek nationality, like the Jewish, has never been crushed out nor lost.

The 515th meeting of the Society was held at the National Museum, November 6, 1917, at 4.30 p.m.

Prof. James H. Gore presented a paper on *Belgium and the Belgians,* illustrated by lantern slides.

Starting with the revolution which resulted in the withdrawal of the part of Holland that afterward became an independent kingdom with the name Belgium, the speaker explained the duality of languages in Belgium and the ethnic differences between the users of the two tongues.

Immediately prior to the present European war one-tenth of the entire population of Belgium were housed in dwellings which, on easy terms, had become or were becoming the property of the occupants. Thirty-five per cent of the people had accounts in the savings banks and 49 per cent of the inhabitants, male and female, worked at regular callings. Statistics were given to show the thrift of the people, the fertility of the soil, the extent of their foreign trade, and the variety and magnitude of their industries. On each square mile there were 598 inhabitants, and for each inhabitant the railroads annually carried merchandise having a value of $145 as compared with Germany's per capita of $60, and $30 for the United States.

Considerable attention was given to the agricultural commissions —a sort of university extension—which brings to the farmers of the country speakers who tell of recent discoveries and improvements in agriculture that would be of value to the people of each community. To this wise provision can be ascribed a large part of the productivity of Belgium.

The profit-sharing dock laborers of Antwerp were described. It was shown that the prosperity of that port was due to the efficiency of its charging and discharging instrumentalities.

The unique town of Gheel was fully described. In Gheel practically every family cares for one or two feeble-minded persons under the supervision of Government officials. If the family is unable to meet the expense of this care it is borne by the state.

The 516th meeting of the Society was held at the National Museum on Tuesday, November 20, 1917, at 4.30 p.m.

Mr. George Julian Zolnay addressed the Society on *Roumania and her people,* illustrating his subject by native music and by lantern slides.

Mr. Zolnay stated that, with the exception of the Roumanian Jews, there are few natives of Roumania in the United States at the present time, and of these a large majority are from Transylvania and the Bukovina. This accounts for the dearth of accurate knowledge concerning this picturesque country, wedged in between the Carpathian mountains and the Black Sea.

The history of Roumania began in 106 when Trajan conquered Dacia, a country comprising the territory now known as Roumania. At the fall of the Roman Empire in the fifth century the descendants of the Roman soldiers and the Dacian women had become a distinct nationality, speaking a slightly modified Latin which has remained the language of the Roumanian people to the present day. The established religion has remained that of the orthodox Greek Church, although Roumania was a vassal state of Turkey for more than 300 years. During the Russo-Turkish war Roumania regained her independence and was proclaimed a kingdom in 1881, later taking her place as a leading country among the Balkan States.

One of the most remarkable traits of the Roumanian is his love of his national music. This music is so distinct from that of all other nations that only the native musician can render it with the mysterious quality that stirs the Roumanian soul.

Although the misfortunes of war have temporarily prostrated Roumania, it is to be hoped, in the light of her past history, that she will emerge intact, to prepetuate her Latin civilization in the midst of her alien neighbors.

Frances Densmore, *Secretary*.

BIOLOGICAL SOCIETY OF WASHINGTON

The 572d regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, October 20, 1917; called to order by President Hay at 8.15; 42 persons present.

Informal brief notes were presented as follows:

Gen. T. E. Wilcox: *Occurrence of California vulture in Idaho.* He said: I have been requested to record, as it has been doubted, the occurrence of the California vulture in Idaho, then a territory. In the fall of 1879 I came upon two which were feeding on the carcass of a sheep. They hissed at me and ran along the ground for some distance before they were able to rise in flight. They were much larger than turkey buzzards, with which I was quite familiar, and I was very close to them so that I could not be mistaken in their identity. The cattle-men said that the California vulture or buzzard was not uncommon there before they began to poison carcasses to kill wolves. Dr. Coues gives as their habitat "Rocky Mts. to the Pacific." Boise River mountains rise to over 7000 feet just back of where the vultures were feeding. The exact locality was near the Hot Springs above Boise City. Poison and population have now destroyed that far northern habitat. The *Boise Statesman*, if any of Editor Kelly's time are now living, may be able to confirm the above statement.

Dr. R.W. Shufeldt exhibited a small living specimen of the southern tortoise, or "gopher," *Testudo polyphemus*, and made remarks on its habits.

Dr. L. O. Howard, referring to the previous note, called attention to the peculiar insect fauna found in the burrows of the "gopher," many of the species having the characteristics of cavern dwelling insects.

President W. P. Hay in the same connection remarked on the fact that a species of frog of the genus *Rana* so far as is known is only found in the burrows of the "gopher."

Dr. T. S. Palmer remarked on bird roosts that had lately been observed in the vicinity of Washington, calling particular attention to the martins and starlings in them.

Mr. W. L. McAtee exhibited six rare bird papers which he wished to dispose of for the benefit of the Society.

Mr. William Palmer made comments on some of the papers referred to by Mr. McAtee.

Lieutenant Lyon remarked that among the comparatively small number of stools of patients that he had examined at the Walter Reed General Hospital he had found seven containing ova of *Necator americanus*.

The regular program consisted of three communications:

Dr. T. S. Palmer: *A key to ornithological literature.* This review of the literature of birds was discussed by Dr. L. O. Howard and by Dr. Frank M. Chapman, who mentioned particularly the literature and the active workers on South American birds.

Mr. A. S. Hitchcock: *The alpine flora of the Adirondacks and the White Mountains.* During August Mr. Hitchcock visited the Adirondack Mountains in New York and the White Mountains in New Hampshire for the purpose of studying the alpine grasses. In the former region collections were made on Mt. McIntyre and on Whiteface Mountain, both of which support an alpine flora at the summit above tree line. Mt. Marcy, the highest peak of the Adirondacks (5344 feet), was not investigated because it was impracticable to make the trip in one day from any of the surrounding bases. However Mt. McIntyre (5112 feet), being nearly as high, presents the same conditions as those to be found on Mt. Marcy. Four days were spent among the high peaks of the White Mountains. Entering from the east by way of Crystal Cascade, the speaker ascended through Tuckerman Ravine to the summit of Mt. Washington, passing the night at the Lake of the Clouds Hut (Appalachian Mountain Club). The second day's trip was to the A. M. C. Madison Huts, passing the peaks of Clay, Jefferson, and Adams. The third night was spent at Lake of the Clouds Hut, but the return trail was to the east through the Great Gulf. On the fourth day the descent was made through Huntington Ravine over a difficult trail. Nine species of grasses may be classed as alpine, though a few others extend into the alpine zone from the lower zones (e.g., *Deschampsia flexuosa*, *Calamgrostis canadensis*). The alpine species are *Torresia* (*Hierochloa*) *alpina*, *Phleum alpinum*, *Agrostis borealis*, *Calamagrostis langsdorfii*, *Trisetum spicatum*, *Deschampsia atropurpurea*, *Poa laxa*, *P. glauca*, *Agropyron violaceum*. Most of these are circumpolar species which extend southward in the mountains. The distribution of each species was discussed.

Dr. R. W. Shufeldt: *Notes on some United States batrachians.* Dr. Shufeldt gave life histories and the peculiar habits of a large number of North American forms of this interesting group, all the facts presented having been obtained through personal observations, either upon captive specimens or on the animals in their native habitats in the field. Among the forms touched upon were Jefferson's Ambystoma, which the speaker has reared in captivity, and which he illustrated with lantern slides, showing the eggs in the process of hatching, as well as the young when several months old. Other forms taken from life and thrown upon the screen were examples of the marbled salamander) *Ambyst omaopacum*) and the elegant spotted salamander (*A. punctatum*), shown in its terrestrial attitudes as well as seen under water. This form is comparatively rare in the vicinity of Washington, less than ten specimens having been collected within the last thirty years. Some six or eight other species of American salamanders were thrown upon the screen to illustrate their forms and attitudes in life.

The peculiar habit the male of the water newt (*Diemyctylus viridescens*) has of hugging the female was shown from living specimens in an aquarium maintained by the speaker at the time these studies were made. This habit of *Diemyctylus* is quite independent of any sexual act during the breeding season, and has been especially referred to in the published life histories of the animal.

Large colored drawings were exhibited, giving the rare Anderson's tree toad and several of the *Hylidae*. Additional presentations by means of lantern were given of all the frogs, toads, and hylas of the Atlantic States, as well as some southern species. The remarkable gopher frog of Florida was fully illustrated and its life history given in considerable detail.

Dr. Shufeldt's remarks were discussed by Messrs. W. P. Hay, William Palmer, L. O. Howard, A. Wetmore, and A. A. Doolittle.

The 573d regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, November 3, 1917; called to order by President Hay at 8 p.m.; 58 persons in attendance.

Informal brief notes were presented as follows:

Dr. T. S. Palmer called attention to the fact that the first botanical society in this vicinity had been founded one hundred years ago, and that members who failed to attend its meetings were subject to fines. He also exhibited a recently issued Bibliography of British Ornithology, which in addition to the usual bibliographic data contains biographical sketches of the authors of titles listed in the bibliography.

Dr. L. O. Howard called attention to the recent centennial celebration of the Medical Society of the District of Columbia.

Dr. H. M. Smith reported that the recent fur-seal census shows an increase of about 10 per cent over the previous census, the total number being 468,000. He also reported that the flesh of whales, owing to the decreasing supplies of other meats, is being used for human food in the United States, especially on the Pacific Coast.

Mr. C. Birdseye remarked that large quantities of palatable seal meat are annually thrown away by sealers along the northeast coast of North America.

Lieutenant M. W. Lyon, Jr., exhibited a photograph of a human anatomical anomaly in which a kidney and its corresponding ovary and uterine tube were lacking. It was the third case of congenital absence of a kidney which he had encountered in two years.

Mr. WILLIAM PALMER exhibited a sectioned tympanic bone of a whale and called attention to its great density and hardness.

The regular program consisted of three communications.

Rear-Admiral G. W. BAIRD: *An unusual human specimen.* He commented on and exhibited a lantern slide of a double monster in a native Filipino girl of usual intelligence. The external visible parasite consisted of two lower extremities. She had slight control over these extremities, much less now than when she was a small child.

This communication was discussed by Drs. C. W. STILES, M. W. LYON, JR., and R. W. SHUFELDT.

VERNON BAILEY: *How the pine squirrels help to feed the bears of the Yellowstone Park.* A general account of the bears in the park was given and it was shown that part of their diet consists of pine seeds obtained from cones cut off by squirrels. Cones from which the bears had extracted seeds were exhibited.

C. BIRDSEYE: *The fur industry of Labrador.* A detailed account of this industry, including fur farming, was given and choice skins of the more important fur-bearing animals exhibited. This communication was discussed by Mr. A. WETMORE and Dr. L. O. HOWARD.

M. W. LYON, JR., *Recording Secretary.*

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HISTORY.—*The origin and early days of the Philosophical Society of Washington.*[1] William H. Dall, National Museum.

The history of the scientific societies in Washington has been admirably told by Mr. G. Brown Goode in his memoir on the origin of the U. S. National Museum. There were, before the formation of the Philosophical Society, two or three societies, all of which finally died. One that included most of the naturalists was called the "Potomac-Side Naturalist's Club;" and it is a matter of some little interest that I had recently a call from Prof. John Chickering, the son of Professor Chickering, of Gallaudet College, who was one of our former members; and he told me that in going over his father's papers, he found the records of meetings of the "Potomac-Side Naturalist's Club."

Then there was the National Institute, which struggled along for a number of years very bravely against adverse circumstances, and finally was obliged to give up on account of the expense of maintaining a museum and other things of that sort which were beyond the means of the members of such a small society.

When I returned from Alaska in 1868, I found that there existed in Washington a club of, I presume, about 20 members, which was, to the best of my recollection, called the "Physical Club." It may be added that its membership comprised some of the most distinguished men of science in Washington, and

[1]An address delivered at the 789th meeting of the Philosophical Society of Washington, April 28, 1917.

Professor Henry was chairman. General Sherman, Admiral Jenkins, J. E. Hilgard, and a number of other men whose names are national property were members of this club. The general method was to have an address or paper by some member of the club, and afterward a social meeting with refreshments furnished by the host of that evening. They were most enjoyable evenings. However, in the course of time, it began to be felt by some of the members that the tax on the less wealthy members of the club was too great. The meetings were held fortnightly, and in the course of the season they would come around several times to the same member. There were others who wished very much to join, but could hardly be accommodated in the houses of the old members; and after more or less discussion about it Professor Henry suggested to some of the men who brought the matter to his attention that they should appoint a committee to organize a society and to have the whole subject laid before the club, to form an organization that would omit the refreshment part of the entertainment; that would make for scientific purposes; and that would be available for any scientific man, either visitor or resident of Washington, and would be restricted to men of science.

The result of this was that a committee was formed whose report you have heard read by the Secretary. The meeting was held in the Regent's room of the Smithsonian Institution, and Professor Henry, by unanimous vote, was made chairman.

A skeleton of a constitution and by-laws, which had been prepared by the Committee of the club, was presented at the meeting and adopted with some amendments. Then General Barnes, who was Surgeon-General, and was one of the members, was good enough to offer us more commodious quarters in the city. In those days coming over to the Smithsonian building, especially at night, was something of a task. The paths were not paved; if it happened to be rainy it was a very muddy walk indeed. There was a rather rickety bridge at Tenth Street over a very bad smelling canal which we all had to cross in order to get into the Smithsonian grounds. I do not know whether any of the present members know that that part of Washington was formerly known and is still known to old residents as "The Island" because it was separated from the city by the James Creek Canal. It is that broad road just south of the Center Market that was formerly the location of this canal, which formed a sort of semicircle and came around the museum grounds enclosing the more elevated land on which the Smithsonian Institution stands, and then went southward through the wide lowland nearly parallel with New Jersey Avenue, Southwest, to rejoin the Potomac, where a small remnant not yet filled in still exists. At that time nearly all of the members of the Society lived in the city and therefore found it desirable to have the place of meeting where they would not have to go through the Smithsonian grounds, often through a considerable amount of mud.

Probably those names that were read by the Secretary mean somewhat less to the members of the Society at present than they meant to us in those days, and I have made an analysis of the committee of the founders, which will, perhaps, throw a little light on the subject.

From the Smithsonian Institution there were of course, Prof. Joseph Henry and William B. Taylor, who was a very erudite man and had a considerable part in the activities of the Institution, T. R. Peale, S. F. Baird, Theodore Gill, and myself. From the Geological Survey (there was at that time no National Survey) came Dr. F. V. Hayden; the Signal Service was represented by General A. J. Myer; from the office of the Nautical Almanac came J. H. C. Coffin, whose great work on the *Winds of the Globe* is well known to all meteorologists.

From the Army there were General Sherman, General Benêt, General Humphreys, General George H. Elliott, General Casey, General Parke, and General Meigs, who built the Cabin John Bridge and had a good deal to do with many of our other principal buildings here in the District; from the Army Medical Museum staff and the Medical Department of the Army there were Dr. Woodward, a microscopist of high reputation; Dr. Otis, who was a distinguished anthropologist; Dr. J. S. Billings, to whom we owe the *Index Medicus;* and Dr. J. K. Barnes, who was Surgeon-General of the Army. Then there were Admiral Foote, Admiral

Sands, and Admiral Jenkins, and from the Naval Observatory Asaph Hall, Simon Newcomb, and William Harkness. These men were all distinguished. I suppose no Society of such a small number of persons as this ever had quite so many distinguished men in proportion to the whole number. I have always felt it a very great honor to have been permitted to join with them in calling myself a founder of the Society.

The original number o founders, that is, those whose signatures were on the list for the formation of the Society, was 43, including Professor Henry who proposed the name, Philosophical Society of Washington, giving to the adjective its original meaning implying the inclusion of all branches of science. No list of members was published in the *Bulletin* until 1874 when the number was 128, there having been four deaths of members, but during that time 85 additional members became connected with the Society. Professor Henry presided over the Society until his death in 1878.

The *Bulletin*, which was issued shortly after the formation of the Society, when enough material had accumulated to form a volume, was reprinted at Professor Henry's suggestion, as a volume of the *Miscellaneous Collections of the Smithsonian Institution*. That procedure was continued during Professor Baird's lifetime. The publications were made up, edited, and printed by the Society, the Smithsonian Institution publication being made by the use of stereotype plates. The reprint was not issued until 1888.

Meetings were held at the offices of the Surgeon-General in the old Ford Theater Building, and were extremely interesting. The Society was made up of men who could say something interesting on almost every branch of science.

We had some very remarkable work presented to the Society. We were privileged, I think, to have the first testing of the telephone. Mr. Bell was introduced by one of the members of the Society. A telephone wire and receiver were strung up in the room where we had our meeting and the transmitter was taken off into another room at some distance and each member of the Society was enabled to hear communications that came from the other room. That was before 1876, when the first public exhibition of the telephone took place at the Centennial Exposition at Philadelphia.

Among other things, I remember a paper by Dr. A. F. A. King in which the mosquito theory of the transmission of malaria was fully set forth. Dr. King was one of those who originated the theory that the disease is transmitted by these insects. Of course, the theory required proof, and it was not till a good many years afterward that proof was furnished by contributors from the Medical Corps of the Army and others.

Most of the papers in the early days were intended to be published elsewhere than in the *Bulletin* of the Society. They were read there for the information of the members, and when the *Bulletin* was printed, it would give the title of the paper and state the place in which it was published, and in that way reference could be had from the *Bulletin* to the place of publication of anything that was read before the Society. At first, of course, the pecuniary resources of the Society were not great and it could not afford to publish many papers, but owing to the fact that most of the members were members of the Government staff under one Bureau or another, and that the publication of their results would naturally have to be through Government agencies, the system adopted was fairly satisfactory. The Society was a great boon to all of us who desired to know something of what was going on in the departments of science with which we were not personally acquainted.

I think that there were none of us but derived welcome and interesting information, and added to our store of knowledge from the communications that came from other members in quite different fields of work. I ought perhaps to mention one of the remarkable things that were done by members of the Society at that time. This was the work of Dr. Woodward of the Army Medical Museum in microscopy. He was the first, as far as I know—at all events in this country, and I think the first anywhere—to succeed in getting a diatom photograph of a perfection and size that would reveal, for instance, all the almost invisible, complete and beautiful ornamentation with which it is provided. Dr. Woodward brought forth his new slides and explained the working of the modifications that he made to his microscope in order to produce this work, and then threw on the screen the beautiful figures, sometimes of an almost invisible diatom enlarged to six feet high, showing every detail of its beautiful structure. They were very interesting indeed. In fact I might go on for a long time with reminiscences of what was brought before us; but we are to hear from others of what developed in the Society as it grew larger and larger and the number of scientific men increased, and how bodies of our members formed other societies and gave to them independent lives.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEODESY.—*Descriptions of triangulation stations in Georgia.* C. H. SWICK. U. S. Coast and Geodetic Survey Special Publication No. 45. Pp. 43, with 1 illustration. 1917.

This volume is supplementary to *Triangulation in Georgia*, U. S. Coast and Geodetic Survey Special Publication No. 43, abstracted in a preceding number of this JOURNAL (**7**: 584. 1917), and contains all available descriptions of the triangulation stations in Georgia whose geographic positions are given in the previous volume. Practically all of the triangulation data in Georgia, the observations for which were made before 1917, are now in published form and so are readily available for the use of engineers, geographers, and surveyors.

C. H. S.

GEOLOGY.—*The De Soto–Red River oil and gas field, Louisiana.* GEORGE CHARLTON MATSON and OLIVER BAKER HOPKINS. U. S. Geological Survey Bulletin 661–C. Pp. 40, with maps, sections, and illustrations. 1917.

The De Soto-Red River oil and gas field lies in the northwestern part of Louisiana. In 1912, gas was discovered in De Soto Parish near Naborton at a depth of about 800 feet. Deep drilling resulted in the discovery of small quantities of oil, and on May 10, 1913, the completion of the Gulf Refining Company's Jenkins well No. 2 proved the presence of a notable oil pool. The producing oil and gas bearing sands are in the Gulf series of Upper Cretaceous age.

The shales associated with the sands and in some places the sands themselves contain considerable organic matter which was apparently derived chiefly from vegetation, and it is believed that the oil and gas were formed from this organic matter by slow chemical changes, which may have been facilitated by moderately high temperature and the pressure caused by the load of sediments that overlie them, and by the thrusts to which they have been subjected.

The gas and oil in the De Soto-Red River field were probably accumulated under hydraulic pressure. This hypothesis is supported by the relations of these substances to the structure and by the occurrence of the oil in very productive pools of small area. R. W. Stone.

GEOLOGY.—*The Bowdoin dome, Montana, a possible reservoir of oil or gas.* Arthur J. Collier. U. S. Geological Survey Bulletin 661–E. Pp. 17, with maps, sections, and illustrations. 1917.

The Bowdoin dome is situated on Milk River, in northeastern Montana, on the main line of the Great Northern Railway between Malta on the west and Hinsdale on the east. A well drilled here for water several years ago has been yielding a small flow of gas ever since, and it is thought that the region offers a chance of success to the driller of deeper wells. In 1915 a large gas well was drilled at Havre. Only the Upper Cretaceous Claggett shale, Judith River formation, and Bearpaw shale, and some of the more recent surficial deposits are exposed in the immediate vicinity of the Bowdoin dome. The structure revealed by the Judith River formation in its outcrop around the valley of Milk River is that of a very broad, flat dome. The dips of the sandstone are so low as not to be detected by the unaided eye and are best recorded in feet to the mile. There is no place around the dome where a dip as high as 1 degree has been found.

The Bowdoin dome has a structure which if found in Oklahoma or Ohio would be regarded as favorable for the accumulation of oil or gas.

R. W. Stone.

GEOLOGY.—*The Corsicana oil and gas field, Texas.* George Charlton Matson and Oliver Baker Hopkins. U. S. Geological Survey Bulletin 661–F. Pp. 43, with maps, sections, and illustrations. 1917.

The Corsicana oil and gas field, in Navarro County, Texas, measures 20 miles from north to south and 10 miles from east to west. Oil was first discovered here in the city of Corsicana, and the field has been productive for more than twenty years.

The oil and gas are obtained from the upper part of the Upper Cretaceous, the light oil and the gas in the Corsicana oil pool and in the Chatfield and Edens gas pools probably coming from the Taylor marl and the heavy oil and the gas in the other pools from the Navarro formation. This field continued to yield almost the entire production of Texas until 1909, when the gas fields of Clay County were developed. The Lower Cretaceous formations have not been reached in any of the wells in the Corsicana field.

The strata in the Corsicana field dip in general to the southeast at a rate of 50 to 100 feet to the mile. The uniformity in direction and amount of dip is interrupted at a number of places by folds, but none of the folds are continuous over large areas. The greatest dips observed on the folds are at the rate of 560 feet to the mile, and these high dips are confined to small areas. The irregularities in the normal position of the strata seems to have been produced by forces acting in two directions, as two systems of folds are determinable—one approximately parallel to the dip of the rocks and the other at right angles to it. So far as observed, there is no evidence of faulting, or breaking of the rock strata, in this field.

A review of the discussion of the structure or a study of the structure map of the Corsicana field shows that oil and gas occur in this field under two different structural conditions. They have accumulated along the crests of well-defined anticlines, as in the Burke pool, and also in beds of fairly uniform dip, as in the Corsicana pool. Drilling has shown, however, that the sands of this field are lenticular and vary in porosity and thickness from place to place.

In the Corsicana district there are at least two productive sands which are believed to belong to the Taylor formation—the Corsicana and Edens sands. The Corsicana sand is the principal producing sand and yields light oil and a small amount of gas at a number of places, particularly toward the north end of the district.

The oil of the Corsicana field is believed to have originated from organic matter in the shales that inclose the sands and to a minor extent in the sands themselves. R. W. Stone.

GEOLOGY.—*Structure of the northern part of the Bristow quadrangle, Creek County, Oklahoma, with reference to petroleum and naturat gas.* A. E. Fath. U. S. Geological Survey Bulletin 661–B. Pp. 31, with maps, sections, and illustrations. 1917.

The rocks exposed at the surface in the Bristow quadrangle and those beneath it to a depth of 2500 feet or more are a part of the Pennsylvanian series, the series to which belong the surface rocks throughout the oil fields of northeastern Oklahoma. The strata dip slightly north of west about 50 feet to the mile, or a little more than half a degree.

However, the westward slope of the beds is modified by variations in the rate of dip, by local folds, and by small faults. Accumulations of oil and gas are generally found in close relation to local irregularities in the general structure of a region, and it is to such folds and irregularities that attention is principally directed in this paper.

R. W. STONE.

PARASITOLOGY.—*Life history of* Ascaris lumbricoides *and related forms.* B. H. RANSOM and W. D. FOSTER. Journ. Agr. Research **11**: 395–398. November 19, 1917.

The development of *A. lumbricoides* and closely related forms is direct, and no intermediate host is required. The eggs, when swallowed, hatch out in the alimentary tract; the embryos, however, do not at once settle down in the intestine, but migrate to various other organs, including the liver, spleen, and lungs. Within a week, in the case of the pig *Ascaris*, the migrating larvae may be found in the lungs and have meanwhile undergone considerable development and growth. From the lungs the larvae migrate up the trachea and into the esophagus by way of the pharynx, and this migration up the trachea may already become established as early as a week after infection. Upon reaching the alimentary tract after their passage through the lungs, the larvae, if in a suitable host, presumably settle down in the intestine and complete their development to maturity; if in an unsuitable host, such as rats and mice, they soon pass out of the body in the feces. Heavy invasions of the lungs by the larvae of *Ascaris* produce a serious pneumonia which is frequently fatal in rats, mice, and guinea pigs, and apparently caused the death of a young pig one week after it had been fed with numerous *Ascaris* eggs. It is not improbable that ascarids are frequently responsible for lung troubles in children, pigs, and other young animals. Age is a highly important factor in determining susceptibility to infection with *Ascaris*, and susceptibility to infection greatly decreases as the host animal becomes older.

B. H. R.

PARASITOLOGY.—*Oil of chenopodium and chloroform as anthelmintics.* M. C. HALL and W. D. FOSTER. Journ. Amer. Med. Associat. **68**: 1961–1963. June 30, 1917.

Oil of chenopodium as an anthelmintic should be accompanied by large doses of castor oil, and when so given is a very effective and safe remedy against ascarids. Chloroform in castor oil was found to be more effective against hookworms than any other remedy tested.

B. H. R.

PARASITOLOGY.—*The occurrence in the United States of certain nematodes of ruminants transmissible to man.* B. H. RANSOM. N. Orl. M. & S. J. **69**: 294–298. October, 1916.

Attention is called to the fact that three of the four species of the nematode genus *Trichostrongylus* that have been recorded as parasites of man are of more or less common occurrence in ruminants in the United States, indicating the probability that they also occur in human beings in this country but have been overlooked. B. H. R.

PARASITOLOGY.—*The zoological position of the Sarcosporidia.* HOWARD CRAWLEY. Proc. Acad. Phila. **68**: 379–388. August 14, 1916.

The Sarcosporidia are usually assigned to the Neosporidia, one of the two subclasses recognized as making up the class Sporozoa, but it is considered by the present writer that they belong in the other subclass, Telosporidia and should be placed in the order Coccidiomorpha, which accordingly would include three suborders—Coccidia, Haemosporidia, and Sarcosporidia. The probability is suggested in view of certain evidence given that the Sarcosporidia in their normal life cycle depend upon an alternation of hosts, at least one of which must be a carnivorous animal. B. H. RANSOM.

PARASITOLOGY.—*Serum therapy for trichinosis.* BENJAMIN SCHWARTZ. Journ. Amer. Med. Associat. **69**: 884–886. September 15, 1917.

Serum from animals convalescent from trichinosis when injected into other animals did not produce immunity to trichinosis in the latter. Trichinous meat mixed with serum from animals during the active or convalescent stage of the disease proved to be still capable of producing the disease. Animals once infected and harboring trichinae in their muscles were not immune to further infection when fed trichinous meat. Serum from a trichinous animal had no observable ill effects on the larvae freed from their cysts by artificial digestion. None of the results of the experiments appears to be in harmony with the assertions made by Salzer (1916, 1917) concerning the value of serum from convalescent animals as a prophylactic or curative agent in trichinosis. B. H. RANSOM.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY OF WASHINGTON

The 574th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, November 17, 1917; called to order by President HAY at 8 p.m.; 78 persons present.

On recommendation of the Council the following named persons were elected to membership: Miss KATHERINE A. STUART, Alexandria, Va.; H. C. FULLER, Institute for Industrial Research, Washington, D. C.; HERBERT POPENOE, Assistant Editor, *Journal of Heredity*, Washington, D. C.

Under the heading brief notes and exhibition of specimens, Dr. R. W. SHUFELDT exhibited two grasshoppers, the black Louisiana form of *Rhomaleum micropterum*, and a specimen of the same species from Florida, the latter being much lighter in color, a sort of tan with a tendency in places to pinkish and greenish.

The regular program was a symposium: *Recently introduced pests and the problem of accidental introductions.*

1. C. L. MARLATT: *The pink bollworm of cotton*, illustrated by lantern slides. (No abstract.)

2. A. L. QUAINTANCE: *Recently introduced fruit insects*, illustrated by lantern slides. (No abstract.)

3. PERLEY SPAULDING: *Some biological aspects of the spread of the white-pine blister rust*, illustrated by lantern slides. Mr. Spaulding said that the white-pine blister rust probably originated in Asia, spread thence to Europe, and more recently to North America. The factors concerned in its distribution are: (1) Man aids distribution by extensive long distance shipment of nursery stock of pines and possibly of *Ribes* infected by this disease. He hinders distribution by quarantines and inspections of nursery stock shipments. (2) Animals and insects carry the spores about on their bodies thus aiding local spread of disease. They also hinder the production of spores by eating the fruiting bodies and the surrounding host tissues. Gypsy moth larvae which are known to be blown for miles feed freely upon the spores and in infected areas the spores stick in great numbers to their bodies. (3) Wind blows the spores freely about, as well as gypsy moth larvae which bear spores upon their bodies. Rain hinders spread by beating down spores which are floating about in the air. Sunlight within a short time destroys the viability of exposed spores.

This disease is but one of many which has spread from one country to another and in many cases from one country throughout the world. A list of thirty such diseases caused by bacteria and by representatives of all the large groups of parasitic fungi was given, together with the country of origin and present distribution. The conclusion was drawn that it is necessary to control the commercial importation of living plants in such a way that only healthy plants will be received in this country.

4. L. O. HOWARD: *Some points for consideration in a discussion of the problem of accidental introduction.* Dr. Howard discussed briefly the influence which our knowledge of the broad life zones of the world might have in regard to restrictive legislation among nations, and the influence which our knowledge of the life zones of the United States, largely due to Merriam and the Bureau of Biological Survey of the Department of Agriculture, might have on sectional quarantines. He pointed out the greater probability of the establishment of an injurious form coming from what might be termed a "parallel life zone"—as from the Nearctic to the Palearctic—than from another zone, but showed that recent experience has indicated that the country is not free from danger from certain pests coming from zones of radically different types of life. He invited discussion of the broader biological aspects of the question.

Prof. H. MAXWELL-LEFROY, Imperial College of Science, London, Prof. W. M. WHEELER, Bussey Institution, Harvard University, E. W. NELSON, J. B. GORDON, and VERNON BAILEY took part in the discussion.

The 575th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, December 1, 1917; called to order by President HAY at 8 p.m.; 26 persons present.

On recommendation of the Council, LEE R. DICE, of the University of Montana, was elected to membership.

The following informal communications were presented:

Dr. WALTER P. TAYLOR: *Exhibition and discussion of distribution of marmots from the State of Washington.* Dr. Taylor exhibited specimens of marmots collected in the State of Washington, where both the *caligata* and *flaviventris* groups are represented, citing certain facts in their distribution which emphasizes the principle that the extent of zonal distribution of an animal depends, not alone on the temperature and other requirements of that animal, but also upon the presence or absence, in particular restricted areas, of closely related types filling the same or a similar niche in the economy of nature. He also called attention to the fact that the distribution of these animals is in harmony with what we know of the antiquity of the Columbia River as a barrier to the distribution of boreal forms, and suggested that as compared with the portions of the Cascade Mountains north and south of the Columbia River, the Olympic Mountains have probably been isolated comparatively recently. Discussed by Gen. T. E. WILCOX.

ALEX. WETMORE discussed the peculiar molting in ducks by which the large wing feathers are simultaneously shed, rendering the birds flightless for a period during which time they take refuge in marshes.

Dr. T. S. PALMER called attention to the recent successful meeting of the A. O. U. and the interest now taken in birds of foreign countries.

Dr. L. O. Howard made remarks on a recent article in a French scientific journal giving analysis of bread found on a Zeppelin, some of rye made into sandwiches of suet, and some of rye and rice with cheese, it being of notably better quality than bread taken from German prisoners, some of the latter being made in part of the inner bark of poplar trees.

W. P. Hay exhibited lantern slides of the marine turtles of eastern North America with an account of their habits, distinctive characters, and uses to man. Discussed by Gen. T. E. Wilcox and by Admiral Baird who described a native method of catching hawkbill turtles without injuring the skull.

Alex. Wetmore remarked on red bats seen November 17. Discussed by Vernon Bailey and by M. W. Lyon, Jr., who had seen brown bats flying in the evening during the Christmas holidays several years ago at Hyattsville.

The regular program was as follows:

Charles Wardell Stiles: *Haak as author of Brisson's 1762 edition of Regnum Animale.* Dr. Stiles being out of the city on sanitary work at one of the southern military camps, the paper was presented by Dr. T. S. Palmer. The work was exhibited and it was shown that Brisson was not its author. Dr. Palmer gave some interesting facts about the life of Brisson and some of his contemporary associates.

Lieut. M. W. Lyon, Jr.: *The relative resistance of the red blood corpuscles of the sheep, ox, and hog.* A résumé of the hemolytic action of human serum, certain fish serum, and hypotonic salt solutions on these corpuscles was given. The results are being published in the Journal of Infectious Diseases.

M. W. Lyon, Jr., *Recording Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

The 123d regular meeting of the Society was held at the Cosmos Club, Tuesday, November 6, 1917. Fifty-nine members and 4 guests were present. Among the guests were Dr. L. P. De Bussy, now on his way from Sumatra to Amsterdam, Holland, to become Director of the Colonial Museum at the latter place, and also Prof. H. H. Whetzel, in charge of the Plant Pathology Department, Cornell University, Ithaca, N. Y. The program was devoted to a discussion of some of the newly-discovered diseases of corn.

G. N. Collins: *Maize: Its origin and relationships.* The reasons for believing that maize has originated as a hybrid between teosinte, *Euchlaena mexicana*, and some member of the Andropegoneae were reviewed.[1] Maize is dependent on cross fertilization for normal and vigorous development. It has now been demonstrated that teosinte does not share with maize this intolerance of self-pollination. Thus maize appears to be unique among the grasses in possessing this characteristic of hybrids. The inheritances of the characters separating maize and teosinte have been studied in hybrids and none were found

[1] Journ. Wash. Acad. Sci. **2**, 520–530. 1912.

to be either alternative or Mendelian. These results were advanced as evidence against the hypothesis that maize has originated by mutation from teosinte. A summary of the evidence to date was held to support the view that teosinte and the unknown ancestor of maize had evolved by gradual changes along divergent lines and that the divergence took place before the separation of the Maydeae and the Andropogoneae.

Evidence was presented for believing that the Maydeae and Andropogoneae were closely related and should not be considered as separate tribes. It was urged that a recognition of the close relationship of these two groups was of practical importance in the study of maize diseases and as a guide in establishing quarantine regulations.

W. H. Weston: *The downy mildews of maize, their origin and distribution.* During the past twenty years considerable alarm has been occasioned by several serious downy mildews which have appeared on maize and its relatives in the eastern tropics. *Peronospora Maydis* Rac. has been very destructive to maize in Java, Madoorah, and Atjeh since 1892; and although Euchlaena has so far proven immune, crosses of this plant with maize are extremely susceptible. *Sclerospora sacchari* Miy. was reported in 1911 as causing serious injury to maize and sugar cane, and capable of inoculation onto Euchlaena, in Formosa; and was later found also in Queensland and the Fiji Islands. *Sclerospora Maydis* (Rac.) But. appeared on maize in India about 1913; and in 1916 a species of Sclerospora, possibly identical with this, was found to be destroying the maize crop in certain parts of the Philippines. Since these parasites are unknown in the Americas where maize originated, it is probable they have spread to maize from some of the several related grasses native to the Orient. To prevent the tremendous loss that would undoubtedly follow the introduction of these diseases into the United States, the importation of maize and its relatives from infected countries has been prohibited.

G. R. Lyman: *Plant Disease Survey work on the Physoderma disease of maize.* This disease was first found in this country by Barrett at Urbana, Illinois, in 1912. It was first reported as of economic importance by Barre in South Carolina in 1914. During the next two years, the disease was found to be prevalent in North and South Carolina, Georgia, Florida, Alabama, and Mississippi. In 1917, it was also found generally distributed in Tennessee.

In September of this year, the Plant Disease Survey put twelve scouts into the field to act in cooperation with the Office of Cereal Investigations, Bureau of Plant Industry. In addition to the states named, the disease was found to be prevalent in eastern Virginia, Kentucky, southern Illinois, southeastern Missouri, Arkansas, and Louisiana, and to be sparsely present as far north as New Jersey, southern Minnesota, and South Dakota, and as far west as central Nebraska and central Texas. It has evidently spread as far as climatic limitations will permit its development, being inhibited by cold weather in the North and by lack of moisture in the West.

An intensive study was made of selected regions in the South Atlantic and Gulf States to obtain data on the seriousness of the disease and on its relation to various environmental factors. High temperature and moisture are necessary for extensive development, and in favorable regions in the South the disease causes a damage of 5 per cent to 10 per cent. It will not be a serious factor in the North and West except locally and under exceptional conditions.

The disease was also found on teosinte at two points in South Carolina and at one point in Louisiana.

Heavy infection of fields never before planted to corn may be explained by the presence of other host plants or by the carriage of infection on the seed corn.

The 124th regular meeting of the Society was held at the Cosmos Club, Tuesday, December 4, 1917; 72 members and 8 guests were present.

C. S. Scofield: *Geographical aspects of Haitian agriculture.* Haiti lies adjacent to the steamship route between New York and Panama and has the most direct access to our markets of any of the American Tropics. The climate is favorable to crop production, the land is fertile, and the dense population provides a cheap and abundant supply of labor. The coastal delta plains are favorably located for irrigation and the production of sugar cane and cotton, and the hill slopes are well suited to coffee, which is now the chief commodity of export. The interior plains and the higher mountain slopes produce an abundance of grass for stock production.

The present government, with American cooperation, has eliminated the conditions of internal disturbance that formerly retarded development and prosperity. The construction of roads and the protection of the peacefully inclined inhabitants is resulting in greatly increased crop production, which is opportune at this time.

C. B. Doyle: *Botanical aspects of Haitian agriculture.* In Haiti there is very little left to represent the original forest covering. The primitive milpa system of agriculture is used and the natives live in scattered families or small groups. There are only a few large plantations on the island, the bulk of the crops of the three principal exports (coffee, cacao, and cotton) being produced on the small native farms.

Most of the food plants are of American origin, but as in many tropical American countries, it is the introduced species that have become of the greatest importance to the natives. Many different kinds of fine fruits are abundant, but several species prominent in other parts of tropical America, such as the papaya, sapote, sapodilla, and pineapple, are absent or little used. Among the root crops that are commonly grown are sweet potatoes, yams, yautias, and cassava, and more recently white potatoes are being successfully produced in the cool mountain districts southeast of Port au Prince.

In comparison with other tropical countries, conditions appear favorable for crop production in Haiti, if a more effective organization of agriculture can be established, together with a better means of marketing the products.

H. N. Vinall, *Corresponding Secretary.*

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CHEMISTRY.—*Methods of gas warfare.*[1] S. J. M. AULD, British Military Mission. (Communicated by L. J. Briggs).

All I can do in the short time available is to give you, if I can, a general idea of what gas warfare really means on the Western Front at the present time. Some of you may have gotten the idea that gas is just an incident, and that there is not as much attention being paid to it as there was two years ago. That idea is entirely wrong. Gas is used to a tremendous extent, and the amount that has been and is being hurled back and forth in shells and clouds is almost unbelievable. I will try to give you a general idea of what is occurring and make the lecture rather a popular than a technical description. I shall also, for obvious reasons, have to confine myself to describing what the Germans have been doing, and will say nothing about what we are doing.

Possibly the best plan would be to state more or less chronologically what occurred. I happened to be present at the first gas attack and saw the whole gas business from the beginning. The first attack was made in April, 1915. A deserter had come into the Ypres salient a week before the attack was made, and had told us the whole story. They were preparing to poison us with gas, and had cylinders installed in their trenches. No one believed him at all, and no notice was taken of it.

[1] Report of a lecture delivered before the Washington Academy of Sciences on January 17, 1918.

Then came the first gas attack, and the whole course of the war changed. That first attack, of course, was made against men who were entirely unprepared—absolutely unprotected. You have read quite as much about the actual attack and the battle as I could tell you, but the accounts are still remarkably meager. The fellows who could have told most about it didn't come back. The Germans have claimed that we had 6000 killed and as many taken prisoners. They left a battle field such as had never been seen before in warfare, ancient or modern, and one that has had no compeer in the whole war except on the Russian front.

What the Germans expected to accomplish by it I am not sure. Presumably they intended to win the war, and they might conceivably have won it then and there if they had foreseen the tremendous effect of the attack. It is certain that they expected no immediate retaliation, as they had provided no protection for their own men. They made a clear and unobstructed gap in the lines, which was only closed by the Canadians, who rallied on the left and advanced, in part through the gas cloud itself.

The method first used by the Germans, and retained ever since, is fairly simple, but requires great preparation beforehand. A hole is dug in the bottom of the trench close underneath the parapet, and a gas cylinder is buried in the hole. It is an ordinary cylinder, like that used for oxygen or hydrogen. It is then covered first with a quilt of moss, containing potassium carbonate solution, and then with sand bags. When the attack is to be made the sand bags and protecting cover are taken off the cylinder, and each cylinder is connected with a lead pipe which is bent over the top of the parapet. A sand bag is laid on the nozzle to prevent the back "kick" of the outrushing gas from throwing the pipe back into the trench. Our own methods are practically identical with those first used by the Germans.

The success of a cloud gas attack depends on thorough preparation beforehand. The attackers must know the country, the layout of the trenches, and the direction and velocity of the wind with certainty. Favorable conditions are limited practically to wind velocities between 12 and 4 miles an hour.

A wind of more than 12 miles an hour disperses the gas cloud very rapidly. An upward current of air is the worst foe of gas. The weight of the gas is not an important factor in carrying it along, for it mixes rapidly with air to form the moving "cloud." The time occupied by a gas attack is too short to permit of much diffusion of the gas out of the original mixture.

The gas attack must be planned very carefully. If the trench line is very irregular it is likely that gas will flow into a portion of one's own trenches. The limits of safety in wind direction are thus determined by the direction of the lines of the trenches. The Germans use a 40° angle of safety; that means that on a given straight portion of the front the wind direction must lie between the two directions which make angles of 40° with the neighboring sections of the front. The most suitable type of country is where the ground slopes gently away from where the gas is being discharged. The Germans made one mistake in believing that hilly or wooded country would not do. This was refuted by the French, who made a successful gas attack in hilly and wooded country in the Vosges, as admitted in a captured German report. If the country is flat like that about Ypres, and the wind direction is right, there is very little difficulty about making an attack, especially if the enemy does not know anything about it. The element of surprise is important.

German gas attacks are made by two Regiments of Pioneers, with highly technical officers, including engineers, meteorologists, and chemists. They brought their first cylinders into the line without our knowing anything about it, except from the deserter's report which was not believed. The element of surprise was greatly lessened when we began to know what to look for and to recognize the sounds incident to the preparation of a gas attack.

The first attack was made with chlorine. If a gas attack is to be made with gas clouds, the number of gases available is limited. The gas must be easily compressible, easily made in large quantities, and should be considerably heavier than air. If to this is added the necessity of its being very toxic and of low chemical reactivity, the choice is practically reduced to two gases: chlorine and phosgene. Chlorine is to gas warfare what nitric acid is to high explosives. Pure chlorine did not satisfy quite all the requirements, as it is very active chemically and therefore easily absorbed. Many men in the first attack who had sufficient presence of mind saved themselves by burying their faces in the earth, or by stuffing their mufflers in their mouths and wrapping them around their faces.

There were several gas attacks of almost exactly the same kind early in 1915. There was no gas between the end of May, 1915, and December, 1915, and by that time adequate protection had been provided.

The first protection was primitive. It consisted largely of respirators made by women in England in response to an appeal by Kitchener. They were pads of cotton wool wrapped in muslin and soaked in solutions of sodium carbonate and thiosulfate; sometimes they were soaked only in water. A new type appeared almost every week. One simple type consisted of a pad of cotton waste wrapped up in muslin together with a separate wad of cotton waste. These were kept in boxes in the trenches, and on the word "gas" six or eight men would make a dive for the box, stuff some waste into their mouths, then fasten on the pad and stuff the waste into the space around the nose and mouth. But this got unpopular after a bit, when it was discovered that the same bits of waste were not always used by the same men. During the early part of 1915 this was the only protection used.

Then came the helmet made of a flannel bag soaked in thiosulfate and carbonate, with a mica window in it. A modified form of this device with different chemicals is still used in the British army as a reserve protection. It is put over the head and tucked into the jacket, and is fool-proof as long as well tucked down. This stood up very well against chlorine.

In 1915 we got word from our Intelligence Department of a striking kind. It consisted of notes of some very secret lectures given in Germany to a number of the senior officers. These lectures detailed materials to be used, and one of them was phosgene, a gas which is very insidious and difficult to protect against. We had to hurry up to find protection against it.

The outcome was a helmet saturated with sodium phenate. The concentration of gases when used in a cloud is small, and 1 to 1000 by volume is relatively very strong. The helmet easily gave protection against phosgene at a normal concentration of 1 part in 10,000. That helmet was used when the next attack came in Flanders, on the 19th of December. This attack was in many ways an entirely new departure and marked a new era in gas warfare.

There are three things that really matter in gas warfare, and these were all emphasized in the attack of December. They are: (1) increased concentration; (2) surprise in tactics; (3) the use of unexpected new materials.

Continued efforts have been made on both sides to increase the concentration. The first gas attack, in April, 1915, lasted about one and a half hours. The attack in May lasted three hours. The attack in December was over in thirty minutes. Thus, assuming the number of cylinders to be the same (one cylinder for every meter of front in which they were operating), the last attack realized just three times the concentration of the first, and six times the concentration obtained in May. Other cloud gas attacks followed, and the time was steadily reduced; the last attacks gave only ten to fifteen minutes for each discharge. We believe that the cylinders are now put in at the rate of three for every two meters of front, and may even be double banked.

The element of surprise came in an attack by night. The meteorological conditions are much better at night than during the day. The best two hours out of the twenty-four, when steady and downward currents exist, are the hour between sunset and dark and the hour between dawn and sunrise. Gas attacks have therefore been frequently made just in the gloaming or early morning, between lights. This took away one of the easy methods of spotting gas, that of seeing it, and we had to depend upon the hissing noises made by the escaping gas, and upon the sense of smell.

Another element of surprise was the sending out of more than one cloud in an attack. After the first cloud the men would think it was all over, but ten minutes or half an hour later there would come another cloud on exactly the same front. These tactics were very successful in at least one case, namely, the attack near Hulluch in 1916. Some of the troops discarded their helmets after the first wave and were caught on the second, which was very much stronger than the first.

Efforts were also made to effect surprise by silencing the gas. But silencers reduced the rate of escape so greatly that the loss of efficiency from low concentration more than made up for the gain in suddenness. Another method was to mix the gas up with smoke, or to alternate gas and smoke, so that it would be difficult to tell where the gas began and the smoke ended.

The last attack made on the British by this means was in August, 1916. Since that time the Germans have used gas three times on the West Front against the French, and have also used it against the Italians and the Russians. It has been practically given up against the British, although the method is by no means dead.

The last attack was a slight set-back in the progress of gas defense. The casualties had been brought down to a minimum, and, as shown by the fact that the percentage of deaths was high, protection was complete in all cases where used, casualties being due to unpreparedness in some form. The attack in question was brought on under difficult conditions for the defenders, as it was made on new troops during a relief when twice as many men were in the trenches as normally. Furthermore, they had to wear helmets while carrying their complete outfit for the relief. This was the second time the Germans caught us in a relief, whether through information or luck we cannot say.

The protection that had been devised against phosgene proved effective at the time, but provision was made to meet increased concentration of phosgene. We never had any actual evidence during the attack that phosgene was being used, as no samples were actually taken from the cloud, but cylinders of phosgene were captured later. Glass vacuum tubes, about 10 by 30 cm., with a tip that could be broken off and then closed by a plasticine-lined glass cap, were distributed, but the only one that came back was an unopened tube found in a hedge, and marked by the finder "Dangerous; may contain cholera germs." In a gas attack everybody keeps quiet or else has a job on hand, and conditions are not conducive to the taking of gas samples. The original types of vacuum tube were smaller than those now used.

There was a long search for materials that would absorb phosgene, as there are few substances that react readily with it. The successful suggestion came from Russia. The substance now used very extensively by all is hexamethylenetetramine (urotropine) $(CH_2)_6N_4$, which reacts very rapidly with phosgene. Used in conjunction with sodium phenate, it will protect against phosgene at a concentration of 1:1000 for a considerable period. An excess of sodium hydroxide is used with the sodium phenate, and a valve is provided in the helmet for the escape of exhaled air. The valve was originally devised so that the hydroxide would not be too rapidly carbonated, but it was found in addition that there is a great difference in ease of breathing and comfort if a valve is placed in the mask. The helmet is put on over the head, grasped with left hand around the neck and tucked into the jacket. This form is still used in reserve.

By this time gas shells were beginning to be used in large numbers, and it became evident that protection by a fabric could not be depended on with certainty. The box type of respirator was the next development. Respirators have to fulfill two requirements which are quite opposed to one another. In the first place they should be sufficiently large and elaborate to give full protection against any concentration of any gas, whereas military exigency requires that they be light and comfortable. It is necessary to strike a balance between these two. Upon a proper balance depends the usefulness of the respirator. Oxygen apparatus will not do on account of its weight and its limited life. Two hours' life is excessive for that type. The side that can first force the other to use oxygen respirators for protection has probably won the war.

The concentrations of gas usually met with are really very low. As has been said, a high concentration for a gas cloud is

1 part in 1000, whereas concentrations of two or three per cent can be met by respirators depending on chemical reactivity. One such respirator is a box of chemicals connected by a flexible tube with a face-piece fitting around the contours of the face, and provided with a mouthpiece and nosepiece.

As regards the chemicals used there is no secret, for the Germans have many of the same things. Active absorbent charcoal is one of the main reliances, and is another suggestion that we owe to the Russians. Wood charcoal was used in one of their devices and was effective, but most of the Russian soldiers had no protection at all.

We wanted to protect against chlorine, acids and acid-forming gases, phosgene, etc., and at one time were fearful of meeting large quantities of hydrocyanic (prussic) acid (HCN). At one period every prisoner taken talked about the use of prussic acid, saying that the Kaiser had decided to end the war and had given permission to use prussic acid. Protection was evidently needed against it. The three things that then seemed most important were: (1) chlorine and phosgene; (2) prussic acid; (3) lachrymators. Charcoal and alkaline permanganate will protect against nearly everything used, even up to concentrations of ten per cent for short periods.

The German apparatus, developed about the same time, is of different pattern, and is still employed. It consists of a small drum, attached directly to the front of the face-piece, and weighs less than the British respirator but must be changed more frequently. It has no mouthpiece. The chemicals are in three layers: first an inside layer of pumice with hexamethylenetetramine, in the middle a layer of charcoal (sometimes blood charcoal), and outside baked earth soaked in potassium carbonate solution and coated with fine powdered charcoal.

As regards the future of the gas cloud, it may be looked upon as almost finished. There are so many conditions that have to be fulfilled in connection with it that its use is limited. It is very unlikely that the enemy will be able to spring another complete surprise with a gas cloud.

The case is different with gas shells. The gas shells are the most important of all methods of using gas on the Western

Front, and are still in course of development. The enemy started using them soon after the first cloud attack. He began with the celebrated "tear" shells. A concentration of one part in a million of some of these lachrymators makes the eyes water severely. The original tear shells contained almost pure xylyl bromide or benzyl bromide, made by brominating the higher fractions of coal-tar distillates.

The German did his bromination rather badly. As you know, it should be done very carefully or much dibromide is produced, which is solid and inactive. Some of the shells contained as much as 20 per cent dibromide, enough to make the liquid pasty and inactive. The shells used contain a lead lining, and have a partition across the shoulder, above which comes the T. N. T. and the fuse. These shells had little effect on the British, but one attack on the French, accompanied by a very heavy bombardment with tear shells, put them out badly. The eyes of the men were affected, and many of the men were even anesthetized by the gas, and were taken prisoner.

Our first big experience was an attack at Vermelles. The Germans put down a heavy barrage of these shells and made an infantry attack. The concentration was great, the gas went through the helmets, and the men even vomited inside their helmets. But it is difficult to put down a gas barrage, and there is danger that it will not be a technical success. In the instance cited certain roads were not cut off sufficiently, so that reinforcements got up. This attack, however, opened our eyes to the fact that, as in the case of gas clouds, concentration would be developed so as to make it high enough to produce the required effect under any circumstances.

When the Germans started using highly poisonous shells, which was at the Somme in 1916, they did not attend to this sufficiently, although enormous numbers of shell were used. The substance used was trichloromethyl-chloroformate, but not in great strength. It had no decided reaction on the eyes, hence the men were often caught.

The quantity of gas that can be sent over in shells is small. The average weight in a shell is not more than six pounds, whereas the German gas cylinders contain 40 pounds of gas. To put over the same amount of gas as with gas clouds, say in five minutes per thousand yards of front, would require a prohibitive number of guns and shells. It becomes necessary to put the shells on definite targets, and this, fortunately, the Germans did not realize at the Somme, although they have found it out since.

The use of gas out of a projectile has a number of advantages over its use in a gas cloud. First, it is not so dependent on the wind. Again, the gunners have their ordinary job of shelling, and there is no such elaborate and unwelcome organization to put into the front trenches as is necessary for the cloud. Third, the targets are picked with all the accuracy of artillery fire. Fourth, the gas shells succeed with targets that are not accessible to high explosives or to gas clouds. Take, for instance, a field howitzer, dug into a pit with a certain amount of overhead cover for the men, who come in from behind the gun. The men are safe from splinters, and only a direct hit will put the gun out of action. But the gas will go in where the shell would not. It is certain to gas some of the men inside the emplacement. The crew of the gun must go on firing with gas masks on, and with depleted numbers. Thus it nearly puts the gun out of commission, reducing the number of shots say from two rounds a minute to a round in two minutes, and may even silence it entirely. Another example is a position on a hillside with dugouts at the back, just over the crest, or with a sunken road behind the slope. Almost absolute protection is afforded by the dugouts. The French tried three times to take such a position after preparation with high explosives, and each assault failed. Then they tried gas shells, and succeeded. The gas flows rapidly into such a dugout, especially if it has two or more doors.

Among the effective materials used by the Germans for gas shells were mono- and tri-chloromethyl-chloroformate. Prussic acid never appeared; the Germans rate it lower than phosgene in toxicity, and the reports concerning it were obviously meant merely to produce fear and distract the provisions for protection.

During the last five months the actual materials and the tactics used by the Germans have undergone a complete change.

The lachrymator shells are less depended upon than formerly for "neutralization," but are still a source of annoyance. Mere annoyance, however, may be an effective method of neutralizing infantry. For instance, where large amounts of supplies and ammunition are being brought up there are always cross-roads where there is confusion and interference of traffic. A few gas shells placed there make every man put on his mask, and if it is a dark night and the roads are muddy the resulting confusion can be only faintly imagined. It may thus be possible to neutralize a part of the infantry by cutting down their supplies and ammunition.

The use of a gas shell to force a man to put on his mask is practically neutralization. If at the same time you can hurt him, so much the better. Hence the change in gas-shell tactics, which consists in replacing the purely lachrymatory substance by one that is also poisonous.

One substance used for this method of simultaneously harassing and seriously injuring was dichloro-diethylsulfide (mustard gas). Its use was begun in July of last year at Ypres, and it was largely used again at Nieuport and Armentieres. A heavy bombardment of mustard-gas shells of all calibers was put on these towns, as many as 50,000 shells being fired in one night. The effects of mustard gas are those of a "super-lachrymator." It has a distinctive smell, rather like garlic than mustard. It has no immediate effect on the eyes, beyond a slight irritation. After several hours the eyes begin to swell and inflame and practically blister, causing intense pain, the nose discharges freely, and severe coughing and even vomiting ensue. Direct contact with the spray causes severe blistering of the skin, and the concentrated vapor penetrates through the clothing. The respirators of course do not protect against this blistering. The cases that went to the hospitals, however, were generally eye or lung cases, and blistering alone took back very few men. Many casualties were caused by the habit that some of the men had fallen into of letting the upper part of the mask hang down so as not to interfere with seeing. The Germans scored heavily in the use of this gas at first. It was another example of the element of surprise in using a new substance that produces new and unusual symptoms in the victims.

Up to the present time there has been no material brought out on either side that can be depended on to go through the other fellow's respirator. The casualties are due to surprise or to lack of training in the use of masks. The mask must be put on and adjusted within six seconds, which requires a considerable amount of preliminary training, if it is to be done under field conditions.

Among other surprises on the part of the Germans were phenylcarbylamine chloride, a lachrymator, and diphenylchloroarsine, or "sneezing gas." The latter is mixed in with high explosive shells or with other gas shells, or with shrapnel. It was intended to make a man sneeze so badly that when he puts on his mask he is not able to keep it on. The sneezing gas has, however, not been a very great success.

All bombardments now are of this mixed character. The shells used are marked with differently colored crosses, and definite programs are laid down for the use of the artillerymen.

As regards the future of gas shells, it should be emphasized that the "gas shell" is not necessarily a gas shell at all, but a liquid or solid shell, and it opens up the whole sphere of organic chemistry to be drawn upon for materials. The material placed inside the shell is transformed into vapor or fine droplets by the explosion and a proper adjustment between the bursting charge and the poisonous substance is necessary. Both sides are busy trying to find something that the others have not used, and both are trying to find a "colorless, odorless, and invisible" gas that is highly poisonous. It is within the realm of possibilities that the war will be finished, literally, in the chemical laboratory.

The Germans have not altered their type of respirator for some time, and it is not now equal in efficiency to the British or American respirator. The German respirator, even in its latest form, will break down at a concentration of 0.3 per cent of certain substances. The German design has given more weight to military exigency, as against perfect protection, than has the

British. Another thing that weighs against changes in design is the fact that the German, already handicapped by the lack of certain materials, must manufacture 40,000,000 respirators a year in order to supply his Austrian, Bulgarian, and Turkish allies, as well as his own army.

In the British and American armies the respirator must always be carried with the equipment when within 12 miles of the front. Between 12 and 5 miles a man may remove the respirator box in order to sleep, but within 5 miles he must wear it constantly. Within 2 miles it must be worn constantly in the "alert" position (slung and tied in front). When the alarm is given he must get the respirator on within six seconds. The American respirator is identical with the British. The French have a fabric mask made in several layers, the inner provided with a nickel salt to stop HCN, then a layer with hexamethylenetetramine; it has no valve and is hot to wear. The French also use a box respirator, consisting of a metal box slung on the back, with a tube connecting to the face mask; the latter is of good Para rubber and is provided with a valve. One disadvantage of this form is the danger of tearing the single rubber sheet. The German mask now contains no rubber except one washer; the elastics consist of springs inside a fabric, and the mask itself is of leather. It hardens and cracks after being wet, and is too dependent upon being well fitted to the face when made.

(The lecturer exhibited various types of gas shells, helmets, masks, and respirators.)

The following compounds have been used by the Germans in gas clouds or in shells:

1. Allyl-iso-thiocyanate (Allyl mustard oil), C_3H_5NCS (shell).
2. Benzyl bromide, $C_6H_5CH_2Br$ (shell).
3. Bromo-acetone, $CH_2Br.CO.CH_3$ (hand grenades).
4. Bromated methyl-ethyl-ketone (bromo-ketone), CH_2Br-COC_2H_5 or $CH_3.CO.CHBr.CH_3$ (shell). Dibromo-ketone, CH_3-$COCHBr.CH_2Br$ (shell).
5. Bromine, Br_2 (hand grenades).
6. Chloro-acetone, $CH_2Cl.COCH_3$ (hand grenades).
7. Chlorine, Cl_2 (cloud).

8. Chloromethyl-chloroformate (Palite), $ClCOOCH_2Cl$ (shell).

9. Nitro-trichloro-methane (Chloropicrin or nitrochloroform), CCl_3NO_2 (shell).

10. Chlorosulfonic acid, $SO_3.H.Cl$ (hand grenades and "smoke pots").

11. Dichloro-diethylsulfide (mustard gas), $(CH_2ClCH_2)_2S$ (shell).

12. Dimethyl sulfate, $(CH_3)_2SO_4$ (hand grenades).

13. Diphenyl-chloro-arsine, $(C_6H_5)_2AsCl$ (shell).

14. Dichloromethyl ether, $(CH_2Cl)_2O$ (shell).

15. Methyl-chlorosulfonate, CH_3ClSO_3 (hand grenades).

16. Phenyl-carbylamine chloride, $C_6H_5NCCl_2$ (shell).

17. Phosgene (carbonyl chloride), $COCl_2$ (cloud and shell).

18. Sulfur trioxide, SO_3 (hand grenades and shell).

19. Trichloromethyl-chloroformate (Diphosgene, superpalite), $ClCOOCCl_3$ (shell).

20. Xylyl bromide (tolyl bromide), $CH_3C_6H_4CH_2Br$. (shell).

BOTANY.—*Blepharidium, a new genus of Rubiaceae from Guatemala.*[1] PAUL C. STANDLEY, U. S. National Museum.

In the U. S. National Herbarium there are specimens of a striking rubiaceous plant, hitherto undescribed, collected in Guatemala by Mr. Henry Pittier. Some years ago this material was examined by Captain John Donnell Smith, who concluded that it probably represents an undescribed genus. Recently, while preparing an account of the Rubiaceae for the North American Flora, the writer has studied the material and has arrived at the same conclusion. Among North American representatives of the family the plant is noteworthy because of its large, long-petiolate leaves and of its large flowers, borne in peculiar 3-flowered cymes. Its general appearance does not definitely associate it with any of the known genera, and its floral details are such as to necessitate its recognition as a new genus, for which the name *Blepharidium* is here proposed.

[1] Published by permission of the Secretary of the Smithsonian Institution.

Blepharidium Standley, gen. nov.

Shrubs or trees, with subterete branchlets. Leaves opposite, petiolate, the blades large, chartaceous. Stipules intrapetiolar, large, thin, acuminate, entire, caducous. Flowers large, pedicellate, bibracteolate, in 3-flowered cymes, the cymes axillary, long-pedunculate; calyx-tube obovoid, the limb large, prolonged beyond the ovary, 4-lobate, the lobes very broad, imbricate, ciliolate; corolla salverform, coriaceous, the tube slender, elongate, densely villous within except near the base, the limb 4-lobate, the lobes broad, spreading, imbricate in bud, one of them exterior. Stamens 4, inserted in the throat of the corolla; anthers sessile, dorsifixed below the middle, linear, obtuse, included. Disk annular. Ovary 2-celled; style filiform, included, the stigma bilobate, the lobes linear, elongate, acute; ovules numerous, imbricate, winged, the placentae attached to the septum.

Type species, *Blepharidium guatemalense* Standley.

Blepharidium guatemalense Standley, sp. nov.

Branchlets stout, green, glabrous, sparsely whitish-lenticellate, the internodes elongate; stipules ovate-triangular, 2–2.5 cm. long, acuminate or cuspidate-acuminate, brown, glabrous outside, within sericeous-pilose at the base and bearing numerous glands; petioles stout, 2.5–5 cm. long, glabrous; leaf-blades oval-oblong, 17–30 cm. long, 8–14.5 cm. wide, obtuse or acute at the base, obtuse or acute at the apex, concolorous, glabrous above, the costa impressed, the other venation prominulous, sparsely short-pilose beneath along the prominent costa, the lateral veins prominent, about 8 on each side, arcuate-ascending; peduncles 3-flowered, slender, 7–21 cm. long, glabrous, the pedicels stout, 0.3–2 cm. long; bracts foliaceous, oval, about 1 cm. long, the bractlets broadly ovate, 3–4 mm. long, deciduous; calyx glabrous, the tube 4–5 mm. long, the limb 4–5 mm. long, 7–8 mm. broad, the lobes half as long as the tube, broader than long, rounded or truncate, minutely ciliolate; corolla-tube about 6 cm. long, 4–5 mm. thick, glabrous outside, the lobes oval, about 1 cm. long; anthers 7 mm. long; stigma-lobes 6–7 mm. long.

Type in the U. S. National Herbarium, no. 472925, collected in forest along Saklak River, below Secanquím, Alta Verapaz, Guatemala, altitude 300 meters, May 7, 1905, by Henry Pittier (no. 266).

Blepharidium is evidently a member of the Cinchoneae, for although mature fruit, upon which the classification of the Rubiaceae is chiefly based, is not available for study, the large, imbricate, winged ovules are characteristic of this tribe alone. Within the tribe, however, it is not easy to determine the exact position of the genus. In most published keys to the subgroup, it would fall near *Exostema*, but it does not appear to be very closely allied to that genus, in which the anthers are borne on long filaments. By the sessile anthers *Blepharidium* is easily distinguished from all the genera of the Cinchoneae with imbricate corolla lobes.

ZOOLOGY.—*A key to the Philippine subspecies of* Obba marginata *with notes on their distribution.*[1] PAUL BARTSCH, U. S. National Museum.

The preparation of a report on the Philippine Island land shells reveals so many distributional gaps in the material available for study that it seems wise to publish a series of synopses in the form of keys to the various groups as the work progresses, together with a brief account of the zoogeographic facts presented by the data at hand

It is hoped that these sketches may serve to stimulate collectors to bestow their efforts upon localities from which material is sadly needed to render the monographic reports complete.

OBBA MARGINATA Müller

In this species the shell varies from broadly conic (*Obba marginata mearnsi*), to almost lenticular (*Obba marginata samarensis*). The range in size is also great. *Obba marginata saranganica* attains a greater diameter of 35 mm., while in *Obba marginata mearnsi* it does not exceed 19 mm. All the races have a narrow acute peripheral keel to which the summit of the succeeding turn is appressed. The ground color varies from pale buff (*Obba marginata griseola* and *Obba marginata mearnsi*), to pale brownish (*Obba marginata marginata*). In all the subspecies known, the peripheral keel and the extreme summit are edged by a very narrow white or whitish zone, while the rest of the upper surface of the turns is marked by three bands of brown of which one adjoins the peripheral white zone while another bounds the white line at the summit and the third occupies a space almost midway between them. The width of these brown bands varies in the different races. In some they equal the light areas that separate them (*Obba marginata balutensis*), while in others some of them are represented by mere hair lines. The intensity of the color may be the same or may vary in the different bands on the same whorl, the band at the summit being usually much paler than the rest. Two bands are present on the basal sides of all the members of this species, one adjoin-

[1]Published by permission of the Secretary of the Smithsonian Institution.

ing the light peripheral zone and another situated at about one-third of the distance between the periphery and the umbilicus anterior to the periphery. Here, as in the banding of the upper surface, we find a considerable variation both as to intensity of coloration and width of the band. In some the zone at the periphery is merely indicated (*Obba marginata lanaona* and *Obba marginata mearnsi*), while in others they are very dark and broad (*Obba marginata marginata* and *Obba marginata balutensis*). In all the forms the basal lip is toothless. Under the microscope we find that the first half turn is smooth; the turn and a half following this are marked by slender oblique, retractively curved, axial threads, best seen near the summit and at the periphery; while the succeeding turns have in addition to these threads, very fine, closely spaced, impressed lines which cross each other more or less at right angles and the lines of growth at an angle of about 45° and give the surface a fine cloth-like texture.

The various subspecies of *Obba marginata* can readily be divided into two groups, one in which the dark coloration predominates over the light zones and another in which the reverse is true. To the first of these, the dark group, belong the subspecies *saranganica, balutensis, marginata, worcesteri*, and *boholensis*. In the light group we find characters that readily enable one to further subdivide it. In two forms (*mearnsi* and *palmasensis*) the shell is broadly conic. In the rest the shell is lenticular. This last complex is again divisible. One part (subspecies *griseola*, *samarensis*, *pallescens*, and *nana*) has the basal peripheral band well developed. In the other (subspecies *zamboanga*, *lanaona*, and *joloensis*) the basal peripheral band is obsolete.

The distribution, as known to date, extends from the central islands of Samar, Leyte, Bohol, and Cebu, southward over Mindanao to Jolo on the west and Sarangani and Palmas islands on the east in the Philippines, and still farther south beyond our range at least to Celebes. A plotting of the known distribution points strongly to the fact that many additional subspecies may be expected when more careful and extensive collecting shall have been done. The species should occur on the islands between Samar, Leyte, and Mindanao. In Mindanao itself we know it only from the northern coastal strip and Zamboanga and it scarcely stands to reason that there should be a gap in the distribution between the north coast and the little islands of Sarangani, Balut, Olanivan, and Palmas off the southeast coast where it is well represented.

The distribution of the groups outlined above is rather interesting. The subspecies in which the dark coloration predominates are known from Bohol, Camiguin, north of Mindanao and the islands of Olanivan, Sarangani, and Balut off southeastern Mindanao. None of the dark forms so far are known from the large island of Mindanao itself. The broadly conic light-colored *Obba marginata mearnsi* and *Obba marginata palmasensis* come from Sarangani and Palmas, respectively, both off southeastern Mindanao. The light colored lenticular forms having the basal peripheral color band well developed are so far known from Samar, Leyte, Cebu, and northeastern Mindanao, and I strongly suspect that the form recorded from Siquijor and that from Talisayan, Mindanao, will prove to belong here. The light-colored lenticular forms in which the basal peripheral band is obsolete are known from western Mindanao and the island of Jolo.

The following key may be of help in determining the known subspecies[1]:

Dark bands predominating over the light zones.
- Greater diameter more than 30 mm.
  - Lines of growth strongly developed (Sarangani Island). **saranganica** Hidalgo.
  - Lines of growth not strongly developed (Balut Island). **balutensis** new.
- Greater diameter less than 30 mm.
  - Basal bands very dark brown.
    - Greater diameter more than 25 mm. (Camiguin Island). **marginata** Müller.
    - Greater diameter less than 22 mm. (Olanivan Island). **worcesteri** Bartsch.
  - Basal bands light brown (Bohol Island)....... **boholensis** new.

Dark bands not predominating over the light zones.
- Light zones much greater than the dark.
  - Shell broadly conic.
    - Peripheral basal color band moderately strong (Palmas Island)........................... **palmasensis** new.
    - Peripheral basal color band obsolete (Sarangani Island). **mearnsi** new.
  - Shell not broadly conic, lenticular.
    - Peripheral basal brown band obsolete.
      - Median band above and below reddish (Zamboanga, Mindanao).................... **zamboanga** new.

[1] The types of the new subspecies are registered in the U. S. National Museum under the following numbers: *balutensis*, no. 256548; *boholensis*, no. 116914; *palmasensis*, no. 256420; *mearnsi*, no. 256423; *lanaona*, no. 256495; *joloensis*, no. 256549; *samarensis*, no. 256549.

Median band above and below not reddish, all bands brown.
Base very strongly convex (Lanao Province, Mindanao) .... **lanaona** new.
Base very slightly convex (Jolo Island). **joloensis** new.
Peripheral basal brown band not obsolete.
Greater diameter more than 23 mm.
Band near the summit and at the periphery more or less interrupted (Cebu Island). **griseola** Möllendorff.
Band at the summit and near the periphery not interrupted (Samar Island). **samarensis** new.
Greater diameter less than 21 mm.
Peripheral basal band strong (Leyte Island). **pallescens** Möllendorff.
Peripheral basal band not strong (Northeast Mindanao) .... **nana** Möllendorff.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Geology of the Navajo country. A reconnaissance of parts of Arizona, New Mexico, and Utah.* HERBERT E. GREGORY. U. S. Geological Survey Professional Paper 93. Pp. 161, with maps, sections, and illustrations. 1917.

The region bordering the Colorado canyons between Little Colorado and San Juan rivers and extending southward to the line of the Atchison, Topeka & Santa Fe Railway is described. The primary object of the investigations was to "spy out the land," with a view to suggesting ways in which the country could be more fully utilized. The region is arid, and the geologic field work was therefore designed chiefly to obtain information concerning the water supply.

The Navajo country is part of the Colorado Plateau province, a region of folded and faulted sedimentary rocks traversed by innumerable canyons. The consolidated sedimentary rocks exposed in the Navajo country are chiefly of Mesozoic age—Triassic, Jurassic, and Cretaceous. The predominant rock of the whole Navajo country is sandstone of medium grain; limestone and conglomerate are much less common, and typical clay shale is rare.

In the Grand Canyon district the dominating structural features are represented topographically by flat-topped plateaus, bordered by lines of displacement trending roughly north. The simplicity of folded structures in the Grand Canyon district is not, however, duplicated in the region east of Colorado River. Synclines and anticlines, both broad and narrow, sharply delineated monoclines, and domical upwarps follow one another in succession or abut against one another like waves in a choppy sea. In one feature only—their general trend—do the flexures displayed in the Navajo country simulate those of the region farther west. Ten major folds and eight minor folds, in addition to local flexures of small dimensions, were noted in the region between the San Juan and the Puerco and Little Colorado.

The physiographic history of the Navajo country is included in that of the Colorado Plateau. The stratigraphic series of the area is essentially that of the Grand Canyon district; the crustal movements of the two areas, though different in kind, were probably contemporaneous, and it is reasonable to suppose also that the periods of igneous activity for the whole Plateau province are closely related in time.

The surface of the Navajo country has been carved rather than built; features resulting from deposition are relatively unimportant. Talus slopes and alluvial fans are replaced by cliffs; hills and knolls give way to buttes and towers; and graded slopes are represented by walls sculptured into rincons, recesses, alcoves, niches, windows, and arches, of large variety.

Wide, open mouths of niches and caves perched high on the canyon walls are conspicuous. These cavities, protected from rain, from the glaring heat of the sun, and from the suffocating sandstorms, were widely utilized by the ancient inhabitants as building sites—"rock shelters" or "cavate dwellings."

Perhaps the most striking erosion feature within the Navajo country is the recently discovered Rainbow Bridge, which spans Bridge Canyon, on the northwest slope of Navajo Mountain. Its symmetry and graceful proportions, as well as its size and beauty of color, give to this arch a commanding position among the natural bridges of the world. R. W. STONE.

GEOLOGY.—*Ground water for irrigation in Lodgepole Valley, Wyoming and Nebraska.* OSCAR E. MEINZER. U. S. Geological Survey Water-Supply Paper 400-B. Pp. 33, with 4 maps. 1917.

This brief report discusses the distribution and water-bearing character of the Ogalalla and Arikaree formations, the Brule clay, the underlying formations, and the Quaternary stream gravels. Large yields are obtained in the valley from the stream gravels and from the underlying jointed portions of the Brule clay. The strongest well yielded, in a test of one hour, at the rate of 710 gallons per minute with a drawdown of less than 4 inches. The report describes the natural processes of storage of water in the underground reservoir and of discharge therefrom by gravity in the irrigation season. It also gives data by the author and by Mr. H. C. Diesem, of the Department of Agriculture, on the cost of pumping for irrigation. O. E. M.

PETROLOGY.—*Chemical analyses of igneous rocks published from 1884 to 1913, inclusive.* H. S. Washington. U. S. Geological Survey Professional Paper 99. Pp. 1201, with 3 figures. 1917.

This paper is a revision and expansion of Professional Paper 14, published in 1903. In the introductory text the characters of rock analyses are discussed under the heads of representativeness of the sample analyzed and the accuracy and completeness of the analysis. The chief errors, both of commission and omission, to which rock analyses are liable are described, and the scheme for rating analyses as to their quality, adopted in the work, is explained.

It has been the aim to make the present collection as complete and accurate as possible and, in a sense, definitive. The search through the literature, a list of the publications examined being given, has been very extensive, and in this the library of the U. S. Geological Survey has been the main reliance. The number of analyses collected in the tables amounts to 8602, as against 2881 in the previous collection, which analyses are included in the present work. A great improvement in quality over the earlier work is manifest. The tables, which occupy 1098 pages, are divided into four parts: superior analyses of fresh rocks; incomplete but otherwise superior analyses of fresh rocks; superior analyses of altered rocks and tuffs; and inferior analyses. The analyses in Part I are arranged according to the Quantitative Classification and the norm of each, every one of which has been recalculated, is given. A discussion of the rules for naming and of some of the names of this system is to be found in the text.

In appendixes are presented a description of the Quantitative Classification, with a tabular presentation of its divisions and names, a description of the method of calculating the norm, as well as the tables for the calculation of the molecular numbers of the chemical components and percentages of mineral molecules. H. S. W.

PARASITOLOGY.—*Recent progress in the development of methods for the control and treatment of parasites of live stock.* B. H. Ransom. Proc. Second Pan-Amer. Sci. Congr. **3**: 709–718. 1917.

Brief review with list of references. B. H. R.

PARASITOLOGY.—*The sheep tick and its eradication by dipping.* Marion Imes. U. S. Dept. Agr. Farmers' Bulletin 798, 31 pp., figs. 1–15. May, 1917.

A popular discussion with details of methods of control and eradication. B. H. Ransom.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The 118th meeting of the Academy, the twentieth Annual Meeting, was held in the Assembly Room of the Cosmos Club the evening of Tuesday, January 8, 1918, with President W. H. HOLMES in the chair. The minutes of the last Annual Meeting were read and approved.

The Corresponding Secretary, Dr. R. B. SOSMAN, elected by the Board of Managers in September, 1917, to fill the unexpired term of Dr. F. E. WRIGHT, on account of the latter's continued absence from the city while engaged upon war work, reported that on January 1, 1918, the membership consisted of 6 honorary members, 4 patrons, and 470 members, one of whom was a life member. The total membership was 480, of whom 283 reside in or near the District of Columbia. During the year 1917 the Academy has lost by death: WILLIAM BULLOCK CLARK, July 27, 1917; RICHARD BRYANT DOLE, January 21, 1917; ARNOLD HAGUE, May 13, 1917. Reference was made also to the distribution of a new edition of the "red book," the Directory of the Washington Academy of Sciences and affiliated Societies, in July.

The Recording Secretary reported that four public lectures had been held during the past year, including the three on Heredity, as reported upon in the JOURNAL of the Academy for January 4, 1918.

In the absence of the Treasurer, Mr. WILLIAM BOWIE, his report was read by the Secretary. The report showed a balance of $850.93 on January 1, 1917, receipts totaling $6442.69 during the year (including the payment of a note for $2000,) disbursements totaling $4308.81 (including the purchase of a Liberty Loan Bond for $500), and a balance on December 31, 1917, of $2984.81. The Auditing Committee, consisting of Messrs. E. F. MUELLER, H. G. FERGUSON, and H. D. GIBBS, reported that the report of the Treasurer agreed in all respects with the accounts and with the securities on deposit.

Dr. N. E. DORSEY read the report of the Board of Editors.

The report of the tellers, Messrs. J. F. MEYER, H. E. MERWIN, and R. B. SOSMAN, was read by the Corresponding Secretary. The tellers reported that the mail ballot had resulted in the election of the following officers for 1918: *President*, L. J. BRIGGS; *Corresponding Secretary*, R. B. SOSMAN; *Recording Secretary*, WILLIAM R. MAXON; *Treasurer*, WILLIAM BOWIE; *Non-resident Vice-Presidents*, T. A. JAGGAR, JR., and B. L. ROBINSON; *Members of Board of Managers, Class of* 1921, T. H. KEARNEY and A. C. SPENCER.

The following resident Vice-Presidents, nominated by the affiliated societies, were then elected: *Anthropological Society*, JOHN R. SWANTON; *Archaeological Society*, ALEŠ HRDLIČKA; *Biological Society*, J. N. ROSE; *Botanical Society*, T. H. KEARNEY; *Chemical Society*, FREDErick B. Power; *Society of Engineers*, Edwin F. Wendt; *Electrical Engineers*, P. G. Agnew; *Society of Foresters*, Raphael Zon; *Geological Society*, W. C. Mendenhall; *Historical Society*, Allen C. Clark; *Medical Society*, Philip S. Roy; *Philosophical Society*, George K. Burgess.

The Entomological Society and the National Geographic Society had nominated no Vice-Presidents.

The following amendments to the By-Laws of the Academy, designed to avoid the existing conflict of dates between the annual meeting of the Academy and the regular meeting of the Chemical Society, were then read and, in accordance with the By-Laws, referred to the Board of Managers:

(1) In Section 1, Article III, substitute "Tuesday" for "Thursday." The section will then begin as follows: "The Annual Meeting shall be held each year on the second Tuesday of January."

(2) In Section 1 of Article V substitute "Tuesday" for "Thursday."

The retiring President, Dr. Holmes, delivered an address entitled *Man's place in the Cosmos as shadowed forth by modern science*, the newly elected President, Dr. L. J. Briggs, presiding.

"The address was designed to give a brief but comprehensive view of the career of man not in the world simply, but to shadow forth his place in the cosmos of which he was formerly thought to be the central feature. The problems of the immediate past are in part readily solved, while the remote past fades into the impenetrable shadows of the infinite. The problems of the present appear large in the foreground, so that he who runs may read; but the problems of the future find their solutions shrouded in the mists of the unknown and the unknowable.

"The story of the progress of research from the childish romancings of the savage mind through quagmires of superstitious interpretations to the astonishing revelations of modern science is a fascinating chapter in human history. The origin of the earth is found in the reassembling and consolidation of the widely disseminated matter of a spiral nebula, a process believed to be responsible for the evolution of the solar system as a whole—the sun and its attendant bodies. These nebulæ, of which a thousand have been identified, are thought to be due to the encounter of heavenly bodies with such force as to distribute their component particles widely throughout space, the encounters being due to the eccentricity of the orbits.

"The earth thus gathered together by the forces of gravity from the dust of ruined spheres became, after ages of ripening, the seat of life,—an oasis in the vast desert of the cosmos. The story of the beginnings and evolution of living things has been preserved in the fossil-bearing strata of the earth's surface and its outlines are well made out. From the earliest, exceedingly simple and minute forms advance was made throughout several stages of specialization to the culmination in man, each stage requiring millions of years in its accomplishment. But the story is not ended. Mobility, unceasing change is the rule of the universe. That which grows or develops reaches its meridian and passes into other forms. The fate of the human race is wrapped up with the fate of the minute satellite which we call the earth, and is subject to the ever active mobilizing forces of the cosmos. It must be molded and remolded into other worlds and suns and stars forever.

"But there are other wonders. The atoms which now enter into the constitution of all things—our bodies, the world, and the universe,—are indestructible. They have existed always and will continue to eternity. The millions of atoms which now form a drop of human blood, for example, have each a history more marvelous than words can tell or mind conceive, each having passed through changes without beginning and must continue to pass through other changes without end.

"At a certain stage in the earth's evolution life was generated and there is no reason why a million worlds may not have reached a corresponding stage—the stage at which the elements and the energies acting under immutable laws necessarily bring about the particular phenomenon known as life. But in the transformations of worlds these phenomena of life can be but negligible incidents, and the human race which we see so large is with all the other attendant phenomena of life in the world, and in all worlds for that matter, only as a breath in the unending cataclysms of the incomprehensible cosmos.

"If any part of the story of man's place in the universe thus outlined should be challenged, and many parts are open to challenge, the challenger may be assured that, if the present interpretations of science are wrong in whole or in part, the story which will finally be told, or which may never be told, must be more marvelous than this or any other that the human mind has conceived."

The 119th meeting of the Academy was held in the Assembly Room of the Cosmos Club the evening of Thursday, January 17, 1918, the occasion being the first of a series of illustrated lectures dealing with Science in Relation to the War. The speaker, Maj. S. J. M. Auld, of the British Military Mission, delivered an address on the subject *Methods of gas warfare*. A summary of the lecture will be found elsewhere in this number of the Journal (pp. 45–58).

William R. Maxon, *Recording Secretary*.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 517th meeting of the Society was held in the Auditorium of the U. S. National Museum on Tuesday, December 4, 1917, at 4.30 p.m. At this meeting Dr. Amandus Johnson, of the University of Pennsylvania, addressed the society on *The Scandinavian peoples*, illustrating his address with lantern slides.

The Scandinavian Peninsula has undoubtedly been inhabited by its present occupants for 10,000 years or more. When the climate of the country became tolerable after the vast icefields receded, tribes of the Aryan race found their way into southern Sweden, and established there the original home of the Germanic peoples. About the year 3000 B.C., at the end of the Stone Age, considerable advancement in culture had been made, and during the Bronze Age the decorative instinct of the people found expression in works of art unsurpassed elsewhere in Europe at that period. Later the Hallstatt and La Tène civilizations made their influence felt and finally, about the beginning of the Christian Era, Roman culture became the predominant foreign influence. An extensive trade developed with the western world during the following centuries, and many remains of this intercourse are found in Sweden and Denmark.

The most important period historically is the so-called Viking Age, 800–1000 A.D. Wonderful progress had been made in shipping and navigation. Fleets of the Viking ships appeared on almost every shore. The bold sailors sacked cities on the Mediterranean and Black Seas, ruled Ireland for generations, and conquered parts of France, England, and Spain; they founded Russia, and settled colonies in America and numerous other places. Finally Christianity was introduced and the Scandinavians settled down to a life of peaceful toil. The mental and spiritual reaction following the Viking expeditions was intense. A prose literature grew up, especially in Ireland. This was the most remarkable in Europe at the time and was the only original prose of the Germanic race. With it was coupled a poetry no less important. This art died, however, at about the time when distinct Scandinavian nationalities began to develop, and from the twelfth century onward we find long stretches of time nearly void of mental activity.

From this period Sweden began to lead a more separate life, but Denmark and Norway were gradually drawn closer together until the latter country nearly lost its identity. Denmark was the leading power of the north until the appearance of Gustavus Adolphus. Then Sweden acquired the supremacy. Through the supreme ability of her leaders she changed the course of European history and for more than a century played the rôle of a great power. In modern times Sweden has produced leading scientists, created a rich literature, and developed large industrial establishments.

After 1644 Denmark was weakened from time to time by the curtailment of her territory until in 1864 she was reduced to her present area. In the fields of science, letters, and art, however, she can point to brilliant achievements. Norway paid the price of dependency for many generations, and not until her separation from Denmark can we speak of a worthy Norwegian literature. But in the last century the leadership of the drama belongs to her, and in many lines of achievement some of her names rank among the first.

The 518th meeting of the Society was held in the Lecture Hall of the Public Library, on Tuesday, December 18, 1917, at 8 p.m. On this occasion Dr. DANIEL FOLKMAR, U. S. Tariff Commission, delivered a lecture on *Japan: people and policies*, illustrated by numerous lantern slides.

Dr. Folkmar opened his address by asking "Who are the Japanese? Are they as closely related to the Chinese as many Americans think, or are they a very different race, as the Japanese themselves think? The whole attitude of the Japanese toward the Chinese and toward the American people seems to rest on the assumption that they are not Mongolian, strictly speaking, and that they should be treated as our equals."

The Japanese frequently compare their empire with England, the Island Empire which rules a great part of the world from its favored position in the Atlantic, a position similar to that of Japan in the Pacific Ocean. The Japanese are unquestionably a mixed race, like the English and most of the leading nations of the present day. Five distinct ethnic types are to be found among the Japanese. The most important is the Manchu-Korean type, taller than the others and seen chiefly among the upper classes. The second is the well-known Mongolian type, with a broader face. Perhaps the most important element in the present nationality is the Malay strain, whose representatives are small in stature. The Ainu preceded both Mongolians and Malays, and it now appears that they, in turn, were preceded by a smaller race of pit-dwellers. According to Keane the Japanese bear a physical resemblance to the Mongolians, but linguistically are more closely related to the northern Asiatic Finno-Tataric stock. From this point of view the Japanese are more closely related to the Koreans than to the Chinese, since the Korean language is agglutinative and that of the Chinese is monosyllabic. Numerous authorities were cited on this and similar problems of the Japanese people. Japan received its profound philosophies from India and China. Thus the native religion of Japan is Shintoism, together with Buddhistic beliefs that came from India, and Confucianism from China.

Concerning Japanese policies Dr. Folkmar said, "There is no doubt that an exclusive policy dominated the national policies of Japan until Perry, the American, broke down the barriers. This act is now regarded by the leaders and educated classes as one of the most fortunate events in their national history." Dr. Folkmar spoke in high encomium of the manner in which the Japanese Empire has kept its word in restricting the emigration of Japanese to the United States, and said that there can be no doubt of the wisdom of taking the Japanese at their word in the recent convention that has been signed regarding the "open door policy."

The 519th meeting of the Society was held in the West Study Room of the Public Library, January 15, 1918, at 8 p.m. The program consisted of a general discussion of War Anthropology, led by Dr. Aleš Hrdlička, Curator, Division of Physical Anthropology, U. S. National Museum.

Taking as his subject *War and Race*, Dr. Hrdlička first directed attention to the very general and serious apprehension that the present war may have an untoward dysgenic effect on the race, saying that there exists, even among medical men and some men of science, a fear of the effect of shattered constitutions and the lasting results of shocks, strains, exposure, and wounds, together with an acquisition of new diseases. "These assumptions," said the speaker, "are enough to make the pessimist despair of the future of the race, but happily these assumptions are not entirely correct. In the first place we have no scientific basis for the belief that any of the warlike nations of the past have actually degenerated physically as the result of wars. . . . . Unquestionably there are losses from every great war, and in these I include the debilitating effects of wounds and disease, but fortunately these appear to be only temporary."

"There are wonderful laws working on living nature, including humanity. One of these is the elimination of the unfit. Another is adaptation, still another is restitution, and finally there are the laws of compensation. These laws have taken care of war-ridden mankind in the past, and as they work with undiminished vigor they can safely be expected, with such intelligent assistance as can now be given, to accomplish still more in the future." Treating of the action of these laws, Dr. Hrdlička noted that many afflictions caused by the war are curable and others are not transmitted to progeny. The most dangerous diseases of previous wars have largely been eliminated by preventive means, while science is already coping with new conditions that have arisen.

The speaker then recounted some of the compensations that will arise from the war, chief among which he placed the impetus given to the struggle against alcoholism. Important also among the compensations will be the great intellectual stimulus, the social and national regeneration, and the raising of this nation from an isolated and somewhat selfish position to that of a world power in the best sense of the term and for the good of humanity.

In the discussion which followed this communication the office of the Surgeon General, U. S. A., was represented by Lieut. Sidney Morgan, Sanitary Corps, U. S. N. A., who spoke on the surprisingly large percentage of wounded men who, by expert care, are returned to their homes fitted to be useful members of society.

Mr. Frank D. Tansley, ex-president of the Patria Club of New York City, stated that the ratio of casualties in the present war is about the same as that in the Civil War, from which the nation has been able to recover. Mr. E. T. Williams, of the State Department, noted that there may be a deterioration of the race in time of peace, due to industrial conditions and crowding of factories. Dr. John R. Swanton contrasted imperialistic and emulative civilizations, to the advantage of the latter; Mr. James Mooney emphasized the thought that psychology is the dominant factor in race differentiation; and Dr. Leo J. Frachtenberg spoke of predominant elements in every race. Rev. John M. Cooper mentioned an essential vitality which is the outcome of circumstance and which has been, to some extent, lacking in American youth but which may be developed by present conditions.

Frances Densmore, *Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 576th regular and the 38th annual meeting of the Society was held at the Cosmos Club, Saturday, December 15, 1917; called to order by President HAY at 8 p.m.; 19 persons present.

The annual reports of officers and committees were received, followed by the election of officers for the year 1918. The results of the election are given herewith: *President*, J. N. ROSE; *Vice-presidents*, A. D. HOPKINS, H. M. SMITH, VERNON BAILEY, NED HOLLISTER; *Recording Secretary*, M. W. LYON, JR.; *Corresponding Secretary*, W. L. MCATEE; *Treasurer*, NED DEARBORN; *Members of Council*, J. W. GIDLEY, WILLIAM PALMER, ALEXANDER WETMORE, E. A. GOLDMAN, A. S. HITCHCOCK. President ROSE was nominated by the Society as a vice-president of the Washington Academy of Sciences.

President ROSE appointed as Committee on Publications for 1918: C. W. RICHMOND, N. DEARBORN, W. L. MCATEE, J. H. RILEY; as Committee on Communications: WILLIAM PALMER, ALEXANDER WETMORE, R. E. COKER, L. O. HOWARD, A. S. HITCHCOCK.

M. W. LYON, JR., *Recording Secretary*.

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 793d meeting was held at the Cosmos Club October 27, 1917; President BUCKINGHAM in the chair; 27 persons present.

Messrs. J. T. TATE and P. D. FOOTE gave an illustrated paper on *Critical potentials for electrons in metallic vapors*. The subject matter presented was published in this JOURNAL (**7**: 517. 1917).

Discussion: The paper was discussed by Messrs. LOEB, SILSBEE, and BECKER.

By invitation Mr. S. J. CROOKER gave an illustrated paper on *Experiments on direct-current corona*. Electrical discharges in gases at pressures near that of the atmosphere may be divided into five classes: dark, glow, brush, spark, and arc discharges. Corona is a glow or brush discharge which appears on wires at high potentials indicating energy dissipation to the surrounding gas. Engineering experiments on the alternating-current corona have led to a revolution in the design and construction of high-potential transmission lines, machines, transformers, and insulators. Scientific investigations, especially on the direct-current corona, have led to an explanation of the phenomena observed.

A review was given of investigations made at the University of Illinois on the direct-current corona under various conditions. The corona discharge has been found to be a complicated function of the applied voltage; kind of gas and its pressure; size, shape, spacing, condition, and material of wires; temperature; humidity; etc.

The characteristic discharge is a uniform layer of glow for the positive wire and evenly spaced beads or brushes for the negative wire. The critical voltage increases with the radius of the wire and the gas pressure and is different for the positive and negative wires. A slight increase in pressure due to ionization occurs on sudden application of potential to the wire and is a linear function of the energy applied for all gases. In hydrogen the critical voltages are much lower than in air and its characteristics are such that almost complete rectification of alternating currents is possible. When corona is present the potential distribution curves are much distorted from the theoretical position and indicate an accumulation of charges near the electrodes. Roughness or oxidation of the wire lowers the critical point and shifts the characteristic I–V curves. Different metals also show different characteristics.

A short series spark destroys the bead formation on the negative wire, produces divergent pencils, brushes or streamers on the positive wire, and reverses the position of the characteristic I–V curves. A special hot-lime-cathode Braun tube showed the currents through the spark and the gas to be unidirectional pulses.

The uniform positive glow is explained as ionization by collision of gas particles near the wire. The negative beads may be due to a combination of ionization by collision and electron discharge. The series spark impulses may cause a disruptive action in the surface of the wire shooting off high velocity positive ions which give rise to the positive streamers. The apparent destruction of the negative beads is probably a superimposed building up and decay of the observed negative discharge forms for each spark impulse.

Discussion: The paper was discussed by Messrs. Agnew and L. J. Briggs.

The 794th meeting was held at the Cosmos Club November 10, 1917; President Buckingham in the chair; 38 persons present.

By invitation Mr. L. W. McKeehan gave an illustrated paper on *Diffusion of, and recoil from, actinium emanation.* Previous work on the diffusion of actinium emanation and on the distribution of its active deposit between charged metal plates was reviewed, and the causes of some uncertainties in the interpretation of the results were pointed out. Apparatus was designed to avoid the defects thus discovered, and measurements made under a variety of conditions. The value of the diffusion coefficient of the emanation into air at the mean temperature of the experiments, 20.7°C., was found to be 0.109 (plus or minus 2 per cent). The distribution of the active deposit between positive and negative plates at different pressures agreed with that to be expected on the basis of radioactive recoil from the disintegrating emanation, and gave as the range of recoil in air at atmospheric pressure and at 20.7°C. the value 0.0092 cm. A closer theoretical study made it seem probable that the recoil paths are not straight, and preliminary work by the author and another, using C. T. R. Wilson's photographic method for studying the initial portions of α-ray trails, is now in progress.

Mr. N. E. Dorsey gave an illustrated paper on *Radium luminous materials.* No abstract.

Discussion: The paper was discussed by Messrs. Bauer and E. B. Stevenson.

The 795th meeting was held at the Cosmos Club November 24, 1917; President BUCKINGHAM in the chair; 34 persons present.

Messrs. H. E. MERWIN and L. H. ADAMS gave a paper on *Polymorphism of the oxides of lead.* PbO appears in a red, tetragonal form stable below about 500°, and in a yellow, orthorhombic form stable at higher temperatures. Inversion with rising temperature is rapid, but with falling temperature so sluggish that it is the yellow form that is produced commercially from molten lead oxide. From hot solution in concentrated alkali both forms can be obtained. The yellow crystals frequently come out first and definitely orient the subsequent red crystals which are found attached to them. Pressure with a point upon certain faces of the yellow form causes immediate transformation to the red form at the point of pressure and along planes radiating in definite crystallographic directions. Pressure upon other faces causes cleavage, with little or no inversion. Heating causes the yellow crystals to become red before they begin to glow, owing to a large temperature coefficient of light absorption. In powder the red form is dull yellowish.

Discussion: The paper was discussed by Messrs. BUCKINGHAM, WHITE, SWANN, and BURGESS.

Messrs. G. W. MOREY and E. D. WILLIAMSON gave a paper on *Quantitative applications of the phase rule.* The subject of heterogeneous equilibrium is usually developed by the aid of the phase rule, together with the Le Chatelier principle of mobile equilibrium. The phase rule is a qualitative corollary of a perfectly general and widely applicable equation, equation 97 in Willard Gibb's paper "On the equilibrium of heterogeneous substances,"

$$vdp = \eta dt + m_1 d\mu_1 + m_2 d\mu_2 + \quad . \quad . \quad . \quad . \quad . \quad m_n d\mu_n$$

in which v, p, η, and t denote volume, pressure, entropy, and temperature, respectively; μ is defined as being $\left(\frac{\delta\epsilon}{\delta m_1}\right)_{v,\eta,m}$, ϵ being the energy, m_1 the mass of component 1, and the subscripts denote constancy of volume, entropy, and the other masses respectively.

The application of this equation to several problems was discussed. First, the method of derivation of the approximations known as the laws of dilute solutions was exemplified by the derivation of Raoult's law, stress being laid on the assumptions that it is necessary to make in order to derive these approximations from the exact relations. The application of equation 97 to some purely phase rule problems was then discussed. First, theorems were developed enabling the determination of the sequence of the P-T curves that intersect at an invariant point, then the question of the change in slope of the P-T curve of a univariant equilibrium with change in composition of phases of variable composition was discussed.

The subject matter of this paper has appeared in amplified form in the January number of the *Journal of the American Chemical Society.*

Discussion: The paper was discussed by Mr. SOSMAN.

DONALD H. SWEET, *Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. George E. Hale, Director of the Mount Wilson Solar Observatory of the Carnegie Institution, gave the public lecture at the annual meeting of the trustees of the Institution in Washington, on December 13, 1917. The subject of the lecture was "The development of the telescope and our expanding conception of the universe."

Prof. H. C. Cowles, of the University of Chicago, and Mr. E. W. Shaw, of the Geological Survey, spent two weeks of last October in Arkansas, continuing an investigation of the apparently fictitious "lakes" which have been shown on the maps of northeastern Arkansas for the past seventy-five years. Both the geological and the ecological evidence show that the lakes have had no real existence within a period of at least one hundred years. Their origin on the early land survey maps is still a mystery; later maps simply copied the "lakes" from the land maps or from one another. Messrs. Cowles and Shaw have devoted several weeks of each summer since 1913 to this investigation.

Mr. J. E. Spurr, formerly of the Geological Survey and for the past twelve years a consulting mining geologist in New York and Philadelphia, has returned to Washington and is residing at 1755 Park Road.

The Delegate of the Royal Swedish Government in the United States, Dr. Hjalmar Lundbohm, is well known to Washington geologists as the Director of the iron mines of Kiruna, Sweden, and author of papers on the geology of these ores. Dr. Lundbohm gave a talk on the Kiruna ores at the Petrologists' Club on December 18, 1917.

Representative S. D. Fess of Ohio re-introduced on December 11, 1917, the bill for a national university. The bill provides $500,000 for such a university for the fiscal years 1918 and 1919. The institution would be governed by a board of trustees in cooperation with an advisory council representing the states. It would confer no academic degrees and would accept only students of postgraduate standing.

The Patent Office Society of Washington has taken an active interest in the proposed Institute for the History of Science,[1] realizing the great aid obtainable from such an institution in the administration of the patent laws, as well as its general usefulness in aid of scientific investigation and the teaching of science. The Board of Managers of the Washington Academy of Sciences has voted its concurrence with the Patent Office Society in urging the location of the proposed Institute in Washington.

[1] See Science, N. S. **45**: 284, 635. 1917.

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PHYSICS.—*An optical ammeter.* PAUL D. FOOTE, Bureau of Standards.

The high precision in the measurement of temperature possible by use of a properly designed Holborn-Kurlbaum optical pyrometer equipped with a suitable pyrometer lamp is well recognized. If the lamps are operated below 1300° to 1500°C. the calibration of the pyrometer will not change appreciably after years of ordinary use. These two factors, accuracy of photometric settings and constancy in calibration of the lamps, permit the adaptation of this method of photometry to the measurement of current. In the present note two forms of current measuring instrument are described, one of which is strictly a hot-wire ammeter with the hot wire at a temperature between 600° and 1500°C., and the other a device for adjusting a current, by optical methods alone, to any preassigned value. The first method should prove especially useful for the accurate measurement of alternating current of high frequency.

In order to show what precision may be expected in measurement of current through the pyrometer lamp when the instrument is sighted on a source of constant brightness we will make the assumption that a photometric match of the tip of the lamp filament against the uniform background can be made with an accuracy of 0.5 per cent. This assumption is reasonable for precision photometry of this type, but even if the accuracy were only 5 per cent surprisingly accurate measurement of current can be obtained, as will appear below. The current temperature relation for a particular lamp used, G. E. No. 8, has the following form where i is the current in amperes and the absolute temperature of the filament:

$$(1) \quad i = 0.09258 - 0.000010719\ (\vartheta - 273) + 0.00000018074\ (\vartheta - 273)^2$$

whence

$$(2) \qquad \frac{\delta i}{i} = \frac{[-0.000010719 + 0.0000003615\ (\vartheta - 273)^2]\ \vartheta}{i} \frac{\delta \vartheta}{\vartheta}$$

The brightness-temperature relation for this lamp is obtained from Wien's law as follows:

$$(3) \qquad \frac{\delta J}{J} = \frac{c_2}{\lambda \vartheta} \frac{\delta \vartheta}{\vartheta}$$

where $c_2 = 14350$, and J = intensity corresponding to λ the wave length of the monochromatic light employed. In optical pyrometry this wave length is usually made about $\lambda = 0.65\mu$ by the use of a suitable red glass. Combining equations (2) and (3) one obtains:

$$(4) \qquad \frac{\delta i}{i} = \frac{[-0.000010719 + 0.0000003615\ (\vartheta - 273)^2]\ \vartheta^2}{i} \frac{\lambda}{c_2} \frac{\delta J}{J}$$

Thus for a particular value of such as 1273° absolute we have:

$$(5) \qquad \frac{\delta i}{i} = 0.06\ \frac{\delta J}{J}$$

Hence, if the photometric match is made with an accuracy of 0.5 per cent *the current i is determined with an accuracy of 0.03 per cent, or to three parts in ten thousand.* If the photometric match is made with an accuracy of only 5 per cent, the current is determined to three parts in one thousand, which is a precision scarcely to be obtained by an ammeter, especially for alternating current.

One means for adapting this method of photometry to the measurement of current is shown in figure 1, where A' is a red glass screen, A the pupil diaphragm, B the ocular lens, C the electric lamp connected to the electrical apparatus, F a second electric lamp, E a diffusing opal glass screen and D a lens focusing upon E and C. The alternating current flowing through C

brings the lamp to incandescence. By adjusting the rheostat *G* the brightness of the lamp *C* is matched against the image of the background *E* illuminated by *F*. The current required for the match is read potentiometrically by use of the resistance standard *K*. Hence the value of the alternating current is determined by an auxiliary measurement of direct current. The relation between the currents through *F* and *C* is obtained in the primary standardization of the instrument by using a direct current through *C* and measuring this potentiometrically. For the highest precision a commutating switch may be used with *C*,

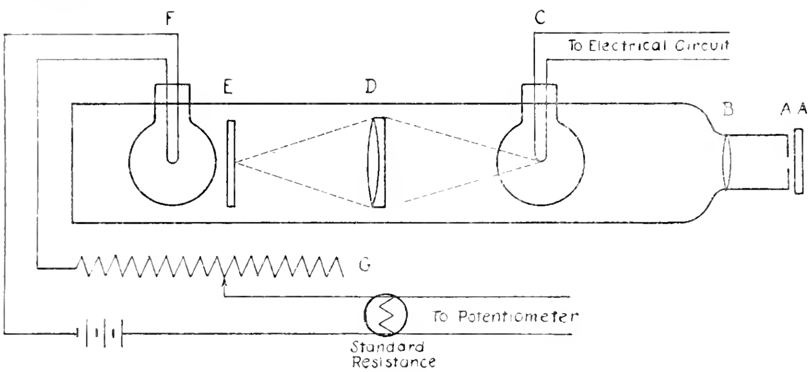

Fig. 1. An optical ammeter.

so that the standardization with direct current may be performed immediately following the observations with alternating current. The range of currents which can be measured by any one system of lamps exceeds 1 : 2, and lamps having filaments of varying sizes may be used for a large range in value of currents. Thus one lamp may be employed for alternating currents between 0.25 and 0.50 ampere, another lamp between 0.5 and 1 ampere, etc. Or with the same lamp, the range may be extended by the use of shunts, although this latter method is probably objectionable for very high frequency. If the induction effect becomes serious for the horseshoe filament, a lamp having a straight wire filament can be used.

When a suitable magnification system is employed, the diffusing screen *E* is unnecessary and a magnified image of *F* may be projected directly on the filament C. Another modification of the above method is obtained by reversing the positions of the lamps F and C. The above described principle can be employed for the measurement of alternating voltage, as well as current. In this case the lamp filament must be of very small wire in order that the instrument possess a high resistance. For voltages from 60 to 110 volts a 7.5-watt lamp, which has a resistance of 1600 ohms, should prove satisfactory.

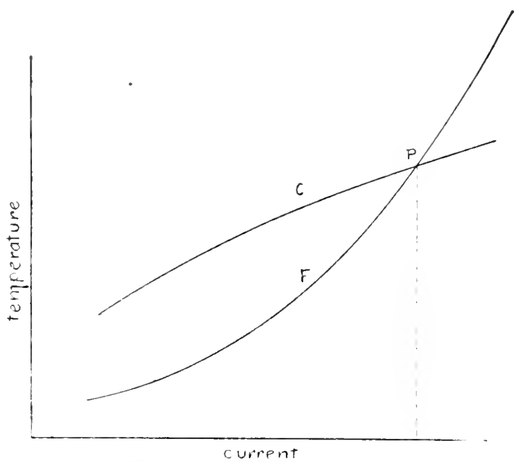

Fig. 2. Current-temperature relation for two lamps C and F. If a diffusing screen is used in front of the lamp F, the above curve F refers to the apparent temperature of the screen.

The apparatus shown in figure 1 may be employed for the determining of a fixed current of any preassigned value. A system similar in principle to this has been used, for determining a fixed temperature but to the writer's knowledge the method has never been employed for current measurements. Suppose that the apparent temperature-current relations of the lamps C and F are represented by the curves shown in figure 2. The two curves intersect at the point P. Hence, when the lamps C and F are connected in series and are caused to glow by either alternating or direct current the two filaments possess the same

[1] Siemens and Halske French Patent No. 466064.

temperature and are accordingly matched for the current corresponding to P. The condition for a match thus defines a standard current which can be adjusted to any desired value by the use of a suitable shunt. The match is effected by use of an adjustable rheostat in series with the two lamps. The precision obtainable is much less than that possible with the first method described and depends upon the slopes of the two curves of figure 2 at the point of intersection. Near the point P these curves can be assumed to be straight lines. Whence we have:

(6) $i = a + bt$ for lamp C

(7) $i' = a' + b't'$ for lamp F

From (6) and (7)

(8) $$\delta\,(t-t') = \frac{\delta i}{b} - \frac{\delta i'}{b'} = \frac{b'-b}{bb'}\,\delta i, \text{ since } i' = i$$

when the lamps are connected in series. Hence the precision with which the lamps can be matched (i. e., when $t - t' = 0$) depends upon the relative slopes of the temperature-current curves for the two lamps. As seen from equation (8) it is of advantage to have the slopes of the two curves at P differ considerably. There would be no accuracy whatever if the slopes were nearly the same. Using apparatus assembled as shown in figure 1, but without paying special attention to the procuring of lamps having widely different constants, b, the readings given in table 1 were made by four different observers, one of whom was unskilled in photometric matching. The accuracy is only fairly satisfactory, but undoubtedly could be improved by the proper selection of lamps.

TABLE 1

C. W. K.	E. F. M.	C. O. F.	P. D. F.
0.933	0.930	0.933	0.934
0.934	0.923	0.931	0.934
0.935	0.929	0.933	0.933
0.933	0.930	0.933	0.933
0.933	0.930	0.933	0.933
0.932	0.932	0.931	0.933
Means 0.9333	0.929	0.9323	0.9333

The final mean is 0.9320 ampere, and the average deviation is 0.18 per cent. The final mean, neglecting the readings of one observer, is 0.9330 ampere, and the average deviation is 0.06 per cent. Thus this method can be used to define a standard current with an accuracy of 0.2 per cent.

It may be pointed out that both of the above methods give results that are practically independent of the temperature of the room. Hence, an ammeter designed on these principles has a zero temperature coefficient.

MINERALOGY.—*Vivianite from the land pebble phosphate deposits of Florida.* THOMAS L. WATSON and STAPLETON D. GOOCH, University of Virginia.

INTRODUCTION

During recent mining operations by the Coronet Phosphate Company on its property on the Northwest Quarter of Section 34, Township 29, Range 22, about 1½ miles southeast of Plant City, Florida, fairly abundant crystals of vivianite were exposed over an area of moderate dimensions. The occurrence was noted by the junior writer, who is chemist to the Coronet Phosphate Company, and who kindly sent the senior writer a liberal supply of the mineral and matrix for study.

Although not a common mineral, vivianite has been observed both in this country and abroad in a variety of associations, more especially in veins with the sulphides pyrite and pyrrhotite, in bog iron ore deposits, and in clays and marls. In all its occurrences the mineral is regarded as secondary in origin.

Previous to the recent mining operations by the Coronet Phosphate Company near Plant City that resulted in exposing vivianite, the only reference to the occurrence of the mineral in Florida phosphate deposits found in the literature accessible to us is a general statement by Matson,[1] who remarks that vivianite has been noted at several places but is probably rare. In a

[1] MATSON, G. C. *The phosphate deposits of Florida.* U. S. Geol. Survey Bull. 604, p. 85. 1915.

recent letter to one of us (Watson), Dr. E. H. Sellards, State Geologist of Florida, states that a specimen of vivianite was brought to his office in August, 1916, by a citizen of Avon Park, Desoto County, Florida. The exact locality was not given, but Dr. Sellards says the mineral presumably came from south of Avon Park, which would place the locality some distance to the southeast of the land pebble phosphate area as defined on the map by Matson.[2] The vivianite was associated with bog iron ore.

Vivianite is apparently a rare mineral in the Florida phosphate deposits, and so far as we are aware it has not hitherto been described, although noted in places in association with phosphate deposits of the Florida type. Because of these facts and the general character of the vivianite crystals found near Plant City, the occurrence is regarded of sufficient interest and importance to warrant a published record.

GEOLOGIC SECTION

The vivianite occurs in a ferruginous or dark-yellow ocherous matrix of earthy character about 20 feet below the surface at the contact of the pebble phosphate bed with the "bedrock" (clay in this section), and partly in each. The vivianite matrix covers an area of approximately 1000 square feet, with the vivianite-bearing portion limited to about 20 feet square and 2 or 3 feet deep.

The section follows.

	Thickness in feet
Overburden:	
Black sandy soil containing organic matter	2
Sand with very little admixed clay, partly indurated and colored red by iron oxide	12
Clay, more or less phosphatic	1
Phosphate:	
Pebble phosphate with some sand	4–6
Bedrock:	
Dark yellow ocherous earth, locally hardened and red in color, containing besides vivianite scattered pebbles of phosphate and small rounded quartz grains	2+

[2] Matson, G. C. Op. cit. Folded map in pocket.

The contact between the overburden and the phosphate bed is sharply defined. The land pebble phosphate belongs to the Bone Valley gravel formation, which is generally regarded as Pliocene in age, although Matson[3] thinks there is some evidence of the Miocene age of the phosphate. The formation is believed to be of marine origin,[4] the materials of which were probably deposited under shallow water conditions.

DESCRIPTION OF THE VIVIANITE

The mineral is distributed irregularly through the ocherous matrix as single crystals and crystal aggregates. Individual crystals attain a maximum length of 22 mm., are prismatic in form, usually much elongated, and not infrequently flattened parallel to 100, with vertical striations sometimes developed. End faces were not observed, the crystals terminating usually in rough and uneven surfaces. In the crystal aggregates, the unattached end of the individuals sometimes exhibits acicular form. Fibrous structure, usually radiate or divergent, is sometimes developed.

Perfect cleavage is developed parallel to 010. The luster is pearly on cleavage faces, vitreous on other faces. Hardness 2; specific gravity 2.693. Color varies from light or pale green through blue-green to deep indigo blue, the pale green being predominant. Streak colorless to faint bluish white, which rapidly changes to deep blue on exposure. The finely ground powder after exposure to sunlight for more than 30 days remained deep blue without any indication of changing to brown as reported by some writers. Crystals vary from transparent to translucent, becoming more or less opaque on prolonged exposure.

The optical properties of the pale-green fragments of the vivianite similar to those yielding the analysis in table 1, kindly determined for the writers by Mr. E. S. Larsen, gave the following results: Optically (+); $2V$ large; dispersion not strong; X is normal to 010; Z makes an angle of $28° 30' \pm 1°$ with c.

[3] Matson, G. C. Op. cit., p. 69.

[4] At Pembroke aggregates of *silicified oyster shells* have been observed by Dr. Sellards and the junior writer (Gooch) in the pebble phosphate deposit.

The refractive indices are:

$$\alpha = 1.580 \pm 0.003, \ \beta = 1.598 \pm 0.003, \ \gamma = 1.627 \pm 0.003.$$

The grains are colorless and nonpleochroic under the microscope. On fine grinding the powder changes to deep blue, which has similar properties as the pale-green fragments, but is strongly pleochroic, with X = deep cobalt blue, Y and Z, colorless. Fragments of the deeply colored blue crystals show similar properties and absorption formula as the deep-blue powder of the pale-green fragments.

A carefully selected sample of transparent pale-green crystals of the vivianite was analyzed with the results shown in table 1.

TABLE 1

Chemical Analysis of Vivianite (By S. D. Gooch)

FeO	32.64
Fe_2O_3	9.43
P_2O_5	29.99
H_2O − 105°C	11.86
H_2O + 105°C	15.84
SiO_2	0.12
CaO	0.02
MnO	0.25
TiO_2	trace
	100.15
Specific Gravity	2.693

Careful chemical tests showed the absence of Al_2O_3, MgO, the alkalies (Na_2O and K_2O), F, SO_3, and CO_2. Attention is directed in the analysis to the seemingly high percentage of ferric oxide. This constituent is invariably present in blue vivianite in varying quantity, analyses showing it to range up to 33+ per cent. The presence of ferric oxide in the colored varieties of the mineral has been regarded as due to alteration (oxidation), but microscopic examination of the mineral and the very rapid change in color of the streak or powder, suggested that the change might possibly be due to inversion from one form to another.

Microscopic examination of the Florida vivianite indicated that the blue color was not uniform but was developed in or along streaks, apparently fractures or cleavage planes or both. The very rapid change in color of the streak of vivianite or of its powder on fine grinding, from white or faint bluish white to deep or indigo blue, is a well known property of the mineral.

Further chemical study of the mineral was undertaken to determine, if possible, whether the change in color was due to oxidation or to inversion. For this purpose a lot of uniformly colored pale-green crystals was selected and divided into two portions. The first portion was accurately weighed, dissolved *without* grinding, and ferrous iron determined. The second portion was reduced to powder by fine grinding and exposed to sunlight for five hours, after which a weighed sample of the exposed powder was dissolved and the ferrous iron determined. The results follow:

	UNGROUND VIVIANITE	FINELY GROUND VIVIANITE
	per cent	*per cent*
FeO..	42.88	38.43

These figures clearly show that fine grinding of the mineral resulted in the oxidation of 4.45 per cent FeO to Fe_2O_3, equivalent to 4.94 per cent Fe_2O_3. A second lot of pale-green crystals of the Florida vivianite was submitted to Prof. F. P. Dunnington, of the University of Virginia, who found on analysis 40.58 per cent FeO and *no* Fe_2O_3 on dissolving the crystals without grinding.

The results show beyond reasonable doubt that the presence of Fe_2O_3 in blue vivianite, which is probably the common variety of the mineral, is due to oxidation and not to inversion. The rapidity with which oxidation takes place on fine grinding, manifested in very rapid change of color (blue), is noteworthy and of special interest.

COMPOSITION OF THE MATRIX

The matrix is a dark brownish yellow ocherous earth, locally hardened and red in color, containing besides vivianite irregularly scattered phosphate pebbles of chalky white color with surfaces partly smooth but usually more or less pitted, and scant rounded grains of pellucid quartz. It readily dissolves in hot dilute hydrochloric acid.

The composition of the matrix is shown in the analysis given in table 2. The sample analyzed was representative of the matrix, except that care was taken in selecting the sample to avoid as far as possible the inclusion of phosphate pebbles.

TABLE 2

Chemical Analysis of Vivianite Matrix (By S. D. Gooch)

SiO_2	4.17
Al_2O_3	4.96
Fe_2O_3	65.20
FeO	1.41
MgO	trace
CaO	1.68
Na_2O, K_2O	0.16
H_2O − 105°C	4.14
H_2O + 105°C	12.72
MnO	0.56
TiO_2	0.14
P_2O_5	5.02
F	trace
SO_3	none
CO_2	none
	100.16

The analysis clearly indicates that the matrix is not a clay, but an earth composed of the hydrates of iron and aluminum, chiefly the former, hydrous phosphates of calcium, iron, and aluminum, and some free quartz. It is characterized by the essential absence of hydrous silicate minerals, especially kaolinite, a fact confirmed by microscopic study. The slight insoluble residue left on boiling a portion of the matrix in dilute hydrochloric acid was found to be composed of quartz and not of silicate minerals.

RELATIONS OF VIVIANITE TO THE ASSOCIATED MINERALS

The principal associated minerals are hydrous oxide of iron, probably limonite chiefly, calcium phosphate forming the phosphate pebbles, and rounded grains of quartz. The relations of the vivianite to these minerals clearly indicate its later formation, for the vivianite frequently incloses phosphate pebbles and occasionally a small rounded quartz grain. More often the quartz grains are inclosed by the phosphate pebbles, whose surfaces are frequently pitted with cavities, suggesting the possible removal of some mineral. Some cavities in several of the pebbles examined were filled with vivianite. In no specimens of the vivianite examined were there indications of inclusions of the brownish-yellow ocherous material, but some of the vivianite crystals showed irregularities of surface similar to embayments which we believe resulted probably from external interference of the ocher on crystal growth.

ORIGIN OF THE VIVIANITE

The vivianite from the Florida locality is of secondary origin, formed we believe by the action of ferrous-iron solutions on the phosphate. Although rated at the present time as a rare mineral in the land pebble phosphate deposits, the conditions certainly appear to be favorable to a more general formation and distribution of the mineral in these deposits.

PETROLOGY.—*The significance of glass-making processes to the petrologist.* N. L. Bowen, Geophysical Laboratory. (Communicated by A. L. Day.)

The entry of the United States into the war was the occasion of an enormously increased demand for optical glass to be used in all kinds of military instruments. The supply of glass from abroad was almost completely cut off. In the effort to meet the demand by domestic production many problems were met with for whose solution the advice and assistance of scientific men seemed desirable. Glasses are, for the most part, silicate mixtures that have been melted at a comparatively high temperature and then cooled to the glassy state. Since the principal activity of the Geophysical Laboratory has been the study of the behavior of silicates at high temperatures, it was expected that the experience of that organization might be of material assistance, and its services were therefore called upon. I was one of the several sent to the glass plant of the Bausch and Lomb

Optical Company, where we went hoping not merely to be of assistance in solving these urgent problems but expecting also to learn something of more general interest concerning the behavior of silicate liquids when handled on the comparatively large scale of the glass plant.

One of the principal requirements of optical glass is homogeneity. A fragment of glass to be used for a lens or prism must have the same refractive index and therefore the same chemical composition in all its parts, and from every pot of glass made a considerable proportion is rejected because it fails to fulfil this requirement. Naturally, the causes of inhomogeneity are diligently sought for, with the hope of removing them or reducing them to a minimum, and it may be stated that these causes are now pretty well understood. To those interested in the causes of inhomogeneity (differentiation) in masses of silicate rocks the factors that lead to inhomogeneity in these artificial silicate melts are perhaps of sufficient interest to merit description.

Optical glass is made in a great many varieties with a wide range of composition. SiO_2 and B_2O_3 are the principal acidic oxides, and the alkalies with CaO, PbO, BaO, and ZnO are the principal basic oxides, though a number of other oxides enter into the composition of special glasses. The alkalies, lime, and baryta usually go into the batch in the form of carbonates; lead and zinc as oxides; and silica as quartz sand. The carefully mixed batch is usually fed in several instalments into the pots, which have already been heated to the melting temperature. Factors tending to produce inhomogeneity immediately set to work. Some constituents of the batch are readily fusible, others, especially the sand, are quite refractory. The more fusible portions quickly form a liquid which tends to filter downward through the porous structure formed by the grains of the more refractory material. This action is especially marked in the heavy glasses rich in lead.

As typically developed the result may give every appearance of liquid immiscibility and the formation of two liquid layers. The two layers may be sharply marked off from each other and may so persist throughout the run. But that we have here no true case of liquid immiscibility and that the persistence of two layers is due entirely to the slowness of diffusion is shown by the fact that appropriate stirring will completely eliminate this layering and give a single homogeneous liquid. When real immiscibility occurs in the glass pot, as it does under certain circumstances, it is quite a different matter. If the alkaline carbonates used in the batch contain a considerable amount of chloride or sulfate, these salts form a separate liquid layer which floats on top of the glass, forming the "salt water" of the glass-maker. No amount of stirring, however vigorous, will render such a mass homogeneous. This immiscibility between silicate, on the one hand, and sulfate or chloride, on the other, serves but to emphasize that immiscibility between silicate and silicate is not encountered in the whole range of glass compositions.

This process of settling down of heavy liquid through the porous mass of the batch can take place only at a stage when the mass is mostly solid. A factor tending to produce a closely related result comes into play at the stage when the mass is mostly liquid. Of all the ingredients of the batch the sand is usually the last material to dissolve. The sand grains tend to rise in the liquid and thus to render the upper parts more siliceous and of lower density. This action results in a continuous density gradient rather than in a sharp division into two layers. That it is not a spontaneous arrangement of the liquid according to the Gouy-Chaperon phenomenon is shown by the fact that as time goes on diffusion tends to lessen the gradient rather than to increase it.

Figure 1 is a photograph of a fragment of glass taken from such a pot, the straight edge being part of the original upper surface of the glass. Two parallel plane faces were cut normal to this surface and the specimen was photographed in a bright light close to a white screen. Under these conditions heavy shadows are cast by the globules of low refracting glass surrounding the silica grains and by the tails of similar material pointing downward from them. It is obvious that silica is continually being transferred towards the top.

There can be no doubt of the correctness of this explanation of the density gradient as a result of the floating of sand grains, for fortunately the action can be interrupted and observed at an intermediate stage. When the pot is removed at such a stage and the glass is chilled, sand grains are found suspended in the glass. That they were rising slowly in the liquid and dissolving at the same time is shown by the fact that pointing downward from each grain there is a tail of glass of lower refractive index than the surrounding glass.

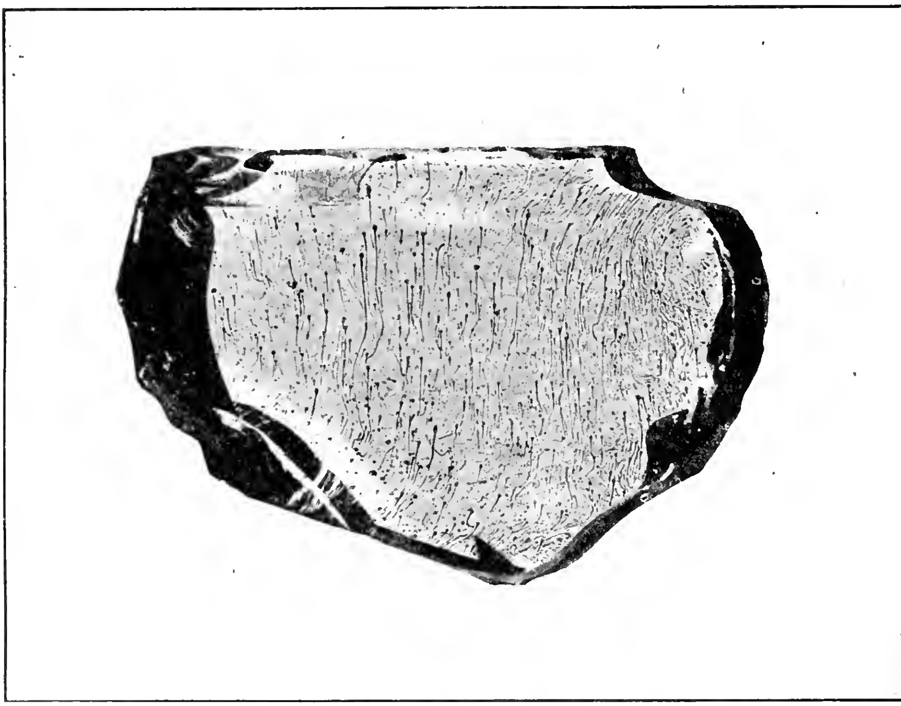

Fig. 1. Glass containing rising silica grains. Natural size.

In a former paper[1] I criticized the interpretation that has been offered of the result of a certain experiment by Morozewicz. The glass from his experiment showed a density and composition gradient, with the heavier portion at the bottom of the pot, and this arrangement had been explained as the result of the Gouy-Chaperon action. I offered the suggestion that the ar-

[1] *The later stages of the evolution of the igneous rocks.* Journ. Geol., Suppl. to Vol. 23, p. 5. 1915.

rangement was due to differential melting with the sinking of heavy liquid at an early stage and the rising of silica grains at a later stage, though I had not at that time seen or studied the phenomenon. A careful study of the behavior of the ingredients of a glass batch leaves no question as to the correctness of this interpretation. There is, then, no experimental basis for the belief in an appreciable result from the Gouy-Chaperon action in a small pot and, therefore, no present reason for assigning to it any greater importance in rock magmas than that which theory would indicate.

There are two other factors making for inhomogeneity in glass: the solution of the pot, and the volatilization of certain ingredients from the surface of the liquid. No doubt the corresponding processes, namely, solution of the surrounding rocks and escape of material into them, have their place in magmatic differentiation, but if their quantitative effect in the glass-pot is any criterion they cannot be regarded as approaching in importance the two processes (sinking of liquid and floating of silica) that have been described above. However, the conditions are so different that one should be careful not to push the analogy too far in these cases. It may be safely stated, however, that, contrary to certain claims that have been made, glass-making processes offer no support for the belief in liquid immiscibility among silicates, nor for the belief in a significant density stratification in a mass wholly liquid. They do, however, suggest the importance of gravity acting on a mass partly liquid and partly solid, and emphasize two stages, (1) that at which there is much liquid and little solid, and (2) that at which there is little liquid and much solid. The effects of these processes in magmas,—sinking of crystals at an early stage of crystallization and squeezing out of residual liquid at a late stage,—have been discussed in some detail elsewhere.[2]

The association of gabbro with granite or of basalt with rhyolite, and the complete absence of intermediate types that is often noted, have been held by some to necessitate some sort of discontinuous differentiation, whereas crystallization-differentiation should, for the most part, be continuous. Evans has offered the suggestion that in aqueous magmas there may be a

[2] Op. cit.

separation into two liquid portions, the lighter of which contains most of the water together with much silica, alumina, and the alkalies.[3] This is, of course, a possibility not altogether to be excluded, nevertheless all the available evidence is against it. Such experimental work as has been done hitherto on aqueous silicate melts gives no indication of a tendency towards a separation into two liquid layers.[4] But the range of this work is limited as yet and one must fall back largely upon examination of the geological evidence. Over against the lack of types intermediate between gabbro and granite (granophyre, micropegmatite) in some localities should be placed the abundance of intermediate types elsewhere. Again, if we examine the gabbro of a gabbro-granophyre occurrence we almost invariably find a certain amount of the granophyre occurring in the gabbro, frozen in as Daly puts it.[5] And when we examine the manner of occurrence of this frozen-in material we find nothing to lead us to believe that it represents an immiscible liquid. It does not form globular masses, large and small, scattered through the gabbro. It occupies crystallization interstices with all the marks of a crystallization residuum. Add to this the fact that it corresponds in composition with the kind of crystallization-residuum one is led to expect from experimental studies, and the reasons for appealing to liquid immiscibility may be regarded as of insignificant weight. Many petrologists regard liquid immiscibility as the ready solution of all difficulties. Realizing that present evidence is against it, some are led to "hope" that it may yet be experimentally demonstrated in silicate magmas. Until then one must regard its occurrence in silicate magmas as resting on pure assumption, an assumption that is in most cases not even helpful, and probably never preferable to the well-supported theory of crystallization-differentiation.[6]

[3] J. W. Evans. Discussion of paper by G. W. Tyrrell on *The picrite-teschenite sill of Lugar.* Quart. Journ. Geol. Soc. **72**: 130. 1917.

[4] G. W. Morey and C. N. Fenner. *The ternary system H_2O-K_2SiO_3-SiO_2.* Journ. Am. Chem. Soc. **39**: 1173. 1917.

[5] Igneous Rocks and Their Origin, p. 241.

[6] I would be the last, however, to claim complete miscibility between sulfides and silicates. Cf. Tolman and Rogers (*A study of the magmatic sulfid ores.* Stanford Univ. Publ. 1916, p. 10).

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Strontianite deposits near Barstow, California.* ADOLPH KNOPF. U. S. Geological Survey Bulletin, 660–I. Pp. 14. 1918.

Strontianite in economically important quantity has recently been found near Barstow, San Bernardino County, California. The formation in which the deposits occur consists of a series of lake and terrestrial beds of Upper Miocene age. A threefold subdivision of the beds may easily be recognized. The strontium deposits are restricted to the middle subdivision, which is made up chiefly of grayish-green clay in thick beds. In places reefs of algal limestone are prominent, and obviously this part of the formation was laid down in a lake.

Strontianite and strontium-bearing rock have been found at a large number of places in a belt about 2 miles long. They occur as layers that lie parallel to the bedding of the inclosing clays and are distributed at intervals through a thickness of several hundred feet. The strontianite occurs in two forms—as fibrous masses of resinous color and luster and as dense, exceedingly fine grained gray or drab material, which in appearance exactly resembles limestone. The two varieties occur separately as a rule, but in some deposits they are intermingled, spherulites of coarse resinous strontianite being irregularly scattered through gray aphanitic strontianite rock. Some celestite is present in the lower-grade material of the district.

The thickest body of pure spherulitic strontianite that had been found at the time of visit is 14 inches thick, but the gray aphanitic strontianite rock had been found in layers as much as 3 feet thick.

The strontianite deposits were formed by the replacement of the lacustral limestone beds that are interstratified in the clays. They thus differ widely from the only other commercially productive strontianite deposits—those of the Münster district, Westphalia—which consist of a series of steeply inclined veins cutting horizontal marine calcareous shales of Upper Cretaceous age. They resemble them in one fundamental respect, however, in that they were formed later than the strata that inclose them.

GEOLOGY.—*Geology and water resources of Big Smoky, Clayton, and Alkali Spring valleys, Nevada.* OSCAR E. MEINZER. U. S. Geological Survey Water-Supply Paper 423. Pp. 167, with maps and other illustrations. 1917.

This paper describes in detail three typical desert basins of the Basin-and-Range Province, with respect to their physiographic development and the absorption, circulation, and discharge of their ground waters.

Two cycles of erosion are shown in the Toyabe Range by two strongly contrasting types of topography. After the region had been eroded to a stage of maturity, probably late in the Tertiary period, it was faulted and uplifted, and the resulting escarpment was attacked by the streams, producing a very rugged front. Extensive faulting, continuing until recent time, is shown not only by precipitous mountain fronts but also by observed displacements, by polished surfaces, and by numerous escarpments in the valley fill. Evidences of glaciation, previously reported, are believed not to exist.

Elaborate systems of beach ridges or embankments, the largest nearly 50 feet high, mark the outlines of two Pleistocene lakes, designated by the author as Lake Toyabe and Lake Tonopah. Lake Toyabe, when at its highest level, was about 40 miles long, 9 miles in maximum width, and covered an area of approximately 225 square miles, or 18 per cent of the drainage basin in which it lay. Lake Tonopah, when at its highest level, was about 22 miles long, $5\frac{1}{2}$ miles in maximum width, and approximately 85 square miles in area, or only about two-fifths the area of Lake Toyabe. This area was only 4.2 per cent of the total drainage basin tributary to the lake—a percentage less than one-fourth as great as that of Lake Toyabe.

The most important contribution of the report is a quantitative discussion of the origin, absorption, circulation, and discharge of the ground water, and of the criteria for determining areas of ground-water discharge. The amount of absorption was estimated chiefly by measuring stream flow at successive points on a part of the 54 small streams that discharge into Big Smoky Valley, and deducting for evaporation and transpiration from the wetted areas. The total annual supply of ground water was estimated to be several tens of thousands of acre-feet. The criteria for determining areas of discharge are (1) the moisture of the soil and the position of the water table, (2) the appearance of soluble salts at the surface and the distribution of these salts in the soil, and (3) the distribution of plants of certain species that feed on ground water. On the map are shown the areas of discharge (aggregating 130,000 acres), and also the depths to the water table predicted on the basis of these areas.

Alkali Spring Valley illustrates the other type of desert basin in which there is no ground-water discharge, the facilities for underground leakage apparently being great enough to dispose of all the water that is absorbed.

Big Smoky Valley contains three distinct types of ground water, which are genetically related to the geologic formations from which they are derived. The processes of concentration were different in the lacustrine epoch than they are at the present time, and they differ in the clay cores below the playas from those in the surrounding zones of active discharge. O. E. M.

PALEONTOLOGY.—*Orbitoid foraminifera of the genus Orthophragmina from Georgia and Florida.* Papers by C. Wythe Cooke and J. A. Cushman. U. S. Geological Survey Professional Paper 108-G. Pp. 16, with 5 plates. 1917.

The first paper, by C. W. Cooke, describes several localities on Chipola River, Florida, Flint River, Georgia, and Suwannee River, Florida, at which species of *Orthophragmina* have been found in the Ocala limestone and enumerates the species of other organisms that are associated with them. The occurrence in the Ocala limestone of the genus *Orthophragmina*, which elsewhere appears to be restricted to the Eocene, is corroborative evidence of the Eocene age of that formation.

The second paper, by J. A. Cushman, describes and figures 6 new species and one new variety of *Orthophragmina*. C. W. C.

ORNITHOLOGY.—*Second annual list of proposed changes in the A.O.U. check-list of North American birds.* Harry C. Oberholser. The Auk **34**: 198-205, April, 1917.

This is a résumé of recent ornithological activities not already treated in the American Ornithologists' Union Check-List of 1910, its supplement, and the First Annual List of Changes in the same. It consists of additions, subtractions, rejections, and the changes in generic, specific, and subspecific names made for zoological reasons, purely nomenclatural questions being excluded. In the present list there are added 13 genera recently described or raised from subgenera; one species and 14 subspecies either described as new, revived, or recently captured within the boundaries of North America. Two species are eliminated as synonymous, and one proposed subspecies is rejected for the same reason. Furthermore there are many changes in names due to the recognition of additional genera, the descriptions as new of the North American representatives of wide-ranging species, the replacing of later by earlier names, and similar causes. This brings the subject down to December 31, 1916, and annual lists of the same character are to follow hereafter. H. C. O.

ORNITHOLOGY.—*A cooperative bird census at Washington, D. C.* Harry C. Oberholser. Wilson Bull. **39**: 18–29. March, 1917.

The importance of counting the actual numbers of birds over given areas, particularly during the breeding season, has already been shown. Similar censuses during the height of the spring migration are also of considerable value, both as a basis for comparison of the relative numbers of the different species in the same year and of the same species in different years. Such a count was made by 15 local ornithologists in the vicinity of Washington, D. C., on May 12, 1913. The country investigated consisted of the region within 20 miles of the city of Washington and comprised the valleys of the Potomac and Anacostia rivers, together with tributary streams and adjacent valleys. The routes of the 13 parties, each of which covered a distance of from 5 to 55 miles, traversed the country in all directions from Washington; and the results were very interesting. One fact of distribution was emphasized by these trips, which is that almost all the best places for birds about Washington lie in the more or less immediate valleys of the Potomac and Anacostia rivers. On this day the total number of species observed by all the parties was 129, of individuals actually counted, 1257. The largest number of species noted by any individual was 91, and the largest number of birds 3049. As the year 1913 was not particularly good for birds, this record is likely to be much increased by future observations. Three species, *Podilymbus podiceps, Totanus flavipes*, and *Dendroica palmarum hypochrysea*, noted on this day, had not previously been observed so late in the spring. The six most numerous species, in the order of their abundance, were, rather surprisingly, as follows: *Passer domesticus hostilis, Hirundo rustica erythrogastris, Iridiprocne bicolor, Melospiza melodia melodia, Chaetura pelagica*, and *Lucar carolinensis*. H. C. O.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers, at its meeting on January 21, 1918, adopted the budget for the year 1918, increasing the allotments to the JOURNAL and the Committee on Meetings. The appointment of the following committees was announced:

Executive	*Membership*	*Meetings*
L. J. BRIGGS	PAUL BARTSCH	W. F. G. SWANN
R. B. SOSMAN	C. L. ALSBERG	C. S. HUDSON
WILLIAM BOWIE	G. W. COOK	K. F. KELLERMAN
G. K. BURGESS	W. J. HUMPHREYS	E. B. PHELPS
A. C. SPENCER	T. W. VAUGHAN	E. W. SHAW

Prof. FRIDTJOF NANSEN, of the University of Kristiania, Norway, now in Washington as Minister Plenipotentiary of Norway on special mission to the United States of America, has been elected an honorary member of the ACADEMY.

Messrs. O. H. TITTMANN and W. D. HUNTER were elected vice-presidents to represent the National Geographic Society and the Entomological Society of Washington, respectively.

ROBERT B. SOSMAN, *Corresponding Secretary.*

GEOLOGICAL SOCIETY OF WASHINGTON

The 320th meeting was held at the Cosmos Club, April 25, 1917.

INFORMAL COMMUNICATIONS

F. E. MATTHES read a greeting from Prof. Emmanuel de Margerie. former president of the Société Géographique de France, to the men of science in America, acclaiming with enthusiasm the entrance of the United States into the war.

REGULAR PROGRAM

G. P. MERRILL: *The rarer constituents of meteorites.*

G. F. LOUGHLIN: *The relation of copper and zinc in the carbonate ore at Ophir, Utah.* (Published in U. S. Geol. Survey Bull. 690-A.)

F. E. MATTHES: *The preglacial history of Yosemite Valley.*

The 321st meeting was held at the Cosmos Club, May 9, 1917.

INFORMAL COMMUNICATIONS

H. M. Ami: *Notes on the geology of Asia Minor.* The general geologic features were outlined with special reference to large undeveloped mineral resources.

REGULAR PROGRAM

Willis T. Lee: *Geology and scenery of the Rocky Mountain National Park.*

E. O. Ulrich: *The limitations of fossils in correlation.*

T. Wayland Vaughan: *Summary of results of study of marine bottom samples from Murray Island, Australia, the Bahamas, and Florida.*

The 322d meeting was held at the Cosmos Club, November 28, 1917.

INFORMAL COMMUNICATIONS

B. S. Johnson: *Chalmersite, $CuFe_2S_3$, a new ore of copper.* This mineral occurs extensively in greenstone in several localities in Alaska. It is associated with pyrrhotite and chalcopyrite. A satiny sheen due to cleavage is one of its distinguishing characteristics.

R. C. Wells: *Tungstenite, disulphide of tungsten, a new mineral.* The disulphide of tungsten, WS_2, was found in material from the Emma mine, Little Cottonwood district, Utah, associated with pyrite, tetrahedrite, and galena. The mineral resembles graphite and shows slickensided surfaces but has a specific gravity of about 7.4. It is decomposed by aqua regia or by fusion with niter. It occurs massive, is dull to brilliant metallic in luster, is gray in color, and its hardness is about 2.5.

R. W. Stone: *The development of valuable magnesite deposits in the State of Washington.* This material is suitable for replacing imported magnesite for use in paper-making and for refractories. The significance of previously reported analyses of this material was not appreciated, and its rediscovery and recognition as a commercially valuable substance was purely accidental.

REGULAR PROGRAM

Eugene Wesley Shaw: *The "lakes" of northeastern Arkansas, and some features of the work of the Mississippi River.* Northeastern Arkansas has, according to all maps of the region, numerous large and small lakes. As a matter of fact most of these lakes are fictitious and many are not even swamps. The "lakes" are generally believed to have been caused by the New Madrid earthquake of 1811–12 and are widely known as "sunk lands." However, in most of them the surface has not been depressed; they do not have a basin form but instead are as high as surrounding country. All are in the heavily forested bottom lands of the lower Mississippi. In this forest there are natural openings that are swampy and some of them have shallow temporary or permanent lakes. Such openings are found both inside and outside the areas mapped as lakes, and other features, such as low ridges and depressions and soil varieties, show little relation to the "lakes" or to their "shore lines."

The "lakes" were first reported and mapped by the original public land Survey of about seventy-five years ago. The field work, like much other public land surveying, was done under contract at a price perhaps too low for thorough and honest work. The early maps have been copied unquestioningly by all later ones, though strange to say there have been numerous later field examinations by various organizations, some purporting to be fairly detailed surveys of one sort or another, and few if any maps state that they are based on the land survey.

Ownership of the lands represented as lakes hangs on the correctness of the original survey. If it was correct and the lakes have become filled or drained their fertile beds must now be parceled out among those owning bordering lands—the riparian claimants. If, however, the old surveys were erroneous, the lands are now, it is said by lawyers, the property of the nation and open to homestead. Up to about 1910 no one claimed the lands—perhaps because they were poorly protected by levees and were more or less infested with malaria but perhaps to a large extent because of the reputation given Arkansas by songs and tales that have led homeseekers to pass over this rich State for less productive lands farther west. As a matter of fact few if any lands yield heavier crops of corn and cotton than those of northeast Arkansas, this area seeming to be too far north for serious difficulty with the boll weevil. In the past five years or since the question of title to the "lakes" was first raised, squatters have taken possession so far as allowed and there has been much contention between them and the riparian claimants.

The Department of Justice has brought suit to quiet the title to the lands in the government and since there is almost no one living who can testify as to whether or not the lands were lakes at the time of the old survey, the writer has been called upon at various times to determine if possible by the use of geology and physiography whether or not one or another of the areas was a lake at the time of the old survey. Ecologist H. C. Cowles was employed to gather for the same purpose the testimony of the trees of the immense hardwood forests that cover the "lakes" and surrounding land.

At first it seemed probable that the geologic and physiographic evidence would be indecisive because the whole region has been subject to annual overflow up to the time the levees were completed (and occasionally since) and hence to more or less erosion and sedimentation. It was found, however, that with the exception of the natural levee belts bordering the Mississippi and the larger bayous and other tributaries, erosion and sedimentation proceed very slowly and hence the presence or absence of basins, shore features, lake deposits, etc., could be used.

Although there are probably more low swampy areas inside the meander or "shore" lines of the lakes than outside and in places a bayou or other natural feature follows one of the lines for a part of its course, there is with one or two possible exceptions not only no recognizable lake basin, shore features, or lake deposits but for the most part no relation between the meander lines and any boundary of any feature or deposits, all manner of natural boundaries crossing the "shore lines" at all angles and all kinds of the natural features and deposits of the region being found both inside and outside of the "lakes."

The testimony of the trees, according to Dr. Cowles, has a similar bearing. The forest consists of oak, ash, elm, hickory, cottonwood, pecan, various gums, cypress, locust, maple, hackberry, sycamore, etc., large proportions of which are over seventy-five years old and none of which, according to the same authority, will germinate and grow in a lake—not even excepting cypress. The spur roots are with rare exceptions at the surface indicating no practically erosion or sedimentation.

Here and there are small tracts in which the timber was shaken down by the New Madrid earthquakes of 1811–12 and the surface being depressed, elevated, covered with the sand of "sand blows" or otherwise changed, a different society of trees has sprung up—all less than 105 years old and some growing astride, the still remaining fallen trunks. In such places events of the past century are clearly recorded.

Perhaps the most important inferences concerning the work of the Mississippi River are (1) that it is probably filling and not deepening this part at least of its valley and (2) that throughout most of the flood plain the rate of sedimentation is very slow—not more than a few inches per century.

E. S. Bastin: *Genesis of the ores at Tonopah, Nevada.*

The 323d meeting was held at the Cosmos Club, December 19, 1917.

INFORMAL COMMUNICATIONS

Lawrence LaForge: *The occurrence of "Springs" in place names in the United States.* The word is more common in the Southern States. The relation of the place names to glaciation, limestone formations, habits of the people, etc., was referred to.

Discussion: David White called attention to the remedial qualities of springs and the disposition of the people of the South to resort to springs. T. W. Vaughan spoke of nameless springs throughout the Southern States and their association with limestone formations. O. E. Meinzer referred to the large springs along fault scarps in Nevada, and W. B. Heroy spoke of the ratio of area of a state to the number of place-names containing the word "Springs."

REGULAR PROGRAM

Sidney Paige: *Coal and iron in the terms of peace.*

H. E. Merwin, *Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 47th annual meeting (796th regular meeting) was held at the Cosmos Club, December 8, 1917; President BUCKINGHAM in the chair; 29 persons present. The minutes of the 46th annual meeting were read. The report of the Secretaries was read by Mr. Sweet. One member, Thomas W. Smillie, died during the year, one member resigned, and one member was dropped. Two members were transferred to the absent list, and two members were transferred from the absent to the active list. Twenty-four new members were elected. The present active membership is 170. Fifteen regular meetings were held, at which 37 formal and 7 informal communications were presented. A complete revision of the by-laws was adopted on November 24. According to the new by-laws the functions heretofore performed by the Executive Committee and the General Committee are concentrated in the General Committee. At the same time the General Committee is reduced to thirteen members.

The Treasurer's report through December 1, 1917, was read by Mr. MUELLER. The total receipts for the year, including cash balance of $443.66, were $2,537.29; the total disbursements were $2,353.16; cash balance on December 1, 1917, $184.13. The total par value of the investments now held by the society is $12,500. The report of the Auditing Committee, consisting of Messrs. MAUCHLY and BEARCE, was read by Mr. MAUCHLY. This committee reported that the statements in the Treasurer's report had been found correct. The reports of the Auditing Committees and the Treasurer were ordered accepted and placed on file.

The report of the Committee of Tellers, consisting of Messrs. SILSBEE and WHITE, was read by Mr. WHITE. A total of 43 ballots was received. From among those placed in nomination by the informal ballot, the following officers were duly elected for the ensuing year: *President*, G. K. BURGESS; *Vice Presidents*, W. J. HUMPHREYS, R. B. SOSMAN; *Corresponding Secretary*, E. C. CRITTENDEN; *Recording Secretary*, H. L. CURTIS; *Treasurer*, E. F. MUELLER; *General Committee*, J. A. FLEMING, W. F. G. SWANN (two year term) and R. L. FARIS, W. P. WHITE (one year term).

The rough minutes of the meeting were read and approved.

DONALD H. SWEET, *Secretary*.

The 797th meeting was held at the Cosmos Club, December 22, 1917; President BURGESS in the chair; 39 persons present. The minutes of the 795th meeting were read in abstract and approved.

The paper of Messrs. E. D. WILLIAMSON and L. H. ADAMS on *Measurement of the compressibilities of solids under hydrostatic pressure up to 12,000 megabars* was presented by Mr. E. D. WILLIAMSON. The paper was illustrated by lantern slides. Specimens on which measurements had been made were exhibited and some of the actual apparatus shown.

The compressibilities of the principal earth constituents are of interest in a large number of geophysical problems but, owing to the difficulties that offer themselves in the experimental determination, practically no reliable data are available. This paper described a method by means of which the volume-change under hydrostatic pressure of any solid may be determined with an accuracy of about one part in a hundred million of the original volume of the solid. Results were presented for the metals gold, copper, silver, aluminum, zinc, tin, cadmium, lead, and bismuth; for the alloys brass, cast-iron, and tin-bismuth eutectic; the minerals halite, quartz, orthoclase, labradorite, oligoclase, pyrite, mica, and enstatite. The pressure range was from 2000 to 12,000 megabars (1 megabar = 0.987 atmosphere).

In carrying out the determination the solid, surrounded by a liquid such as kerosene, was enclosed in a thick-walled steel bomb fitted with a movable, leak-proof piston and pairs of simultaneous readings were taken of (1) the displacement of the piston and (2) the pressure.

The P-ΔV graphs were found to be nearly straight lines, but there exists a slight though distinct curvature such that the graphs are concave to the pressure axis. For the more compressible substances, the curvature is sufficient to allow of a rough estimate of the change of compressibility with pressure. This change amounts to as much as 10 per cent of the value at the initial pressure for the most compressible substances.

The average compressibility of the earth at the surface was calculated to be 1.63 parts per million per megabar.

Discussion: The paper was discussed by Messrs. SWANN, WHITE, and BURGESS.

A paper by Messrs. N. S. OSBORNE and M. S. VAN DUSEN upon *Latent and specific heats of ammonia* was presented by Mr. M. S. VAN DUSEN. The paper was illustrated by lantern slides.

Using a calorimeter of the aneroid type, specially designed for the peculiar conditions, the specific heat and latent heat of vaporization of ammonia have been determined throughout the temperature interval $-40°$ to $+40°$C. The apparatus used has been previously described in detail before the Society. It consists essentially of a cylindrical metal shell suspended within a thermally controlled metal jacket. The metal shell or calorimeter, containing the ammonia to be investigated, is provided with an electrical heating coil and a platinum resistance thermometer.

In the measurements of specific heat two independent methods were used, each of which avoids sources of error present in the other. In the first method, the heat added to a fixed amount confined in the calorimeter under saturation conditions and the resulting change in temperature are measured By using data for the specific volumes of the two phases and the latent heat of vaporization, the corrections for vapor are applied, giving the specific heat of the saturated liquid.

In the second method the calorimeter is kept full of liquid at a constant pressure. The heat added to the variable amount in the calorimeter and the resulting change in temperature are measured. A correction for the heat withdrawn in the expelled liquid is determined by special experiments. By the use of data for the heat of pressure variation of the liquid obtained from separate measurements, the corrections for pressure variation are applied, the result being a second determination of the specific heat of the saturated liquid.

The greatest difference between the mean results of both methods and the results of either method as represented by empirical equations is less than 1 part in 1000.

In the measurements of latent heat the jacket temperature was kept constant while a measured amount of ammonia was evaporated, slightly superheated, and withdrawn from the calorimeter. The approximate amount of heat required to effect this change was added electrically, the small balance being due to thermal leakage and change in temperature of the system, both of which were kept small and were measured. Analysis of the process occurring in the calorimeter during an experiment leads to a method of calculation whereby data from other sources than the direct observations enter only in the computation of correction terms, which can be made small by careful manipulation.

The result of each of the determinations agrees with the mean result as expressed by means of an empirical equation within 1 part in 1000.

Discussion: The paper was discussed by Messrs. White, Burgess, Sosman, and Bichowski.

The 798th meeting was held at the Cosmos Club, January 5, 1918; Vice-President Humphreys in the chair; 54 persons present. The minutes of the 797th meeting were read in abstract and approved.

Mr. O. S. Adams presented a paper on *Lambert's conformal conic projection.* The paper was illustrated by lantern slides.

Since the spheroidal surface of the earth is nondevelopable, it is impossible to make a perfect map of a section of any extent upon a plane surface. The best that can be done then is to choose an approximation that may preserve the features desired in the proposed map. A projection is called conformal or orthomorphic when any infinitesimal element of the map is exactly similar to the element that it represents. The Lambert conformal conic projection is admirably suited to the mapping of any region that has no great extent in latitude. The parallels become concentric circles and the meridians become radii of this system of circles. The projection is for this reason very easily constructed and thus fulfils one of the practical requirements for a projection. With this method of projection, a map could be constructed of the United States that would not be in error of scale in any part by more than 1.2 per cent. The fact that angles are preserved and that the error of scale is within the limits of scaling makes its use in France of great service at the present time. The projection is of interest historically because it was originated by Johann Heinrich Lambert in 1772, and afterwards fully discussed by Gauss. Since the projection is conformal, it is especially interesting to mathematicians as an example of the application of the theory of functions of a complex variable. This simple example of the broad subject of conformal mapping of one surface upon another deserves careful consideration by all who wish to get a thorough grasp of the subject that is so important in the natural sciences as well as in pure mathematics. All honor is due the Alsatian Lambert for his perception of the important features of such a method of projection. However, even he did not dream of the importance that the conformal relationship was to assume both in pure and applied mathematics.

Discussion: The paper was discussed by Messrs. Sosman, Harris, Littlehales, and Jones.

Mr. William Bowie presented a paper on *Primary triangulation and precise leveling as done by the United States Coast and Geodetic Survey.* The paper was illustrated by lantern slides and by three reels of moving pictures which showed the instruments used in the precise leveling and primary triangulation and the amount of work that has been done in the United States, and also the methods of carrying on the various operations.

There have been completed to date about 38,000 miles of precise leveling and 14,200 linear miles of primary triangulation and primary traverse. These operations give standard elevations and geographic positions throughout the country which are used by surveyors and engineers for the control of their operations, especially in the map making of the country. The work is of particular value in State and international boundary surveys.

Three reels of motion pictures were shown; one gave an excellent idea of the methods employed by an up to date precise leveling party. As now conducted, the precise level is mounted on a small motor velocipede which runs on the railroad track. The instrument is mounted on the car in the morning and it is not dismounted until the day's work is completed. It is not even removed when the car is lifted from the track to allow trains to pass. The recording of the rod readings is now done on a listing adding machine which is mounted on a second motor car.

Improvements recently made in the methods of organizing and conducting the precise level party made it possible to increase greatly the rapidity with which this work is done. The maximum progress made by a precise leveling party in any one month was 159.6 miles of completed line. Each mile of this was leveled over at least twice. The total number of single miles of leveling in that month was 324. As much as 20 miles of single line were leveled in one day of seven hours of actual observing.

The second reel showed the erection of the towers or signals which are used in triangulation in a wooded or flat country to elevate the instrument to sufficient height to make it possible to observe from one point to another. The length of lines of the triangulation varies from a minimum of about 4 miles to a maximum of something over 100 miles. The signal is a double structure, consisting of an inner tripod on which the instrument rests and an outer four-legged structure called the scaffold which supports the observer and the lightkeeper. The two structures are entirely independent of each other and do not touch at any point. The reel showed the operation of erecting one of these towers from the time the building party arrived at the station until the structure was entirely completed. These towers are usually from 40 to 60 feet in height and are built of lumber purchased at the point most convenient to the field of operation. The legs of the structure are set well into the ground and are strongly anchored to prevent their being blown over by the wind.

The third reel showed the method of conducting the observing party. It showed the automobile trucks used in carrying the party and outfit from station to station and the various operations connected with the observing. It also showed the lightkeeper at work with his signal lamp or heliograph. Practically all of the observations of primary triangulation are now made on sunlight reflected from a mirror called a heliograph and on the signal lamps used at night. The modern signal lamp has a very high candlepower and the light can be sent over long lines and through atmosphere which would make observing impossible with the old style of lamp. The new electric lamp is one having contracted filament with dry cells furnishing the electric current. In the older type of lamp the fuel used was acetylene gas.

The primary triangulation is carried on much more rapidly today than ever before, but there has been no decrease in the accuracy of the observations. The accuracy of the triangulation is that expressed by an average closing error of about 1″. The probable error of any one direction in the triangulation is usually less than $\frac{1}{3}''$. This accuracy is very great, as is shown by the fact that one foot at a distance of 40 miles from the observer subtends an angle of 1″. The accuracy in the results is obtained by repeating the angles a number of times and taking the mean. The errors are probably caused by atmospheric conditions.

H. L. Curtis, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Among the members of the ACADEMY who are now with the military forces of the United States are:

Lieutenant Colonel R. F. BACON, with the Chemical Service Section of the National Army, in France.

Brigadier General WM. H. BIXBY, U. S. A., retired, President of the Mississippi River Commission and Division Engineer, Western Division River and Harbor Improvements, at St. Louis, Mo.

Major W. R. BLAIR, with the Meteorological Service of the Signal Corps, in France.

Major EDWARD H. BOWIE, with the Meteorological Service of the Signal Corps, in France.

Major ALFRED H. BROOKS, Geologist on the staff of General Pershing, American Expeditionary Forces, in France.

Major General WILLIAM CROZIER, U. S. A., Chief of Ordnance.

Major L. A. FISCHER, Ordnance Officers' Reserve Corps, Bureau of Engineering.

Major General W. C. GORGAS, U. S. A., Surgeon General, Medical Corps.

Lieutenant Colonel HENRY S. GRAVES, with the Twentieth Engineers (Forestry) in France.

Captain CAREY V. HODGSON, Engineers' Reserve Corps, at Anniston, Alabama.

Major DOUGLAS W. JOHNSON, National Army.

First Lieutenant WALTER D. LAMBERT, Engineers' Reserve Corps.

First Lieutenant M. W. LYON, JR., Medical Reserve Corps, at Walter Reed General Hospital, Washington.

Colonel JOHN MILLIS, U. S. A., Corps of Engineers, at the Office of the Division Engineer, Southeast Division, Savannah, Georgia.

Brigadier General A. W. VOGDES, U. S. A., Retired, at San Diego, California.

Major W. H. WILMER, member Medical Research Board, and Assistant to Chief Surgeon, Aviation Section of the Signal Corps.

Captain FRED. E. WRIGHT, Ordnance Officers' Reserve Corps, detailed to the Bausch & Lomb optical glass plant in Rochester, New York.

Dr. H. M. AMI, formerly of the Geological Survey of Canada, is spending the winter in Washington. Dr. Ami is in charge of problems of war metals and minerals in the Trade Department of the British Embassy.

Dr. George E. Hale, Director of the Mount Wilson Solar Observatory at Pasadena, California, has been in Washington since last spring as Chairman of the National Research Council, which is now acting as the Department of Science and Research of the Council of National Defense.

Mr. Nicholas H. Heck has been transferred from the Coast and Geodetic Survey to the Navy Department, as a Lieutenant in the Naval Reserve Forces.

Dr. George Tully Vaughan has been called to active service in the Medical Corps of the Navy.

Dr. Otto Klotz, who with the late Dr. W. F. King, his predecessor, was a founder of the Dominion Astronomical Observatory at Ottawa, has been appointed Chief Astronomer and Director of the Observatory. Dr. Klotz has presented his scientific library of some 2000 volumes, a collection of a lifetime, to the Observatory.

Prof. Charles A. Kofoid, of the Department of Zoology, University of California, has been elected a corresponding member of the Société de Pathologie Exotique of Paris.

Prof. J. C. Merriam, of the University of California, has been in Washington for several months on business connected with the National Research Council.

Dr. Charles Doolittle Walcott, Secretary of the Smithsonian Institution, has been elected a corresponding member of the Académie des Sciences of Paris in the section of geology, in place of Sir Archibald Geikie, who has been elected a foreign associate.

The following have become members of the Academy since the beginning of the year: Prof. Charles August Kraus, Clark University, Worcester, Massachusetts; Dr. Philip S. Roy, 1200 Massachusetts Avenue; Prof. John Warren Smith, Weather Bureau; Dr. Edwin Frederick Wendt, Interstate Commerce Commission.

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BOTANY.—*Plant life on saline soils.*[1] THOMAS H. KEARNEY, Bureau of Plant Industry.

The topic that I have chosen for consideration this evening may not, at first thought, seem a very inviting one. Those of you who are familiar with salt marsh vegetation along the sea-coast and with the plant life of so-called "alkali" soils in the arid part of the country must have been impressed with their monotonous and rather unprepossessing aspects. Even the mangroves of tropical and subtropical shores, the most highly developed type of salt plants or halophytes, while intensely interesting from a biological point of view, are by no means so attractive to the casual eye as are many other forms of tropical plant life.

Nevertheless the halophytes have long been a subject of the greatest interest to botanists. Study of this vegetation in relation to its environment leads us into some of the most intricate problems in plant physiology.

ORIGIN AND NATURE OF THE SALINE COMPONENTS

Soils containing an excessive quantity of readily soluble salts are for the most part confined either to the immediate neighborhood of the ocean or to arid interior regions. In the former case the salinity of the soil is caused by periodical inundation

[1] Address of the retiring president of the Botanical Society of Washington delivered February 5, 1918.

with normal or dilute sea-water and the salts present are such as occur in the ocean.

In arid regions away from the coast, the accumulation of salts is due to local erosion. Owing to the scantiness of the rainfall, the saline components of the country rocks are not, as in humid regions, carried away by rivers flowing into the ocean. Instead they are transported short distances by the surface and underground drainage channels and become accumulated in the bottoms of the valleys and of closed basins. In this way are formed the salt lakes and the alkali flats, covered during the dry season with a glistening white crust of salts, which are so characteristic a feature of arid countries the world over.

Sea-water is practically uniform in the nature and proportion of its different salts and the same is necessarily true of the soil of coastal marshes. In both cases, sodium chloride strongly predominates. On the other hand, the saline components of soils in arid regions vary with the composition of the rocks from which they were derived. Salts of sodium (chloride, sulphate, carbonate, bicarbonate) are usually the most abundant, but the corresponding salts of potassium, magnesium, and calcium are commonly also present.

Since each salt, when presented in a pure solution, has its specific toxicity for plants, it might be thought that corresponding differences would be observed in the vegetation of "alkali" soils of different chemical composition. But there is little evidence that such is the case. The reason doubtless is that the solution in saline soils, like the water of the sea, is a "balanced" solution, in the sense of Loeb and Osterhout.[2] It rarely happens, in arid regions, that soluble salts occur in large quantity where the soil is deficient in calcium; and the presence of calcium equalizes, in large measure, the different toxicities shown in pure solutions by salts of the other bases.[3] Consequently, it is usu-

[2] W. J. V. OSTERHOUT. *On the importance of physiologically balanced solution for plants.* Bot. Gaz. **42**: 127. 1906; also **44**: 259. 1907. The same investigator has developed the subject in numerous subsequent papers.

[3] T. H. KEARNEY and F. K. CAMERON. *Some mutual relations between alkali soils and vegetation.* U. S. Dept. Agr. Rept. **71**: 7–60. 1902. T. H. KEARNEY and L. L. HARTER. *The comparative tolerance of various plants for the salts common in alkali soils.* U. S. Dept. Agr. Bur. Plant Ind. Bull. 113. 1907.

ally not so much the chemical composition of the soil solution as its concentration and the resulting osmotic pressure which affect vegetation.[4]

CONCENTRATION OF THE SOIL SOLUTION

Saline soils are extremely diverse in respect to texture, water-holding capacity, humus content, and fertility. The one thing that they have in common is a high concentration of the soil solution. This factor, also, is extremely variable, since not only the absolute quantity of salts may differ enormously within very short distances, but the concentration of the solution fluctuates continually, being diluted by rainfall or by inundation and concentrated by evaporation.

The fluctuations are greatest, of course, in deserts, where rainfalls of brief duration alternate with long periods of extreme drought. A salt content amounting to 3 per cent of the dry weight of the soil, to the depth penetrated by the plant roots, is not uncommon in arid regions. With this salt content, and with a water-holding capacity of 50 per cent, the soil, even when saturated with water, would have a solution concentration of 6 per cent, or twice that of sea-water. If the soil dried out to the wilting point for plants,[5] the concentration would reach 30 per cent, which is beyond the point of saturation for sodium chloride.

Even in humid climates the periodical fluctuations are by no means negligible. Hill[6] reported that in a salt marsh in Brittany, heavy rains lasting two days reduced the concentration of the soil solution to one-sixth of what was observed immediately before the rain began. If the original concentration had been that of sea-water, this would correspond to a fall in osmotic pressure of from about 22 to about 3.5 atmospheres.[7]

[4] This does not hold in the case of sodium carbonate ("black alkali") which, because of its strong alkalinity, is much more toxic than other salts of sodium.

[5] L. J. Briggs and H. L. Shantz. *The wilting coefficient for different plants and its indirect determination.* U. S. Dept. Agr. Bur. Plant Ind. Bull. 230. 1912.

[6] T. G. Hill. *The Bouche d'Erquy in 1908.* New Phytol. **8**: 97. 1909.

[7] Careful computations of the osmotic pressure of sea water have recently been published by R. H. True (*Osmotic experiments with marine algae.* Bot. Gaz. **65**: 71. 1918).

AGRICULTURAL IMPORTANCE OF SALINE SOILS

Saline soils are of small agricultural value until the excess salt has been removed by drainage and by flooding with fresh water. Extensive and successful reclamation work along these lines has been accomplished in India and in Egypt. Ganong[8] has described the methods by which the salt marshes at the head of the Bay of Fundy have been converted into hay meadows worth from $100 to $200 per acre.

Different crop plants differ in their adaptability to saline soils and a few of them are so resistant to concentrated solutions that they may be regarded as partial halophytes. First and foremost is the sugar beet, the supposed ancestor of which is a plant of the sea strand in Europe and northern Africa. Asparagus is another example, since the nearest related wild forms are said to inhabit saline soils and the cultivated form finds itself quite at home when it strays to the borders of salt marshes. Among fruit trees the date palm and the pomegranate are notable for their ability to thrive where the soil solution is highly concentrated.

From an agricultural point of view, however, the resistance of the plant is of less importance than the quantity and quality of the product for which it is grown. Cereals will make a fairly vigorous growth in soils where grain production is practically inhibited. The value of the beet for sugar making is much impaired, in saline soils, by the high ash content of the roots. Date palms, in spite of their vegetative vigor under such conditions, produce fruit of inferior value. Forage plants that are grown for the sake of the leaves and stems are usually, therefore, the most profitable crops for soils of relatively high salinity.

DISTRIBUTION OF THE VEGETATION

The principal types of halophytic vegetation may be roughly classified as:

1. *Marine formations,* consisting of aquatic plants, chiefly algae, which live in the ocean and in brackish water.

[8] W. F. Ganong. *The vegetation of the Bay of Fundy salt and diked marshes.* Bot. Gaz. **36**: 161, 280, 349, 429. 1903.

2. *Salt marsh*, composed mainly of grasses, rushes, and sedges, with various other annua and perennial herbs as a secondary element. Salt marsh vegetation is found chiefly in temperate regions, where it occurs both on the sea-coast and in very wet saline areas of the interior.

3. *Salt scrub*, composed of woody species, in large part Chenopodiaceae, ranging in size from half shrubs to almost tree-like dimensions. This formation is typically developed only where the climate is arid and the soil is not constantly wet.

4. *The mangrove formation*, of small trees belonging to the Rhizophoraceae and a few other families. This vegetation occupies muddy shores within reach of the tides, in and near the tropics.

Time permits only brief reference to the fascinating problem of the local distribution of halophytes. The vegetation of saline soils, both along the sea-coast and in the interior, often shows beautiful examples of zonation, determined, in large part, by differences in salinity, although the physical properties and the water content of the soil are likewise important factors.

The correlations between distribution of the plants and salt content of the soils are often so close as to permit of agricultural classification of the land on this basis, as has been demonstrated by Hilgard[9] and his colleagues in California and by Briggs, Shantz and the writer[10] in the vicinity of Great Salt Lake. The different types of halophytic vegetation were found to indicate with considerable precision the degree of salinity of the soil and hence whether the land is suitable for crop production or could be rendered suitable by the usual methods of reclamation. The indicator plant method is particularly useful in dry areas where there may be no superficial evidence of salinity but where large quantities of salt may be present in the subsoil.

The importance of halophytes as geological agents deserves

[9] E. W. Hilgard. Soils, pp. 534-549. New York, 1906.

[10] T. H. Kearney, L. J. Briggs, H. L. Shantz, J. W. McLane, and R. L. Piemeisel. *Indicator significance of vegetation in Tooele Valley, Utah.* Journ. Agr. Research **1**: 365-417. 1914.

mention. Oliver[11] and other British ecologists have investigated the manner in which Spartina, Salicornia, etc., colonize and hold newly-deposited soil on the sea-coast. Vaughan[12] gives an interesting account of land-building by the mangrove in southern Florida.

Halophytic vegetation is characterized by world-wide uniformity. Each of the principal types—salt marsh, salt scrub, and the mangrove formation—has much the same appearance, wherever it occurs. The comparatively small number of species, the similarity of the life forms, and the scarcity of showy flowers give a monotonous and even somber appearance to these plant formations.

In taxonomic composition, likewise, there is comparatively little variation within each of the major halophytic formations, in different parts of the world. The genera, and in many cases even the species, are very widely distributed. The great majority of extreme halophytes are comprised in comparatively few families. Probably not less than one-half of the species belong to the Chenopodiaceae, which comes nearer to being a purely halophytic group than any other of the larger families of plants. Smaller families which are predominantly halophytic are Plumbaginaceae, Frankeniaceae, Tamaricaceae, and Rhizophoraceae. Families which, although not primarily halophytic, contribute numerous genera and species to this vegetation are Gramineae, Cruciferae, and Compositae. Other large groups are conspicuous for their absence from saline soils. Among these are the lichens, mosses, ferns, Araceae, Orchidaceae, Fagaceae, and Ericaceae.

STRUCTURE OF HALOPHYTES

As a rule, the leaf surface of halophytes is much reduced as compared with that of mesophytes. In Salicornia and allied

[11] F. W. Oliver. *The shingle beach as a plant habitat.* New Phytol. **11**: 73. 1912. *Some remarks on Blakeney Point, Norfolk.* Journ. Ecol. **1**: 4. 1913. *Vegetation and mobile ground as illustrated by* Suaeda fruticosa *on shingle.* Journ. Ecol. **1**: 249. 1913.

[12] T. W. Vaughan. *The geologic work of mangroves in southern Florida.* Smiths. Misc. Coll. **5**: 461. 1910.

genera of Chenopodiaceae and in the tamarisks, the assimilating tissue is located mainly in the stems, the leaves being mere scale-like vestiges. The mangroves are a striking exception, possessing a heavy crown of broad leaves.

Thickness of the leaves and stems characterizes most halophytes, aside from the grasses and grass-like plants. LeSage[13] compared numerous maritime species with the most nearly related inland forms and found that in the great majority of cases the former had the thicker leaves. In some species the thickening results merely from an increase in size of cells or in number of layers of the chlorophyll tissue, but many halophytes possess also a specialized water storage tissue of thin-walled cells, containing few or no chloroplasts.

The degree of succulence is closely associated with the salinity of the medium. Several investigators have reported that non-halophytic species, when watered with salt solutions, show an increase in the thickness of the leaf. Conversely, halophytes, when grown in an ordinary garden soil with fresh water irrigation, often develop thinner leaves and stems than in their natural habitat. Batalin[14] found that even Salicornia responded in this manner. Holtermann[15] obtained a marked increase in the thickness of the water storage tissue of mangroves by watering the plants with a sodium chloride solution of about twice the concentration of sea-water. On the other hand, irrigation with fresh water resulted in the development of much thinner leaves than were observed in the normal habitat.

Casu[16] has pointed out that succulent halophytes occur in nature only where the soil has a high water content as well as a high salt content. It is otherwise with the succulent xerophytes, such as Cactaceae, which prefer soils that are normally

[13] P. LESAGE. *Recherches expérimentales sur les modifications des feuilles chez les plantes maritimes.* Rev. Gén. Bot. **2**: 54, 106, 163. 1890.

[14] A. BATALIN. *Die Wirkung des Chlornatriums auf die Entwickelung von* Salicornia herbacea. Bull. Congr. Internat. Bot. Hort., 1884, p. 219. St. Pétersb. 1885.

[15] C. HOLTERMANN. *Der Einfluss des Klimas auf den Bau der Pflanzengewebe.* Berlin, 1907.

[16] A. CASU. *Contribuzione allo studio della flora delle saline di Cagliari.* Ann. di Bot. **2**: 403. 1905.

dry, as well as non-saline. Since the Cactaceae, as Cavara[17] and Livingston[18] have shown, are also characterized by a low osmotic pressure of the cell sap, while the succulent halophytes develop very high pressures, it is evident that the relation between succulence and salinity is by no means a simple problem.

Schimper and other ecologists regarded halophytes as being xerophytes, or drought resistant plants, in that their structure is modified so as to reduce transpiration. Later investigators have shown the one-sidedness of this point of view. It originated largely in the mistaken conception that plants of the sea beaches and dunes, many of which have a markedly xerophytic structure, are really halophytes.[19] It is true that in arid climates many, but by no means all, salt plants exhibit xerophytic peculiarities, such as reduced leaf surface, sunken stomata, thick cuticle, highly developed palisade tissue, and small intercellular spaces. On the other hand, certain xerophytic characters, particularly hairiness and the excretion of resin and of aromatic volatile oils, are rarely met with in halophytes, even in those that inhabit deserts.[20]

In cool, humid regions, some of the most characteristic salt marsh plants exhibit almost no xerophytic peculiarities, having a thin cuticle, stomata level with the epidermis or even slightly raised, and large intercellular spaces. Terras[21] in Scotland and Cross[22] in New Zealand studied the anatomy of coastal halophytes and concluded that some of them have the structure of aquatic plants rather than of desert plants.

[17] F. Cavara. *Risultati di una serie di ricerche crioscopiche sui vegetali.* Contrib. Biol. Veg. (Palermo) **4**: 41. 1905.

[18] B. E. Livingston. *The relation of desert plants to soil moisture and to evaporation.* Carnegie Inst. Publ. 50. 1906.

[19] T. H. Kearney. *Are plants of beaches and dunes true halophytes?* Bot. Gaz. **37**: 424. 1904.

[20] Detailed descriptions of the anatomy of many European halophytic species and an extensive bibliography are given by H. Chermezon (*Recherches anatomiques sur les plantes littorales.* Ann. Sci. Nat. IX. Bot. **12**: 117–313, *figs. 1–52.* 1910).

[21] J. A. Terras. *Notes on the salinity of the cell sap of halophytes.* Proc. Scottish Micr. Soc. **4**: 152. 1906.

[22] B. D. Cross. *Some New Zealand halophytes.* Trans. New Zealand Inst. **42**: 545. 1910.

The gist of the matter is that many halophytes that grow under climatic conditions favorable to intense transpiration, or in soils subject to periodical drought, show xerophytic modifications; but high concentration of the soil solution does not necessarily induce this type of structure if the climate is humid and an abundance of soil moisture is normally present.

WATER ECONOMY OF HALOPHYTES

It has been repeatedly demonstrated that absorption of water by the roots of nonhalophytic species is difficult or impossible when the soil solution reaches such concentrations as are encountered in the natural habitats of halophytes. When forced to obtain their water from a relatively concentrated salt solution, ordinary mesophytes, such as the common crop plants, show a marked decrease in transpiration and in photosynthetic activity, resulting in diminished growth.

Schimper[23] argued from the known behavior of nonhalophytes when exposed to strong salt solutions, and from the assumed xerophytic structure of all halophytes, that the latter are subject to the danger of injury from excessive accumulations of salt in their assimilating cells, and that protection against this danger is secured by reduction of the transpiration. He later[24] modified this view by attributing the supposed necessity for reduced transpiration to the difficulty of absorption by the roots from a strong salt solution. In his view a saline soil is "physiologically dry," even when saturated with water.

More recent investigations have demolished all of the premises upon which this theory rested. It has already been pointed out that by no means all salt plants possess a transpiration-reducing structure, so that we are justified in speaking of halophilous mesophytes and hydrophytes, as well as of halophilous xerophytes. Species that inhabit dry saline soils in arid regions doubtless find advantage in such structural modifications as tend to diminish transpiration; but the researches of

[23] A. F. W. SCHIMPER. Die indo-malayische Strandflora, p. 26. Jena, 1891.

[24] A. F. W. SCHIMPER. Pflanzengeographie auf physiologischer Grundlage, p. 100. Jena, 1898.

Rosenberg[25] and Delf[26] on salt marsh plants in northern Europe and Von Faber's[27] investigations of mangroves in the East Indies have shown that many halophytes transpire freely when growing in their normal habitats.[28]

In conformity with these results as to transpiration, Ganong[29] and Hill[30] have proven that high osmotic pressures are developed in the roots of halophytes. Difficult absorption of water cannot, therefore, be a universal condition of existence for this type of vegetation.

The salt plants are evidently able to carry on normally the processes of photosynthesis, metabolism, and growth, notwithstanding the presence of much salt in their cell sap This is sufficient proof that they are not inconvenienced by the high osmotic pressures in their cells nor by the specific toxicity of the salt. It is clearly not permissible to draw conclusions as to the normal physiology of halophytes from the pathological conditions induced in nonhalophytes by exposure to concentrated salt solutions.

Our knowledge of the physiology of halophytes is one-sided, since it has been gained chiefly by the study of salt marsh plants in northern Europe and of the mangrove formation in the tropics. Neither of these environments affords such extreme conditions as must be endured by plants inhabiting saline soils in desert regions. Here the atmospheric conditions are conducive to excessive transpiration, while enormous fluctuations in the water content of the soil and in the concentration of the soil solution

[25] O. Rosenberg. *Ueber die Transpiration der Halophyten.* Kongl. Vetensk. Akad. Förhandl. 531. 1897.

[26] E. M. Delf. *Transpiration and the behavior of stomata in halophytes.* Annals of Botany **25**: 485. 1911.

[27] F. C. von Faber. *Ueber Transpiration und osmotischen Druck bei den Mangroven.* Ber. Deutsch. Bot. Ges. **31**: 277. 1913.

[28] It has been ascertained by Holtermann and by Ruhland, however, that in halophytes grown in strongly saline soils and having a high concentration of the cell sap, the quantity of water transpired is smaller than when the same species are grown in the absence of an excessive quantity of salt.

[29] Bot. Gaz. **36**: 358–362. 1903.

[30] T. G. Hill. *Observations on the osmotic pressures of the root hairs of certain salt marsh plants.* New Phytol. **7**: 133. 1908.

require corresponding powers of accommodation in the absorbing organs of the plant. A thorough investigation of the water economy of desert halophytes is, therefore, much to be desired

OSMOTIC PRESSURE IN ROOTS AND LEAVES

Comparatively few determinations have been made of the osmotic pressures in the roots of halophytes. The data at hand indicate that, at least under the comparatively favorable conditions of coastal salt marshes, the plant is easily able to cope with the problem of absorption. Thus Hill found that the root hairs of Salicornia can develop a pressure corresponding to that of an 8.7 per cent solution of sodium chloride, which is probably equivalent to about 65 atmospheres.

As regards halophytes that inhabit arid regions, determinations appear to have been made only on the leaves and stems. In ordinary mesophytic plants of temperate climates the osmotic pressure of the leaf cells seldom exceeds 30 atmospheres and is usually much lower than this. But pressures up to 100 atmospheres were detected in the leaves and stems of salt plants by Cavara in Italy and by Fitting[31] in the Sahara Desert. Ruhland was able to develop, in the leaves of *Statice Gmelini*, a pressure which he estimated at 165 atmospheres.[32]

It is not improbable that the absorbing roots of desert halophytes cease temporarily to function when, as doubtless often happens, the osmotic pressure of the soil solution greatly exceeds 100 atmospheres. Miss Halket's[33] observation that when the salt content of the soil solution reached 17 per cent, plants of Salicornia remained alive and apparently uninjured but ceased to grow, points in this direction.

There is abundant evidence of the ability of halophytes to

[31] H. FITTING. *Die Wasserversorgung und die osmotischen Druckverhältnisse der Wüstenpflanzen.* Zeitschr. Bot. **3**: 209. 1911.

[32] It does not follow that equally high pressures would have been detected in the roots, since comparative determinations upon different organs of the same individual plant have shown, in numerous cases, that the osmotic pressures of the root cells are lower than those of the leaf cells.

[33] A. C. HALKETT. *The effect of salt on the growth of Salicornia.* Annals of Botany **29**: 143. 1915.

accommodate their osmotic pressure to fluctuations in that of the medium. Hill found this to be the case in the root hairs of Salicornia. Von Faber observed that the pressure in the leaf cells of mangroves varied with the salinity of the soil solution. Cavara found that in Italian salt marsh plants the pressures were from 2 to 3 times as high after a long dry period as during the rainy season. The enormous power of osmotic accommodation possessed by many bacteria, fungi, and algae is well known. Plants that inhabit the waters and shores of estuaries and tidal creeks, where daily fluctuations of great magnitude in the salinity of the medium occur, must possess the ability to alter their osmotic pressure rapidly.[34]

SALT CONTENT OF THE TISSUES

Various means are employed in developing these high pressures. In some cases the salt absorbed from the soil solution appears to be the principal factor, while in other cases organic compounds elaborated by the plant itself (carbohydrates, tannins) play the chief part. Fitting found that among species growing side by side in the Sahara Desert, and manifesting approximately the same resistance to plasmolysis, some had a highly saline cell sap, while in others there was no noteworthy accumulation of salt. He concluded that the maximum amount of salt that can be accumulated in the tissues is a character of the species, independent, in large measure, of transpiration and of the salt content of the soil.

Many halophytes take up sodium and chlorine in greater proportion than these occur in the soil solution. Such plants, even when grown on soils containing only traces of these elements, may accumulate large quantities in their tissues.[35]

Schimper[36] ascertained that certain weeds that are character-

[34] An interesting example of such accommodation is described by W. J. V. Osterhout (*The resistance of certain marine algae to changes in osmotic pressure.* Univ. Calif. Publ. **2**: 227. 1906).

[35] G. Paris found that the leaves of a species of Atriplex, when growing on a soil containing the merest trace of chlorides, had an ash content of 37 per cent and a chloride content of 10 per cent of the total dry weight (*Sul'* Atriplex halimus *L.* Staz. Sper. Agrar. Ital. **44**: 141. 1911).

[36] A. F. W. Schimper. Die indo-malayische Strandflora, p. 142. 1891.

istic of soils rich in nitrogen also possess this power of selective absorption. Individuals of these species were found to give a strong reaction for nitrates, even when growing on soils of low nitrogen content.

The quantity of water-soluble salts taken up by halophytes is often considerable. Cameron[37] found that in a sample of greasewood (Sarcobatus) salts of sodium constituted about 20 per cent of the total dry weight of the leaves. All of the sodium chloride present was apparently free in the cell-sap and could be recovered by leaching the dry material with water, as Déhérain[38] had previously ascertained to be the case with *Salsola Kali*. Paris, on the other hand, states that in *Atriplex Halimus*, the results of freezing-point determinations indicated that, of the total chlorine found in the ash, only about half was free in the cell sap.

In view of the injurious effects of concentrated solutions of sodium salts upon ordinary plants, the question arises, how are halophytes able to adjust themselves to such extreme salinity of their cell-sap? A strong development of water tissue, the cells of which contain few or no chloroplasts, is, as we have seen, characteristic of many salt plants. The plausible suggestion has been made that much of the salt taken up by such plants is stored in this tissue, rather than in the green assimilating cells, although apparently no direct evidence of such segregation has been obtained.

Many halophytic species are able to check the accumulation of salt in their tissues by excreting it, in solution, upon the surface of their leaves and stems. This phenomenon is not confined to plants that possess specialized excretory organs. In the case of grasses like Spartina and Distichlis excretion is supposed to take place through the stomata.[39]

The best known cases of salt excretion are found in the Plumbaginaceae, Frankeniaceae, and Tamaricaceae. The members of these families are characterized by the possession of

[37] F. K. Cameron. U. S. Dept. Agr. Rep. **71**: 64–66. 1902.

[38] P. Déhérain. *Sur l'assimilation des substances minérales par les plantes.* Ann. Sci. Nat. VI. Bot. **6**: 366. 1878.

[39] A. B. Klugh. *Excretion of sodium chloride by* Spartina glabra alterniflora. Rhodora **11**: 237. 1909.

epidermal glands, the cells of which are very rich in protoplasm and have a large nucleus. The process of excretion by these organs is not a passive filtration, but a true glandular activity, as has been demonstrated by the writer[40] and by Ruhland.[41] The latter investigator also obtained fairly conclusive evidence that the salt content of the leaves is materially reduced when excretion is actively taking place.

It would seem to be significant that as a rule the species which excrete salt do not possess a highly developed water-storage tissue. On the other hand, salt excretion is not known to occur in the Chenopodiaceae, the largest and most important of halophytic families. This family includes numerous genera in which water-storage tissue is exceptionally well developed.

PHYSIOLOGICAL CHARACTERISTICS OF SALT PLANTS

From what has been said, it is evident that there are many gaps and many apparent contradictions in our knowledge of the normal physiology of the salt plants. Two characteristics, however, are general and may be said to be conditioned by the nature of the environment. These are

1. Ability to develop a high osmotic pressure in the cells of the absorbing organs, thus allowing water to be taken up from solutions of a concentration which would inhibit absorption in nonhalophytic species. Coupled with this, is the power of accommodating the pressure to (often rapid) changes of concentration in the medium.

2. Ability to carry on normally all essential physiological functions, notwithstanding the presence of salt in the cell sap in quantities which, in nonhalophytic species, would seriously hamper or entirely prevent photosynthesis, metabolism, and growth.

IMPORTANCE OF SODIUM TO HALOPHYTES

The problem of whether halophytes can grow in the absence of an appreciable quantity of sodium salts has been the subject

[40] T. H. Kearney. *On the excretion of hygroscopic salts in Frankenia and Statice.* Science N. S. **19**: 419. 1904.

[41] W. Ruhland. *Die Salzdrüsen der Plumbaginaceen.* Jahrb. Wiss. Bot. **55**: 409. 1915.

of numerous cultural experiments. The results are contradictory even, in some cases, when the same species was used by different experimenters. Unquestionably, certain species that in nature are confined to saline soils, will not only thrive but grow more vigorously in the absence of a noteworthy quantity of salt, although the appearance and structure of the plants may be materially altered.

Batalin claimed that even such an extreme halophyte as *Salicornia herbacea* can be grown successfully in ordinary garden soil, watered with river water. On the other hand, Peklo[42] found that this plant soon died in a Knop nutrient solution, which contains no sodium, but flourished in the same solution plus 2 per cent of sodium chloride. Similar results with other species of Salicornia were obtained by Miss Halket.

The published data on cultural experiments which indicate that sodium salts are important to halophytes, do not permit a conclusion to be drawn as to whether the limiting factor is the presence of the element sodium or merely a high total concentration in the medium. It would be interesting to know whether the results with Salicornia in water cultures would have been equally satisfactory, if the salt added in excess to the nutrient solution had been potassium chloride, instead of sodium chloride.

In order to determine definitely whether the salt plants can completely dispense with sodium, it would, of course, be necessary to insure the absence of any trace of the element, in both plant and culture medium. Since sodium is known to occur even in the seeds of halophytes, this experimental condition is probably impossible to realize.

SODIUM IN PLANT NUTRITION

Consideration of the physiology of halophytes brings up the question, what, if any, is the rôle of sodium in plant nutrition? Osterhout[43] states that this element, because of its protective or antagonistic action, is essential to the maintenance of life in

[42] J. Peklo. *Bemerkungen zur Ernährungsphysiologie einiger Halophyten.* Oesterr. Bot. Zeitschr. **62**: 47, 114, 172. 1912.

[43] W. J. V. Osterhout. *Plants which require sodium.* Bot. Gaz. **54**: 532. 1912.

certain marine algae; and results obtained by Benecke[44] indicate that some of the Cyanophyceae may grow equally well if potassium is completely replaced by sodium in the nutrient solution. In regard to the nutrition of vascular plants, however, no fact seems to be better established than the indispensability of a minimum of potassium. On the other hand, it has never been proven that sodium is indispensable to any of the higher forms of plant life.

Although sodium is almost always found in the ash of plants, it does not, as far as we know, enter into organic combination. This would seem to indicate that plant life is not conditioned by its presence as by the presence of potassium, phosphorus, and magnesium. Nevertheless, it by no means follows that under certain conditions sodium may not be an important factor in growth.

Different investigators of the fertilizer value of sodium salts report widely divergent results, but it is impossible to ignore the numerous instances in which beneficial effects have been observed, especially where the soil is deficient in potassium in readily available form.[45]

Such effects are doubtless, in many cases, due chiefly to the setting free by chemical reaction in the soil of the potassium of relatively insoluble compounds. But even when such reaction was excluded by growing the plants in water cultures or in quartz sand, without the addition of potassium, sodium has been observed to stimulate growth.

It would seem, therefore, that when potassium is not available in sufficient quantity, some of the physiological functions which are normally performed by that element may be assumed by sodium. In regard to the nature of these functions, the following suggestions have been made:

[44] W. Benecke. *Ueber Culturbedingungen einiger Algen.* Bot. Zeitung **56**: 84–96. 1898.

[45] This has been the subject of long-continued investigation by the Rhode Island Agricultural Experiment Station. The results have been published in the annual reports for 1894 to 1908 and in bulletins 47, 104, 106, and 153. See especially H. J. Wheeler and B. L. Hartwell (*Concerning the functions of sodium salts.* R. I. Agr. Exp. Sta. Ann. Rep. **1906**: 186–316. **1907**).

1. Translocation, into and within the plant, of indispensable anions, such as nitrogen and phosphorus.
2. Maintenance in the cells of a requisite minimum osmotic pressure, upon which depends the turgor necessary for growth.
3. Antagonistic or protective action, in relation to other elements, by which a balanced solution is maintained.
4. Neutralization of organic acids formed within the plant.
5. Stimulation of diastatic activity in the cells.

In the present national emergency, current notions in regard to fertilizers should be subjected to the most rigorous criticism. A huge superstructure of opinion in regard to our potash requirements has been erected by the commercial fertilizer interests, domestic and foreign, upon an amazingly small basis of proven fact.

The enemy boasts that his control of the great potash deposits makes him the agricultural dictator of the world. Wilhelm Ostwald is quoted as having said that the United States "went into the war like a man with a rope around his neck, a rope which is in enemy hands." All the resources of an ably-directed propaganda have been employed for years in fostering among us the belief that we are helplessly dependent upon Germany in this matter. It would be folly, and worse than folly, to concede such a claim until we have thoroughly examined its foundations.

For certain soils and certain crops, the addition of potash in readily available form may well be essential to profitable production. But who knows whether the indispensable minimum is 250,000 tons or only one-tenth of that quantity? Cannot the apparent need be lessened by better tillage, by rotation with green manure crops, and by the more extensive use of farm manure? Will not the use of cheaper chemical fertilizers—salts of sodium, calcium, magnesium—alleviate many of the supposed cases of "potash hunger?" Until these questions have been answered, no one dare say that our absolute requirement of potash fertilizers cannot be met by the development of domestic sources of supply.

BOTANY.—*A new species of Rondeletia from Mexico.*[1] PAUL C. STANDLEY, National Museum.

In an interesting collection of plants received recently from Dr. B. P. Reko, of the State of Oaxaca, Mexico, by the U. S. National Museum, are specimens of a handsome rubiaceous plant referable to the genus *Rondeletia*. The plant offers so many characters not found in other species as to suggest a new generic type, but the species of *Rondeletia* already known show a remarkable range of variation for the family Rubiaceae, and the present plant is perhaps not more abnormal than some of the Cuban species, such as *R. tinifolia* Griseb. and *R. correifolia* Griseb.

Rondeletia Rekoi Standley, sp. nov.

Branchlets stout or slender, obtusely tetragonous, densely and persistently white-tomentose, with a close tomentum; stipules linear oblong, 6 to 9 mm. long, bidentate at the apex, erect, persistent, densely tomentose outside on the lower half, glabrate and green above; leaves opposite, the petioles very stout, 0.5 to 1.5 cm. long, white-tomentose, the blades ovate or elliptic-ovate, 8.5 to 19 cm. long, 3 to 8.5 cm. wide, rounded and short-decurrent at the base, very acute or subacuminate at the apex, subchartaceous, bright-green above, lustrous, scabrous with short slender curved hairs, the intermediate veins very prominent, finely reticulate, beneath densely covered with a close white tomentum, the costa prominent, the lateral veins slender, about 14 on each side, subarcuate, the margin plane or subrevolute; inflorescence terminal (a pair of cymes present at the base of the peduncle), the peduncles stout, 8 to 9 cm. long, the rachis 6 to 9 cm. long, bearing numerous short-pedunculate bifid cymes, the branches of these 1.5 to 2.5 cm. long, the flowers sessile, secund, the bractlets oval or oblong, obtuse, green, glabrate, about equaling the calyx-tube; calyx-tube densely white-tomentose, the 4 lobes oblong or oval, about 1 mm. long, rounded at the apex, green, glabrate, spreading; corolla white-tomentose outside, the tube stout, 5.5 to 7 mm., long, glabrous in the throat, the 4 lobes rounded, 2 mm. long, undulate; anthers sessile, included; capsule 3.5 to 4 mm. broad, didymous-globose, densely white-tomentose; seeds minute, pale-brown, angulate.

Type in the U. S. National Herbarium, no. 867145, collected at Cafetal Las Pilas (Cerro Espino), Oaxaca, Mexico, altitude 400 meters, October 10, 1917, by Dr. B. P. Reko (no. 3490).

[1] Published by permission of the Secretary of the Smithsonian Institution.

It is difficult to determine the exact relationship of *Rondeletia Rekoi* among its Central American allies. The dense tomentum of the leaves is characteristic of many continental species, but the plan of the inflorescence is unlike that of any other *Rondeletia*. The cymes simulate perfectly those of the genus *Antirhea*, of the remotely related tribe *Guettardeae*, although in that group the cymes are solitary and axillary, rather than racemose, as in this plant. The stipules, too, of *R. Rekoi*, are different from those of any other species, and the prominent reticulation of the upper leaf-surface seems unique. The plant shows a strong color contrast between the bright green upper surfaces of the leaves and the white lower surfaces and stems, and would doubtless prove attractive in cultivation.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Ground water in San Simon Valley, Arizona and New Mexico.* A. T. SCHWENNESEN. U. S. Geological Survey Water-Supply Paper 425-A. Pp. 35, with maps. 1917.

This is a preliminary report on an extensive investigation of the Quaternary geology of the San Simon Valley and adjacent parts of Gila Valley and its relation to artesian water supplies in the region. The stream deposits, which resemble the ordinary deposits of other desert basins, are here separated by beds that were laid down in a lake or other body of water to a depth of several hundred feet. These lake beds form a gentle syncline whose axis nearly coincides with the axis of the valley. They include 300 to 400 feet of dense, homogeneous, blue clay, which serves well as a confining bed for the water in the underlying sand strata and older alluvium. Extrusive basalt is interbedded with the stream deposits and layers of tuff occur in the lacustrine formation.

The report gives data on artesian and pump wells, and on the decrease in artesian pressure. It includes an excellent discussion of agricultural possibilities by R. H. FORBES. O. E. MEINZER.

GEOLOGY.—*Ground water for irrigation in the Morgan Hill area, California.* W. O. CLARK. U. S. Geological Survey Water-Supply Paper 400-E. Pp. 48, with 3 plates. 1917.

The water-bearing formation in the area consists of recent alluvial deposits which are composed of clay or claylike materials, sand, and gravel. Most of the deposits were formed by Coyote River, which has built an alluvial fan entirely across the valley and which has alternately diverted the streams on it into the Bay of Monterey and into San Francisco Bay.

In this report an attempt is made to estimate the quantity of ground water available for irrigation within the area, based on the annual fluctuation of the water table and the porosity of the materials as shown by the logs of wells within the area. The results concerning porosity are checked against a pumping test made at the Lower Gorge by the Bay Cities Water Company in which records were kept of the quantity of water pumped, the area over which the water table was lowered as a result of pumping, and the amount of lowering. A further check is made by the use of stream-flow data, which show the amount of water lost by Coyote River through percolation during a four-year period, 1903 to 1907. W. O. C.

GEOLOGY.—*Tin resources of the Kings Mountain district, North Carolina and South Carolina.* ARTHUR KEITH and D. B. STERRETT. U. S. Geological Survey Bulletin 660-D. Pp. 24, with maps, sections, and illustrations. 1917.

The Kings Mountain district contains both metamorphic and igneous rocks, and the metamorphic rocks include some of sedimentary and some of igneous origin. In age the rocks range from Archean to Triassic. The formations that are associated with the tin deposits are the Carolina gneiss and a Roan gneiss, of Archean age; the Bessemer granite, of pre-Cambrian age; the Whiteside granite; and, especially, tin-bearing pegmatites of late Paleozoic age.

The pegmatite occurs in sheets, lenses, and irregular masses ranging in thickness from a few inches to many yards and attaining half a mile in length. The tin-bearing deposits occur in pegmatite masses within Archean rocks, either the Roan gneiss or the Carolina gneiss along or near its contact with the Roan gneiss. The cassiterite appears to have been one of the first minerals in the pegmatite to crystallize, and it seems clear that the cassiterite was an original constituent of the pegmatite. R. W. STONE.

GEOLOGY.—*Zinc carbonate and related copper carbonate ores at Ophir, Utah.* G. F. LOUGHLIN. U. S. Geological Survey Bulletin 690-A. Pp. 14, with illustrations. 1917.

This paper calls attention to the marked lamellar structure of the zinc carbonate, the prevailing absence of calamine, and the intimate association of the zinc carbonate with copper carbonates in the Ophir mining district. The processes of deposition of the carbonates are described and the following conclusions of economic importance are reached:

It is to be expected that bodies of lamellar zinc carbonate like those at Ophir will prove to be of high grade, owing to the complete removal of limestone, but of small dimensions and confined to the immediate vicinity of fractures and open bedding planes. Such small bodies are not likely to lead to larger bodies of massive ore, unless they lie near to groundwater level, or to some impervious stratum or fault that impounded the waters containing the oxidized compounds of zinc.

Where mixed sulphide deposits in limestone contain both copper and zinc in considerable quantity the resulting carbonate ores of both metals are to be expected in the oxidized zone, the copper carbonate immediately below the position of the original sulphide body or its siliceous casing, and the zinc carbonate below the copper carbonate.

R. W. Stone.

ORNITHOLOGY.—*Notes on North American birds, II.* Harry C. Oberholser. The Auk **34**: 321–329. July, 1917.

The Arizona subspecies of *Vireo bellii*, originally characterized by Mr. Ridgway, and commonly regarded as inseparable from *Vireo bellii pusillus*, is shown to be different and is recognized as *Vireo bellii arizonae* Ridgway. The form of *Baeolophus inornatus* inhabiting the Pacific Coast region from northern Lower California, north through southern California to Santa Barbara County, and described by Mr. Ridgway as *Baeolophus inornatus murinus*, is also reinstated. Two races of *Baeolophus wollweberi* are admitted: *Baeolophus wollweberi wollweberi* (Bonaparte), from central and southern Mexico, and *Baeolophus wollweberi annexus* (Cassin), from northwestern Mexico and the contiguous portion of the southwestern United States. Reasons are given for the recognition of *Geothlypis trichas brachidactyla* (Swainson), from the northeastern United States and southeastern Canada; *Vermivora celata orestera* Oberholser, from the western United States, southwestern Canada, central and northern Mexico; *Molothrus ater artemisiae* Grinnell, from the western United States and western Canada; and *Loxia curvirostra bendirei* Ridgway, from the mountains of the western United States; all of which have been discredited by recent authors. The recent attempted elimination of *Dendroica caerulescens cairnsi* on the ground of untenability is shown to be wrong, and its characters as a recognizable race are given. The British form of *Passer domesticus*, with which the introduced English sparrows of the United States are found to be identical, recently described as *Passer hostilis*, is shown to be but a subspecies of the continental European bird, and should therefore be called *Passer domesticus hostilis*. H. C. O.

ORNITHOLOGY.—*Three remarkable new species of birds from Santo Domingo.* J. H. Riley, Smithsonian Misc. Coll. **66**: No. 15. Pp. 1–2. December 1, 1916.

That the possibilities of the avifauna of the island of Santo Domingo are not yet exhausted is emphasized by the three remarkable new birds recently discovered there by Dr. W. L. Abbott. The first is an owl, *Asio noctipetens,* of a genus hitherto unrepresented on the island. Another is *Brachyspiza antillarum,* belonging to a genus not before detected in any of the West Indies. Still more remarkable is a new white-winged crossbill, *Loxia megaplaga,* of another genus hitherto unknown from the West Indies. Strangely enough, this new *Loxia* is much more closely allied to *Loxia bifasciata* of northern Europe than to *Loxia leucoptera* of North America. Harry C. Oberholser.

ORNITHOLOGY.—*Generic names applied to birds during the years 1906 to 1915, inclusive, with additions and corrections to Waterhouse's "Index Generum Avium."* Charles W. Richmond. Proc. U. S. Nat. Mus. **53**: 565–636. August 16, 1917.

This is, as its title indicates, a summary of the generic names proposed during the decade which has elapsed since the publication of Dr. Richmond's last similar list, including other names previously omitted or overlooked. A list of the errors in the Index Generum Avium of Waterhouse is first given, together with lists of all the Linnaean genera and a list of the genera published in Bonaparte's papers in the Ateneo Italiano, May and August, 1854. The main part of this paper is an alphabetical list of 607 generic names, together with authority, original citation, type and manner of determination, and indication of the family to which it belongs. Many changes in current names and other nomenclatural notes are added in footnotes. The following new generic names are introduced: *Tychaedon* Richmond, for *Aedonopsis* Sharpe, preoccupied; and *Amoromyza* Richmond, for *Merops samoensis* Hombron and Jacquinot. A catalogue of the 607 generic names of the alphabetical list, arranged under families, is also added.
Harry C. Oberholser.

ORNITHOLOGY.—*The birds of the Anamba Islands.* Harry C. Oberholser. Bull. U. S. Nat. Mus. **98**. Pp. v+75, pls. 1–2. 1917.

The Anamba Islands lie in the South China Sea between the Natuna Islands and the Malay Peninsula. They comprise about 20 principal islands, with possibly 200 more islets and rocks, spread over a geographical area some 55 by 65 miles in extent. Dr. W. L. Abbott was, in 1899 and 1900, the first ornithological collector to visit these islands, and he made a collection of 212 specimens, representing 44 species and subspecies, of which 21 were new. These, together with other observations made by Dr. Abbott, bring the number of birds known from these islands up to 66. This number will doubtless be greatly increased by future explorations, though the Anamba group does not seem to be so rich in bird life as the Natuna Islands, which lie nearer Borneo. In only one case, so far as known, are there two subspecies of the same species on different islands in this group. Of the birds now known from the Anambas, 11 are migrants from the north, and do not breed on the islands. Fifteen subspecies are peculiar to the Anamba Islands, and six other subspecies occur outside of the group only on some other islands of the South China Sea. The remaining 24 Anamba birds belong to more or less wide-ranging species. Taken as a whole, the Anamba Islands are faunally most closely allied to the Malay Peninsula; less so, but about equally to Sumatra and Borneo; still less to Java; and only slightly to Indo-China. Among the most interesting of the new forms discovered by Dr. Abbott in the Anamba Islands might be mentioned those of the genera *Muscadivores*, *Collocalia*, *Artamides*, *Cyornis*, *Hypothymis*, *Kittacincla*, *Lamprocorax*, and *Dissemurus*.

H. C. O.

ORNITHOLOGY.—*The birds of Bawean Island, Java Sea.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. **52**: 183–198. Feb. 8, 1917.

Bawean Island is mountainous, with an area of approximately 100 square miles, from which some 18 species of birds had been recorded prior to Dr. W. L. Abbott's visit from November 19 to 28, 1907. His collection of 35 specimens of birds is of much interest, since 7 of the 15 species represented prove to belong to undescribed forms, most of them, so far as known, confined to this island; and since it adds 8 species to the list, making a total of 26 now known from here. The avifauna of Bawean Island as a whole is most closely allied to that of Java, but it has also a marked Bornean infusion. Among the most interesting new forms discovered by Dr. Abbott are a new hawk of the genus *Spilornis*, very different from the Bornean *Spilornis pallidus* and much nearer the Sumatran bird, *Spilornis bassus*; a new species of *Strix*, very different in coloration from *Strix orientalis* and *Strix ocellata*, the characters of both of which it somewhat curiously combines; and a new form of *Malacocincla abbotti*. A series of *Microtarsus baweanus*, collected by

Dr. Abbott, proves this bird to be only a subspecies of *Microtarsus chalcocephalus* of Java. H. C. O.

ORNITHOLOGY.—*A review of the genus Pedioecetes in Colorado.* F. C. LINCOLN. Proc. Biol. Soc. Wash. **30**: 83–86, pl. 1. May 23, 1917.

The sharp-tailed grouse inhabiting the eastern foothills of the Rocky Mountains in Colorado is found to differ subspecifically from *Pedioecetes phasianellus columbianus* of Colorado west of the Continental Divide and also from *Pedioecetes phasianellus campestris* of the plains in the northeastern part of this State, and is named *Pedioecetes phasianellus jamesi.* HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Additions to the Haitian avifauna.* PAUL BARTSCH. Proc. Biol. Soc. Wash. **30**: 131–132. July 27, 1917.

The form of the South American *Porzana flaviventris* occurring on the island of Haiti proves to be a recognizable subspecies, and is named *Porzana flaviventris hendersoni,* after Mr. John B. Henderson. The Haitian golden warbler is distinguished from *Dendroica petechia petechia* of Jamaica and reinstated as a subspecies under the name *Dendroica petechia albicollis* (Gmelin). Eleven other species, mostly water-birds and shore birds, are listed as additions to the avifauna of the island of Santo Domingo. This list includes *Chaetura pelagica,* an entirely unexpected record for April. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The Porto Rican grasshopper sparrow.* JAMES L. PETERS. Proc. Biol. Soc. Wash. **30**: 95–96. May 23, 1917.

The resident form of the grasshopper sparrow found in Porto Rico proves to be separable from both the Curaçao and Santo Domingo forms, and is named *Ammodramus savannarum borinquensis.*

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Preliminary diagnoses of apparently new birds from Colombia and Bolivia.* W. E. CLYDE TODD. Proc. Biol. Soc. Wash. **30**: 3–6. January 22, 1917.

Seven new species here described are *Phoenicothraupis rubiginosus,* from Colombia; *Attila caniceps,* from Colombia, and *Attila neoxenus,* from Bolivia, two remarkable new birds of this tropical genus; *Xiphocolaptes obsoletus,* from Bolivia; *Celeus innotatus,* from Colombia; *Pyrrhura subandina,* from Colombia; and *Eupsychortyx decoratus,* from Colombia. Ten subspecies from Colombia and Bolivia are also described, among the most interesting of them *Bubo virginianus elutus,* from Colombia. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*New genera, species, and subspecies of South American birds.* W. E. CLYDE TODD. Proc. Biol. Soc. Wash. **30**: 127–130. July 27, 1917.

Two new genera are *Idiospiza*, proposed for *Linaria inornata* Lafresnaye; and *Poecilurus*, for *Synallaxis candaei* Lafresnaye. A new species is *Poecilurus atrigularis*, from Colombia. Nine new subspecies from Venezuela, Colombia, and Panama are also described.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Mutanda ornithologica. I.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **30**: 75–76. March 31, 1917.

During the past several years the writer has incidentally noted a number of necessary changes in the current scientific names of birds. This article is the first of a series designed to set forth these changes. In the present installment the following changes are made, chiefly on the ground of preoccupation: *Nettion torquatum* (Vieillot) becomes *Nettion leucophrys* (Vieillot); *Chloephaga magellanica* (Gmelin) becomes *Chloephaga leucoptera* (Gmelin); *Cerchneis gracilis* (Lesson) is renamed *Cerchneis araea* Oberholser; *Cerchneis alopex deserticola* Reichenow is renamed *Cerchneis alopex eremica* Oberholser; and the fossil *Rallus intermedius* Milne-Edwards is called *Rallus adelus* Oberholser, nom. nov.

H. C. O.

ORNITHOLOGY.—*Washington region [winter of 1916–1917].* HARRY C. OBERHOLSER. Bird-Lore **19**: 153. 1917.

This paper is the first of a series designed to present current reports on the birds about Washington, D. C. This installment treats of the winter birds of 1916–1917 up to the month of March. That winter proved notable for the presence of several interesting northern visitors, including *Loxia leucoptera*, *Loxia curvirostra minor*, *Spinus pinus pinus*, and *Olor columbianus*. An individual of *Polioptila caerulea caerulea*, seen, January 1 (erroneously recorded as January 2), and one *Corthylio calendula calendula*, noted, January 20, also are worthy of special mention. During the beginning of the spring migration two species appeared much earlier than ever previously noted: *Seirus motacilla* on March 17, and *Nemospiza henslowii henslowii* on April 1. H. C. O.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The 120th meeting of the Academy was held in the Assembly Room of the Cosmos Club the evening of January 31, 1918; called to order at 8.30 by President Briggs. The amendments to the By-Laws presented at the Annual Meeting, January 8, 1918 (see this Journal of February 4, 1918), were adopted, on the recommendation of the Board of Managers.

Professor Fridtjof Nansen, of the University of Kristiania, Norway, at present Minister Plenipotentiary of Norway on a special mission to the United States, delivered a lecture on *Changes in oceanic and atmospheric temperatures and their relation to changes in the sun's activity.*

The lecturer gave a very comprehensive review, illustrated with lantern slides, of the subject matter of a book recently published by him jointly with Professor Björn Heland Hansen, of the Museum of Bergen, under the title, *Temperatur-Schwankungen des Nordatlantischen Ozeans und in der Atmosphäre. Einleitende Studien über die Ursachen der klimatologischen Schwankungen.*[1]

The primary aim of the research was to find the relations existing between oceanic and atmospheric temperatures. The surface temperature of the water in various parts of the North Atlantic at the coldest time of the year formed the foundation of the first study. When the region covered by the data is divided into approximately equal areas, the temperature curves of these areas are found to be parallel. It is evident from the form of the curves that these changes of temperature taken as a whole are not due to changes in the water-masses transported. A relation does appear, however, between these changes and the prevailing direction of the wind, as deduced from atmospheric pressure gradients. Where the wind turns south of (i.e. is directed south of) its average direction over a period of years, the temperature of the water is lower than the average for the same period, and vice versa. A similar parallelism between wind direction and water temperature appears along the coast of Norway; the effect near the coast is based upon the direction of the wind with respect to the land, as well as upon the season of the year. The air temperature variations on land appear earlier than the variations in water temperature.

Certain periodicities appear in all the curves of oceanic and atmospheric temperatures, but they vary in type. At the same time a relation also appears between these curves and curves of sun-spot activity

[1] Videnskapsselskapets Skrifter, I Mat.-Naturv. Klasse, 1916, No. 9. Kristiania, 1917.

and magnetic elements. The 11-year period is prominent. An oceanic type and a continental (Eurasian) type can be distinguished. The latter follows the sun-spot curve directly, whereas the former type follows the sun spots inversely. There is also a third and very remarkable type in which the curve changes more or less suddenly from direct to inverse. This sudden inversion is brought out in many curves, comparing stations in different parts of the earth, and the inversion occurs in very many cases at about the year 1896.

When the temperature curves for different months of the year are compared with the sun-spot curves, these three types of agreement again appear in very puzzling and unexpected combinations.

In addition to oceanic and atmospheric temperatures, other meteorological elements (air pressure, wind velocity, rainfall, cloudiness, mean daily temperature-amplitude) show a relation to the sun spots, sun prominences, and magnetic variations, and show not only the 11-year period but also shorter periods of two, three, and five and one-half years.

The fluctuations of the temperature at the earth's surface do not follow directly the variations in the energy received from the sun as determined by the measurements of Abbot and Fowle. The daily and yearly temperature-amplitudes are believed to furnish sufficient refutation of hypotheses based on supposed variations in the absorbing and reflecting power of the atmosphere, as well as of Humphreys' hypotheses as to formation of ozone or effects of volcanic dust. Blandford's hypothesis of the effect of increased evaporation in lowering continental temperatures at sun-spot maxima is also not supported by the facts of tropical land and ocean stations.

The mistake of most authors when they have discussed the causes of temperature changes has been that they took for granted that the average temperature at the earth's surface was directly dependent on solar radiation, and would give a direct indication of heat received. They have not considered sufficiently the fact that a very great proportion of the sun's radiation is absorbed by the higher layers of our atmosphere and that the distribution of heat in the atmosphere is of the greatest importance for the temperatures at the earth's surface. They seem very often to have forgotten that the variations in the sun's activity, and in the so-called "solar constant," and also in the sun's electric radiation, may primarily influence the higher layers of the atmosphere, thus indirectly guiding the distribution of atmospheric pressure and the circulation not only of these higher layers but also of the lower parts of the atmosphere. In this manner the temperature of the higher latitudes may be influenced more than that of the tropics, where the conditions are so stable.

The variation in *pressure gradient* seems much more closely related to the temperature of land stations than is the variation in air pressure itself. For instance, the Colombo-Hyderabad gradient runs parallel to the temperature in the Himalayas but opposite to the temperature at Batavia, while Bombay forms an example of those strange reversals occurring about 1896. The Iceland-Azores gradient has exactly opposite effects in Norway and in mid-Atlantic. An increase of air circulation may thus have opposite effects in different regions. The sun spots and magnetic elements sometimes oppose and sometimes agree with the variations in pressure gradients.

Various periodicities appear in the sun spots as well as in the terrestrial phenomena. In the sun spots there is an 8-month period corresponding with the conjunction or opposition of the planets Venus and Jupiter with the sun. This same period occurs in the North Atlantic gradient, and was found by Krogness in the magnetic declination at Kristiania. There are also periods of six and twelve months in the magnetic elements, due to the position of the earth. The combination of these 6, 8, and 12-month periods gives a 2-year period for the magnetic and meteorological elements on the earth. But in the fluctuations of the sun spots a similar period of two years is also discovered, and especially noticeable are indications of minima every second year. Before 1896 there is an agreement between the 2-year minima of temperature at certain stations and the corresponding sun-spot minima, but the agreement is remarkable in that the greatest depressions in the sun-spot curve coincide with the smallest depressions in the temperature curve; this relation ceased about 1896, hence the peculiar inversion already referred to.

Other periodicities have been recognized. A 32-33-month period at Batavia may be a combination of the 2-year period already referred to and a 3.7-year period suspected by Lockyer. Secular changes of relatively long period (35 years and over 100 years) also are probable. The researches of Clayton have recognized correlations in daily temperature and pressure fluctuations at various stations over the earth and the fluctuations in the daily heat radiation of the sun as measured by Abbot and Fowle, the same three types appearing in these meteorological variations as have been noted in the long-time variations. Krogness recognizes 14-day and 27-day periods in magnetic storms, as well as in air-pressure gradients, wind, and temperature, in northern Norway.

To summarize the results of these investigations: In different groups of areas on the earth the meteorological elements (temperature, barometric pressure, rainfall, etc.) fluctuate or pulsate, so to speak, in time with one another, while in other groups of areas the fluctuations or pulsations are exactly inverted, and finally, some areas show transition stages between the two. The result of all this is a very complicated picture of the meteorological fluctuations. But by means of appropriate analyses we see that from this complicated and apparently chaotic set of fluctuations there arises a clear picture of the very intimate relation between all these variations and the variations in the sun's activity. We have seen that even changes of very short duration in the sun's radiation (of heat as well as electricity) are distinctly repeated in our meteorological conditions and in the surface temperature of the ocean. The effects of the solar variations are probably transferred by means of variations produced in the distribution of pressure in our atmosphere. Changes in solar radiation probably first affect the higher layers of our atmosphere, and thus create an unrest which in turn is transmitted to the lower strata near the earth's surface.

Such dynamic changes will produce different effects in different regions of the earth. But by thorough and complete analyses of the great meteorological material now at hand it may be possible to find the general rules. This will be an important step forward toward understanding the laws ruling our atmosphere.

For this purpose it will also be of the greatest importance to have the wonderful researches of Abbot and Fowle continued with the greatest possible efficiency. These investigations of the sun's radiation of heat, which they have been carrying on for a long series of years at Washington, Mount Wilson, Mount Whitney, and in Algeria, have given us the remarkable revelation that our sun is a variable star, the most important discovery that has been made in this field in many years. (*Author's abstract.*)

William R. Maxon, *Recording Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 577th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, January 12, 1918; called to order at 8.00 p.m. by President Rose; 38 persons present.

On recommendation of the Council the following were elected to membership: E. A. Chapin, F. P. Metcalf, Charles E. Chambliss.

President Rose announced the death on October 29, 1917, of Miss Katherine M. Raber, a former member of the Society.

President Rose announced the membership of the Publication Committee as C. W. Richmond, J. H. Riley, N. Dearborn, and W. L. McAtee; of the Committee on Communications as William Palmer, Alex. Wetmore, R. E. Coker, L. O. Howard, and A. S. Hitchcock.

The Recording Secretary read a letter from the Washington Academy of Sciences in which subscriptions to the Journal of that Society were solicited on the part of members of the affiliated societies, and in which the aims and character of the Journal were set forth.

Dr. L. O. Howard introduced Prof. Stephen A. Forbes, of the University of Illinois, as a visitor to the Society who was invited by the President to take part in the discussions.

Under the heading brief notes, General T. E. Wilcox presented a note read by the Secretary on the inability of camels to swim.

A. S. Hitchcock outlined the plans formulated by a gathering of botanists during the scientific meetings recently held in Pittsburgh for the establishment of an abstract journal on the subject of botany.

The regular program consisted of three communications as follows:

N. E. McIndoo: *The senses of insects*, illustrated by charts. Three types of olfactory organs were discussed. (1) The lyriform organs are found on all the appendages of spiders. (2) The olfactory pores found on the appendages of insects were divided into simple and compound organs; the former being a single sense cell whose peripheral end pierces the integument, and the latter being a group of sense cells whose peripheral ends pierce a common plate; the compound organs are found only on the antennae of a certain coleopterous larva. (3) The antennal organs discussed are the pore plates, pegs, pit pegs, and end pegs; each of these organs is innervated, but the nerve does not come in direct contact with the external air as it does in the lyriform organs and olfactory pores.

Bees recognize one another chiefly by the odors they emit; in a colony there are a queen odor, drone odor, family odor, individual odor, and a hive odor. The hive odor is the most important one, because without it a colony of bees could not exist. These odors are produced by a special scent-producing organ.

The tactile sense of bees is very acute, and these insects can discriminate between certain foods better than people, although they have no sense of taste; this is accomplished by means of the highly developed olfactory sense after the bees have eaten a little of the foods.

The paper was discussed by Dr. L. O. Howard and Alex. Wetmore.

Eleanor C. Allen: *Wax models of fleshy fungi*, with an exhibit of several models. Miss Allen said she had been engaged for the past four years in making models of this sort for the Milwaukee Public Museum. She illustrated her talk by models of four species of mushrooms, each being represented by a group of several individuals arranged as in their living condition. She described the processes incident to the making of the finished groups. Living specimens growing in woods or fields are found and before picking sketches of the group and complete notes in regard to color and habitat are made. Then plaster models of the various individuals are made. In the laboratory, using these models, wax mushrooms are cast and the details of these are worked out by careful modeling, coloring, and the addition of various materials to give a natural appearance of texture. Habitat material such as grass, moss, stumps, etc., are gathered and chemically treated. Backgrounds, natural to individual species, are prepared from these materials and upon these the wax facsimiles are arranged. Miss Allen showed photographs of the numerous groups which she has made and which are now installed in the Milwaukee Public Museum.

Miss Allen not being a member of the Society was introduced by President Rose. Her communication was discussed by the chair, and by Messrs. F. V. Colville and A. S. Hitchcock.

C. B. Doyle: *Some agricultural and botanical features of Haiti*, illustrated by lantern slides. In Haiti there is very little left to represent the original forest covering. The primitive milpa system of agriculture is used and the natives live in scattered families or small groups. Most of the food plants are of American origin, butit is the introduced species that have become of the greatest importance to the natives. There are only a few large plantations on the island, the bulk of the crops of the three principal exports (coffee, cacao, and cotton) being produced on the small native farms. Many different kinds of fine fruits are abundant, but several species prominent in other parts of tropical America, such as the papaya, sapote, sapodilla, and pineapple, are absent or little used. Among the root crops that are commonly grown are sweet potatoes, yams, yautias, and cassava, and more recently white potatoes are being successfuly produced in the cool mountain districts southeast of Port au Prince. In comparison with other tropical countries, conditions appear favorable for crop production in Haiti, if a more effective organization of agriculture can be established together with a better means of marketing the products.

The paper was discussed by Major E. A. Goldman, Dr. L. O. Howard, O. F. Cook, A. S. Hitchcock, and the chair.

M. W. Lyon, Jr., *Recording Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

The 125th regular meeting of the Society was held at the Cosmos Club, Thursday, January 3, 1918. There were 65 members and 8 guests present. The following persons were elected to membership: A. A. Hansen, Leonard W. Kephart, H. E. Allanson, F. P. Metcalf, Nathan Menderson, and T. Ralph Robinson. The following scientific program was given:

C. V. Piper: *The botany and economics of the tribe Phaseoleae.* The word bean traces back philologically to *Vicia faba* known as the horse bean, broad bean, Windsor bean, etc. In present-day usage the word bean is most commonly used for the common or kidney bean *Phaseolus vulgaris.* Botanists in general restrict the term *bean* to the botanical tribe Phaseoleae, but the original bean *Vicia faba* belongs to the tribe Viciae. By extension the word bean has also been applied to seeds in other families, as the castor bean, cacao bean, vanilla bean, etc. On the other hand some of the Phaseoleae are commonly known as peas; for example, pigeon pea and cowpea.

For the purpose of this discussion the term bean is restricted to the botanical tribe Phaseoleae. In this tribe Engler and Prantl recognized forty-seven genera, and Bentham and Hooker fifty. In recent years one additional undoubtedly distinct genus has been described and many botanists subdivide some of the older genera. Thus from Phaseolus have been segregated Dyslobium and Strophostyles and perhaps other natural genera still remain to be separated from the Phaseolus complex. Engler and Prantl divide the tribe Phaseoleae into six subtribes, of which the most important is the Phaseolinae. Of the eight to twelve genera in this tribe all but one or two are economic and seven are important as sources of human food.

All of the edible beans are of very ancient agriculture and most of them have not been found, or at least identified, as wild plants. The exceptions which are known as wild are the cowpea, the horse bean, the soy bean, the lima bean, the moth bean, and the Niger bean.

Most of the beans used for human food are prone to create digestive disturbances, in strong contrast with the seeds of the pea tribe, but very little is known of the substances in beans which cause these troubles.

The speaker discussed briefly the botanical characters of the more important genera. Detailed data were given concerning the species that are of economic importance in the United States. Particular attention was called to the tremendous increase and relative importance of the velvet bean and of the soy bean.

W. J. Morse: *Morphological character and food value of soy-bean varieties.* The soy bean is native of southeastern Asia and has been cultivated as a food crop by the Chinese for more than 5000 years. In extent of uses and value it is the most important legume grown in Asiatic countries. The plant is found growing in its wild form in southern China and on the southern islands of Japan.

The number of varieties cultivated in the Orient is very extensive and during the past ten years the Department of Agriculture has brought in through the Office of Foreign Seed and Plant Introduction nearly 1000 introductions, nearly all of which were distinct sorts. Very seldom is the same sort received twice unless from the same locality. In China and Japan the varieties are distinguished by color, shape, size, and use of the seed, and, to a slight extent, by the maturity. Certain sorts are favored for making bean cheese, others for bean sprouts, some for soy sauce, and still others for the production of oil and meal. In America, varieties are classified according to color, size, and shape of seed, maturity and habit of plant, and color of pubescence and flowers. Analyses made of all varieties introduced thus far show a range of from 12 to 24 per cent oil and from 30 to 46 per cent protein. The Department of Agriculture is doing considerable work in the selection of high oil-bearing varieties and also those with a high percentage of protein for food purposes. Investigations as to starch content indicate varieties having a total absence of starch to a few having perhaps about 3 per cent. In most varieties examined, the starch is found around the hilum, while in one instance a small quantity was found scattered throughout the cotyledons.

In Oriental countries the soy bean is utilized largely for food, being elaborated into a great variety of productions such as soy sauce, vegetable cheeses (fresh, dried, fermented, and smoked), vegetable milk, and bean sprouts. All of these products are rich in protein and furnish, with rice, a well-balanced diet to the people of these countries. In Europe and America soy-bean flour or meal has been used to a small extent for many years as a special food for persons requiring a food of low starch diet. During the last two or three years the dried beans are assuming a place on the American market and are used the same as the field or navy bean. The green beans, about three-quarters to full grown, are finding favor as a green vegetable, being utilized like the lima or butter bean.

As an oil seed, the soy bean has taken an important place in the world's commerce and has become an important competitor of other vegetable oils. Hundreds of thousands of tons of beans are being crushed for oil and meal in Asia, America, and European countries. The oil is used quite extensively in the manufacture of food stuffs such as butter and lard substitutes.

The soy bean, with its products, oil and meal, present great possibilities in supplementing our ordinary food products during the present emergency, and once introduced on the market will give a highly nutritious food at very low cost. Extensive areas in the United States are suited to the production of soy beans. Although the acreage of the crop the past season is about five times that of five years ago, it should, and no doubt will, assume an important place among the farm crops of the United States.

Charles Thom: *Fermented soy-bean products.* Some preliminary experiments have been made to determine the conditions of making and ripening the Chinese soy cheeses.

The presence of a protein allied to the casein of mammalian milk makes possible the manufacture of these cheeses. The basis of these is the so-called Tofu or Dofu; it has various names. This is a soft curd made by the coagulation of the soy-bean milk with calcium sulphate, raw salt, or by acid milk or whey. As it appears in the market, it contains about 83 to 88 per cent water, 7 to 11 per cent protein, 4 to 5 per cent fat, and perhaps 0.5 per cent ash. In the fresh form it is comparable to low-grade Neufchatel or cottage cheese which runs about 10 per cent higher in nutritive constituents. The cakes of curd are usually about 2 inches square and 1 inch thick. These little cakes are ripened in cool, very moist rooms, until covered with a deep felt of mold; then packed in jars with excessive amounts of salt and allowed to cure slowly. The concentration of brine is such as to reduce the activity of microorganisms to a minimum. The final cheeses have high flavor, rather strong odor, and too much salt to be consumed in bulk as cheese. They are covered with red sauce and variously combined with other food products before consumption.

J. A. LeClerc: *The composition of the soy bean and its use in breadmaking.* The speaker presented the results of the analyses of several hundred samples representing 45 varieties and grown in six different localities. From these results it was shown that soy beans contain on an average 18.6 per cent of fat and about 40 per cent of protein. It was shown that when all these varieties were grown in the six different localities the influence of environment on the protein and fat content was marked. The average protein content of some soy beans grown in one locality was as low as 38 per cent, while those same varieties grown in another locality would contain as much as 42 per cent, indicating definite varietal characteristics. The same conclusions hold for the fat content. In general, soy beans that are high in fat are low in protein, and vice versa. It was also shown how soy beans can be used as a flour substitute. Samples of bread made with 20 per cent soy bean and 80 per cent white flour were exhibited.

H. N. Vinall, *Corresponding Secretary.*

SCIENTIFIC NOTES AND NEWS

The Bureau of Standards has purchased eight acres of land west of Connecticut Avenue and has let contracts for a new engineering laboratory, 175 by 350 feet and four stories in height. The new building and its equipment will cost in the neighborhood of $1,000,000, and will increase the capacity of the Bureau by 50 per cent. The Pittsburgh laboratory of the Bureau, including the work on glass and ceramics, will be transferred to Washington. It is expected that the new building will be occupied during the coming summer.

Mrs. E. H. Harriman has turned over to the Carnegie Institution of Washington the Eugenics Record Office established by her at Cold Spring Harbor, Long Island, New York, in 1910. Included in the gift are 80 acres of land, an office building, a large residence and the valuable records already compiled. Mrs. Harriman also has created an endowment fund yielding an annual income of $12,000 for maintenance of the work.

Mr. Frederick Webb Hodge, since 1910 Ethnologist-in-charge of the Bureau of American Ethnology, Smithsonian Institution, resigned on February 28, to accept a position with the Museum of the American Indian, Heye Foundation, in New York City. Dr. Jesse Walter Fewkes, ethnologist on the Bureau's staff since 1895, has been appointed chief of the Bureau.

Dr. Rollin Arthur Harris, mathematician and physicist, who had been employed in the Coast and Geodetic Survey for 28 years, died on January 20, at the age of 55. He was a member of the Philosophical Society, and one of the original members of the Academy. His work was concerned principally with the theory of functions as applied to geodesy and cartography, and with problems of tides and cotidal maps.

Dr. J. W. Turrentine, of the Bureau of Soils, is now in charge of the experimental kelp-potash plant of the Bureau, at Summerland, California. The plant has been in operation since late August, and is now marketing daily about $300 worth of materials produced incidentally in experimentation. While primarily experimental, it is built and equipped to make possible the obtaining of commercial data. It has a capacity of about 150 tons of raw kelp per day, and its equipment includes a self-propelling harvester; a pier with unloading device and conveyors; rotary kilns and furnaces for drying; retorts for destructive distillation; lixiviator; evaporator and crystallizer; centrifugal dryers; and the necessary incidental equipment. Dr. Turrentine has as his assistants Mr. E. B. Smith, formerly of the office of Public

Roads, Mr. P. S. Shoaff, formerly Chief Chemist of the Holly Sugar Corporation, and Dr. G. C. Spencer, formerly of the Bureau of Chemistry, together with an operating force numbering forty-three.

Prof. C. C. Nutting, a member of the Academy, is organizing a party of naturalists, composed almost entirely of graduate students and instructors in zoology at the State University of Iowa, to carry on investigations regarding marine fauna in the vicinity of the islands of Barbados and Antigua, British West Indies. The party will sail about April 27 from New York and expects to return about August 1. The time will be divided between the islands of Barbados and Antigua, at both of which places the Colonial Governments have placed adequate quarters for the party. A well-equipped launch with excellent facilities for dredging down to 200 fathoms has been proffered by a Washington friend, who himself will be a member of the party.

In his preliminary trip to Barbados last summer Prof. Nutting found that the natives of these islands are quite expert in diving, and one of them was capable of bringing up specimens from a depth of 10 fathoms. It is the intention to make rather extensive use of native divers to procure specimens down to this depth.

The following persons have become members of the Academy since the last issue of the Journal: Miss Frances Densmore, Bureau of American Ethnology, Smithsonian Institution; Major William McPherson, War Department, 1800 Virginia Avenue; Dr. Francis Briggs Silsbee, Bureau of Standards.

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OCEANOGRAPHY.—*An electrical instrument for recording sea-water salinity.*[1] ERNEST E. WEIBEL and ALBERT L. THURAS, Bureau of Standards. (Communicated by S. W. Stratton.)

The modern tendency in physical research is to replace indicating instruments by recording instruments wherever possible. This has been especially true in the science of meteorology, where the recent advances have been brought about almost entirely by the remarkable improvements and developments in recording instruments. In the related science of oceanography there are practically no recording instruments now in general use, except possibly the tide-gage. If meteorology has been so greatly benefited by such instruments, surely in oceanography, where the changes in the physical properties are so much more regular and therefore more easily interpreted, great advances should be looked for through the addition or substitution of recording instruments.

A few years ago a recorder using a platinum resistance thermometer,[2] giving a continuous record of the surface temperature of the ocean, was designed and constructed at the Bureau of Standards. This instrument has been used successfully on board ship and some very interesting records have been obtained which show the distribution of temperature and thereby indicate the location of ocean currents and also give a knowledge

[1] Done under the auspices of the Interdepartmental Committee on Oceanography, subcommittee on instruments, apparatus, and measurements.

[2] WAIDNER, DICKINSON, and CROWE. Bureau of Standards Bull. 10: 267. 1914.

of their boundary conditions which could hardly be obtained by repeated single measurements of temperature.

The temperature, however, is not nearly so reliable a clue to the location of currents and the origin of water masses as is the salinity. A body of sea water may change considerably in temperature in moving from one place to another, but unless the evaporation or rainfall is excessive its concentration will change comparatively little. By salinity is meant the number of grams of salt or solids in one kilogram of sea water. The composition of these salts is very nearly constant everywhere in the open ocean, but the salinity, or concentration of the total salts, varies from place to place.

From a consideration of the properties of sea water that vary with the salinity, the electrical conductivity seemed to be the most susceptible to continuous measurement, if the difficulty due to the variation of conductivity with temperature can be overcome. This difficulty is avoided by the use of a method which is compensated for temperature.

This paper describes the method of measurement and the experimental work done towards the production of an apparatus to give a continuous record of sea-water salinity to the accuracy required in the most precise oceanographic research. The work has not been finished, but from the results obtained we believe that the method is practical and sufficiently important to warrant publication at the present time, even though the apparatus is not yet built.

DESCRIPTION OF THE METHOD

The method consists in measuring the ratio of the resistance of sea water in two equal or nearly equal electrolytic cells A and B (fig. 1); one cell A is sealed and contains sea water of a known average salinity, the other cell B is open and has flowing through it the sea water to be measured. This ratio is obtained by a Wheatstone bridge using alternating current to eliminate polarization effects in the cells. A calibration of the apparatus can be made at any time by using sea water of known salinity in the open cell. This can be done either by carrying standard samples or by determining the salinity of the sea water flowing through the open cell by some accurate method that can be used on board ship. Such a method giving salinity by a measurement of density has been described.[3] A record of the resistance ratio of the two cells is made by a recorder similar to those now in use for measuring temperature, but some changes will have to be made to adapt it for using alternating current.

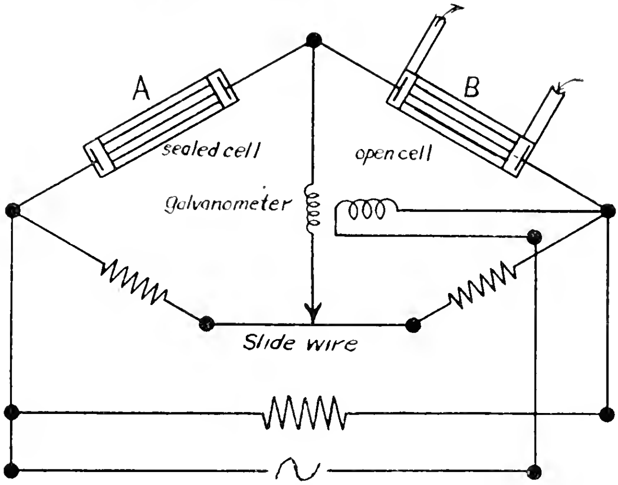

Fig. 1.

The new and important feature of this method is the use of two cells containing liquids of nearly the same properties, which make it possible to compensate almost completely for the large temperature coefficient of sea water. The two cells are placed in a uniform temperature bath and the error will be only that due to the small differential temperature coefficient of the two solutions.

EXPERIMENTAL WORK

Preliminary experiments to test the general feasibility of the method showed:

1. Good balances can be obtained with a simple Wheatstone

[3] Thuras, A. L., Journ. Wash. Acad. Sci. 7: 605. 1917.

bridge circuit containing the two electrolytic cells, using either a telephone at 500 cycles per second or an alternating current galvanometer at 60 cycles per second as a detector.

2. The temperature compensation is sufficient. For the maximum difference in salinity the lack of compensation did not exceed 0.03 in salinity (0.03 gram of solids per kilogram of water) for a change of 10°C.

3. No appreciable change in balance due to the flow of the sea water through the open cell was obtained.

4. To obtain a continuous record of salinity an alternating-current galvanometer similar to the usual direct-current galvanometer is needed to operate the recorder. This galvanometer was constructed of the electromagnet moving coil type,[4] and had a sensitivity and other operating constants as good as those of the direct-current galvanometers now used. After these preliminary experiments on some temporary cells had shown the feasibility of the method a more careful study was made of certain sources of error in order to obtain data upon which to base the design of the final cells. These effects are:

1. Heating effect of the current in the cells;

2. Temperature lag of the sealed cell when the sea-water temperature in the bath suddenly changes;

3. Time necessary for the resistance ratio to reach its true value if the sea water passing through the open cell changes in salinity.

In the ordinary conductivity measurements performed in a laboratory the heating effect of the current can be made negligible by using a sufficiently sensitive galvanometer or telephone receiver, but with the less sensitive recording galvanometer this current must be much larger and consequently requires a specially designed cell to dissipate the heat developed. From experiments on differently shaped cells the heating coefficients, i.e., temperature rise per watt dissipated in the cells, were found to be approximately inversely proportional to the diameters and lengths of the cells. Since the length of cell is limited by

[4] WEIBEL, E. E., Bureau of Standards Sci. Paper No. 297 p. 23. 1917

practical considerations, it was necessary to increase the diameter in order to reduce this coefficient.

To determine the temperature lag, different cells were placed in a stirred bath and their time constants were found by changing their temperatures slightly from the temperature of the bath and reading the resistance at definite intervals as the cell gradually assumed the temperature of the bath. By time constant is here meant the time necessary for the temperature of the cell to approach the temperature of the bath to 67 per cent of its initial difference in temperature.

The time constants were found to be very approximately inversely proportional to the square of the diameter of the cells. Therefore the condition that is required to reduce the heating coefficient is opposite to that which will reduce the time constant, and since both of these values must be small special *multiple tube* cells were designed which will fulfill these conditions.

The time lag produced by a change in concentration of the sea water was determined by passing water of different salinities through a cell and it was found that if the cell is being swept out at the rate of three or four volumes a minute the ratio will respond within three or four minutes for probably the maximum change in salinity which can occur. The following considerations will show the purpose of reducing these factors as much as possible.

In general the temperature and salinity of the ocean changes very gradually from place to place so that usually no special cell would be required to record the salinity, but at some places as for instance in the vicinity of the Grand Bank of Newfoundland, where the cold fresh water of the Labrador Current meets the warm salty water of the Gulf Stream, the temperature and salinity change comparatively rapidly in moving from one body of water to the other. At these places such a specially designed cell is necessary. A few years ago a number of temperature records of the ocean were taken from a vessel going at moderate speeds and the most sudden change in temperature was 3.5° in about one minute. If this change is assumed to be instantaneous, the temperature of the sealed cell will in less than two minutes be so near that of the open cell that the error will be less than 0.02 in salinity.

Although there are as yet no observations on the rate of change of salinity, it is assumed that the maximum change in a short interval of time is not greater than 2 in salinity. This value is estimated from the relative changes of temperature which are discussed above. A response to this change to within 0.02 in salinity in less than two minutes can be obtained by washing out the cell at the rate of 3 or 4 volumes a minute. However, if the temperature and salinity change at the same time, which is

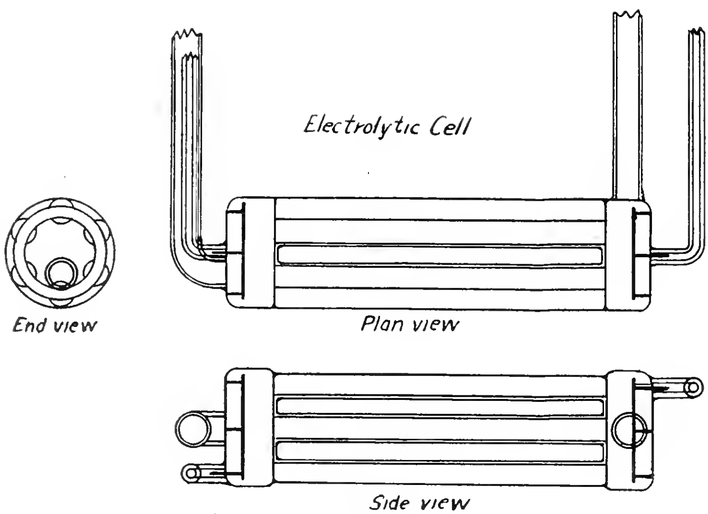

Fig. 2.

quite probable, the lag of the recorder will be the sum of the two and if they are both a maximum at the same time, which is quite improbable, then the total time lag will be 4 minutes. This is probably the worst possible condition that can occur, but it is well to point out that as the regain of the true reading is exponential the recorder will at first quickly approach its correct value and although it takes four minutes to reach within 0.02 in salinity it will take much less than two minutes to obtain an accuracy of 0.04 in salinity. However, if a more careful study of the change in salinity between different water masses is required it is only necessary to increase the flow through the open cell and to make a correction for the error caused by the rapid change in temperature. Since another recorder will be used to measure the temperature of the sea water this temperature correction for the salinity can easily be obtained.

MULTIPLE TUBE CELLS

Each of the 2 cells that have been designed (fig. 2) contains 6 parallel glass tubes 14 cm. long and 1 cm. in diameter. These tubes are joined at each end to bulbs containing annular-shaped platinum electrodes. Each electrode has an area of 5.3 sq. cm. and is held rigidly in place by 4 platinum pins which are welded to the electrode and sealed into the glass wall of the cell. The cells are designed so that there are no pockets in which air can collect, and the sea water is admitted in such a manner as to sweep off any bubbles that might collect on the electrodes. The inlet and outlet tubes are sufficiently large to insure a thorough washing out of the cell in sufficient time to respond to the maximum changes in salinity that are liable to be met with on a vessel running at moderate speed.

RECORDER

In order to obtain a continuous record of sea-water salinity the Wheatstone bridge and galvanometer must be embodied in a recorder mechanism such as that developed by the Leeds & Northrup Company. The most important changes in their present recorder are due to the use of alternating current. The electrical connections are as shown in fig. 1. The current may be obtained from the usual 60-cycle supply, but if only direct current is available then the small direct-current motor used for driving the recorder mechanism can be equipped with slip rings and be operated as a converter. The recorder paper should be ruled so that salinities can be read directly.

INSTALLATION AND OPERATION ON BOARD SHIP

To obtain a continuous record of surface salinity, the apparatus will be set up similarly to the temperature-recording apparatus previously used.[5] The recorder will be properly secured in a convenient place on the vessel and insulated wires will lead from it to the cells. The cells (see fig. 3) will be mounted close together in a bath through which water direct from the ocean will flow continuously. This will insure a uniform temperature throughout the bath. A flow of water will also be maintained

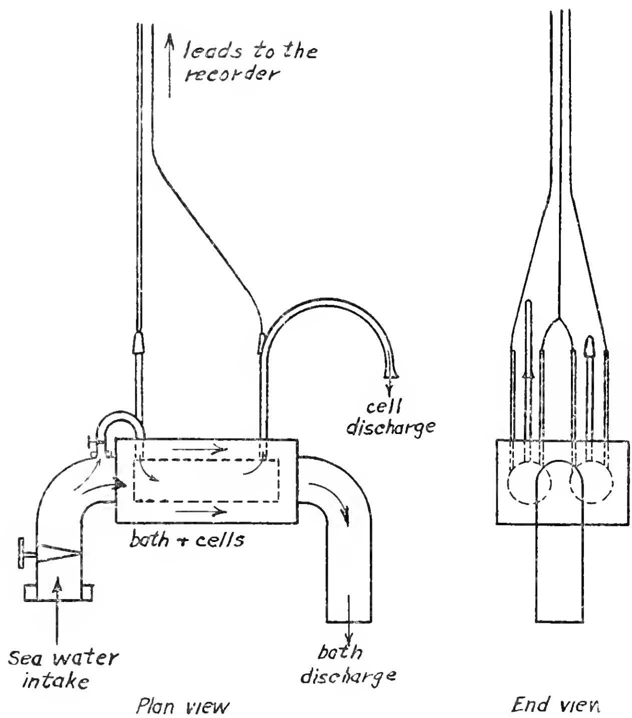

Fig. 3.

through the open cell, this water being tapped off from the main supply which passes through the bath. This flow must be broken as it leaves the cell in order to eliminate the resistance error due to shunting the open cell. The bath and connections to the sea-water supply will be carefully covered with heat insulating material to insure a uniform temperature throughout.

[5] Treasury Dept., U. S. Coast Guard Bull. **5**: 27. 1915.

SUMMARY

An apparatus to give a continuous record of sea-water salinity by the measurement of its electrical conductivity is described. A pair of electrolytic cells has been designed which when used with a suitable alternating-current galvanometer will give satisfactory operation in connection with a recorder. The temperature compensation is obtained by placing both cells, which are in the two arms of a Wheatstone bridge, in a uniform temperature bath.

ETHNOBOTANY.—*The maho, or mahagua, as a trans-Pacific plant.* O. F. Cook, Bureau of Plant Industry, and Robert Carter Cook.

As noted previously in this Journal[1] the word *cumara* or *kumara,* a name for sweet potatoes, is found in the Pacific islands and among the Quichua Indians of the interior valleys of southern Peru, on the eastern slopes of the Andes. Considering the plant as a native of America, the preservation of an American name among the Polynesians appears significant. If the sweet potato and its name were carried into the Pacific in prehistoric times, other evidences of communication may be discovered.

The underlying question is whether agriculture and civilization arose independently in the two hemispheres, or had their early development in America and reached Asia by way of the Pacific islands. Did civilization grow from a single primary root, or were there parallel developments among widely separated peoples? The agriculture of ancient America undoubtedly was indigenous, since it was based on native plants. Nevertheless, several of the American plants, as the coconut palm, the sweet potato, the bottle-gourd, the yam-bean, and the upland species of cotton, appear to have been cultivated in the Pacific islands and the Malay region long before the period of discovery by Europeans. Civilization being an outgrowth of agriculture, evidence from the cultivated plants seems pertinent.

The *maho,* or *mahoe,* to use the Jamaican or West Indian name

[1] **6**: 339. 1916.

that has found its way into dictionaries, is one of the economic plants that appears to have attained a trans-Pacific distribution in prehistoric times. It is a handsome woody shrub or small tree, with large lemon-yellow flowers, a member of the mallow family, a relative of the cotton plant, the okra, and the hollyhock. The leaves are entire and broadly cordate, much like those of the linden or basswood, a similarity recognized in the name given by Linnaeus, *Hibiscus tiliaceus*, or linden hibiscus. Some writers have called it lemon hibiscus and others corkwood. Many botanists have treated the maho as representing a genus distinct from Hibiscus under the name Paritium, though as originally proposed the genus was called Pariti, one of the East Indian vernacular names being adopted by Adanson as the generic designation.

A SOURCE OF FIBER AND FIRE

Among the early Polynesians the maho must have been a very important plant, since it affords two indispensable materials and has many incidental uses. The bark contains a strong, flexible fiber adapted to many purposes, tying and binding, building houses and boats, snaring or trapping game, and making bark cloths, nets, mats, baskets, and other equipment of primitive life. The wood of the maho has the peculiarity of readily producing fire by friction. The ease with which the natives of Tahiti were able to produce fire from maho wood is remarked by Darwin in the *Voyage of the Beagle*:

> A light was procured by rubbing a blunt-pointed stick in a groove made in another, as if with intention of deepening it, until by the friction the dust became ignited. A peculiarly white and very light wood (the *Hibiscus tiliaceus*) is alone used for this purpose; it is the same which serves for poles to carry any burden, and for the floating outriggers to their canoes. The fire was produced in a few seconds; but to a person who does not understand the art it requires, as I found, the greatest exertion; but at last, to my great pride, I succeeded in igniting the dust.

The heart-wood of the maho is described in Gill's *Jottings in the Pacific* as very tough and durable, fragrant, of a very dark-green color, and well adapted for making paddles and the framework of boats and houses. Gill states that most of the firewood used in the islands is furnished by this tree, and also claims for it an important function in agriculture:

> Perhaps the greatest blessing conferred upon these islanders by this tree is its power of renewing the fertility of the soil. Nothing exhausts the soil so speedily as yams or cotton. In ten or twelve years the soil is utterly impoverished. The native plan then is to allow it to be overrun with lemon hibiscus bush. When the timber has become heavy you may be sure the soil is perfectly renewed. The soil which once was dry and hard is now light and extremely rich.

Such a possibility of reclaiming abandoned lands might prove of practical importance in many tropical countries, and would doubtless facilitate the commercial cultivation of the maho as a fiber or paper plant, which has been suggested.

A WILD PLANT IN AMERICA

As with the coconut palm and the sweet potato, the maho figures more prominently among the Polynesians than among the natives of tropical America, although the American origin of the plant is even more clearly indicated. While the coconut and the sweet potato are not known to exist in a truly wild state, the maho is an abundant or even a dominant species in many localities, all the way from Porto Rico and southern Florida to the banks of the Guayaquil River, on the Pacific coast of South America. Although used in the same ways as in the East Indies, for bark cloth and cordage, and for kindling fire, as indicated by Oviedo, Dampier, Sloane, Barrerre, and many later writers, these uses were shared with many other plants, so that no special prominence was attained by the maho. Sloane's *History of Jamaica* states that the outer layers of the bark were used for making ropes and the inner for clothing the slaves.

A CULTIVATED PLANT IN THE OLD WORLD

In the Pacific islands and in eastern Asia the status of the maho was notably different from that in America. Lack of other materials may have enhanced its importance. The making of bark cloth was a much more highly developed art among the Polynesians than in America. The maho cordage was used especially for making canoes, its strength and durability not being affected by exposure to water. The plant was grown regularly from cuttings, and in some parts of the East Indies a condition of seedlessness appears to have been reached, as with other species that have been subject to vegetative propagation for long periods.

In some of the islands the maho grows spontaneously, and covers large areas that have been abandoned after previous cultivation. As a result of extensive studies of plant dispersal in the Pacific islands, Guppy classes the maho with the candlenut as introduced trees which have replaced native forest vegetation. Low banks of tidal rivers are the favorite habitat. Though many botanists have written of the maho as a cosmopolitan seashore plant, its wide dissemination may be due largely to human agency, as with the coconut palm. The distribution in both cases extends over tropical America and the Polynesian area, including the islands and shores of the Pacific and Indian oceans.

DISTRIBUTION OF THE NAME IN AMERICA

The name maho, with many variations, is widely distributed in tropical America, and is applied locally to many other plants. The form usually employed in Spanish books is *majagua* or *mahagua*, in French *mahaut*, *mahoe*, or *mahou*. In Ecuador the maho is said to be called *jagua*. A reduplicated form, *mahou-mahou*, is listed by Martius for the Galibi Indians of Brazil, but the simple form *mahu* is also mentioned in relation to Mahu as a Tupi place name on the Upper Amazon (*Ethnographie*, 512). How far the plant extends up the Amazon is not known. No definitely recognizable equivalent has been recorded in the Quichua language of Peru, but *ahua*, meaning "string" or "thread," *ahuani* to weave, *ahuac* a weaver, and many other terms of textile implication are of possible interest for comparison with Hawaiian words of similar sound and meaning.

The chief center of popularity for *majagua* as a plant name is in the West Indies. Oviedo, who appears to have written the first account of the plant in Santo Domingo, early in the sixteenth century, called it *demmahagua* and it is still called *demajagua* and *emahagua* in Porto Rico. In de la Maza's dictionary of native Cuban plant names the word *majagua* or its diminutive *majagüilla*, appears in nearly a score of Spanish combinations, *majagua azul*, *majagua blanca*, *majagua de costa*, *majagua hembra*, etc., in application to several genera of *Malvaceae* and *Tiliaceae*, which have fibrous barks, including Hibiscus, Thespesia, Pavonia, Helicteres, and Guazuma. The Porto Rican name of Thespesia is *maga* or *magar*, while *maya* and *maguey* are the native West Indian names of Bromelia and Agave, two other important groups of fiber plants. Several species of Ficus, also with fibrous barks, are called *gagüey*, *jagüey*, or *jagüeicillo*. In Porto Rico *yagua* is the name of the leathery, fibrous leaf-bases of the royal palm.

The list of Mexican plant names by Ramirez and Alcocer includes *majagua* as the name of *Hibiscus tiliaceus* and *Hampea integerrima*, and also *mahahua*, *masahua*, and *majagüilla*, as names of the maho or of Helicteres, Heliocarpus, and Thespesia.

Maho names collected by Pittier from seven of the native languages of Costa Rica apparently have no relation to the West Indian and South American series of maho words, as may be seen from the following list: Bribri, *stsá;* Brunka, *kró-kua*, or *krók-ua;* Térraba, *kip-kuó* and *tro-kró;* Dorasque Gualaca, *kis;* Dorasque Chánguina, *i-lak;* Cuna, *Chagua tupú;* Guaymi, *kó* and *kuá-tá*. Two more aberrant names, *choucoron* and *guimauve*, are listed in Van Wijk's *Dictionary of Plant Names*, probably from Guiana.

OTHER PLANTS CALLED MAHOE IN AMERICA

Among the plants that share the name, or that have been confused locally with the *maho* elsewhere in the West Indies are *Thespesia populnea*, *Hibiscus clypeatus*, and *Sterculia caribaea*. In French Guiana and Brazil the names *mahoe cochon*, *mahaguo* *de playa* and *mahaujo* are applied respectively to *Sterculia pruriens*, *Helicteres baruensis*, and *Muntingia calabura*. The last is called *majaguilla* in Venezuela, according to Ernst, who also gives *mijagua* as a name of *Anacardium rhinocarpus*. Gomez de la Maza gives *macagua* as a Cuban name of *Pseudolmedia* and *majagüin* for Pavonia. All these trees have fibrous barks that can be used for the same purposes as the maho bark. Muntingia is very widely distributed and may be considered as replacing the maho in the drier or more elevated regions of tropical America. A Quichua name for tough-barked trees is *p-hancho* or *pjancho*. Muntingia is called *ccarapjancho* in the lower Urubamba Valley, while a species of Heliocarpus is known as *llaosapjancho*.

From Colombia the names *mamagua* and *maragua* have been recorded by Pittier,[2] in relation to another fibrous-barked tree of the mulberry family, *Inophlocum armatum*. In Costa Rica and Panama, according to Pittier, the name *majagua* is not applied especially to the maho tree or its bark, but to any kind of tough bark that can be used for tying. Yet *majagüita* is given as the Costa Rican name of *Pavonia dasypetala*, a plant that furnishes a very tough fiber used by the Indians.

NAMES OF THE MAHO IN POLYNESIA

The tendency in many of the island languages is to suppress the consonants and reduce words to monosyllables, but when the simplified Polynesian names of the maho (*mao*, *mau*, *au*, *hau*, *fau*, and *vau*, are brought together, the essential unity of the series is apparent. For the tree itself the nearest approach in Polynesia to American forms of the name is *moaua*, recorded from Easter Island, or *marau*, from New Guinea, but *mahu*, *mahui*, *mahoe*, *mahaga*, *mahini*, *mahae*, *maoa*, *maharo*, *mahore*, *magoe*, *mageo*, *malo*, and many similar words, relate to the operations of peeling, spreading, pounding, or rubbing the bark, to bark cloth, or to ropes, strings, or strips of bark used in tying or snaring, or in other ways that connect naturally with the maho.

[2] Journ. Wash. Acad. Sci. **6**: 114. 1916.

Although little can be inferred with confidence from single instances, the Polynesian maho vocabulary includes several rather prominent groups of words, as the examples will show. Many other words that may prove to be compounds or derivatives of maho names are to be found in the vocabularies of Tregear, Andrews, Pratt, and Churchill.

In suggesting that the Polynesian *hau* and *fau* probably came from a root meaning to "bind or tie up," Christian is in accord with a custom of philologists to deduce particular names from words of more general meaning, but primitive languages, though usually rich in specific names, may lack generic terms, which are a later development. Thus a language having many names for different kinds of spiders and different kinds of plants may still have no terms to include all spiders or all plants, so that such names as *spider-wort* or *bind-weed* are impossible. Even the Spanish could not have *bind-weed*, there being no proper equivalent of *weed*, as representing a class of plants that infest cultivated lands and interfere with the growth of crops.

The question whether *fau* refers primarily to the tree or to the act of using the bark is raised by Churchill:[3]

> In the utter absence of perspective in which these languages appear before us it would be idle to engage upon the attempt to discover whether in sense the tree or the act of using its bast is primordial. In the records before us the stem carries the tree sense without the verb in the Paumotu, the Marquesas, Nukuoro, and Aneityum; nowhere the verb where the noun does not designate a plant which yields a string.

It seems not impossible, however, that orientation in such matters may be improved by taking account of the origins, distributions, names, and uses of the agricultural and economic plants. Churchill has collected linguistic evidence of Polynesian migrations from west to east. That such migrations took place may also be inferred from the cultivation of Malayan and Asiatic plants in all of the islands, but the possession of American plants by the early Polynesian has also to be recognized and explained.

[3] Polynesian Wanderings, 328.

POLYNESIAN COGNATES RELATING TO FIBERS

That a root word associated with the idea of ying or binding may be very prolific in derived forms and meanings is apparent from such a series as our English band, bend, bind, bond, bound, boundary, bundle, etc. A more recently developed analogy is that of our word *wire*, now used not only as the name of fibers or cords made of metal, but also to designate the many different uses to which such material can be put, from fastening things together to sending telegrams. Corresponding series of words appear to have developed in the Pacific archipelagoes from such an original as *maho* or *mahagua*, in connection with each of the principal uses and activities connected with this tree.

In Hawaii *mahui* means to join, unite, adhere to, or imitate; *hoo-mau* is to tie on, or to fit, as sandals or shoes; *maunu*, anything that affords a hold on a person for purposes of witchcraft; *haua* and *kauhau*, to strike, to whip, chastise, or apply stripes; *auau*, a snare for catching and killing birds; *kau*, to catch, hang up, suspend; *kauo*, to drag or haul; *kaula*, a rope or strong cord, a tendon or bowstring. In Easter Island *mahetu* means twisted, like bark for rope; *mahani*, a habit, custom, or practice; and *hakamahani*, to tame, or keep tied, *haka* being a causative prefix; *hai* is to tie up; *hahai*, a package or bundle; *hahie*, firewood; *magoe* and *hahamageo*, to splice or tie together; and *hakamaga*, a roof, which primitive builders usually tie on with strips of bark. In Samoa *fau* is not only the name for the maho shrub and of string or bark used in tying, but is also the verb to tie, or to build by tying the timbers of a house together; *afauto* is the rope along the top of a fishing net; *fafau* is to lash on, to fasten with sinnet, as an adz to its handle, or an outrigger to a canoe; *faufau*, to fasten on, to tie together; *afaga*, the bandage put on the feet when climbing the coconut tree; *faufili*, a cord used by women to fasten on their burdens; and many other compounds given by Pratt.

Easter Island shares with Tonga and New Zealand such words as *mahaga*, *mehaga*, and *mahanga*, relating to nooses in ropes, snares, baits, or allurements for taking game or fish. A Samoan name for rope is *maea*, while *maa* is a sling in Tahiti. In Paumotu *maka* is a sling, *hakamau* is to thread, join, or assure; *fakamau*, to sustain; *mau*, solid or stable; *fakahau*, to reconcile, soothe, or conciliate; *hau*, to rule, reign, or surpass, superior, kingdom, government, order, peace; *haunoho*, to stay or sojourn; *meamau*, sure, safe; *mehara*, to remember, idea, disposition, sense; *mauri*, soul or mind.

POLYNESIAN COGNATES RELATING TO BARK CLOTH

Although the paper-mulberry appears in recent times to have been more prominent than the maho as a source of bark cloth, words relating to bark cloth indicate an earlier dominance of the maho. Three distinct classes of bark-cloth words may be recognized; the first referring to the peeling and spreading of the bark, the second to the beating of the bark to separate the woody material from the fibrous network, and the third class to the finished bark cloth and its uses.

Words of the first class are represented in Hawaii by *mahihi* and *mahole*, to peel off bark from a tree, and *mahola*, to spread out, but *mahole* also means to open wide, exhibit or display, and *maholo* carries such meanings as to inspect or approve, wonder, admiration, beautiful, glorious, or admirable. In Tahiti *mahae* means to tear. *Mahore*, in the dialect of the New Zealand Maoris, means peeled, while *mahora* means to spread out. In Easter Island *maharo* means to spread out, and also to flatter, admire, or glorify. In Paumotu *mahu* is to deliver; *mahoro*, miscarriage or abortion; *pahore*, to peel off or scale; *pahure*, to be skinned; *kihoe pahurehure*, to flay; *papahoro*, to slip; *pagore*, smooth or without hair on the body; *pahere*, to lop, to prune; *pakirotu*, a piece of wood for beating off bark. In Tahiti, according to Tregear, the word *pahere* means to pare off the rind, and in Mangareva *pahore* is to pare, or the peel taken off.

Among the prominent examples of the second class of maho words, those that relate to the beating, softening, and cleaning of the bark, is *hau*, in some islands the name of the tree, in some meaning to tie or unite, in others, to reconcile or rule. But in Hawaii, Tonga, and New Zealand *hau* or *hauhau* carries the idea of smiting, chopping, attacking, or conquering. *Wao* and *wau* are to scratch or to scrape. Of words more similar to *maho* or *mahagua*, Hawaii affords *maoha*, to rub or chafe; *mahaha*, soft and tough, also applied to a kind of fish and to a variety of taro; *maholehole*, bruised, crushed together; and *maua*, lame, sore, stiff, close or stingy. The Samoan word *maoa* means "to make a chopping or hammering sound," *vau*, *vavau*, and *valu*, to bruise, pound, scrape, grate, or rub down, as taro or arrowroot. In New Zealand, *mahoe* is a small mallet, said to be used for striking the tattooing chisel, but bark cloth was also beaten with mallets. In Paumotu *mihara* is to regret, rue, or repent; *maha*, to sooth; *mahaki* or *maehaki*, to slacken, abate, hinder, or soften; and *pahurehure*, a bruise or contusion. The Mangarevan *tahoa*, "to make papyrus by beating," is evidently connected with the Easter Islanders' *hahoa*, to cut, wound, or hurt.

The third class of bark-cloth words relates to the finished product and its uses. In Easter Island *mahututu* is "bast cloth in the last stages of composition." In Hawaii *aha*, *aho*, and *ahu* have numerous applications in connection with fibers, cords, and mats. *Ahu* in particular is a fine mat, *moena* a coarse mat, and *kapahau* "a fine species of *kapa*" made from the bark of *hau*. In Samoa *auafa* are "the fine mats constituting the wealth of a family;" *fauepa* is "to prepare the fine mats on which a dead chief is laid in state." In Paumotu *vauvau* means mat, rug, carpet, seat; *kaho* or *kao* is cloth or clothing; and *malo* a strip of bark cloth girded about the loins. *Pahorehore* in Paumotu is defined as to smooth out linen, but is similar to several words already mentioned in relation to the preparation of bark cloth.

POLYNESIAN COGNATES RELATING TO FIRE

The importance of the maho in relation to fire is reflected in the fact that the name for the tree in some of the archipelagoes, including Easter Island, is *purau*, that is, fire-*au*, while *tamau* is the word for tinder in Easter Island and Paumotu. A reduplicated form *purao-purau* is recorded from Paumotu; *pura* means phosphorescent; *purero*, to emit, issue, or appear; *purara*, to diverge or to spread a report, as analogous to the eventual breaking out of a hidden or smouldering fire.

In Samoa *mafu* is to burn, and many Polynesian and Malay words relating to fire might be considered as echoes of the use of the maho for fire-making. *Mahao* was a Hawaiian name for pith, or for soft, rotten wood. In Wallace's list of Malayan fire-names *aow* occurs several times, and is accompanied by many similar words, *aousa, hao, ahu, afu, yafu, yap,* and *api*, the last also being widely distributed. In Tahiti *aahi* is a rag, wick, or lint for use as tinder; while in Hawaii *ahu* or *aahu* is a bag in which fire materials were carried. Kindling fire by friction is the meaning of *hogi* and *ogi* in Paumotu, and the same islands have *vera, viru,* and *viku* as another group of words relating to fire, possibly connected with *veru* a name for cloth, through the use of rags as tinder.

The two sticks of *au* wood used in bringing fire by friction have separate names in Samoa, the stick with the groove *aunaki*, that held in the hand *aulima*, the latter name being applied also to the handle of a tool of any sort. *Siaga*, another Samoan name for "a large stationary stick used in rubbing fire," is like *siapo*, the Samoan name for bark cloth, and *sia* means "to get fire by rubbing one stick on another." A fire-stick is *kounati* in Mangareva and *kauati* in New Zealand, but in Paumotu *kauati* is to make fire by friction. The use of fire in clearing land or of sticks for digging may be reflected in such words as *mahi*, which in Hawaii means to dig the ground for the purpose of planting food. In Paumotu *ahu* means to transplant, and in New Zealand to cultivate. Other uses of the wood for carrying burdens and for floating outriggers of canoes, as mentioned by Darwin in Tahiti, are reflected in such words as *auamo* and *aumaka*, names for burden-sticks in Samoa; *auala*, the bier of a dead chief; *ama*, an outrigger in Samoa, Hawaii, and Paumotu; *aumafute*, the Samoan name of the wood of the paper-mulberry after the bark is stripped off; *mafuna*, meaning to peel off, also in Samoa. The buds and young shoots of the maho were eaten in times of scarcity by the natives of some of the islands, the living tissues being mucilaginous, like those of okra.

SYNONYMS OF MAHO WORDS

That other kinds of words, unlike *maho* or *mahagua*, share their meanings in some of the islands does not make the parallel series of maho words appear less significant. Other words for bark, skin, or cloth are *kiri*, *kere*, *kero*, *iri*, or *ere*, which may connect also with *gere*, to strip, and *goregore*, peel or rind, in Paumotu. *Kuku* or *tutu* is a widely distributed word for beating or preparing the bark, and in Samoa *tutu* also means to kindle fire. The principal word for bark cloth is *kapa* or *tapa*, which philologists have considered an imitation of the sound of beating the bark, and *tutu* could be derived in the same way.

In Samoa, where there are no k's, *siapo* is the principal name of bark cloth, made from the paper-mulberry, but *sema* is the name of "a red *siapo*," a color which may indicate maho-bark cloth. Bark cloth and fine mats were valuable property among the Samoans and had a collective name, *toga*, and *tolo* is another Samoan word for kindling fire by friction. Nets or cords to make them were called *kupenga* in New Zealand, *kupega* in Mangareva and Paumotu, and *hupena* in Hawaii, the last a curious approximation to the Greek *hyphaino*, to weave, and *hypha*, a thread.

The mallet for beating cloth is called *ike*, *eike*, or *ie*, and similar words mean to strike, defend, choose, select, or send. In addition to this *ike* the Paumotu people have *iku*, to rub, rasp, or to file; *ika*, to make fire by friction of wood; *rotika*, fire; *roroni*, to twist or wring; *rori*, to strangle with a cord; *rorirori*, pliant, flexible, or supple; *rore*, seductive or deluding. In Maori, *rore* is a snare, according to Tregear. The series may belong with the maho words, to which it runs closely parallel.

DERIVATIVE PLANT NAMES IN POLYNESIA

That the maho was an ancient possession of the island people is also to be inferred from the borrowing of its name for other plants, including three prominent cultivated species that undoubtedly were natives of Asia or the Malay region. From the manner of naming these plants it appears that the islanders must have had previous acquaintance with the maho. In Fiji, according to Seemann, the maho is called *vaudina*, meaning the genuine *vau*, to distinguish it from several other plants called *vau*.

THE NAME OF THE PAPER-MULBERRY

One of the Polynesian namesakes of the maho is the paper-mulberry tree, called in many islands *maute* or *aute*, in Hawaii *waoke*, *wauke*, or *kawauke*, in Mangareva *eute* or *ute*. A practical reason for considering the paper-mulberry a kind of *au* (the suffix *te* meaning another kind) is that it yields bark cloth, and of a finer quality than the maho. In many of the early accounts of the islands the paper-mulberry appears more prominent than the maho, though now it is seldom cultivated and on the heavily forested islands is becoming extinct, as noted by Cheeseman in Rarotonga. It is not a strictly tropical tree, being hardy in the United States, and often escaping from cultivation. It is supposed to be a native of Japan or China rather than of the Malay region. There is a slight resemblance to the maho in habits of growth and general appearance, adult trees having simple oval or cordate leaves, but on young plants and root-sprouts the leaves are deeply notched and divided.

Other names that may belong to the paper-mulberry are *roga* in Paumotu and *roa* in Tahiti, which suggest *toga*, the Samoan name for collections of bark cloth and fine mats. These were valued as property and used as a medium of exchange. The paper-mulberry was also called *tutuga* in Samoa, and a second growth of paper-mulberry *tuapipi*. Seemann gives *ai masi* and *malo* as the native names of the paper-mulberry in Fiji, but *Ficus scabra* is also called *ai masi*, with the explanation that *masi* is derived from a verb *masia*, meaning to scour.

THE NAME OF THE ROSE OF CHINA

The Polynesians also applied the name *aute* to the "rose of China," *Hibiscus rosa sinensis*. In Rarotonga, according to Cheeseman, the maho is *au*, the paper-mulberry *aute*, and Chinese rose *kaute*. Though not at all similar to the paper-mulberry and not used for bark cloth, the rose of China is a close relative of the maho, with the same kind of large showy flowers which render it a favorite garden shrub among the Polynesians. It was as natural that the rose of China should be called *aute* on account of its flowers as the paper-mulberry on account of its bark, but almost inconceivable that either of the two plants called *aute* should have been named directly from the other. Two Fijian names of the rose of China, *senitoa* or *seniciobia*, show no resemblance to the Polynesian names.

NAMES OF THE SCREW-PINES

Another prominent plant with a name that may have been borrowed from the maho is the Pandanus, or screw-pine, called by the Hawaiians *hala* or *halau* and by the Samoans *fala*, names that may be understood as *hau*-leaf or *fau*-leaf, and that appear proper enough when we take into account the fact that the long narrow leaves of the Pandanus are rich in fiber, and were woven or braided into mats or used in other ways like the bark of the maho or paper-mulberry. From Fiji Seemann reports *voivoi* as a native name of *Pandanus caricosus*, the species that is cultivated for the sake of its fine fiber, and *vaku vaku* for *Freycinetia milnei*, a screw-pine with edible fruit. Another name for Pandanus, possibly cognate with *maho*, is *tima*, in Paumotu, where *mau* means thread or to join. *Timau* may be analogous to *maute*, the name of the paper-mulberry in Easter Island, and is also similar to *tamau*, the word for tinder in Easter Island.

OTHER POLYNESIAN PLANTS WITH MAHO NAMES

In addition to these prominent species, maho names are applied in Polynesia to several other trees or shrubs Thus among the New Zealanders, who did not have the true maho, one of the indigenous trees (*Melicytus ramiflorus*) is called *mahoe*, and the same word is used, according to Tregear, for "a small mallet used for striking the tattooing chisel." *Mahoewai* is another New Zealand tree name, which also means "to spread out," while *mahore* means "peeled."

The Samoans give the name *faupata* to a native plant, *Cypholopus macrocephalus*, related to ramie, used for weaving fine mats of a sort called *je sina,* second only to the kind called *je toga,* which are made from Pandanus leaves. A Samoan species of *Trama* is called *fau ui, fau uta* is another plant name, *fauatagaloa* is "a species of indigenous cotton," and *ma'o* is the "collective name of several trees." One tree is called *ma'oui* and another *mafoa.*

In Hawaii, *mau-a* and *ma'ua* are recorded as plant names, the former as a timber tree and the latter as food in times of scarcity, as also stated of *kemau,* which may refer to the same plant. *Mao* and *hulu hulu* are given by Watt as Hawaiian names of a native wild cotton (*Gossypium tomentosum*). Cotton and okra are called *vau vau* in Fiji, referring no doubt to the fact that these plants resemble the *vau,* this being the Fijian name of the maho. Another close relative of the maho is *Thespesia populnea,* called *mulo mulo* in Fiji, *milo* or *miro* in Samoa. It was considered a sacred tree in Tahiti, and called *toromiro.* In Mangareva *koumiro* is a name of the cotton plant. Cheeseman records a species of Grewia as *auere* in Rarotonga, where *au* is the maho. Another possible cognate is *mamaki,* recorded as the Hawaiian name of a special kind of bark cloth made from *Pipturus albidus,* a bush related to the ramie plant.

Some of the figs or banyan trees of Polynesia also furnished bark cloth and their names may be modified maho-words. In Rarotonga, according to Cheeseman, *aoa* is the name of *Ficus prolixa,* a tree planted to mark boundaries, and as the source of a coarse kind of bark cloth. In Tahiti also *aoa* refers to one of the fig trees and to bark cloth made from it. *Aoa, aofafine,* and *aotane* are names of the banyan and other fig trees in Samoa. *Giliau* and *kiliau* are given by Christian as names of the banyan tree in some of the Caroline Islands, where the maho is called *gili fau.* Another species, *Ficus tinctoria,* is called *mati* in Rarotonga and *matti* in Tahiti, names possibly equivalent to *maute* or *aute,* and suggestive also of names of some of the large wild fig trees in Central America, *amate* in Guatemala, and *chilamate* in Costa Rica. In Rheede's *Hortus Malabaricus* two species of figs are called *atty alu* and *ittyalu.*

Still another bark-cloth tree is *Antiaris bennetti,* called *maru* in Fiji and *mami* in some of the other islands, according to

Seemann. Even the breadfruit tree has a fibrous bark and is sometimes used to make bark cloth. One of several names for breadfruit is *mai*, which could be considered a variant of *mâu*, as *fai* replaces *fau* in some of the islands.

Maho words also appear to be used in the general sense of bush or woods, maho thickets being the only forest on some of the smaller islands. Thus in Samoa *la'au* is tree, timber, or firewood; *vao* is bush, *vai vau*, unoccupied land between two villages, and *vaomaoa*, the forest. In Hawaii *wao* is "a wild place," while *mahakea* is jungle or uncultivated land. In the Quichua language of Peru *mahiska* means abandoned and *mahini* to go wild.

MAHO NAMES OF THE WESTERN PACIFIC

In many of the Micronesian islands the names of the maho are compound words, *kili fau*, *kini fau*, *gili fau*, *gili fai*, *giri fai*, *gini fai*, probably meaning bark-*fau*, to distinguish from the other applications of the word. Christian states that in Ponape the maho is called *kalau*, while in another island *kalaua* means bark. In Yap the name of the maho is *kal*. In the Paumotu also *kiri* means bark or cloth, equivalent to *ere* among the Hawaiians, and to *iri*, meaning skin.

Christian gives *pa* and *pe* from two of the Caroline Islands. In Siam *po* is a name for a related fibrous-barked shrub, *Hibiscus macrophyllus*. In China *ma* is an ancient name for hemp, represented in writing by an independent radical which appears in many compound names of other plants.

It may be doubted whether names like *vahu*, *balibago*, and *pago*, used in Fiji, the Philippine Islands, and Guam, also belong to the *maho* series, but relation seems possible in view of intermediate Polynesian forms like *bago*, crooked, *faga*, to bend, and *haga*, to form or to build. In addition to the more prominent Tagalog name *balibágo*, Merrill's *Dictionary of the Native Plant Names of the Philippine Islands* gives *balabágo*, *malabago*, *malabayo*, and *raquíndi*, with numerous variants or compounds of *bali* and *bago* as names of other plants. Names reported from Madagascar and neighboring islands, *baro*, *foulsapate*, *var*, *varo*, *vau*, *vaur*, appear to connect with the Malay and Polynesian series. Van

Wijk also gives *eronoré* as a Gaboon name, the maho being reported from a few localities in West Africa. Three distinct names are recorded by Schumann and Lauterbach in German New Guinea, *daua*, *marau*, and *papalan*, and another form in the Solomon Islands, *dakatako*.

A wide-spread Asiatic name is *bellipata* or *bellipatta*, which has been reported from Singapore, Ceylon, and Bombay. Several other oriental names, *baniá bariá*, *baru*, *beligobel*, *bola*, *bourao*, *chelwa*, *lo*, *surihagas*, *suringas*, *thengben*, and *thingban*, are listed in Watt's *Dictionary of the Economic Products of India*, or in Van Wijk's *Dictionary of Plant Names*. Some of these names probably were borrowed from other fiber-producing species of Hibiscus, several of which are natives of India. The name *pariti* adopted by Adanson from Rheede's *Flora Malabarica*, published in 1686, was also used in the native language to form compound names of several species of Hibiscus and Gossypium.

Many other maho names exist, no doubt, in the languages of Borneo, New Guinea, and other parts of the East Indies, as well as in Tropical America, but these are not likely to alter the general contrast between the very wide distribution of the words that connect with maho or mahagua and the very local distribution of the others.

SUMMARY

The maho, mahagua, or linden hibiscus (*Pariti tiliaceum*) is one of the economic plants to be taken into account in studying the problem of contacts between the inhabitants of tropical America and the Pacific islands, in prehistoric times. Though considered a native of America, the maho appears to have been distributed over the islands and shores of the Pacific and Indian oceans before the arrival of Europeans.

Readiness of propagation and of transportation by cuttings renders this plant well adapted for cultivation and dissemination by primitive peoples. Although human assistance in transportation does not appear to be so definitely required with the maho as with the sweet potato and other plants that are grown from only cuttings, the names of the maho afford almost as definite indications of human contacts as in the case of *kumara*, a name for sweet potato already known to have been shared by the Pacific Islanders with the Indians of Peru.

The name *maho* or *mahagua*, with numerous local variants, is widely distributed in tropical America and is closely approximated in many of the Pacific islands, in relation either to the plant itself or to its principal uses for fiber, bark cloth, and fire-making. While the genetic relationships of particular words or applications are to be considered as possible rather than as proved, the general coherence of names and uses would seem to justify a thorough philological investigation. One gains an impression of the language being formed *in situ*, as a reflection of familiar objects and activities in the minds of the islanders.

That the primitive Polynesians were in possession of the maho before they became acquainted with similar Asiatic plants may be inferred, in view of the indications that Polynesian names of other important cultivated plants—the paper-mulberry (Papyrius or Broussonetia), the rose of China (*Hibiscus rosa sinensis*), and the screw-pine (Pandanus)—were derived from names of the maho. The making of fire by friction of wood and of cloth by beating the bark of trees with grooved mallets are specialized arts which may have been carried with the maho from America across the tropical regions of the Old World. A plant that enabled primitive man to kindle fire and tie things together must be held to have contributed much to the arts of civilization.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Mining developments and water-power investigations in southeastern Alaska.* THEODORE CHAPIN, H. M. EAKIN and G. H. CANFIELD. U. S. Geological Survey Bulletin 662-B. Pp. 92, with maps, sections, and illustrations. 1917.

Contains short papers on the work of 1916, as follows: *Mining developments in the Ketchikan and Wrangell mining districts*, by THEODORE CHAPIN; *Lode mining in the Juneau gold belt,* by H. M. EAKIN; *Gold placer mining in the Porcupine district,* by H. M. EAKIN; *Water-power investigations in Southeastern Alaska,* by G. H. CANFIELD.

R. W. STONE.

GEOLOGY.—*Mineral springs of Alaska.* GERALD A. WARING, with a chapter on the *Quality of some surface waters,* by RICHARD B. DOLE and ALFRED A. CHAMBERS. U. S. Geological Survey Water-Supply Paper 418. Pp. 109, with 9 plates and 16 figures. 1917.

The report contains a preliminary chapter on the physiography and geology of Alaska by ALFRED H. BROOKS. The mineral springs are grouped for description into hot, carbonated, sulphur, iron, and salt springs, and individual mention is made of most of the 110 springs whose locations are shown on maps accompanying the report. Analyses of a number of the waters are given, and their characters are described briefly in relation to the rock formations through which they issue.

A number of the stream waters of the Territory were also analysed, and their characters are discussed in a separate chapter, by RICHARD B. DOLE and ALFRED A. CHAMBERS. G. A. W.

GEOLOGY.—*The Helderberg limestone of central Pennsylvania.* JOHN B. REESIDE, JR. U. S. Geological Survey Professional Paper 108-K. Pp. 41. 1917.

A study of seven localities in Pennsylvania leads to the following conclusions:

1. The Tonoloway limestone and the Keyser, Coeymans, and New Scotland members of the Helderberg limestone may be traced from Maryland through central Pennsylvania with their respective characteristic lithology and faunas, and the essential equivalents of all are to be found in New Jersey and eastern New York.

2. The Keyser member decreases in thickness northward from Maryland.

3. The Devonian elements in the fauna apparently decrease from Maryland to New Jersey and New York.

4. The suggestion of an unconformity at the top of the Keyser in Maryland is borne out in Pennsylvania by the variations in thickness of the member and the presence of arenaceous material at the base of the Coeymans. R. W. STONE.

GEOLOGY.—*Geologic structure in the Cushing oil and gas field, Oklahoma, and its relation to the oil, gas, and water.* CARL H. BEAL. U. S. Geological Survey Bulletin 658. Pp. 64, with maps, sections, and illustrations. 1917.

The geologic work done in the field has disclosed the following principal facts:

1. The folding of the formations in the Cushing field usually becomes greater with increase of depth, and there are many marked differences in structure among the Layton, Wheeler, and Bartlesville sands and the surface beds.

2. The interval between the Layton and Bartlesville sands is generally greater around the edges of the anticlines than on their crests.

3. The distribution of the bodies of oil, gas, and water indicates that the source of the oil lay west of the Cushing field.

4. In general the oil area in an elongated dome, where folding is simple, extends farther down on the long axes of the anticline or dome than on the steeper sides.

5. The water surfaces on which the oil and gas rest in the different sands are not level but are inclined away from the centers of the anticlinal folds. R. W. STONE.

GEOLOGY.—*The Palestine salt dome, Anderson County, Texas; The Brenham salt dome, Washington and Austin counties, Texas.* Oliver B. Hopkins. U. S. Geological Survey Bulletin 661-G. Pp. 28, with maps, sections, and illustration. 1917.

Viewed as a whole the Palestine dome is a quaquaversal fold on whose flanks are highly inclined beds that dip in all directions away from its center but become approximately horizontal within a few miles; the center of the uplift is extensively faulted, mainly in a northeasterly direction, producing an irregular distribution of the Cretaceous beds and a triplication of the outcrop of the Austin chalk.

Such an intensive and highly localized vertical uplift of quaquaversal form could be produced only by vertical thrust from below. The results observed are analogous to those produced by driving a punch into a sheet of cold steel: the effects are entirely local.

The peculiar local nature of salt domes may be due to the effect of dynamic activity at certain points along lines of deformation, aiding in the solution and transportation of salt, gypsum, etc., from deep-lying formations, probably Permian, to the position in which they are found.

The highly folded, faulted, and eroded condition of the Palestine dome and the general absence of oil and gas as surface seepages and in shallow wells in this area detract from its oil prospects.

The results of drilling for oil in the Brenham dome have been discouraging, except that they have demonstrated the presence of a salt dome. Suggestions are given regarding further drilling at this dome.

R. W. Stone.

GEOLOGY.—*Oil and gas possibilities of the Hatchetigbee anticline, Alabama.* Oliver B. Hopkins. U. S. Geological Survey Bulletin 661-H. Pp. 33, with maps, sections, and illustrations. 1917.

The geological examination of the area shows that a broad, low anticline, the Hatchetigbee anticline, extends from a point north of Jackson, Ala., northwestward across Tombigbee River to the Alabama-Mississippi state line and beyond; that the disturbance of the earth's crust which produced this fold also produced a fault, the Jackson fault; that the Hatchetigbee anticline has in general stronger dips on its southwestern slope than on its northeastern; that two areas along the crest of the fold are particularly favorable, structurally, for the accumulation of oil and gas, and other areas along the crest of the fold and along the east side of the Jackson fault are also favorable; that the best chances for accumulations of oil are probably in the sands above and below the Selma chalk, which lies from 780 to 2700 feet below the surface along the crest of the anticline; and finally that there are doubtless other areas of favorable structure in the adjoining region where oil and gas may have accumulated if they are present in commercial quantities anywhere in the region.

R. W. Stone

ORNITHOLOGY.—*Washington region [April and May, 1917].* Harry C. Oberholser. Bird-Lore **19**: 211–212. 1917.

The months of April and May, 1917, were unusually cold at Washington, D. C., and the resultant spring migration of birds was peculiar. Many species of migrants that appeared in April were ahead of their usual schedule, but many that came in May were very much delayed. A number of birds rare in the District of Columbia, at least during spring, made their appearance, chiefly in May. Conspicuous among these were *Phalacrocorax auritus auritus*, *Larus atricilla*, *Chlidonias nigra surinamensis*, *Hydroprogne caspia*, *Phloeotomus pileatus abieticola*, *Pisobia fuscicollis*, and *Protonotaria citrea*. H. C. O.

ORNITHOLOGY.—*Description of a new subspecies of* Perisoreus obscurus. Harry C. Oberholser. Proc. Biol. Soc. Washington **30**: 185–188. December 1, 1917.

A new geographic race of the Oregon jay is here described as *Perisoreus obscurus rathbuni*, from Clallam County, Washington. It is darker than either *Perisoreus obscurus obscurus* or *Perisoreus obscurus griseus*, and much more grayish above than the former, with a usually broader whitish nuchal collar. Its geographic distribution is apparently limited to that part of the State of Washington about Puget Sound and the Strait of Juan de Fuca. H. C. O.

ORNITHOLOGY.—*A review of the subspecies of the Leach Petrel* (Oceanodroma leucorhoa (*Vieillot*). Harry C. Oberholser. Proc. U. S. Nat. Mus. **54**: 165–172. October 19, 1917.

Notwithstanding the considerable attention that has been paid to the petrels of the *Oceanodroma leucorhoa* group, there is evidently something yet to learn concerning these birds. A study of the entire species, with extensive material, leads to the conclusion that three forms are recognizable: *Oceanodroma leucorhoa leucorhoa* (Vieillot), which breeds in the North Atlantic and North Pacific Ocean; *Oceanodroma leucorhoa beali* Emerson, which breeds from southeastern Alaska to the coast of northern California; and *Oceanodroma leucorhoa kaedingi* Anthony, which occurs off the Pacific coast of Lower California, south to the Revillagigedo Islands, western Mexico. Of these three forms only the first and third are currently considered valid. Furthermore, *Oceanodroma leucorhoa kaedingi* has hitherto been treated as a species, whereas it is but a subspecies of *Oceanodroma leucorhoa*. H. C. O.

ORNITHOLOGY.—*A new subspecies of* Geothlypis beldingi. HARRY C. OBERHOLSER. The Condor **19**: 182–184. December 7, 1917.

A very distinct subspecies of the Belding yellow-throat is here described as *Geothlypis beldingi goldmani*, from San Ignacio, Lower California. It differs from *Geothlypis beldingi beldingi* in its much duller and less yellowish upper parts, whitish instead of yellowish area on the crown behind the black mask, and more restricted yellow of lower surface. Its breeding range is confined to central Lower California, although a single specimen indicates its wintering in the Cape San Lucas region. H. C. O.

ORNITHOLOGY.—*A remarkable martin roost in the city of Washington.* HARRY C. OBERHOLSER. Bird-Lore **19**: 315–317. December 1, 1917.

Although late summer roosts of the purple martin are by no means uncommon in the eastern United States, there is apparently no record of a martin roost in the District of Columbia prior to 1917. During the latter part of the summer of this year great numbers of the purple martin (*Progne subis subis*) gathered nightly in the Mall, along Fourth Street, where they roosted in the trees along the street-car line. The birds were first noted here on August 5 and continued nightly to resort to this roost until September 9. The number of birds ranged from about 2500 to about 12,000, but the usual number was between 7000 and 8000. They assembled daily about 25 or 30 minutes before sunset and were all at rest in the trees by from 12 to 30 minutes after sunset. Their evolutions during this period were of much interest. During the martin occupation this roost regularly housed also between 100 and 500 European starlings (*Sturnus vulgaris vulgaris*), from 1000 to 4000 purple grackles (*Quiscalus quiscula quiscula*); also, on a few days, a number of bank swallows (*Riparia riparia riparia*) and rough-winged swallows (*Stelgidopteryx serripennis serripennis*). H. C. O.

ORNITHOLOGY.—*Notes on North American birds. III.* HARRY C. OBERHOLSER. The Auk **34**: 465–470. October, 1917.

This paper contains technical notes on two genera and three species. The genus *Bannermania* Mathews and Iredale, recently proposed for the reception of *Oceanodroma hornbyi* (Gray), proves on examination of further material to be invalid, since the characters given in the original diagnosis are not constant. The name of the species should therefore remain *Oceanodroma hornbyi*.

The subgenus *Cymochorea* Coues, recently raised to generic rank by Mathews and Iredale, seems not to be worthy of this elevation. A careful examination of the species of *Oceanodroma* discloses the fact that there are no constant structural differences between them, and that consequently all must be included in the same genus. In view of this, *Cymochorea* Coues can be considered of nothing more than subgeneric rank.

A new subspecies of booby (*Sula dactylatra californica*), recently described by Dr. Walter Rothschild from San Benedicto Island, in the Revillagigedo group, western Mexico, although said to be from California, has apparently never been taken within the confines of that State, and therefore must be excluded from the list of North American birds.

The name *Fregata aquila* Linnaeus, currently applied to the North American frigate bird, has been shown by Mathews to be applicable only to the bird of Ascension Island in the South Atlantic Ocean. The frigate birds of North America now prove to belong to two other species: that of the West Indies and southeastern United States being *Fregata magnificens rothschildi* Mathews, and the Pacific bird, *Fregata minor palmerstoni* (Gmelin).

The name *Strix wapacuthu* Gmelin, recently revived for the Arctic horned owl (the *Bubo arcticus* of Swainson), is now shown, as contended previously by Mr. Brewster, to be applicable only to *Nyctea nyctea*, and thus unavailable for the other species, which should therefore still be called *Bubo virginianus subarcticus* Hoy. H. C. O.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The meeting of the Board of Managers on February 18, 1918, was devoted chiefly to the discussion and amendment of the report of a special committee on membership policy. The Board adopted rules for the guidance of the Committee on Membership, limiting the resident membership of the ACADEMY to 20 per cent of the active scientific population of Washington, as represented by the number of names in the "Red Book" (the biennial directory of the ACADEMY and its affiliated societies). The requirements for admission to membership, which are stated only in general terms in the By-Laws of the ACADEMY, were more exactly defined by the Board; the principal qualifications adopted is that "the nominee shall have attained recognition for original and meritorious scientific investigation."

ROBERT B. SOSMAN, *Corresponding Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 578th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, January 26, 1918; called to order at 8 p.m. by President ROSE; 62 persons present.

On recommendation of the Council, J. B. NORTON and S. F. BLAKE, both of the Department of Agriculture, were elected to membership.

On recommendation of the Council a proposed amendment to the constitution was announced by which members of the Society might become life members upon the payment of fifty dollars in two annual installments of twenty-five dollars each.

Under the heading brief notes and exhibition of specimens the following informal communications were presented:

A. WETMORE remarked on food habits of grackle with reference to eating and cracking pin-oak acorns, the peculiar structure of the bill of the genus *Quisqualus* being specially adapted for this purpose. This was discussed by Messrs. PAUL BARTSCH, VERNON BAILEY, and F. V. COVILLE.

A. S. HITCHCOCK called attention to a recently issued flora of the Rocky Mountains by P. A. Rydberg, in which 6600 species of plants of that region are described.

PAUL BARTSCH referred to a recently received collection of Philippine shells from the island of Luzon, containing an unusually large number of new forms.

L. O. HOWARD referred to the utilization of acorns for the manufacture of alcohol.

W. L. McAtee described the behavior of ducks, geese, bitterns, jacksnipe, and kingfishers in North Carolina during the recent continued cold weather; the kingfishers' activities being confined to the vicinity of spring holes.

The regular program of the evening was as follows:

Emerson Stringham: *Notes on the speed of fishes, especially the alewife.* Mr. Stringham said the question of the speed with which fish swim has elements which, it would seem, might make it popular, but there appear to be few recorded observations. It becomes of economic importance in connection with the effect of water power development on the fisheries.

Three preliminary points should be mentioned. In the first place some fish, besides swimming, are able to jump from the water and by this means pass over a current which it would be wholly impossible for them to swim through; we are not concerned here with that question. Secondly, it is assumed that if a fish can maintain itself against a steady current of so many miles an hour, it can swim the same number of miles an hour in still water. Thirdly the velocity of a stream is much less at the bottom or behind obstacles than at surface.

A Belgian engineer (G. Denil), while studying fishways, concluded that the salmon could swim at a speed of 3.15 meters a second for at least 14 meters. The author also refers to similar figures given by a French engineer. In a report on the obstructed condition of the Frazer River published in the Report of the British Columbia Commissioner of Fisheries for 1913, the author (G. P. Napier) expresses the opinion that the limiting velocity of a steady stream up which a sockeye salmon is apparently capable of swimming a very short distance lies between six and seven miles an hour. Mr. H. von Bayer, of the Bureau of Fisheries, published a paper on fishways in 1910, in which he said that the current velocity in fishways should not exceed 10 feet per second. It is remarkable that the three figures, which appear to be independent of each other, are almost identical. The Belgian estimate is about 6.9 miles an hour, the Canadian's is 6 to 7 miles an hour and the American's is 6.8 miles an hour.

In the spring of 1917 Mr. Stringham had an opportunity to study several fishways in Massachusetts, and to make some observations on the velocities of water up which the fish swam. These fish belonged to the species *Pomolobus pseudoharengus* (Wilson), one of the common alewives. The instrument used to measure the velocity of the water was a Price current meter lent by the Bureau of Standards. Measurements were made of the rate of flow at 7 points in the fishway where the current appeared to be greatest, and it was found to vary from 4 to 5 feet per second. At Middleboro the fish were unable to ascend a little sloping falls where the velocity was about 11 feet per second. Just below they were swimming through one place where the current was 5.3 feet per second. At East Warham the head of water, and therefore the velocity could be varied. The fish swam up a slope about 3 feet long where the water was going down at rates of 6.1, 7.8, and even 9.8 feet per second. They were perfectly helpless when it was raised to 13.5 feet per second.

These figures show that for a few feet at least this species can swim through water flowing about 10 feet per second. That is the same figure suggested for the salmon by two different investigators and is the limit suggested for fishways by a third.

The paper was discussed by WILLIAM PALMER, A. N. CAUDELL, VERNON BAILEY, PAUL BARTSCH, H. M. SMITH, E. A. GOLDMAN, and R. W. SHUFELDT.

W. E. SAFFORD: *Natural history of Paradise Key, Florida.*

Mr. Safford's paper was illustrated by numerous lantern slides and is to be published in the Annual Report of the Smithsonian Institution.

M. W. LYON, JR., *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 309th regular meeting of the Society was held at the Saengerbund Hall, January 4, 1918; called to order by President SASSCER; 26 members and 10 visitors were present.

A resolution was adopted providing for a permanent entertainment fund to be administered by an Entertainment Committee appointed by the Executive Committee.

Articles III (Members) and VII (Fees) of the Constitution were amended.

The regular program consisted of the address of the retiring President, Prof. C. R. ELY, upon *Recent entomological chemistry.* This interesting review of literature called forth considerable discussion, participated in by Messrs. MIDDLETON, SASSCER, G. G. AINSLIE, WOGLUM, BAKER, WOOD, and BISHOP.

At the close of this discussion the Society was entertained by some brief remarks from two of our visitors, Prof. A. L. LOVETT, of the Oregon Agricultural College, and Mr. R. H. ALLEN, of Massachusetts.

Mr. PAINE exhibited some interesting photographs made under artificial light.

The 310th meeting of the Society was held at the Cosmos Club, February 7, 1918; called to order by the PRESIDENT; 29 members and 9 visitors were present.

The annual report of corresponding-secretary-treasurer was accepted. The corresponding secretary announced the following changes in the publication of the Proceedings: The Proceedings will appear in nine numbers per year instead of four, and will carry advertising. The cover will be printed on the same kind of paper as the text, the seal omitted, and in the space now occupied by the seal will appear the table of contents. Each page will carry a running head which will constitute a complete citation, and the printing of the list of members present at meetings as well as all business transacted at the meetings will be discontinued. Other minor changes looking to the improvement of the publication will also be made.

Dr. CARLOS F. PORTER, of Santiago, Chile, and Mr. ROBERT M. FOUTS, of Washington, D. C., were elected to membership.

The regular program was as follows:

C. L. MARLATT: *Notes on the work of the Federal Horticultural Board.* Mr. Marlatt gave a very comprehensive account of the organization, purposes, and scope of the services of the Board.

In discussing Mr. Marlatt's remarks, Dr. L. O. HOWARD gave a very interesting account of the events and causes which led to the passage of the Plant Quarantine Act.

CARL HEINRICK: *On the Lepidopterous Genus Apostega and its larval affinities.* The author illustrated his remarks with a number of charts and drawings. This communication drew forth considerable discussion, participated in by Messrs. MCINDOO, PIERCE, ROHWER, BAKER, BOVING, CRAIGHEAD, and HYSLOP.

Under the head of short notes:

Dr. HOWARD announced the recent death of an early member of the Society, Mr. CHAS. R. DODGE. Mr. SCHWARZ also gave a few reminiscences of Mr. Dodge.

Mr. SNYDER called attention to a recent article entitled *Origin of castes in termites* by Dr. C. B. Thompson, of Wellesley College, published in the *Journal of Morphology.* Mr. Snyder spoke very highly of the paper, as did also Messrs. BAKER and HOWARD.

Mr. SNODGRASS expressed his pleasure at the evident interest manifested and progress being made in the study of insect anatomy. Messrs. HOWARD, CAUDELL, and CRAIGHEAD gave additional remarks along the same line.

Dr. T. J. HEADLEY, of New Jersey, responded to the president's invitation to address the Society by giving some interesting reminiscences from his experiences.

Mr. J. G. SANDERS, of Harrisburg, Pennsylvania, responding to a similar invitation, gave an interesting account of some of his experiences since leaving the Bureau of Entomology to go to Wisconsin and later to Pennsylvania. He gave an especially interesting account of some recent researches in Pennsylvania on the life history of the Angoumois grain moth.

A. B. GAHAN, *Recording Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 799th meeting was held at the Cosmos Club, January 19, 1918, with President BURGESS in the chair. There were 45 persons present.

Mr. E. T. WHERRY presented a paper on *Certain relations between optical properties and crystal form, and their bearing on the question of "crystal molecules" in organic compounds.* The refractive indices of several simple organic compounds have been determined by the immersion method, and their values substituted in the Lorentz formula connecting refractive index and density. The "refraction ratio," or ratio of the several values obtained for each substance, has been compared with the crystallographic axial ratio in each case. In some substances, as urea and iodoform, the two sets of values show exact inverse proportionality, and it is concluded that this indicates that the number of pinacoidal planes in the two crystallographic directions in the crystal molecule, or unit cell of the space lattice, is the same. Others, like oxalic acid, show inverse proportionality in two directions but not in the third, although in the latter a simple integral relation exists. It is concluded that in these the crystal molecule contains different numbers of planes in some directions than in others. In acetamide, which is dimorphous, the planes show somewhat greater divergence in the unstable than in the stable form, suggesting that there is a tendency toward equalization of the number of planes. From these data it is possible to draw conclusions as to the types of space-lattices represented in these substances, without the necessity of submitting them to examination by X-rays.

Discussion: The paper was discussed by Messrs. MERWIN, WHITE, SOSMAN, and BICHOWSKI.

A paper by W. F. MEGGERS and C. G. PETERS on *The refractive index and optical dispersion of air,* was presented by Mr. PETERS. This paper was illustrated by lantern slides. A survey of previous researches on refraction of air shows that most investigators have worked either with white light or with one monochromatic radiation, and dispersion measurements have been limited to a small interval of the spectrum. No index measurements exist for waves longer than those corresponding to orange light, and in the ultra-violet the dispersion formulas disagree by more than 10 per cent of the index of refraction.

Recent work in spectroscopy makes it very desirable to have more accurate and extensive data on the index of refraction and dispersion of air. The international system of standard wave length measurements made under other conditions require small corrections because of the effect of temperature and pressure of the air upon its optical dispersion. Furthermore, it is often desirable to multiply wave lengths measured in air by the indices of refraction of air for these wave lengths and thus convert them to their value in vacuum. An accuracy of one part in several millions is now striven for in the measurement of wave lengths, and to maintain their relative accuracy in the reduction to vacuum values it is necessary to know the indices of refraction to about one unit in the seventh decimal place.

For several years the Bureau of Standards has been engaged in the accurate measurement of wave lengths. Interferometer comparison of wave lengths have been made throughout a large range of spectra and the grating spectra of more than fifty of the chemical elements have been photographed and measured in the red and infra-red spectral regions. In connection with these accurate measurements of wave lengths, it was thought advisable to measure the absolute indices of refraction of air for the entire spectra region that is accessible to photography.

Accuracy and efficiency recommended the use of a interferometer of the Fabry and Perot type for this work, since this apparatus can be conveniently enclosed in a chamber in which the temperature and pressure of the air can be regulated as desired, and it also permits simultaneous observations for a large number of different wave lengths. Sections of the circular fringes, produced by various radiations from a source of light illuminating the parallel plates of the interferometer, were photographed either with a grating or a prism spectrograph, first when the space between the plates was evacuated and then when dry air at measured temperature and pressure was present.

The index of refraction of air for a particular wave length was obtained directly from measurements of the photographed interference fringes, which allowed the ratio of lengths of this wave in vacuum and in air to be calculated. Observations were made at spectrum intervals of about 40 *A* from the extreme ultra-violet at 2200 *A*, through the visible spectrum and into the infra-red to 9000 *A*.

Complete sets of observations were made on dry air at atmospheric pressure and at temperatures of 0°C., 15°C., and 30°C. These are quite well represented by the following dispersion formulae:

$$(n - 1)_0 \times 10^7 = 2875.66 + \frac{13.412}{\lambda^2 \times 10^8} + \frac{0.3777}{\lambda^4 \times 10^{16}}$$

$$(n - 1)_{15} \times 10^7 = 2726.43 + \frac{12.288}{\lambda^2 \times 10^8} + \frac{0.3555}{\lambda^4 \times 10^{16}}$$

$$(n - 1)_{30} \times 10^7 = 2589.72 + \frac{12.259}{\lambda^2 \times 10^8} + \frac{0.2576}{\lambda^4 \times 10^{16}}$$

The coefficient of index variation with temperature was found from these observations to be a function of the wave length. For long waves this optical temperature coefficient is identical with the density temperature coefficient, i.e., $\frac{1}{273}$, but as the ultra-violet absorption band is approached it increases rapidly, becoming $\frac{1}{258}$ at 2500 *A*.

Discussion: This paper was discussed by Messrs. BURGESS, SWANN, CRITTENDEN, and MEGGERS.

The third paper, on *Barometric ripples*, was presented by W. J. HUMPHREYS. This paper was illustrated by lantern slides. Small pressure changes, amplitude usually 0.1 to 0.3 mm. and period of 5 to 10 minutes, and continuing for hours or even days together, are very common during cold weather.

As first demonstrated by Helmholtz, whenever layers of air that differ in density at their interface flow over each other, long billows, analogous to gravity water waves, are produced, which conform, approximately, to the equation

$$d_1 (u - V)^2 + d_2 (V - v)^2 = \frac{g\lambda (d_2 - d_1)}{2\pi}$$

in which V is the velocity of wave propagation, d_1 and d_2 the densities of the layers whose velocities are u and v respectively, g the gravity acceleration, and λ the wave length. If, now, the under layer is colder than the upper, as often happens during winter, and rather shallow, 100 meters to 500 meters thick, say, the passage of the air billows, like the passage of waves in shallow water, necessarily produces greater or less corresponding changes in the pressure on the bottom layer changes that appear as a series of ripples in the record of a sensitive barograph. Furthermore, such shallow air billows, like shallow water waves, doubtless are turbulent—a condition that accounts, presumably, for the surprisingly rough flying the aviator often experiences during winter at low levels (300 meters and less).

During summer when air billows rarely form near the surface, though frequently at greater altitudes, especially that of the cirrus cloud, barometric ripples and shallow turbulences of the kind just mentioned seldom occur. This, doubtless, is because wave disturbances in air as in water do not penetrate far beneath the wave level.

Discussion: Mr. LITTLEHALES called attention to the fact that where there are two layers of water of different density, waves frequently occur at the interface that separates the two water layers and yet no waves are visible on the surface. These waves at times are sufficient to impede the progress of vessels. The paper was further discussed by Messrs. WHITE, BURGESS, SWEET, BUCKINGHAM, and SOSMAN.

H. L. CURTIS, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Honorary Advisory Council for Scientific and Industrial Research of Canada visited Washington on February 25–28. The Council is considering plans for the encouragement of scientific research in Canada, and spent some days in consultation with members of the National Research Council, and in visiting the scientific bureaus of the Government. The visiting members were: Professor A. B. Macallum, of the University of Toronto, (chairman); Professor S. F. Kirkpatrick, of Queen's University, Kingston; Professor R. F. Ruttan and Professor F. D. Adams, of McGill University, Montreal; President A. S. Mackenzie, of Dalhousie University, Halifax; Mr. Arthur Surveyer, of Montreal; Mr. J. B. Challies, of the Water Power Branch, Department of the Interior, Ottawa, (Honorary Secretary of the Council).

Professor C. A. Kofoid, of the Department of Zoology, University of California, has been commissioned a major in the Sanitary Corps of the National Army, and is stationed at the Department Laboratory, Fort Sam Houston, San Antonio, Texas.

Major R. A. Millikan, member of the National Research Council and Chief of the Science and Research Division of the Signal Corps, has been commissioned a Lieutenant Colonel in the Signal Corps.

In honor of the appointment of Dr. J. W. Fewkes as Chief of the Bureau of American Ethnology, a complimentary luncheon was tendered to him and Mrs. Fewkes at the Smithsonian Institution on Friday, March 1, 1918. Every member of the staff and all the employees of the Bureau were present. At the close of the luncheon Dr. Fewkes made a brief address, recalling the high traditions of the Bureau of Ethnology and outlining plans for its further development. The primary objects of ethnologic research in this country were defined by Dr. Fewkes as, *Man in America,—where did he come from, how long has he been here, and what has he been doing since he came?* Short speeches were made by members of the Bureau, the first speaker being Mr. James Mooney, who noted that the study of ethnology tends to bind the whole human race together by securing a better understanding of mankind.

The following persons have become members of the Academy since the last issue of the Journal: Mr. Lon A. Hawkins, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.; Dr. Oscar Riddle, Department of Experimental Evolution of the Carnegie Institution of Washington, Cold Spring Harbor, Long Island, New York; Mr. Erskine Douglas Williamson, Geophysical Laboratory of the Carnegie Institution of Washington, Washington, D. C.

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GEOCHEMISTRY.—*Note on the inorganic constituents of two small crustaceans.*[1] F. W. Clarke and B. Salkover, Geological Survey.

It is well known that very small crustaceans, such as the copepods, form an important part of the marine plankton, and that they serve as food for larger animals, like the fishes and cetaceans. The larger crustaceans all have shells or skeletons which contain much calcium phosphate, and a comparison of the two classes seemed to be a matter of some interest. Accordingly two samples, each made up of hundreds of individuals, were obtained from the U. S. National Museum and subjected to partial analysis. They were as follows:

1. *Temora longicornis* (O. F. Müller), from the coast of New England. Weight of dried sample, 0.6105 gram. A copepod.

2. *Thysanoessa inermis* (Kroyer), from Balena, Newfoundland. Weight of dried sample, 1.5973 grams. A small shrimp.

As the amount of material was insufficient for a thorough analysis, only three determinations were made on each sample. They were: loss on ignition, mainly organic matter and water; phosphoric oxide; and residue insoluble in acid. The phosphoric oxide, P_2O_5, was recalculated into the form of tricalcic phosphate, $Ca_3P_2O_8$, and with that adjustment the analyses assume the following shape.

[1] Published by permission of the Director of the U. S. Geological Survey.

	1	2
Loss on ignition	96.05	92.08
Tricalcic phosphate	2.77	7.68
Insoluble	0.92	0.22
	99.74	99.98

These analyses show that the inorganic matter of these minute creatures consists almost entirely of calcium phosphate, although more refined analyses on larger quantities of material would doubtless show small percentages of other things. So far, however, it seems that these very small organisms effect what is perhaps a primary concentration of the traces of phosphorus that exist in sea water, and so, as food for the larger animals, they furnish the material from which the skeletons of marine vertebrates are built. It is a familiar fact that vertebrate skeletons consist largely, although not exclusively, of calcium phosphate.

GEOLOGY.—*Correlation of the deposits of Jackson and Vicksburg ages in Mississippi and Alabama.*[1] CHARLES WYTHE COOKE, Geological Survey.

The deposits of Jackson and Vicksburg ages in Alabama are usually referred to a single formation, the "St. Stephens limestone," although many writers have pointed out differences between the upper and the lower parts. Smith and Johnson[2] divided the "St. Stephens limestone" into three members which correspond roughly to the major divisions adopted in this paper, and incomplete studies in western Alabama led Vaughan[3] to the opinion that more detailed investigation would differentiate the Jackson from the Vicksburg.

This paper summarizes the results of field studies on the stratigraphy and paleontology of the "St. Stephens limestone"

[1] Published by permission of the directors of the U. S. Geological Survey and the Mississippi Geological Survey.

[2] SMITH, E. A., and JOHNSON, L. C., U. S. Geol. Survey Bull. 43: 20. 1887.

[3] VAUGHAN, T. W., U. S. Geol. Survey Prof. Paper 71: 738, 739. 1912.

made in 1913 and 1914 for the U. S. Geological Survey. It contains also a synopsis of a manuscript report on the Jackson formation and the Vicksburg group in Mississippi prepared in partial fulfilment of an agreement between the U. S. Geological Survey and the Mississippi Geological Survey for a coöperative investigation of the physiography, stratigraphy, and ground waters of Mississippi. The correlations and names adopted are shown in Table 1.

TABLE 1

Correlation of the Jackson and Vicksburg deposits in Mississippi and Alabama

<table>
<tr><th>Age</th><th colspan="4">Mississippi</th><th>Alabama</th></tr>
<tr><td rowspan="4">Oligocene</td><td rowspan="4">Vicksburg group</td><td colspan="4">BYRAM CALCAREOUS MARL</td></tr>
<tr><td rowspan="2">MARIANNA LIMESTONE</td><td colspan="2">Glendon limestone member</td><td rowspan="3">MARIANNA LIMESTONE</td></tr>
<tr><td>Mint Spring calcareous marl member</td><td rowspan="2">"Chimney Rock" facies</td></tr>
<tr><td>FOREST HILL SAND</td><td>RED BLUFF CLAY</td></tr>
<tr><td>Eocene</td><td>JACKSON FORMATION</td><td colspan="3">Yazoo clay member
Moodys calcareous marl member</td><td>OCALA LIMESTONE</td></tr>
</table>

JACKSON FORMATION

In Mississippi, Lowe[4] has divided the Jackson deposits into formations described by him as Yazoo clay marl, Moodys Branch green marl, and Madison sands. The last of these, which was doubtfully placed in the Jackson by Lowe, is here referred to the Vicksburg group and will be discussed later. The other two intergrade so much that it seems advisable to consider them members of a single formation rather than as constituting independent formations. In the succeeding discussion they are

[4] Lowe, E. N., Mississippi, its Geology, Geography, Soils, and Mineral Resources. Mississippi Geol. Survey Bull. 12: 78–84. 1915.

called the Yazoo clay member and the Moodys calcareous marl member of the Jackson formation, of which the Yazoo clay is the upper and the Moodys marl the lower member. Although the typical exposures of the Yazoo clay are in the bluff of Yazoo River at Yazoo City, Mississippi, both of these members crop out in the vicinity of Jackson, Mississippi, where their relative stratigraphic position is evident. The Moodys calcareous marl member is named from Moodys Branch, a small tributary of Pearl River within the city limits of Jackson.

The Jackson formation in Mississippi is composed chiefly of more or less calcareous clay and less prominent sand and marl beds. At Jackson and Garland's Creek, the Moodys marl member contains at the base a bed of shells inclosed in quartz sand and glauconite and merges below into lignitic clay and sand supposed to be of upper Claiborne age (Yegua formation). Toward the top, the Moodys member is less sandy and much more calcareous and contains thin beds of indurated marl or impure limestone. Although these ledges of marlstone are discontinuous, the zone in which they are found extends from Yazoo River to western Alabama, where it has been called the "*Zeuglodon* bed."[5] The Yazoo clay member consists almost entirely of calcareous, very plastic clay of various colors, but in most places blue or green when wet but gray when dry.

The thickness of the Jackson formation varies considerably from place to place. In general, the Moodys marl thins from east to west and the Yazoo clay thickens rapidly in the same direction. In central and western Mississippi, its thickness does not much exceed 35 or 40 feet, but farther east, owing to the interpolation of beds of sand and clay, it is materially greater. In Alabama, a few miles east of the Mississippi state line, the equivalents of the Moodys marl are more than 90 feet thick. The Yazoo clay member is thickest in the extreme western part of Mississippi, where well borings south of Vicksburg indicate a thickness of nearly 600 feet, and thins rapidly toward the east.

[5] Schuchert, Charles, U. S. Nat. Mus. Proc. **23**: 329. 1900; Cooke, C. W., U. S. Geol. Survey Prof. Paper 95: 116. 1915.

In the vicinity of Jackson the Yazoo clay probably does not exceed 200 feet in thickness; at Shubuta it is reduced to 70 feet; and in western Alabama it becomes of negligible thickness and merges with the underlying member. The aggregate thickness of the Jackson formation appears to be about 600 feet in western Mississippi, about 230 feet at Jackson, and about 150 feet at Shubuta.

In Choctaw and Washington counties, Alabama, and in the adjacent part of Mississippi, the stratigraphy of the Jackson is somewhat different. The formation divides naturally into five lithologic units, as follows:

Subdivisions of the Jackson formation in western Alabama and eastern Mississippi

	feet
5. Yazoo clay member: Greenish gray calcareous clay with white calcareous concretions	8–50
4. "*Zeuglodon* bed.": Buff argillaceous marl with hard ledges. *Terebratulina lachryma*, *Aturia alabamensis*,[6] *Ostrea trigonalis*, *O. falco*, *Pecten perplanus*, *Schizaster armiger*, *Basilosaurus cetoides*	8–15
3. Fine yellow sand with indurated lumps in the upper part. Well exposed at Cocoa, Alabama	11–70
2. Greenish yellow, calcareous, very plastic clay	30–50
1. Hard yellow or brown impure limestone or indurated marl with *Periarchus lyelli* or *P. pileus-sinensis* and *Pecten perplanus*	0–15

Division 1 of this generalized section appears to be largely identical with the "*Scutella* bed" which Smith[7] doubtfully referred to the "St. Stephens limestone." In a section at Willow Branch[8] I drew the Claiborne-Jackson line at the top of an attenuated remnant of this bed, and Hopkins[9] accepted this correlation. My reasons for referring this bed to the Jackson are the following: (1) *Pecten perplanus* and *Periarchus pileus-sinensis*, species elsewhere restricted to deposits of Jackson age,

[6] I am probably to blame for the slip of the pen which caused Hopkins to list *Belosepia ungula* instead of *Aturia alabamensis* in the "*Zeuglodon* bed" (U. S. Geological Survey Bull. 661-H: 296. 1917). Fortunately, I attached the correct name to the specimen figured by him on plate 27.

[7] Smith, E. A., Johnson, L. C., and Langdon, D. W., Report on the Geology of the Coastal Plain of Alabama. Alabama Geol. Survey, p. 111. 1894.

[8] Cooke, C. W., *The age of the Ocala limestone*. U. S. Geol. Survey Prof. Paper 95: 115. 1915.

[9] Hopkins, O. B., *Oil and gas possibilities of the Hatchetigbee anticline, Alabama*. U. S. Geol. Survey Bull. 661-H: 294, 297. 1917.

have been found in it at some places; (2) it is the first calcareous bed of a series dominantly calcareous and succeeds noncalcareous sands; (3) at Willow Branch and one or two other places there is evidence strongly suggestive of unconformity between this bed and the underlying Gosport sand.

The other four divisions are the same as those described by Hopkins[10] and need no further comment here. Sections illustrating them are given by Hopkins and Cooke in the papers cited.

The Jackson formation contains a large marine fauna. From Jackson, Mississippi, I have listed 200 species of mollusks and Vaughan has identified 12 species of corals; of these, about 49 are survivals from the Claiborne and about 15 are supposed to have lived also in Vicksburg time. Canu and Bassler[11] list 67 species of Bryozoa from Jackson, of which 15 are known from the Claiborne group and 9 from the Vicksburg. The commonest and most significant vertebrate is *Basilosaurus cetoides*.

OCALA LIMESTONE

East of Tombigbee River a rather abrupt change is noticeable in the stratigraphy of the deposits of Jackson age. The beds become progressively more calcareous, lose their individuality, and assume more and more the lithologic and faunal aspects of the Ocala limestone of Florida. In some places a dual division of these beds may be distinguished, but it is not everywhere possible to draw a sharp line of demarkation between the upper and the lower members. The lower part consists chiefly of very argillaceous and somewhat glauconitic limestone, and on Sepulga River the approximate position of the yellow sand at Cocoa (division 3 of the generalized section) is occupied by calcareous sandstone. The upper part, corresponding to the "*Zeuglodon* bed" and the Yazoo clay, consists of soft, cream-colored, amorphous limestone which closely resembles the "chimney rock" of the overlying Marianna limestone.

[10] Op. cit., 296.

[11] Canu, Ferdinand, and Bassler, R. S., *Manuscript list of Eocene and Oligocene Cheilostome Bryozoa.*

As the upper Eocene limestone of southeastern Alabama is continuous with the Ocala limestone of Florida and southwestern Georgia and does not differ materially from it in lithology or in fossils, the name Ocala limestone is extended to all of the deposits of Jackson age in that part of the state, but future more detailed field work may show the propriety of restricting the name Ocala to the upper part of the formation. Just where the boundary between the Ocala limestone and the Jackson formation should be drawn is a matter of expediency, for the transition area, although narrow, is without definite natural limits. Either the Tombigbee River or the 88th meridian might conveniently be selected.

VICKSBURG GROUP

In Mississippi the Vicksburg group falls naturally into three divisions, the upper, middle, and lower Vicksburg, which differ from one another in both lithology and fossils. The first of these, which corresponds to the "Higher Vicksburgian" of Meyer[12] and to the "Upper Vicksburgian" of Casey,[13] is herein named Byram calcareous marl; for the second, which is approximately equivalent to the "Middle and Lower Vicksburgian" of Meyer and to the "Lower Vicksburgian" of Casey, the name Marianna limestone, already in use in Florida, is available; the third includes two facies, a shallow-water or nonmarine facies in western Mississippi, which will be called the Forest Hill sand, and a marine facies in eastern Mississippi and western Alabama known as the Red Bluff clay. In the middle division, or Marianna, two subdivisions are recognized, herein named Mint Spring calcareous marl member and Glendon[14] limestone member. East of Clarke County, Alabama, the middle and lower Vicksburg are similar lithologically and are both included in the Marianna limestone.

[12] Meyer, Otto, Amer. Journ. Sci., 2d. ser., **30**: 71. 1885.

[13] Casey, T. L., Philadelphia Acad. Nat. Sci. Proc. **53**: 515. 1901.

[14] The name Glendon limestone has been adopted, with my consent, by O. B. Hopkins (U. S. Geol. Survey Bull. 661-H. 1917) who had access to my notes and manuscripts.

FOREST HILL SAND

The name Forest Hill sand (from Forest Hill, $5\frac{1}{2}$ miles southwest of Jackson, Mississippi) replaces the "Madison sands" of Lowe,[15] which name is preoccupied. The Forest Hill sand appears to rest conformably upon the Yazoo clay member of the Jackson formation. Although the character of the sediments indicates a change from marine to very shallow water or palustrine conditions at the close of Jackson time, it is probable that the change was gradual and that deposition was nearly continuous. The Forest Hill is overlain conformably by the Mint Spring marl member of the Marianna limestone. The relations of the Forest Hill to the Red Bluff clay are not definitely known, but it is believed that the two were formed contemporaneously, the latter having been deposited under more strictly marine conditions than the Forest Hill sand.

In the type area, the Forest Hill sand consists chiefly of cross-bedded or laminated, more or less ferruginous, silicious sand and some clay.[16] West of this area, the formation becomes more argillaceous and contains lenses of lignite and lignitic clay.

In Warren and southern Yazoo counties, the Forest Hill sand is estimated to be about 60 or 70 feet thick, and at Forest Hill it is between 50 and 60 feet thick.

Petrified wood, leaves, and other plant remains are common in the Forest Hill sand, but recognizable forms are not abundant. No animal remains have been found in the formation.

The Forest Hill sand crops out along the bluff from Vicksburg northward to within a few miles of Satartia. Exposures are numerous in eastern Hinds County and in Rankin County as far east as Rankin. Outliers of the Vicksburg group in Madison County afford good exposures of the Forest Hill sand. Southeast of Rankin the country has not been explored in sufficient detail to determine the extent of the formation in that

[15] LOWE, E. N., Op. cit., 82.

[16] A section at Forest Hill School has been published by O. B. Hopkins (U. S. Geol. Survey Bull. 641–D: 100. 1916). I consider the lower 7 beds of his section as typical Forest Hill sand and refer the upper 6 beds to the Marianna limestone.

direction, but lignitic clays that are tentatively referred to the Forest Hill have been observed at a number of places in Smith County.

RED BLUFF CLAY

Fossiliferous deposits on Chickasawhay River at Red Bluff, 1½ miles below Shubuta, were first noted by Harper[17] in 1857. Three years later they were called the Red Bluff group by Hilgard, who correctly announced that their stratigraphic position lies between the Jackson and typical Vicksburg strata and that their fossils are more closely related to those of the Vicksburg than to those of the Jackson.[18]

Wherever the contact of the Red Bluff clay with the underlying Jackson has been observed, the two appear to be conformable. The upper limits of the formation are less well known, but there seems to be no break between it and the Marianna limestone. As the formation has not been traced west of Wayne County, its relations to the Forest Hill sand are conjectural, but it is believed that the two were approximately contemporaneous in origin and that the Red Bluff clay represents the marine equivalent of the exceedingly shallow water deposits of the Forest Hill sand in the Mississippi Embayment. The formation extends eastward into Alabama but rapidly thins, becomes calcareous, and merges laterally into the Marianna limestone.

The Red Bluff consists chiefly of stiff blue or greenish gypseous clay, but contains also discontinuous ledges of indurated marl or sandstone and a thin bed of shell marl. On Buccatunna Creek the formation is 70 feet thick.

The Red Bluff fauna includes more than 128 mollusks, 6 corals, and a considerable number of Bryozoa. Of the 134 species listed from Mississippi, about 60 appear to be restricted to the Red Bluff beds; about 55 are present in the Mint Spring marl or have varieties there; and about 49 species or varieties are known in the Byram marl, of these species 10 have not yet

[17] HARPER, L., Preliminary Report on the Geology and Agriculture of the State of Mississippi, p. 142. 1857.

[18] HILGARD, E. W., Report on the Geology and Agriculture of the State of Mississippi, p. 136. 1860.

been found in the Mint Spring marl. Twelve mollusks, 3 of which range through the Vicksburg group, are listed also from the Jackson formation, but some of these are characterless species of supposedly very long range.

MARIANNA LIMESTONE

The name Marianna limestone was given by Matson and Clapp[19] in 1909 to the soft, porous, light-gray to white limestones at Marianna and other places in western Florida "which are characterized by an abundance of *Orbitoides mantelli* and other Foraminifera associated with many other fossils, prominent among which are *Pecten poulsoni* and *P. perplanus*."[20] The last named species has since been found to be restricted to underlying Eocene strata[21] and was referred to the Marianna limestone by mistake.

The Marianna limestone was included in the Vicksburg group by Matson and Clapp, by whom it was regarded as the stratigraphic equivalent of the upper part of the bluff at Vicksburg (Byram marl). It was later found to lie conformably upon the Ocala limestone,[22] which had been thought to be the highest formation of the Vicksburg group.

The typical Marianna limestone is very homogeneous, white or cream-colored, and when first quarried is so soft that it is easily sawed into building blocks which harden on exposure. Because of its extensive use for building chimneys, it is popularly known as "chimney rock." This facies of the Marianna limestone extends with remarkable uniformity from Marianna, Florida, nearly to Pearl River, Mississippi. It is characterized nearly everywhere by a great profusion of Bryozoa and an abundance of *Lepidocyclina mantelli*, *Pecten poulsoni*, and

[19] Matson, G. C., and Clapp, F. G., *A preliminary report on the geology of Florida:* Second Ann. Rept. Florida Geol. Survey, p. 51. 1909.

[20] Idem, 52.

[21] Not having seen the type of *Pecten perplanus*, I am accepting as correct the species so named in the collection of the U. S. National Museum and described by Dr. Dall (*Tertiary Fauna of Florida*, p. 732). Hopkins has figured a specimen on plate 27, in U. S. Geol. Survey Bull. 661-H.

[22] Cooke, C. W., *The age of the Ocala limestone.* U. S. Geol. Survey Prof. Paper 95: 109. 1915.

Clypeaster rogersi. From a thickness of 74 feet at St. Stephens Bluff, Alabama, the "chimney rock" thins to about 45 or 50 feet on Chickasawhay River, Mississippi, and to about 20 feet in the neighborhood of Brandon, Mississippi.

Glendon limestone member. Overlying the "chimney rock" and conformable with it is a series of ledges of hard, partly crystalline, yellowish or pinkish limestone interbedded with softer strata of impure limestone composed largely of Bryozoa, Foraminifera, and shells of *Ostrea vicksburgensis* and *Pecten poulsoni.* This rock is distinguished from the other parts of the Marianna limestone mainly by its lithology, but a few species of organisms are restricted to it. At Glendon, Alabama, it is 18 or 20 feet thick and overlies 20 feet of "chimney rock."

The Glendon limestone extends from McGowans Bridge, Conecuh River, to Mississippi River at Vicksburg. It forms the hard ledges at the top of St. Stephens Bluff and the cap rock of several picturesque waterfalls near Vicksburg. Although it is in few places thicker than 20 feet, the Glendon limestone, because of its hardness, is the most conspicuous part of the Vicksburg group in Mississippi, to which it has given the undeserved reputation of being composed chiefly of limestone.

Mint Spring calcareous marl member. The "chimney rock" facies of the Marianna limestone is replaced in western Mississippi by sands and shell marls for which the name Mint Spring calcareous marl is here proposed. The name is derived from Mint Spring Bayou, a small stream entering Centennial Lake just south of the National Cemetery at Vicksburg. The strata to which the name is applied are exposed beneath a waterfall in the lower course of the stream.

Between Vicksburg and Pearl River the Mint Spring marl occupies the entire interval between the Forest Hill sand and the Glendon limestone, but east of Pearl River, it is overlain by a thickening wedge of the Marianna "chimney rock." It has not been recognized east of Chickasawhay River, on which it is exposed $1\frac{1}{4}$ miles northwest of the mouth of Limestone Creek. Other important exposures are along Glass Bayou at Vicksburg, and at Haynes Bluff, 14 miles north of Vicksburg, where it is 25 feet thick.

The list of species collected in the Mint Spring marl includes 160 mollusks and 3 corals. Of these, 81 occur also in the Byram marl, about 55 are found at Red Bluff or are represented there by varieties, and about 66 appear to be restricted to the Mint Spring marl.

BYRAM CALCAREOUS MARL

The type exposure of the Byram marl is in the bank of Pearl River at Byram, Hinds County, Mississippi. The Byram beds were supposed by Casey[23] to constitute a "sub-stage" intermediate in age between the Red Bluff clay and the Mint Spring marl, but more detailed study of the fauna shows that the marl at Byram is of the same age as the upper shell bed at Vicksburg. The formation consists chiefly of sandy glauconitic marl, but contains also thin beds of impure limestone, clay, and sand. At Vicksburg it is 42½ feet thick; on Chickasawhay River incomplete exposures indicate a thickness of at least 70 feet, but at intermediate places the exposed parts are much thinner.

Overlying the Glendon limestone at several localities in Alabama are beds of limestone, marl, and clay that appear to represent the Byram marl. Among these localities may be noted Paynes, Salt Mountain, Gainestown, and Choctaw Bluff (which last I have not visited), in Clarke County; Castleberry, Conecuh County, and Yellow River at Watkins-Henderson bridge, Covington County. It is probable that at least part of the exposure at Natural Bridge, Walton County, Florida, represents the same horizon. The upper 60 feet or more of the section at Salt Mountain probably includes the Byram marl, but as the two species of corals in the limestone at the top are found elsewhere in deposits of Chattahoochee age[24] part of the section may be younger than the Byram. The Glendon limestone member and perhaps also part of the underlying "chimney rock" of the Marianna limestone are represented in the lower part of the

[23] Casey, T. L., Philadelphia Acad. Nat. Sci. Proc. **53**: 517–518. 1901.

[24] Vaughan, T. W., *Tertiary corals from Central America, Cuba, and Porto Rico.* U. S. Nat. Mus. Bull. 102 (in press).

section, all of which was included in the "Coral limestone" of Smith and Johnson.[25] The Salt Mountain section, which has been considerably disturbed by folding and faulting, deserves more critical study than it has yet received.

The Byram marl is the horizon from which Conrad obtained his typical Vicksburg fossils. The formation contains 6 corals and 136 species of mollusks, of which 81 occur also in the Mint Spring marl, 46 persisted from the Red Bluff clay (including 6 which have not been found in the Mint Spring marl), and 55 which appear to be peculiar to the Byram marl. One of the most widely distributed and abundant species is the little *Scapharca lesueuri* Dall, which appears to be restricted to this horizon. The recent discovery at Vicksburg of a coral which T. W. Vaughan[26] reports from the fossil coral reef at Bainbridge, Georgia, Tampa, Florida, and many places in the West Indies, suggests a closer correlation of the Oligocene chert of Flint River with the Byram marl than has hitherto been suspected.

OUTLINE OF GEOLOGIC HISTORY

The beginning of Jackson time was marked by a northward transgression of the sea which carried the marine fauna of the Moodys marl into areas in which swampy conditions had prevailed during upper Claiborne time. This transgression was most pronounced in the Mississippi Embayment where the marine Jackson fauna extended into Arkansas and where the Jackson flora has been recognized by Berry[27] 135 miles farther north than the northernmost recognized upper Claiborne of this area. The effects of this transgression are noticeable as far east as Alabama River and become prominent again in central Georgia, where marine deposits of Jackson age overlap all older Eocene and Cretaceous strata and rest upon the crystalline rocks of the Piedmont.[28]

[25] Smith, E. A., and Johnson, L. C., Tertiary and Cretaceous Strata of the Tuscaloosa, Tombigbee, and Alabama Rivers. U. S. Geol. Survey Bull. 43: 18–21. 1887.

[26] Op. cit.

[27] Berry, E. W., *Erosion intervals in the Eocene of the Mississippi Embayment.* U. S. Geol. Survey Prof. Paper 95: 81–82. 1915.

[28] Cooke, C. W., and Shearer, H. K., *Deposits of Claiborne and Jackson age in Georgia.* U. S. Geol. Survey Prof. Paper 120-C (in press).

In western Mississippi the close of Jackson time was followed by shoaling of the sea, attended by a southward recession of the strand line, in the course of which the lignitic beds and laminated and crossbedded sands of the Forest Hill were deposited. In eastern Mississippi and Alabama, however, the change from Eocene to Oligocene time was not accompanied by changes in physical conditions affecting materially the character of the sediments, for the clay of the upper Jackson and the limestones of the Ocala are succeeded by similar materials in the Red Bluff clay and the Marianna limestone.

While the lignites and crossbedded sands of the Forest Hill were forming in the west and the marine clays and marls of the Red Bluff were being deposited in the intermediate region, the calcareous sediments of the Marianna limestone were accumulating on the Floridian plateau and adjacent parts of Georgia and Alabama. As time went on the phase of deposition producing "chimney rock" progressed westward, and the Marianna limestone overlapped first the Red Bluffs beds and then part of the Mint Spring marl until it had reached the ninetieth meridian. Subsequently, nearly uniform conditions, attending the deposition of the Glendon limestone, prevailed across Mississippi and far into Alabama. Therefore, the Marianna limestone represents a longer time interval in the east, where it includes both the middle and the lower Vicksburg, than in the west, where it is restricted to the middle Vicksburg.

Deposition of the Byram marl appears to have succeeded without interruption that of the Glendon limestone, but the change in character of the sediments indicates a more plentiful supply of mud and sand.

The stratigraphic relations of the Byram marl to the overlying Catahoula sandstone are conjectural. At none of the places where the contact of the two formations has been seen, has any indubitable evidence of unconformity been observed, but at some localities, as near Waynesboro, Mississippi, the change in lithology is so abrupt as to suggest the probability of an interruption in deposition. At other places the transition is so gradual that deposition appears to have been continuous.

BOTANY.—*A new Anemia from Mexico.*[1] WILLIAM R. MAXON, National Museum.

The following new species is one of a number of interesting ferns in a collection received by the U. S. National Museum from Prof. C. Conzatti, of Oaxaca, Mexico, in 1917. At the suggestion of Professor Conzatti it is named as below in honor of his friend and fellow-collector, Dr. Emilio Makrinius.

Anemia makrinii Maxon, sp. nov.

Plants about 50 cm. high; rhizome short-creeping,d ensely clothed with turgid acicular septate dark brown hairs; fronds several, close, distichous, long-stipitate, the sterile and fertile ones nearly alike in size and proportion. Fertile fronds erect, 45–50 cm. long; stipe 25 cm. long, slender, dull stramineous from a dark base, narrowly sulcate laterally and ventrally in the upper part, deciduously blackish-fibrillose; sterile lamina deltoid, 18–25 cm. long, 12–16 cm. broad, acuminate, once pinnate, the rachis stramineous, deeply sulcate ventrally and laterally, glabrate; sterile pinnae 7 or 8 pairs, distant, oblique, straight or mostly falcate, the lowermost the largest, petiolate (4–10 mm.), 6–11 cm. long, 1.4–2 cm. broad, narrowly lance-oblong and long-acuminate or tapering gradually from near the base to a long-attenuate apex, the base subequilateral and broadly cuneate; succeeding pinnae gradually shorter and more oblique, the upper ones free or subsessile, much smaller than the conform or basally lobed terminal segment; costa medial, percurrent, prominent beneath, stramineous, sparsely fibrillose; veins free, very oblique, repeatedly dichotomous, close, prominulous (especially beneath), glabrous; margins faintly cartilaginous, serrate or in the outer part deeply biserrate, the teeth very oblique, nearly straight, flat, acutish; leaf tissue thin-herbaceous, dark green and somewhat iridescent above, paler beneath, glabrous; fertile pinnae ascending, 10–16 cm. long, about half the length of the sterile lamina, the panicle as long as the slender stalk or longer, flattish, 8–15 mm. broad, the lower and middle segments remote, petiolate; spores closely and rather sharply cristate-striate. Sterile fronds similar, but the stipe relatively shorter and the blade more narrowly triangular.

Type in the U. S. National Herbarium, no. 867444, collected at the Cafetal Nueva Esperanza, District of Pochutla, Oaxaca, Mexico, at an altitude of 800 meters, April 9, 1917, by Prof. C. Conzatti, Dr. B. P. Reko, and Dr. Emilio Makrinius (no. 3087). A second collection, received more recently from Dr. Reko, is from the Cafetal Calvario, Oaxaca, altitude 700 meters, September 30, 1917, *Reko* 3365.

[1] Published with the permission of the Secretary of the Smithsonian Institution.

Anemia makrinii belongs to the small group of species with distichous simply pinnate fronds with the basal pinnae fertile, of which *A. speciosa* Presl and *A. mexicana* Klotzsch are the only North American representatives. It resembles *A. speciosa* somewhat in its short fertile pinnae, but differs widely in its more numerous and narrower sterile pinnae, its thin-herbaceous (not rigidly coriaceous) leaf tissue, and in its prominulous veins, the veins of *A. speciosa* being distinctly impressed upon the upper surface. In the character of its leaf tissue it is near *A. mexicana*, but that species is characterized by having the pinnae subcordate-truncate at the base, or exciso-cuneate below, the veins fibrillose-hirtous beneath, and the fertile pinnae erect and invariably surpassing the sterile lamina of the fertile frond. *Anemia makrinii* differs noticeably from both in the flat, nearly straight teeth and only faintly cartilaginous margins of the sterile pinnae, the margins in the two related species being strongly cartilaginous and the teeth stoutish, very rigid, often concave, and curved or, in *A. speciosa*, commonly hamate.

The somewhat iridescent appearance of the upper surface of some of the sterile blades is an interesting character but one probably not of specific importance, as it is variable and tends to disappear. When present it gives the frond a singularly attractive aspect.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*Specific heat of liquid ammonia.* NATHAN S. OSBORNE and MILTON S. VAN DUSEN. Bureau of Standards Scientific Paper No. 313. Pp. 35. 1917.

By use of a calorimeter of the aneroid type specially designed for the peculiar conditions, the specific heat of saturated liquid ammonia has been determined throughout the temperature interval $-45°$ to $+45°$C.

Two distinct and independent methods were used, each of which avoids sources of error present in the other. The greatest difference between the mean results of both methods and the results of either method as represented by empirical equations is less than 1 part in 1000.

As a final result, the specific heat σ in joules per gram per degree centigrade, of liquid ammonia, kept saturated, at the temperature θ, is given in the range $-45°$ to $+45°$C. by the equation

$$\sigma = 3.1365 - 0.00057\,\theta + \frac{16.842}{\sqrt{133 - \theta}}$$

N. S. O.

PHYSICS.—*The latent heat of pressure variation of liquid ammonia.* NATHAN S. OSBORNE and MILTON S. VAN DUSEN. Bureau of Standards Scientific Paper No. 314. Pp. 51. 1917.

When a fluid undergoes a change of pressure, there occurs a transformation of energy into heat or vice versa, which results in a change of temperature of the substance unless a like amount of heat is abstracted or added. This change expressed as the heat so transformed per unit change of pressure will be called "latent heat of pressure variation." For most liquids under usual conditions of temperature and pressure this quantity, which depends on the thermal expansivity, is small compared with the other quantities of heat which are usually observed, but for liquid ammonia in the range -40 to $+40°C$. and corresponding saturated vapor pressures it is sufficiently large to be taken into account in calorimetric determinations of specific heat; and, in consequence, the measurements here described were made as a supplement to a series of such determinations in order to correlate measurements of specific heat of liquid ammonia made at constant pressure with others made under saturation conditions.

The latent heat of pressure variation has been determined in two ways, namely, by direct calorimetric observations and by computation from the expansivity, using for the latter two independent sources of experimental data. Thus, three independent determinations were obtained. N. S. O.

PHYSICS.—*Latent heat of vaporization of ammonia.* Nathan S. Osborne and Milton S. Van Dusen. Bureau of Standards Scientific Paper No. 315. Pp. 33. 1917.

Using a calorimeter of the aneroid type specially designed for the peculiar conditions, the latent heat of vaporization of ammonia has been determined throughout the temperature interval –42 to –52°C. A detailed description of the design and construction of the instrument has been given in a separate paper.[1] The results of each of 34 determinations agree with the mean result as expressed by means of an empirical equation within one part in 1000. An empirical equation was found that in addition to representing closely the results in the range of temperature covered experimentally also conforms to what is known about the behavior of substances in general when approaching the critical point.

As a final result the latent heat of vaporization of ammonia, that is, the heat required to convert saturated liquid into saturated vapor at constant temperature, in joules per gram, is expressed in the range –42 to –52°C. by the equation:

$$L = 137.91 \sqrt{133 - \theta} - 2.466 (133 - \theta)$$

If the latent heat of vaporization is expressed in calories$_{20}$ per gram, taking 1 calorie$_{20}$ = 4.183 joules, the equation becomes

$$L = 32.968 \sqrt{133 - \theta} - 0.5895 (133 - \theta)$$

Using the results obtained for the latent heat of vaporization of ammonia together with the specific heat of the saturated liquid, the specific heat of the saturated vapor has been computed for various temperatures and given in a table. N. S. O.

[1] Bulletin of the Bureau of Standards **14**: 133; Sci. Paper No. 301. 1917.

CHEMISTRY.—*The iodometric determination of sulfur dioxide and the sulfites.* JOHN B. FERGUSON. Journ. Amer. Chem. Soc. **39**: 364–371. March, 1917.

In this paper are presented and discussed the results of an investigation of the various iodometric methods for the determination of sulfur dioxide and the sulfites. The object of this investigation was threefold: (1) To ascertain the limitations of the existing methods and procedures; (2) to determine the important sources of error; (3) to develop, if necessary, procedures suitable for general application.

Sulfur dioxide. Of the methods considered, the excess iodine is suitable for the analysis of mixtures of either high or low sulfur-dioxide content; the Selby Smelter Commission method is suitable for mixtures of low sulfur-dioxide content; the Reich method gives only approximate results unless large samples are available; and the sulfite method must not be used without a correction factor. Two precautions are essential: (1) The gas sample must not come in contact with even a trace of moisture prior to reaching the absorbent; (2) the analyzing apparatus must be free from rubber connectors if mixtures containing 2 per cent or more of sulfur dioxide are to be analyzed; and rubber connectors would best be eliminated altogether. The excess iodine method is recommended.

Sulfites. In the Treadwell method errors due to the oxidation of the sulfite solution arise from various sources and to eliminate them the following procedure is recommended: The solid salt is dissolved directly in an excess of an iodine solution containing sufficient hydrochloric acid, and the excess iodine determined with thiosulfate.

J. B. F.

CHEMISTRY.—*The ternary system H_2O–K_2SiO_3–SiO_2.* GEORGE W. MOREY (Chemical Study) and C. N. FENNER (Microscopic Study). Journ. Amer. Chem. Soc. **39**: 1173–1229. June, 1917.

The ternary system H_2O–K_2SiO_3–SiO_2 has been studied over the temperature range 200° to over 1000°. The work comprises a determination of the composition and properties of the various stable solid phases which can coexist with solution and vapor within the above temperature range, of the composition of the solutions in equilibrium with the solid phases, of the change in composition of these solutions with temperature, and the approximate determination of the corresponding 3-phase pressures. The chief experimental method used was an adaptation of the "quenching" method so extensively used in the Geophysical Laboratory for the investigation of dry melts.

The following compounds occur: Silica, SiO_2; potassium hydrogen disilicate, $KHSi_2O_5$; potassium disilicate, $K_2Si_2O_5$; potassium disilicate monohydrate, $K_2Si_2O_5.H_2O$; potassium metasilicate, K_2SiO_3; potassium metasilicate hemihydrate, $K_2SiO_3.\frac{1}{2}H_2O$; and potassium metasilicate monohydrate, $K_2SiO_3.H_2O$.

The detailed results of the experiments are summarized in tables and also presented graphically by means of curves and photographs of solid models.

A short discussion of some of the theoretical considerations which govern the equilibrium relations in binary and ternary systems containing a volatile component is given and the proper use of the term "solubility" is discussed. G. W. M.

GEOLOGY.—*Geology of Massachusetts and Rhode Island.* B. K. Emerson. U. S. Geological Survey Bulletin No. 597. Pp. 289, with maps and illustrations. 1917.

This treatise, which is accompanied by a large geologic map of Massachusetts and Rhode Island embodying the latest information, describes in detail the distribution, character, and relation of the many varieties of sedimentary and igneous rocks exposed in these two States. R. W. Stone.

GEOLOGY.—*Anticlines in the southern part of the Big Horn Basin, Wyoming. A preliminary report on the occurrence of oil.* D. F. Hewett and C. T. Lupton. U. S. Geological Survey Bulletin No. 656. Pp. 192, with maps, sections, and illustrations. 1917.

This report gives information regarding 50 domes and anticlines in the south half of the Big Horn Basin, Wyo., and contains many structure contour maps.

The area described embraces some productive oil territory in Wyoming that is undeveloped but very promising. Besides the Greybull, Torchlight, and Grass Creek anticlines, which are already sufficiently developed to contribute largely to the production of oil in Wyoming, there are seven or more domes and anticlines in which oil or gas has been struck, but which are not yet sufficiently drilled to indicate their value as oil reservoirs. Thus 11 of the anticlines here described have already proved to be productive.

The probability that the remaining anticlines and domes described in this resort may contain oil or gas has been carefully considered by the authors, who have noted their form and prominence, their mutual relations, their positions in the basin, the formations exposed on their axes, and their similarity to like domes and anticlines that carry or do not carry oil or gas. So far as can now be determined from the surface indications, about half of these are considered promising, but the drill, which is the final test, may show that some of them are barren and that others which are now regarded as less promising may be productive. It is highly probable that half or more of the anticlines and domes here described constitute a large part of the most promising undeveloped oil territory in Wyoming. The Big Horn Basin seems to be destined to furnish a large contribution to the Nation's supply of high-grade oil.

R. W. Stone.

GEOLOGY.—*Louisiana clays, including results of tests made in the laboratory of the Bureau of Standards at Pittsburgh.* George Charlton Matson. U. S. Geological Survey Bulletin 660-E. Pp. 12, with maps and sections. 1917.

This paper shows the geographic and geologic distribution of Louisiana clays and includes 26 tests made by the Bureau of Standards showing the working and burning behavior.

R. W. Stone.

PETROLOGY.—*The problem of the anorthosites.* N. L. Bowen. Journ. Geol. **25**: 209–243. April–May, 1917.

Anorthosites are made up almost exclusively of the single mineral plagioclase and in virtue of this fact they present a very special problem in petrogenesis. The conception of the mutual solution of minerals of the magma and the lowering of melting temperature consequent thereon is no longer applicable. Yet anorthosites give no evidence of being abnormal in the matter of the temperature to which they have been raised; in other words, they give no evidence of having been raised to the temperature requisite to melt plagioclase. A possible alternative is that they may never have been molten as such and are formed simply by the collection of crystals from a complex melt, probably gabbroic magma. This possibility is in harmony with the expectations that grow out of experimental studies and for this reason a consideration of the likelihood that anorthosites have originated in the stated manner becomes imperative.

A discussion of the method whereby accumulation of plagioclase crystals might take place leads to the conclusion that the most promising method is the separation by gravity of the femic constituents from gabbroic magma while the plagioclase crystals, which are calcic bytownite, remain practically suspended. Then, at a later stage, when the liquid has become distinctly lighter, having attained diorite-syenite composition, the plagioclase crystals, which are now labradorite, accumulate by sinking and give masses of anorthosite, at the same time leaving the liquid out of which they settle of a syenitic or granitic composition.

Some of the consequences of this manner of origin of anorthosite are discussed.

A consideration of anorthosites with special reference to the Adirondack and Morin areas gives some reason for believing that anorthosites show the requisite characters. For the Adirondack area especially, evidence is adduced favoring the possibility that there anorthosite and syenite may still occupy the relative positions in which they were generated by the process outlined, the Adirondack complex being interpreted as a sheetlike mass with syenite above and anorthosite below.

Other monomineral rocks present essentially the same problem and are restricted in their occurrence in substantially the same manner if we consider especially those that approach most closely to the strictly one-mineral character. All of the monomineral rocks do occur, however, as dikes and dike-like masses in essentially contemporaneous, congeneric igneous rocks, a fact which may be interpreted as due to the intrusion of a heterogeneous, partly crystalline mass.

On the whole the inquiry gives considerable support to the belief that the monomineral rocks, of which the anorthosites are perhaps the most important representatives, are generated by the process of collection of crystals under the action of gravity.

N. L. B.

PETROLOGY.—*Adirondack intrusives.* N. L. Bowen. Journ. Geol. **25**: 509–512. Sept.–Oct., 1917.

A reply to criticism by Professor Cushing of certain statements relative to Adirondack structure occurring in the paper abstracted above.

N. L. B.

VOLCANOLOGY.—*Persistence of vents at Stromboli and its bearing on volcanic mechanism.* HENRY S. WASHINGTON. Bull. Geol. Soc. Amer. **28**: 249–278. March, 1917.

In August, 1914, six vents were active on the crater terrace of Stromboli. Examination of plans and illustrations in the literature (many of which are reproduced in the paper) shows that at least three of these vents have persisted in location as far back as 1768. Similarly, at Kilauea the main vent has persisted in location for about a century; and there is evidence of such persistence at some other volcanoes. This feature of volcanoes seems to have been previously unnoticed. Another notable feature of the Stromboli vents is that the oldest three of them open about 1000 meters above sea-level near the upper edge of a precipitous scarp of that height. An analogous situation is true of some of the vents at Etna and also of one or two of those of Kilauea.

In the discussion of these and other features it is shown that such vents can not have originated through explosive agencies; but that their formation, situation, persistence in location, and other features can best be explained by Daly's so-called "gas-fluxing hypothesis," which supposes a "blow-piping" of narrow, vertical vents through the superjacent rocks by hot gases derived from the magma in its reservoir below and kept hot by chemical interreactions. H. S. W.

ORNITHOLOGY.—*The migration of North American birds. 1. Five swallows.* HARRY C. OBERHOLSER. Bird-Lore **19**: 320–330. December 1, 1917.

In this article there are given tables of migration dates for both spring and fall, chiefly from the United States and Canada, of the five following species of swallows, together with the subspecies of each: *Petrochelidon lunifrons* (lege *albifrons*), *Iridoprocne bicolor*, *Tachycineta thalassina*, *Riparia riparia*, and *Stelgidopteryx serripennis*. The data given serve as an index to the migratory movements of these species, and include the average date of spring arrival, the earliest date of spring arrival, the average date of last one observed, and the latest date of last one observed, in autumn as well as in spring, together with a statement of the numbers of years of observation on which the averages are based. H. C. O.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The meeting of the Board of Managers on March 5, 1918, was devoted principally to the consideration of nominations and the election of new members. Plans for the development of the JOURNAL were discussed, and were referred to a committee consisting of Messrs. KNOPF, HRDLIČKA, and MAXON, to be reported on at a later meeting. The dues of members absent from the United States on military or naval duty were remitted.

Dr. WOODROW WILSON, The White House, Washington, D. C., was elected an honorary member of the ACADEMY in recognition of his contributions to economic and political history.

ROBERT B. SOSMAN, *Corresponding Secretary.*

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 520th meeting of the Society was held in the West Study Room of the Public Library, January 29, 1918, at 8 p.m. At this meeting Dr. LEO J. FRACHTENBERG made an address on *Poland and the Polish question.* (No abstract.)

The 521st meeting of the Society was held in the West Study Room of the Public Library, February 12, 1918, at 8 p.m. Dr. JOSEPH DUNN, of the Catholic University of America, was the speaker of the evening and presented an interesting paper on *Scotland.*

"The Scotch reached Scotland from Ireland and are not the descendants of Gaelic Celts who had been pushed north by a later (British) invasion of Britain. The first authentic information on Scotland dates from the time of the Romans, 79 A.D. Roman rule in Britain came to an end in 410, and Britain then ceased to be a part of the Roman Empire. The population of Scotland is made up of Pictish, Irish, British, Saxon, Danish, and Norman elements, all of them Indo-Celtic, the three first, Celtic, the three last, Germanic peoples. The Picts contributed the bulk of the population, but were overcome by the Scotti (Irish), who had settled in Dalriada, a part of the present county of Argyle (Airer-Goidel, 'Margo Scottorum'). The Scotti then became the dominant people. Brythonic Celts dwelt in Strathclyde; their chief city was Dumbarton (Dun Brettan, 'Fort of the Britons'). Towards the close of the eighth century, the Danes appeared and ravaged the coast settlements and the isles. The Saxons first appeared in 428 in Britain. In the eleventh century Norman refugees first crossed the border into Scotland.

"The first Irish colonization in Scotland took place toward the end of the second century, but the kingdom of Dalriada was not effected until the close of the fifth. It is these Scotti who have given their name to Scotland. The relations between the two countries was very close and lasted for a thousand years, or at least up to the Reformation, and the early literature and civilization of Scotland belong to Ireland. The Scottish Gaelic reached its greatest extent in the eleventh century, when the Anglian-Celtic linguistic line ran from Tweed to Solway and to the Pentland Frith. The line has since been receding. Of the three parts into which Scotland is naturally divided, the larger part of the central and all of the northern, with the exception of the northeast part of Caithness, the Orkneys, and the Shetlands, is Gaelic-speaking. The 1911 census showed 202,398 Gaelic speakers in Scotland, of whom 18,400 were monoglots.

"According to legend, the name Scotch is derived from Scota, a daughter of one of the Pharaohs. The word is probably related etymologically to the German Schatz, and means 'masters, owners.' Originally, and therefore in all medieval Latin texts down to the end of the eleventh century, it meant only Ireland. Since that date it means specifically Scotland. The Scotch Gael never calls himself Scotch, but Gael, or, to indicate his country, Albanach. English-speaking Highlanders, even though Scotchmen, are Saxons in the mind of a Gael. In the fifteenth century, when English became the predominant speech in the Lowlands, the English and non-Celtic Scotch called Gaelic 'Erse.' Since the sixteenth century the name Scotch has been applied to the English spoken in the Lowlands. So, by a strange freak of fortune, Scotch, originally applied to a variety of Celtic, has come to mean Broad Scotch or Quaint English, a language of Germanic origin.

"The distinction made between the Highlands and Lowlands of Scotland is correct merely so far as the physical configuration of the country is concerned, but incorrect if a racial significance is read into it. There is a mistaken notion that Scotland is a country of two races, Celtic in the north and Teutonic in the south, and that the latter element has displaced the former. No doubt the Lowland Scotchman is a person of very composite blood, but he is above all a Celt.

"When Scotland was in possession of complete autonomy she enjoyed unrivaled prosperity. She was spoken of on the Continent as 'a nation of heroes,' and the French proverb 'Fier comme un ecossais' is still current. Many treaties of alliance were made with France, and Scottish merchants, traders, and scholars were known all over Europe. The disaster at Culloden (1746) would appear to have crushed Scottish nationality out of existence. The incorporating Union of 1707, 'which was carried by force and fraud' (Prof. William Smith), reduced Scotland to the humiliating level of an appendage of England. Lord Roseberry called Scotland 'the milch cow of the Empire,' and the Marquis of Bute and others have estimated that the dead loss to the country as a result of the Union is from twelve to thirteen million pounds per annum. As a result of the 'clearances,' the crofters and cotters have had to move to the towns and their places have been taken by rich men who have turned the country into 'sanctuaries' for deer and grouse. The present day Scotch republicans, who represent a party which came into existence at the time of the French Revolution, are now taking steps to see to it that the principle of 'self-determination' is applied to Scotland."

The 522nd meeting of the Society was held in the West Study Room of the Public Library, February 26, 1918, at 8 p.m. On this occasion Dr. Peter Alexander Speek, of the Library of Congress, addressed the Society on *The problems of race and nationality in Russia.*

Pointing out the difficulties of a definition of the term "nationality," the lecturer stated that race is a perpendicular division of mankind, a group of people separated according to ethnological and anthropological differences which have resulted mainly from the natural surroundings in prehistoric times, and that nationality is a perpendicular subdivision of a race or races, a group of people with common ways and forms of life, but different from other groups because of histological development under the influence of the different geographical conditions and social forces. Thus nationality may be expressed more or less in everything which is native to a human being and characteristic of his existence, in physical form, in mental and spiritual development, in economics, politics, science, arts, moral principles, customs, and habits.

The speaker described Russia as a conglomerate of a large number of highly varied countries, races, and nationalities united by conquests into one body politic, ruled up to the time of the revolution by the same monarch and the same laws and institutions.

In 1914 the population of Russia was nearly 180,000,000, the race composition of which was as follows: Indo-European, about 80 per cent; Ural-Altaic, 14 per cent; Semitic, 4 per cent; indefinite, about 2 per cent. The statistics of nationality were as follows: Indo-European race—Great Russians, about 44 per cent; Little Russians, 18 per cent; Polish, 6 per cent; White Russians, 5 per cent; German, about 2 per cent; Lithuanians, 1 per cent; Lettonian, 1 per cent; Armenian, 1 per cent—Ural-Altaic race: Turkish-Tartar, 11 per cent; Finnish, 2 per cent; Esthonian, 1 per cent—Semitic race: Jews, 4 per cent—other minor nationalities of the above races, 2 per cent of the whole population. The last Russian census shows that there were 123 different and distinct nationalities living in Russia. The Great Russians, about 44 per cent of the population, ruled all the other subjugated nationalities, i.e., 56 per cent of the whole population.

The policy of the Russian monarchy was to Russianize the non-Great Russian nationalities by violence. This policy is to be explained in part by the teachings of Pan-Slavism. Pan-Germanism and Pan-Slavism sprang from the teachings of the German historians and politicians, who emphasized the fact of the absorption of Slavs by Teutons in northern Prussia and of Finns by Slavs in the northern part of

European Russia centuries ago. Overlooking the fact that this absorption resulted from peaceful intercourse and unconscious assimilation, these German writers began to agitate in favor of Germanizing non-German nationalities by violence. Under the influence of this propaganda appeared Pan-Slavism.

It is believed that the desire to denationalize other nationalities rises from the economic interests of the ruling nationality, or rather of its ruling classes, for the differences in nationality handicap the expansion of trade and business. The results of the efforts to crush weaker nationalities have been negative, as bitterness, hostility, and opposing force have been created. The problem of nationality can not be solved by violence.

There are three philosophical doctrines dealing with the problem: cosmopolitanism, emphasizing the unity of mankind and ignoring nationality, or opposing it; nationalism, ignoring the unity of mankind, believing in the separation of one nationality from another and holding one's own nationality to be the highest, with a special mission in history (Messiahs, Kultur, etc.); and internationalism, holding that all nationalities have equal rights for existence. Self-determination of nationalities is a principle of internationalism. When this principle is realized, the growth of peaceful intercourse and voluntary assimilation of nationalities will be secure,—a step forward in the progress of mankind.

Frances Densmore, *Secretary*.

BIOLOGICAL SOCIETY OF WASHINGTON

The 579th regular meeting was held in the Assembly Hall of the Cosmos Club, Saturday, February 9, 1918; called to order by President Rose at 8 p.m.; thirty-six persons present.

Under the heading brief notes and exhibition of specimens, A. S. Hitchcock referred to the feeding of gulls and pelicans at Tobago as observed by him. The gulls outnumbered the pelicans by 10 to 1 and almost as the pelicans brought up fishes, the alert gulls snatched them away before the pelicans could adjust the fishes for swallowing. This note was discussed by the Chair, L. O. Howard, and others.

The regular program was as follows:

S. A. Rohwer: *Notes on the nesting habits of the social wasps.* After stating that the term "social wasps" was restricted to the family Vespidae, Mr. Rohwer told of the recent advances in knowledge of the habits of the Neotropical species by the work of A. Ducke and R. von Ihering. The recent work on the habits suggest that the family may be divided into two sub-families on the shape of the fovea, through which the ligament connecting the gaster with the propodeum passes. These two groups have different habits. In the polygamic forms many of the species swarm, the nest is begun by a number of females and lasts no fixed period. The monogamic forms never swarm, the nest is begun by a single female and is used only a single season. Eighteen slides, arranged to show the development in nest making from the simple type of *Apoica* to the more complex type of *Polybia*, illustrating nests of the polygamic forms, were shown. Eleven slides showing the nests of the monogamic forms were exhibited. These slides showed the differences between the single comb made by species of *Polistes* and the more complex nest made by the *Vespae*. Attention was called to the three different types of location used for the nest by the different species of *Vespa*.

Mr. Rohwer's communication was discussed by A. S. HITCHCOCK, L. O. HOWARD, R. W. SHUFELDT, and M. W. LYON. In the discussion the author called attention to the desirability of collecting the smaller types of nests of social wasps and pointed out how they may be collected with safety.

R. W. SHUFELDT: *Biological abnormalities as exemplified by the collection in the Army Medical Museum.* Major Shufeldt illustrated his communication by lantern slides, presenting various forms of so-called "monsters" and other teratologic types, selected from the different branches of the vertebrata including man. All of the specimens shown were chosen from the collection in the Army Medical Museum.

Attention was invited to the occurrence of such deformities in plants, mollusks, insects, crustaceans, and other forms. Various theories were touched upon as to the causes of these departures from the normal animal or plant. Interesting cases, too, of polydactylism, hermaphroditism, diplogenesis, hydrocephalus, cyclops, spiana bifida, terata katydidyma, and numerous other teratologic types were introduced and explained. A somewhat full account was given of the Siamese twins and the lives they led, and other famous united twins were described, and the propriety of the surgical operation to separate them briefly discussed. This interesting field of research was more or less fully entered upon, and a series of illustrated cases, conditions, and the medico-legal questions involved were passed in review.

The 580th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, February 23, 1918; called to order at 8 p.m. by President ROSE; 48 persons present.

Miss M. T. COOKE, Biological Survey, and EDMUND D. GIBSON, Bureau of Entomology, were elected to membership.

The following informal communications were presented:

VERNON BAILEY exhibited and described some newly born examples of the common opossum, and commented on the comparative sizes of newborn and their parents in various mammals.

R. W. SHUFFELDT exhibited and described a young box tortoise with two heads. The individual had lived for a period of nine months in captivity.

C. D. MARSH called attention to the recently issued *Fresh-Water Biology* by Ward and Whipple.

The regular program comprised two communications:

O. W. BARRETT: *A promising new source of sugar.* Mr. Barrett said that the Kaong, or sugar palm (*Arenga saccharifera*) of the Far East, has been used for centuries as a source of syrup and moist sugar, as well as vinegar, starch, fiber, etc. In 1914 the Bureau of Agriculture at Manila, P. I., worked out a process by which it is possible to produce a fairly light-colored sugar, which crystallizes readily. The opening male inflorescences of the palm are tapped in practically the same way as the coconut and nipa palms are tapped. The fresh sap contains about 15 per cent sucrose, and each flower-branch runs for 8 to 12 weeks. By bringing the fresh sap to about 95°C., then rapidly cooling and treating the liquor above the albuminous precipitate, then treating with lime water until considerably alkalined, then treating with carbon dioxide until another heavy precipitate falls, and finally by boiling the perfectly clear supernatant liquor,—the process is completed. In the Province of Cavite on the Island of Luzon, interesting customs attend the preparation of the inflorescence for tapping, treatment of the raw surface during the flow period, and treatment of the tree afterward. Conservatively reckoned, sugar to the value of $600 to $1000 per acre can be obtained from a moderate stand of Kaong; in other words, without the expense of cultivation, the sugar palm yields a better crop year in and year out for at least twenty years than does the much more popular and better known sugar cane. Vast areas of the sugar palm occur in Indo-China, the Philippines, and Malaya. The trouble heretofore in making a high-grade sugar from the Arenga lay in the large amount of organic impurities in the sap, which with ordinary treatment turn very dark and then tend to reduce the crystallizing power of the sucrose.

Mr. Barrett's paper was discussed by Messrs. A. A. Doolittle, A. S. Hitchcock, and William Palmer.

W. C. Kendall: *Some unrecognized anatomical facts and their relations to fish-cultural practices.* The paper pertained to the peritoneal membranes. Dr. Kendall said that the species of the genera *Oncorhynchus*, *Salmo*, and *Salvelinus* have a certain extent of ventral mesentery, extending from its anterior ventral and intestinal insertions, just back of the base of the ventral fins, to the posterior end of the abdominal cavity. The ovaries of the same species consist of peritoneal folds, each of which is boat-like in form, wi h cross-wise partitions or ovigerous lamellae. In natural position the open or upper surface is inclined inward against the mesovarium so that the ovary is completely enfolded in membrane. A short but varying distance from the posterior end of the abdominal cavity, the dorsal mesentery terminates, leaving a communicating aperture from one side of the abdominal cavity to the other above the intestine for the remainder of its extent. With the termination of the mesentery, the mesovarium also ends. From the posterior end of each ovary, the mesovarium and ovarian membrane continues as a trough-like channel as far as the communicating aperture. Thence the two ovarian membranes, united and attached to the median line of the upper surface of the intestine, form a common trough-like oviducal channel which a short distance from the ovipore diverges to each side and becomes attached to the abdominal lateral walls, thus forming a reduced homologue of the so-called funnel-like oviduct of the smelt as described by Huxley

(Proc. Zool. Soc. Lond., 1883). Contrary to general anatomical and icthyological statements concerning the reproductive organs of Salmonidae, the ova can not naturally "fall into the abdominal cavity," and, if they in any way gain access to it, they can not be extruded. To those familiar with fish-cultural practices as respects Salmonidae the application of these facts is obvious.

Mr. Kendall's communication was illustrated by lantern slides of the structures described. The paper was discussed by R. W. Shufeldt.

M. W. Lyon, Jr., *Recording Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

The 126th regular meeting of the Society was held in the White Parlor of the New Ebbitt Hotel at 8.15 p.m., Tuesday, February 5, 1918. Mr. Walter T. Swingle presided. Fifty-one members and 45 guests were present. Mr. T. H. Kearney, the retiring president, delivered an address on *Plant life on saline soils.* (See this Journal **8**: 109. 1918.) Following the address, there was dancing in the Crystal Dining Room.

The 127th regular meeting of the Society was held at the Cosmos Club at 8 p.m., Tuesday, March 5, 1918. There were 50 members and 4 guests present. L. B. Scott and Sidney F. Blake were elected to membership. The following scientific program was given:

D. N. Shoemaker: *The American species of the genus Phaseolus* (with lantern). The American species of "beans" cultivated are: (1) *Phaseolus vulgaris*, our common bean; (2) *Phaseolus lunatus*, the Lima bean; (3) *Phaseolus coccineus*, the scarlet runner, and (4) *Phaseolus acutifolius*, var. *latifolius*, the tepary bean.

Phaseolus vulgaris is much richer in varieties than the other species, the number reaching at least one thousand. These do not fall into well-defined groups, and their classification is not readily made. The most obvious division is into true dwarfs, or plants of determinate growth, and trailers, or plants of indeterminate growth.

Phaseolus lunatus is rich in varieties, which may be grouped as: (1) Sieva forms, including the small flat Limas,—a group distinct as to vegetative characters as well; (2) large Limas, which may be further divided into large flat and large round or turgid. All three forms of Lima beans occur with determinate and indeterminate growth.

Phaseolus coccineus, as grown in the United States, does not have a large range of varieties, and may best be classified on color of ripe seeds.

Phaseolus acutifolius has few varieties, which can best be divided on seed color.

The varieties of the first species are each confined in their cultural requirements to definable regions. These regions are roughly as follows: (1) The eastern and northern region, extending from New England to Idaho, and south along the Appalachian Mountains to the Georgia border, White pea, White medium, White Marrow, White Kidney, and Red Kidney being the main types grown here; (2) the Pacific Coast region, mainly in California, the varieties being small California Whites and Large California Whites; and (3) the southwestern region from western Texas to southern California, and extending into the mountains through Colorado. The varieties here are old native types of beans long cultivated by the Indians, the best known being the Pinto and California Pinks. Besides these there are Bayos, Mexican Reds, and Mexican Whites. This region is the one where production is on the most rapid increase at present, and where expansion can be almost unlimited since beans are grown both as a dry-land crop and under irrigation.

The Lima bean is grown commercially only in the southern part of California along the coast. Scarlet Runner beans are grown only in the northern part of the United States, and then only in gardens.

Tepary beans are better adapted to dry-land farming than are other species. They are fairly salable. They are found growing wild in some of the mountain ranges of southern Arizona, and are a recently discovered part of the aboriginal agriculture of this region.

W. E. Safford: *Economic Phaseoli of the ancient Americans* (with lantern). The origin of the edible species of Phaseolus was for a long time held to be doubtful. Writers on cultivated plants who relied upon the testimony of early explorers and colonists were not convinced that they were all American. The most convincing testimony is that offered by actual specimens from prehistoric graves, burial mounds, and cave dwellings. The writer was fortunate during his explorations in South America in finding excellent specimens of *Phaseolus vulgaris* and *Phaseolus lunatus* from graves on the coast of Peru. During the recent Pan-American Scientific Congress he made an exhibition in the National Museum of the food plants, textiles, aromatic, narcotic, and other economic plants of this continent, which included several distinct varieties of beans. Among them were *Phaseolus vulgaris*, *Phaseolus lunatus*, and *Phaseolus coccineus*. None of the last-named was found in South America; but on the other hand, a number of smooth globose beans called tehui, or chuvi, by the Quichua Indians were taken from graves at Ancon, and it is possible that these may be specifically distinct from *Phaseolus vulgaris*. In one net of a peculiar shape, which may be likened to a three-fingered glove, at least eight varieties of beans were found, including four kinds of "purutus" (*Phaseolus vulgaris*), three kinds of "pallares" (*Phaseolus lunatus*), and the spheroid 'tehuis" already mentioned. In the same net specimens of cotton seed were also found.

Padre Cobo mentions the fact that the round beans called tehui, often beautifully colored, were used by the ancient Quichuas in playing certain games. In Mexico the variously colored beans of *Phaseolus coccineus* were somewhat similarly used by the Aztecs, who called the beans, "ayacotli," or "ayecotli," and the game of chance played with them "patolli." The fleshy root of this bean, called "cimatl," was used by them medicinally. The white variety of *Phaseolus coccineus* "iztacayacotli," now called ayacote blanco or patol blanco, has been frequently mistaken for *Phaseolus lunatus*, and it is one form of this variety which, under the name of "Aztec bean," has been exploited as a discovery in an ancient cave dwelling of our Southwest. As a matter of fact, it is far inferior to the common *Phaseolus lunatus*, and, though a good snap bean when green, it is scarcely edible when mature.

A few specimens of *Phaseolus lunatus* from Peru are pure white, like the common varieties of our markets; some, however, are mottled like the "pataxte" of Chiapas and the "patani" of the Philippine Islands; others are blackish or maroon colored or yellow and brown and brown particolored. The presence of a number of distinct varieties in a single prehistoric grave indicates that beans had been cultivated in Peru a long time previous to the discovery.

Phaseolus lunatus, the Lima bean, was unknown in North America before the Discovery. When first seen by a certain tribe of Indians they gave it a name signifying, the "bean-that-resembles-the-ground-bean." The ground-bean referred to proved to be *Falcata comosa*, which, in addition to flowers of the ordinary type, yielding small pods enclosing several small seeds, has apetalous flowers on slender creeping basal branches, which bury themselves in the soil and produce solitary seeds resembling Lima beans, usually mottled with purple, but soft and turgid, with an outer skin which never becomes hard, but shrivels on drying. These ground-beans were a food-staple not only of the aboriginal inhabitants of Virginia, but also those of the river valleys of the interior of our country. They are easily gathered and, if cooked when fresh, have a buttery consistency and a pleasant flavor not unlike that of an artichoke.

The lantern slides exhibited included illustrations of *Phaseolus vulgaris* and *Phaseolus lunatus* found in graves with Peruvian mummies and in ancient Indian graves of Argentina and North America; several varieties of *Phaseolus coccineus* ranging from Guatemala to Mexico; and fine large specimens of *Falcata comosa* collected near the Potomac a short distance above Georgetown, together with plants from the normal seeds and from the "ground-beans" referred to, the latter much larger and more vigorous than the former.

David Griffiths: *Illustrations of the conspicuous groups of Opuntia* (with lantern). Doctor Griffiths gave an illustrated talk on the general aspects of the groups of the genus Opuntia, considered in its broadest phases. The slides were selected to show the salient features of the group in the most common representatives both as regards habit and details, they being thrown on the screen mostly in pairs, one showing details and the other habit.

A point of special interest has been revealed in the cultural studies which have extended over a period of ten years, namely, that the Clavateae commonly considered to be naked spined are in reality possessed of spines in scabbards similar to the Cylindropuntia, but the sheaths are early deciduous and consequently not commonly seen in dried specimens. This characteristic of spines in scabbards is distinctly a North American trait and gives a line of cleavage other than a geographical one, the Clavateae being intermediate in this respect between the Cylindropuntia of North America and the Tephrocacti and cylindrical-jointed species of South America.

A few remarks were made upon the food value and the products prepared from the fruits of the genus. Specimens were exhibited of preserved products, still well preserved, made in Mexico by crude processes over ten years ago. Enough of this 10-year-old "queso" was on hand to be sampled by those present. Brief reference was made to "Miel," "Melcocha," and "Colonchi," made from the tuna. Various other economic aspects of the genus were alluded to.

H. N. VINALL, *Corresponding Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 311th meeting of the Society was held at the Cosmos Club, March 7, 1918; forty members and ten visitors present.

The following names were favorably acted upon for regular membership; R. E. SNODGRASS, JOSEPH D. SMITH, and R. H. VAN ZWALUWENBURG.

The regular program was as follows:

VERNON L. KELLOGG: *Possibilities of entomology in the war.* Dr. Kellogg forcefully set forth the need for increased food production and conservation, especially of cereals, and pointed out the great opportunity for important work along both lines devolving upon entomologists through the control of insects. He stated that the food supply of the world was in a critical condition and it was extremely important that all manner of losses from insect infestation be controlled in so far as possible. The speaker was of the opinion that present conditions offered a splendid opportunity for entomologists to do their part in winning the war and at the same time advance the science in public esteem.

In discussing Dr. Kellogg's remarks, Dr. PIERCE gave some interesting observations regarding the effects of the past winter on the cotton boll weevil. He stated that the unusually low temperatures had given the weevil a very severe set-back and he was of the opinion that the same would be found to be true in the case of other insect pests.

Mr. W. R. WALTON stated that while the early fall frosts and severe low temperatures had perhaps reduced insect infestation, they had at the same time badly damaged the winter wheat, thus causing injury as well as benefit.

Mr. C. L. MARLATT stated that Australian stored wheat had been very badly injured by insects and that the British government had sent an entomologist there who would attempt to disinfect it and save the grain for Allied use. This entomologist had stopped in the United States on his way to Australia for the purpose of studying our methods of dealing with such conditions. Mr. Marlatt also spoke interestingly of food conservation by preventing insect damage to other stored products and growing crops.

N. E. MCINDOO: *Olfactory organs of Diptera.* Illustrated with charts and wax models. (No abstract).

W. S. FISHER: *A new species of Agrilus from Florida.* Read by title.
C. T. GREENE: *Three new species of Diptera.* Read by title.

Under the head of notes and exhibition of specimens Mr. S. A. ROHWER discussed an interesting new genus and species of sawfly which he had recently received from California, where it infests *Libocedrus decurrens.*

A. B. GAHAN, *Recording Secretary.*

SOCIETY OF AMERICAN FORESTERS

An open meeting of the Society of American Foresters (Washington Section) was held Thursday evening, February 14, at the home of Mr. S. T. DANA. Twenty-eight active members and twenty-nine visiting members and guests were present.

Lieutenant-Colonel HENRY S. GRAVES, the speaker of the evening, in an informal talk described the work of the forest regiments in France and outlined his experiences while abroad. The work it seems is entirely behind the lines and has for its purpose the supplying of the American Forces with the timbers, ties, and lumber needed at the front, or in the construction of docks, depots, and permanent camps.

The timber lies, for the most part, in state, communal, or private forests and is acquired through the French Government. Cutting is done under regulations laid down by the Forest Service or private owner, and in the state and communal forests under the direction of the local forest officers.

Following Colonel Graves, Major H. L. BOWLBY outlined briefly the kind of work the Road Battalions of the 20th Engineers (Forest), now nearly recruited, expect to be called on to do.

Following the program, refreshments were served and music was furnished by Mr. WM. C. STUMP, after which the meeting adjourned.

An open meeting of the Washington Section of the Society was held Thursday evening, February 28, at the home of Mr. HERBERT A. SMITH. Eighteen members and nine visiting members and guests were present.

Under the head of announcements and communications, Mr. A. O. WAHA read portions of a letter from Captain A. C. RINGLAND now in France with the 10th Engineers (Forest) describing a recent air raid on Paris.

Mr. A. F. HAWES then introduced the topic for the evening, *Forestry and the fuel problem*, outlining the causes of the recent fuel shortage; what had been done by State Foresters, State Fuel Administrators, and the Forest Service to relieve it by encouraging the cutting, marketing, and consumption of wood in place of coal; and what it was hoped could be accomplished in the future by the wood fuel campaign both to relieve the fuel situation another winter, and to stimulate the practice of private and municipal forestry. It was pointed out that the largely increased demand for wood fuel was both an opportunity for and a danger to the practice of forestry in that while it created a market for forest products not otherwise merchantable, it also might lead to over cutting and to the destruction of potential timber trees.

In the discussion which followed, Messrs. MATTOON, BESLEY (State Forester of Maryland), KROUSZ (recently with the Great Southern Lumber Company of Louisiana), MUNNS, R. C. JONES (State Forester of Virginia), SPARHAWK, E. H. JONES (United States Fuel Administration), BAKER, and HARRIS took part outlining their experiences in the wood fuel campaign and discussing the subject from various angles.

Following the program refreshments were served and the meeting adjourned.

An open meeting of the Society was held Thursday evening, March 14, at the home of Mr. E. H. CLAPP. Nineteen members and twelve visiting members and guests were present.

Under the head of announcements Mr. RAPHAEL ZON reported that at a recent meeting in New York the War Committee was reorganized and Prof. J. W. TOUMEY elected chairman. The purpose of this committee is to keep in touch with the needs of the Government and with the available technical foresters of the country in order that specially trained men can be mobilized for war work as needed.

The topic of the evening, *Forest products and the war*, was introduced by Mr. E. H. CLAPP, who outlined briefly the many and varied uses of wood in the present struggle, and pointed out what an indispensable factor wood is in modern warfare. He also described briefly the war work at the Forest Products Laboratory of the Forest Service, mentioning some of the more important investigations now under way or proposed.

Following Mr. Clapp, Mr. H. S. BETTS discussed certain phases of the work of the Forest Products Laboratory bearing directly on the war, illustrating his remarks by reference to a number of models and drawings. In the work of box testing and testing of woods for various purposes the Laboratory has been especially active. As a result existing specifications have been modified in a number of cases in such a way as to allow the substitution of more available woods and lower grade material without lowering the quality of the product. This has made possible a more complete utilization of available supplies with a consequent saving in cost and reduction in the strain on production. He also stated that new methods of kiln drying lumber have been perfected which make it possible to season material in a few weeks that would ordinarily take several years. This has made possible the speeding up of construction of all kinds where seasoned wood is required. Tests of veneers, glues, and methods of gluing have also been of great value, particularly in airplane construction, while changes recommended in wooden ship specifications have made possible their construction in the East where the large timbers originally called for are not available.

Mr. ROLF THELEN then explained the various types of airplanes and their method of construction. He dwelt particularly on the kinds of wood used and the ways in which wood enters into airplane construction, mentioning some of the difficulties encountered in securing suitable material and how these are being overcome.

During the discussion which followed, Dr. L. F. HAWLEY, Chemist for the Forest Products Laboratory, was called on and spoke of the importance of products derived from wood in the war—acetone, acetate of lime, alcohol, and charcoal being mentioned particularly.

Following the program refreshments were served and the meeting adjourned.

J. A. MITCHELL, *Secretary*.

SCIENTIFIC NOTES AND NEWS

The Chemical Society of Washington, the local section of the American Chemical Society, gave a reception at the Smithsonian Institution on February 28, 1918, to visiting chemists on war duty. The guests were received by Dr. F. B. Power, President of the local society; Dr. George P. Merrill, representing the Secretary and Regents of the Smithsonian Institution; Prof. F. W. Clarke, of the Geological Survey; Prof. Charles L. Parsons, Secretary of the American Chemical Society; Dr. W. F. Hillebrand, of the Bureau of Standards; and Dr. C. O. Johns, of the Bureau of Chemistry. Short talks were given later in the evening by Messrs. Merrill, Clarke, and Parsons, and by Major S. J. M. Auld, of the British Mission, Dr. Samuel Avery, of the National Research Council, and Prof. W. D. Bancroft, of the Bureau of Mines Experiment Station.

About 550 invitations were sent to visiting chemists, while the membership of the local section is over 400. The number of chemists now in Washington is thus in the neighborhood of 1000.

Over two-thirds of the scientific staff of the Geophysical Laboratory are absent from Washington on work connected with the manufacture of optical glass. F. E. Wright is in charge of the optical glass plant of the Bausch & Lomb Optical Co. in Rochester, New York, and is assisted by J. B. Ferguson and R. H. Lombard. C. N. Fenner is in charge at the glass plant of the Spencer Lens Co., near Buffalo, New York, and E. T. Allen, E. G. Zies, and N. L. Bowen have assisted at different times at this plant. At the request of the Pittsburgh Plate Glass Co. a party under the direction of J. C. Hostetter and including L. H. Adams, G. W. Morey, H. S. Roberts, and E. D. Williamson, was sent in December to the optical glass plant of that company at Charleroi, Pennsylvania.

The Geological Society of London has awarded the Wollaston medal to Dr. Charles D. Walcott, Secretary of the Smithsonian Institution, in recognition of his contributions to geology and Cambrian paleontology. The Wollaston medal was established "to promote researches concerning the mineral structure of the earth and to enable the council of the Geological Society to reward those individuals of any country by whom such researches may hereafter be made." The list of eighty-seven men of science who have received this medal since its establishment in 1831 contains the names of five other Americans who have been so honored—Louis Agassiz, James Hall, James D. Dana, Grove Karl Gilbert, and W. B. Scott. It is an interesting circumstance to note in connection with the award of this medal to Dr. Walcott that Wollaston, the eminent English chemist who established the medal, was an intimate friend and scientific associate of James Smithson, of London, through whose beneficence the Smithsonian Institution in Washington was founded.

The National Research Council has rented additional space and is now occupying the building at 1015 Sixteenth Street in addition to the offices at 1023 Sixteenth Street. The following four Divisions will be housed in the new offices: (1) Agriculture, Botany, Forestry, Fisheries, and Zoology; (2) Chemistry and Chemical Technology; (3) Geology and Geography; (4) Medicine and Related Sciences.

Dr. H. M. Ami, formerly of the Geological Survey of Canada and now stationed in Washington at the British Embassy, has been elected vice-president of the Société Géologique de France.

A "second general report" by the Permanent Commission of the International Committee in charge of the "Tables Annuelles de Constantes et Données Numériques" has been received. The first volume of these Annual Tables of Constants (covering the year 1910) had appeared, and the volumes for 1911 and 1912 were in preparation at the time of the first report of the commission, which was made to the Eighth International Congress of Applied Chemistry in New York in 1912. The publication of Volume IV, covering 1913, was interrupted by the outbreak of war, and no publication has been possible since that date, although the collection of material has continued under the direction of Dr. Charles Marie, the general secretary, and the following members of the commission: Carrara (Milan), Cohen (Utrecht), Dutoit (Lausanne), Lewis (Liverpool), and Stieglitz (Chicago). French, British, and American grants to the Tables have been continued and even increased during the war. The Philosophical Society of Washington and the Chemical Society have been contributing annually to the project.

The following persons have become members of the Academy since the last issue of the Journal: Mr. James Percy Ault, Department of Terrestrial Magnetism of the Carnegie Institution of Washington, Washington, D. C.; Mr. William H. Babcock, 802 F Street, Washington, D. C.; Mr. Charles Raymond Duvall, Department of Terrestrial Magnetism of the Carnegie Institution of Washington, Washington, D. C.; Mr. John Clyde Hostetter, Geophysical Laboratory of the Carnegie Institution of Washington, Washington, D. C.; Prof. Herbert Spencer Jennings, Johns Hopkins University, Baltimore, Maryland; Dr. Paul D. Merica, Bureau of Standards, Washington, D. C.; Mr. William John Peters, Department of Terrestrial Magnetism of the Carnegie Institution of Washington, Washington, D. C.; Major General Hugh Lenox Scott, Headquarters 78th Division, Camp Dix, New Jersey; Mr. Bradshaw Hall Swales, Division of Birds,

U. S. National Museum, Washington, D. C.; Prof. RICHARD CHACE TOLMAN, Department of Chemistry, University of Illinois, Urbana, Illinois; Prof. EDWIN BIDWELL WILSON, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts; Dr. WOODROW WILSON, The White House Washington, D. C.

RESEARCH INFORMATION COMMITTEE

1. By joint action the Secretaries of War and Navy, with the approval of the Council of National Defense, have authorized and approved the organization, through the National Research Council, of a Research Information Committee in Washington with Branch Committees in Paris and London, which are intended to work in close coöperation with the officers of the Military and Naval Intelligence, and whose function shall be the securing, classifying, and disseminating of scientific, technical, and industrial research information, especially relating to war problems, and the interchange of such information between the Allies in Europe and the United States.

2. In Washington the Committee consists of:

(a) A civilian member, representing the National Research Council, Dr. S. W. Stratton, Chairman;

(b) The Chief, Military Intelligence Section;

(c) The Director of Naval Intelligence.

3. The initial organization of the Committee in London is:

(a) The Scientific Attaché, representing the Research Information Committee, Dr. H. A. Bumstead, Attaché;

(b) The Military Attaché, or an officer deputed to act for him;

(c) The Naval Attaché, or an officer deputed to act for him.

4. The initial organization of the Committee in Paris is:

(a) The Scientific Attaché, representing the Research Information Committee, Dr. W. F. Durand, Attaché;

(b) The Military Attaché, or an officer deputed to act for him;

(c) The Naval Attaché, or an officer deputed to act for him.

5. The chief functions of the foreign committees thus organized are intended to be as follows:

(a) The development of contact with all important research laboratories or agencies, governmental or private; the compilation of problems and subjects under investigation; and the collection and compilation of the results attained;

(b) The classification, organization, and preparation of such information for transmission to the Research Information Committee in Washington;

(c) The maintenance of continuous contact with the work of the offices of Military and Naval Attachés in order that all duplication of work or crossing of effort may be avoided, with the consequent waste of time and energy and the confusion resulting from crossed or duplicated effort;

(d) To serve as an immediate auxiliary to the offices of the Military and Naval Attachés in the collection, analysis, and compilation of scientific, technical, and industrial research information.

(e) To serve as an agency at the immediate service of the Commander-in-Chief of the Military or Naval Forces in Europe for the collection and analysis of scientific and technical research information, and as an auxiliary to such direct military and naval agencies as may be in use for the purpose;

(f) To serve as centers of distribution to the American expeditionary forces in France and to the American naval forces in European waters of scientific and technical research information, originating in the United States and transmitted through the Research Information Committee in Washington;

(g) To serve as centers of distribution to our Allies in Europe of scientific, technical, and industrial research information originating in the United States and transmitted through the Research Information Committee in Washington;

(h) The maintenance of the necessary contact between the offices in Paris and London in order that provision may be made for the direct and prompt interchange of important scientific and technical information;

(i) To aid research workers, or collectors of scientific, technical, and industrial information from the United States when properly accredited from the Research Information Committee in Washington, in best achieving their several and particular purposes.

6. The headquarters of the Research Information Committee in Washington is in the offices of the National Research Council, 1023 Sixteenth Street; the Branch Committees are located at the American Embassies in London and Paris.

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AVIATION.—*Aviation and the war.*[1] C. F. Lee, Commanding Officer, British Aviation Mission. (Communicated by L. J. Briggs.)

I should much prefer to stand here and answer a few direct questions rather than to try to give you miscellaneous information on subjects connected with aviation. But there are representatives here of so many different sciences, men who are in the habit of asking and answering questions on such a variety of topics, that it is probably better that I do not attempt to answer any scientific questions at all on the theory of aviation, especially as my scientific knowledge of it is nil.

Not everyone realizes how long a time it takes to make a service flyer. The average period, from the time that the pupil is brought to the cadet schools of the Flying Corps to the time he is ready to go over-seas and fly over the lines, is about seven months. That is a very considerable length of time, especially in these days of intensive training and preparation, yet the actual training in flying is one of the simplest items. The principal factor to consider in teaching flying in war time is whether it is worth while to spend the necessary time on a pupil. If a country is at peace and there are plenty of machines available, it may pay to stick to a man who will undoubtedly make a flyer sooner or later, for anyone can fly if sufficient time be given to his instruction. But in times of war when, as at the present time, we

[1] Report of a lecture given before the Washington Academy of Sciences on Thursday, March 7, 1918.

have neither a surplus of machines available for flying nor the extra time to spend in training, it is not a practical thing to do. The hard, specialized training which everybody has to come to sooner or later is not only important, but absolutely essential.

Much has been said about "dangerous stunts," frequently with the implication that these are spectacular performances which thrill the spectators but are needlessly risky, and I should like to devote a few words to this matter.

It is quite true that some lives were lost in the earlier days in instructing pupils in what we call "stunting," but it is quite useless to send a man over-seas if he is unable to "stunt." In individual fighting, unless the flyer can really do things better than the German, he is not going to come out alive. For instance, when one machine meets another, each speeds up and goes through every kind of maneuver to get into a good position so as to be able to "get" his opponent. The man who is going to come out alive is the one who can outdo his opponent in flying. It is not a question of "getting away from the German." It is not a matter of getting away at all, but of getting into a good position so that you can down him. He is going to do the same thing as you are, and unless you are able to outdo him in his maneuvers you are going to come out beaten; and unless you are trained to do real stunts (which are really not at all dangerous), you are not going to be able to down him. The danger is not in "stunting;" the danger is in not being able to "stunt."

If a flyer goes over-seas and cannot do these things, then his life isn't worth a "scrap of paper." If he can do these things, and if the time comes when he is absolutely match to match with his opponent, the man who will kill his opponent is the one who can turn his machine about at will and get out of a difficult position. Getting out of the difficult position saves his life, but that is not all; the real problem is to get into a good position so that he can down the enemy, and the downing of the Boche is the thing that every flyer is out for. He is there not to get away; he is there to kill his opponent.

To succeed, the flyer must be taught properly. It may cost one or two lives on this side of the water, but if the men are taught thoroughly it will mean the ending of these casualties on the other side. What is more important, if the flyer does not know how to "stunt," it will not only mean the death of the pilot himself, which is relatively not so important in view of the fact that so many thousands of men have been killed in this war, but it may result disastrously to a great number of men on the ground. When the man in the air goes down, there may be batteries depending on him for spotting our own fire and the enemy's artillery; there may be infantry regiments waiting to know where the Germans are; and there may be whole divisions waiting for certain information. It is thus absolutely criminal to send a pilot to the front who does not know how to fly, and the only way to make him capable is to teach him to stunt. It is now taught at all the flying schools.

The teaching of stunting is not difficult, but we must have pupils who have a certain amount of knowledge and skill. I will give you one or two instances which we had in the beginning of the war. We were very hard pressed for apparatus and very hard up for machines by the end of 1915. A lot of pilots were sent over-seas after they had been given the best training that the short time would allow, but there were many casualties. Some of them were due to the fact that some of these fellows could not really "stunt" their machines. The Boche would get "on their tail" and they would put their nose down. If the man in the disadvantageous position puts his nose down, the pilot on his tail can do the same and get him very easily. Now, the fellow who can stunt will do some fast climbing, turn, and maneuver himself into a better position from which to attack his opponent, while the fellow who cannot stunt will put his nose down and try to get away and will find himself an easy mark for the enemy. This was very noticeable with raw German flyers.

I want to make it very plain that there is no danger whatever in stunting, and I could show you that with proper training a pupil can be taught to stunt in twenty-five hours. The only danger is in doing it too near the ground, but at 2000 feet there is not a single position that the machine cannot be put into with safety.

The evolution of the machines themselves is very interesting. At the beginning of the war we had only about four small squadrons, of 12 machines each. They consisted of what we now call very old machines. There were some Farman machines, some 2. A and B's, and one or two Bleriots, which at that time were considered very speedy machines. All those machines are now considered too slow even for training. In those days they used to fly under 3000 feet and used to come back with a tremendous lot of bullet holes in their machines, but there were not many casualties. As the war went on, with time and experience the machines gradually were improved, until at the present time we have scout machines that fly 135 miles an hour, machines that will climb 15,000 feet in less than fifteen minutes.

That is the evolution that has been forced on France and England. It is a matter of life and death to the Allies to keep just a little better than the German. But it is very hard to get very much better than he. In practically every case a machine is obsolescent from the time that it appears on a production basis at the front. So it is one huge race to get a machine with a little more maneuverability, a little more climbing ability, and a little more speed. Your defense is not the bullet-proof seat you are sitting in; the only defense you have is the maneuverability of your machine.

To return to the training. When the pupils come to the ground schools they get a certain amount of ground training. They are told what the machine can do, and the detailed operations that are performed by the various parts. They are also given the ordinary subjects connected with drill and military life. After six or eight weeks in training, when they have become soldiers to a certain extent and have acquired a certain amount of discipline, they are drafted to a school of flying.

At this school of flying, according to their temperament, according to how they fly, according to age, and according to their all around knowledge, they are assigned to one of three branches: first, the single-seater scout; second, the artillery-observation squadrons; or, third, the bombing machines for both day and night bombing.

All these subjects are highly specialized at the present time. It is absolutely impossible for a pilot to be an expert in all three subjects. He may be an excellent flyer in a heavy machine but he may fail as a gunner; another pilot may be extremely good in the scouts. All these things require special knowledge and special tactics for teaching them. The pilot in the single seater must be an expert gunner. He must know his gun absolutely thoroughly, but if he can't shoot straight he may as well go home. Some machines have three or four guns. If a gun goes wrong, the pilot must be able to locate the trouble and correct it. He must go through various courses of training, including "stunting" courses, and until he has completed these he is not allowed to go over-seas.

Furthermore, before he goes over-seas he has to be absolutely proficient in what is called formation flying. In former days the machines went out one, two, or three at a time. Nowadays it is of no use to go over alone or in pairs. The machines now fly in sixes, eights, twelves, sixteens, and twenty-fours. They fly together, bunched up and well packed in. If the formation is well packed in no Boche will attempt to touch it. But if one of the pilots drops out of the formation, if his engine goes wrong and his revolutions start dropping and he starts losing height, then the enemy is after him. They wait their time until he is well out of his formation and then his only safeguard is to stunt.

A friend of mine (now Colonel), Jack Scott, used to go out "Hun hunting" by himself. He once was out beyond the lines looking at his own squadron, when a squadron of Boches came between him and his own lines. The only thing he could do was to stunt, and although he got bullets all through his machine, his gun was hit, he had three holes through the seat, and a lot of holes through other parts of his machine, he got away all right. But he said he got so tired of flying around and around that he was almost ready to give up, when one of the enemy happened to come in line, and Scott fired when he saw him on his sights. The Boche went spinning to the ground. That little accident heartened him so that he revived and got away.

There was another fellow, Bishop, who was of the same sort. He went out scouting alone and saw five enemy machines just getting ready to leave their aerodrome. He flew right down close on top of them and crashed two machines before they left the ground. He then went for the third machine and sent that crashing to the earth. But things were then getting too hot for him so he climbed two thousand feet, where he finally got the fourth one. Then to show his independence he went after the fifth. He got the Victoria Cross for that.

Artillery machines are quite another matter. They have a very hard job and a very interesting one, and it is a job that requires lots of courage because they have to stay in the same place over the batteries and spot the other batteries' fire. They have to keep their eyes on the land, and on a cloudy day the enemy sometimes creeps up on them through the clouds. Generally speaking these men are a little older and are chosen because they have the temperament and are a little more suited to staying over one place and seeing the job out. It is not very pleasant for the men who are accustomed to scouting to have to fly over a certain area and see the same place every day. The artillery nowadays is practically dependent on wireless and aeroplanes for spotting. The total number of aeroplanes you can get now in a definite area is dependent on the wireless you can get into that area without being "jammed," and not on the total number of machines available.

Coupled with the work with the artillery, these aeroplanes also have duties to perform with the infantry, such as contact patrols.

The next class is that of the bombing machines. Bombing is one of the most difficult things there is. It is extremely hard to drop a bomb upon a certain object when an aeroplane is traveling at such an enormous speed and at such high altitudes. If you should go over Washington in an aeroplane, you would be surprised at the many places where you could drop a bomb and do no damage. With your wide streets and avenues it would be very difficult to drop a bomb on any spot where it would do very much harm. If dropped in the street, it would probably do no more damage than to break a few shop windows. If you struck a definite target it would be with a certain amount of luck.

However, it is not all luck. The man who is highly trained will make more hits than one who is not. There is a special course in bombing and a special course on the bombing sights which are attached to the aeroplane.

There was a friend of mine, Harvey Kelly, who went out flying a great deal alone. He was a happy-go-lucky sort of fellow and thought that he could come and go as he pleased. There wasn't anything that he would not try. Once he saw a battery firing and let off one bomb at it. He saw no result so he came up again and let off another one. He happened to look out over the other side of his machine on his third attempt and saw that bomb burst in a village about a mile away from the battery. So you see it is none too easy to drop bombs accurately on any place.

Machines are frequently used nowadays for going up and down the lines, picking off men in the trenches, and generally making things uncomfortable. Nothing is more detrimental to morale than to have aeroplanes continually flying overhead, and the same is true of the observation balloons. The men on the ground think that you can see far more than you can, even when the aeroplane is 15,000 feet above the ground, when as a matter of fact you can't really see any details at all. There is always the possibility of having a battery of guns directed upon them that keeps the men thinking and worries them. If there is a column of infantry moving behind the lines, the aeroplane cooperating with the artillery can always have a battery of guns directed into it. What with aeroplanes flying overhead all day and bombing going on all night, the morale of the soldiers in the trenches has to stand a severe test.

Bombing by night requires a great deal of practice, and night bombing now is a matter to which serious training is devoted. Every night the machines go over the lines and keep the enemy awake as far as possible. After a long spell of trench work, possibly ten days in the trenches, when the men are at the rear resting and playing games, to be continually disturbed at night cannot but have an effect on their efficiency, making them less likely to be of use when they go back to the trenches. That is one object of bombing—to prevent the enemy from having a rest.

I went down to the Texas flying fields about a month ago, and found the cadets there splendid. They are a keen, real good lot, with good discipline, and are an excellent selection of healthy young men. They are all fellows who play games, or ride, or enjoy some sport, and have been well chosen. But they will have to be taught, even at the cost of some casualties.

(The lecturer then showed a series of lantern slides giving views of the front taken from aeroplanes, including the city of Bapaume in flames, the effect of the bombardment of Guillemont at the battle of the Somme, and the bombing of an aerodrome; aeroplane views of England, showing the kind of information that can be obtained by the aeroplane photographer concerning country to be crossed by the troops; the first flying schools in Wiltshire; repairs to planes and engines; the types of aeroplanes and the older types of guns; and various phases of the training of the flyers.)

PHYSICS.—*Note on the periodic system of the elements.* P. V. WELLS, Bureau of Standards. (Communicated by S. W. Stratton.)

The electron theory of atomic structure gives to the periodic system a new significance. This is shown very clearly by the spiral periodic table of Stoney and others as revised by Harkins and Hall. The spiral form has the advantage of being in a plane instead of in space, and thus of naturally representing two coordinates, atomic number and atomic weight.

Chancourtois, the first to discover periodicity in the properties of the elements, used a helix and a period of sixteen. Newlands discovered the period eight, and called his relation "the law of octaves." Mendeleef recognized both periods but considered eight the fundamental period, from valence considerations. This is also in harmony with the electron theory of valence. I have therefore changed the spiral table given by Harkins and Hall to a period of eight instead of sixteen, as is shown in figure 1. The distance from the center represents atomic weight, the elements occurring in angular order of atomic number, which increases with clockwise rotation. Each group is thus arranged radially, the subgroups being slightly displaced.

The table appears to me to have all the advantages of the space double helix, and is much simpler. It overcomes the artificial-

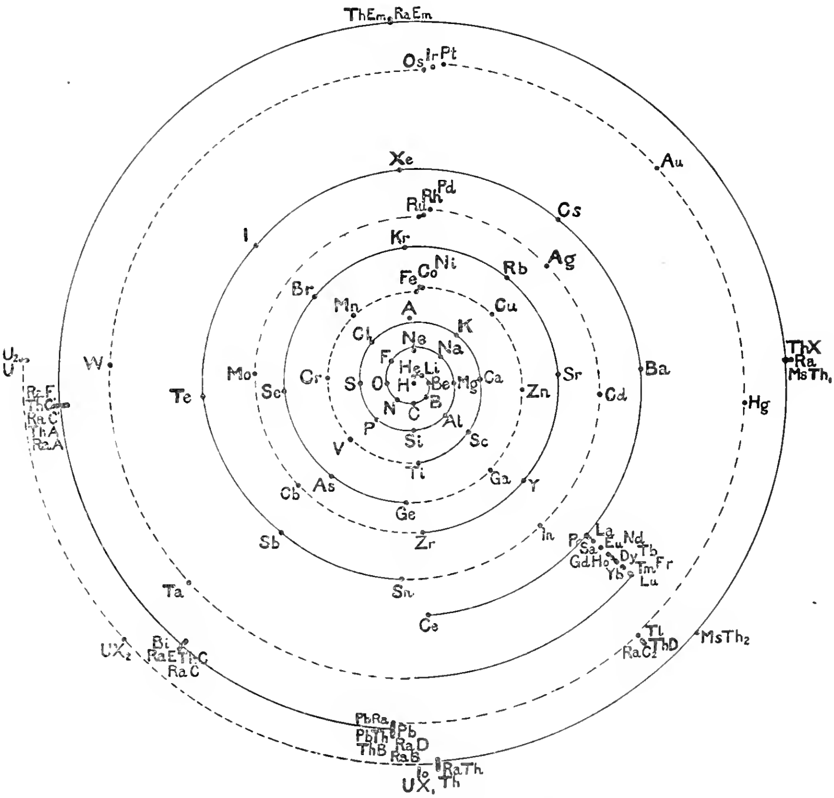

Fig. 1. Spiral table illustrating the electron theory

ity of the spiral of period sixteen, which has two half turns containing no corresponding elements. It brings the subgroups and main groups together, as in Mendeleef's table.

The spiral table is particularly adapted to illustrating the electron theory. Thus each turn represents a ring of eight valence electrons. The vertical axis represents in a general way the transition from positive to negative valence. To the right are the metals of positive valence, to the left the nonmetals of negative valence, etc.

The table suggests that the elements in the first two series are systems too simple to have the more complicated relationships fully developed. It is interesting, however, to note in this connection the possibility of two forms of neon, perhaps an embryonic foreshadowing of the first triplet Fe, Co, Ni. But the main use of the periodic table is to assist the mind in grasping the host of experimental facts accumulated by the chemist. Today these facts are of interest to a wider circle of scientists and the slightest simplification in their presentation is welcome.

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GEOCHEMISTRY.—*Fluorine in sericitization.*[1] Sidney Paige and George Steiger, Geological Survey.

The intense alteration of granodiorite or quartz monzonite porphyries in which large deposits of secondary chalcocite occur (the so-called porphyry coppers) is a matter of common knowledge. This alteration, of two kinds—primary, resulting in the introduction of sericite, pyrite, and quartz; and secondary, resulting in the deposition of chalcocite from descending sulphate solution—leaves the original rock in a scarcely recognizable condition.

The degree of sericitization is in many places astonishing. Where fractures are numerous and ascending waters have freely circulated, the rock mass may be almost wholly replaced by sericite, quartz, and pyrite, the former two minerals occurring in about equal amounts.

Changes resulting from the descending, oxidizing waters have been in places quite as noteworthy; the sericitized rock has been

[1] Published with the permission of the Director of the U. S. Geological Survey. Mr. Steiger is responsible for the chemical analyses.

altered to kaolin, and here again where fractures are plentiful and the descending solutions have been active, considerable parts of the rock in the aggregate have been altered to this mineral or a closely allied compound.

The formation of sericite from feldspar is usually assigned to the action of either heated water alone or to the action of heated water containing carbonate. As may be observed at many places,

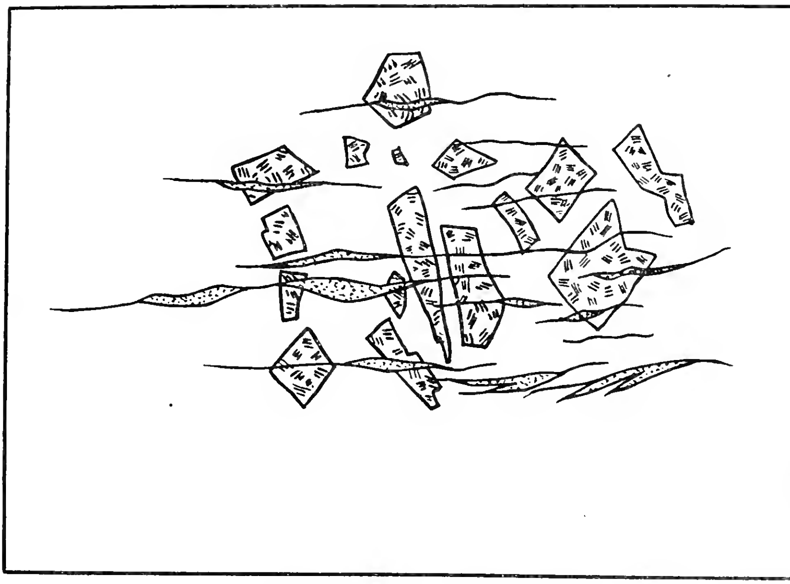


Fig. 1. Illustrating the replacement of breccia by veins of kaolin without movement along the veins.

sericite forms with ease from oligoclase, orthoclase, andesine, and labradorite. According to Lindgren,[2] this fact was first described by Bischof,[3] who also furnished the chemical explanation. The potassium carbonate contained in the water changes the sodium-bearing silicate into potassium silicate, which unites with the aluminum silicate to form sericite.

In the copper deposits at Tyrone, New Mexico—deposits that are typical chalcocite deposits resulting "from secondary enrich-

[2] Lindgren, Waldemar, *Metasomatic processes in fissure veins.* Trans. Amer. Inst. Min. Eng. **30**: 31–608. 1901.

[3] Bischof. Chemische Geologie, I, p. 31 et seq; also p. 44.

ment"—the nature of the formation of kaolin below the chalcocite ore bodies seemed to require more than the ordinary explanation, for the evidence is fairly conclusive that quartz in considerable amount, together with the other constituents of the porphyry, has been metasomatically replaced by kaolin.

In figure 1 a series of veins is illustrated, cutting a very brecciated porphyry. The arrangement of the fragments is such that it is evident that there could have been no movement anlog the veins in any direction. The veins are composed of kaolin. In figure 2 another kaolin vein is illustrated. Here there is a perfect gradation from the common sericitized porphyry at one end of the vein to kaolin at the other end. About midway, quartz phenocrysts, residual from the porphyry still remain inclosed

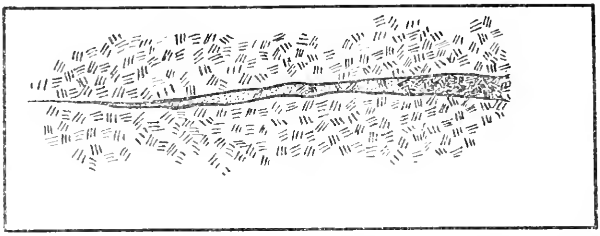


Fig. 2. Illustrating the progressive replacement of porphyry by kaolin. Quartz is the last mineral to disappear.

in the kaolin, whereas the pure masses of kaolin contain none. This is apparently a clear case of the progressive removal of quartz by metasomatic replacement.

In discussing with Dr. Adolph Knopf, of the Geological Survey, this occurrence, which appeared to demand more than the ordinary explanation, Dr. Knopf suggested that perhaps fluorine had been active. In the Tyrone district fluorine occurs in fluorite in veins, at one place in a vien several feet thick and at other places in small veins a few inches thick. It is presumed therefore that it also occurs more generally in small veinlets. That it has not been more generally recognized in small veinlets, however, is natural, for processes of secondary enrichment by waters carrying sulphuric acid are precisely those that would readily attack fluorite and remove it. Nevertheless, it was felt that while fluorine *might* have been present in fluorite in numberless veinlets, a search for another source was demanded, and sericite was chosen as the mineral most likely to contain it.

It is well known that muscovite mica contains fluorine. It is now recognized that sericite is a form of muscovite, but analyses proving that sericite contains fluorine are surprisingly few. Spurr[4] has argued that fluorine is necessary for the formation of sericite, but his tests were not convincing as to the fluorine content of sericite, though its presence in a specimen (which contained no sericite) to the amount of 0.12 per cent indicated that the waters that altered the rock contained it.

To throw more light on the matter therefore, a part of a narrow replacement vein traversing quartz monzonite porphyry was

TABLE I

Analysis of Sericite Vein

SiO_2	68.11	Na_2O	0.44
Al_2O_3	16.84	K_2O	4.08
Fe_2O_3	0.80	FeS_2	6.68
CaO	0.44	F	0.09
MgO	0.50		
			97.98

chosen for analysis. The specimen contained about equal amounts of sericite and quartz and a little pyrite. No fluorite was visible with the high powers of a microscope, and no other minerals than those mentioned were noted.

The results of the analysis obtained are given in table 1.

The mineral composition of the vein, as computed from the analysis, is quartz, 45.30 per cent, sericite, 46.00 per cent, and pyrite, 6.68 per cent; sum, 97.98 per cent. The analysis was carried out by standard methods. The fluorine, however, was indirectly determined by the colorimetric method, depending on the bleaching effect of fluorine on the color produced by hydrogen peroxide with titanium solution. A qualitative check was made by the old Berzelius method, and the presence of fluorine was proved by its etching effect on glass. All the alkalies and the alkali-earth metals were computed into the sericite. Thus a maximum amount of sericite was figured. The percent-

[4] SPURR, J. E., Geology of the Tonopah Mining District. U. S. Geol. Survey Prof. Paper 42: 232–3. 1905.

age of fluorine in the sericite is practically 0.20. Any lesser amount of sericite would show a higher content of fluorine in the sericite than that calculated. Equivalent silica was allotted to the alkalies and the alkaline earths and the remainder computed as quartz. The failure to sum up to 100 per cent is due to water in the sericite, not determined.

When the fact is taken into consideration that sericite is a very abundant mineral in the rocks of the Tyrone district, the amount of fluorine indicated to be present in the district becomes very significant; first in the rôle it must have played in the primary mineralizing waters, for it is an element of great potency in effecting the decomposition of aluminum silicates, and second, its part in further decomposing the rocks during processes of secondary enrichment on being set free by the action of sulphate waters on sericite.

That fluorine is potent to decompose aluminum silicates is evident not only from the fact that it is used in ordinary analytical work for this purpose, but its use forms the basis of several patents involving the decomposition of feldspar or kaolin. The Doremus process of making potassium sulphate[5] involves the treatment of "finely powdered orthoclase with aqueous hydrofluoric acid." A soluble and an insoluble compound are produced. Both are further treated with sulphuric acid; sulphates are obtained and the fluorine gas and acid recovered.

The Childs process of deriving alumina from kaolin involves the passing of hydrofluoric acid gas, or some other volatile compound of fluorine, for example, silicon fluoride, through kaolin.[6]

It is well known that dilute sulphuric acid solutions will decompose sericite and that kaolin or kaolin-like products originate from this reaction. Fluorine will be set free.

The action of fluorine in descending solutions, whether derived from fluorite or from sericite, might well be somewhat as follows: Fluorite is decomposed by sulphuric acid with the formation of calcium sulphate ($CaSO_4$) and hydrogen fluoride (HF) and hydrogen fluoride unites readily with silica to form water and

[5] United States Patent Office, Specification of letters patent No. 1,054,518, patented February 25, 1913.

[6] Patents Nos. 1,036 453 and 1,036,454, dated August 20, 1912

silicon tetrafluoride (SiF_4), a gas soluble in water. Silica would thus be attacked and carried off. It is known that

$$
\begin{array}{l}
SiF_4 + 4H_2O = Si(OH)_4 + (4HF) \\
2SiF_4 + (4HF) = 2H_2SiF_6 \\
\hline
3SiF_4 + 4H_2O = Si(OH)_4 + 2H_2SiF_6
\end{array}
$$

Thus silicon hydroxide and hydrofluosilicic acid are formed. This latter compound is stable only in water, and is inert so far as attacking quartz is concerned. In the rocks under discussion here, it would probably form alkaline salts. On evaporation of the water, however, silicon tetrafluoride (SiF_4) would again be formed and the more or less insoluble alkaline salts deposited. Whether the silicon tetrafluoride set free would, on recombining with water, again produce the active agent hydrofluoric acid is not known. More likely the process outlined above would be repeated, a certain portion of silicon hydroxide, $Si(OH)_4$, being deposited, and the inert hydrofluosilicic acid going again into solution, to again combine with alkaline bases.

But it is to be expected that these salts will yield to decomposition by acidified waters, as does sericite. And there is reason to believe that fluorine will be again and again set free, so long as sulphuric acid waters are present.

SUMMARY

The intense sericitization common in regions where large deposits of secondary chalcocite occur may be in large measure due to the fact that the primary mineralizing waters contained appreciable amounts of fluorine. The further decomposition of the rocks by descending sulphate waters with the attendant formation of kaolin-like substances may also be accelerated by the presence of the fluorine in the sericite, which is set free by reaction with sulphuric acid. The removal of quartz from veins consisting of kaolin-like matter which apparently has metasomatically replaced porphyry is thus explained.

The presence of fluorine in veins and the determination by chemical analysis of 0.20 per cent fluorine in the sericite of the Tyrone district, New Mexico, support this thesis.

CRYSTALLOGRAPHY.—*Note on the fundamental polyhedron of the diamond lattice.* ELLIOT Q. ADAMS, Bureau of Chemistry.[1] (Communicated by Edgar T. Wherry.)

The space lattice according to which the carbon atoms in diamond are arranged has been established by the work of the Bragg's[2] and has been found not to correspond to any of the previously recognized point systems of the cubic type, having planes of "gliding reflection" and axes of "helical symmetry." To each of the already recognized point systems there corresponds a convex polyhedron capable of filling space, and having a symmetry correspondent to that of the point system. No such polyhedron appears to have been described as corresponding to the diamond lattice. The form of this polyhedron has been worked out and is given below.

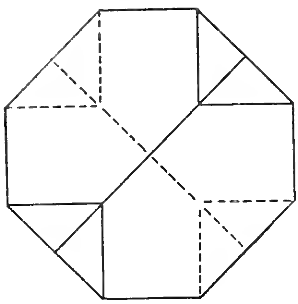
The polyhedron corresponding to the simple cubic lattice is the cube (100); to the face-centered lattice, the rhombic dodecahedron (110); and to the cube-centered lattice, the cubo-octahedron (111), (100), in which the octahedral faces are truncated just enough to make them regular hexagons. Since each carbon atom in diamond is near *four* others, tetrahedral faces will be present. As space can not be filled with tetrahedra, some other face must occur also. This face proves to be that of the rhombic dodecahedron, truncating the tetrahedral faces sufficiently to make them regular hexagons. The polyhedron may be called the dodeca-tetrahedron κ (111), (110). (See figures 1–3).

That diamond is crystallographically holohedral, while the unit polyhedra, as may be seen from the figures, are hemihedral, results from the fact that the mode of arrangement in space of the dodeca-tetrahedra constitutes a sort of twinning. Practically all the elements of the fourth column of the periodic table crystallize in a form similar to that of diamond. If the alternate atoms in such a lattice are different, the crystal becomes hemihedral, as in the case of sphalerite (ZnS). In this case the polyhedra corresponding to the two elements need not be equal in size,

[1] Contribution from the Color Investigation Laboratory of the Bureau of Chemistry, U. S. Department of Agriculture.

[2] BRAGG, W. H., and W. L., X-Rays and Crystal Structure, p. 102. 1915; Proc. Roy. Soc. (A) **89**: 277. 1913.

and the dodecahedral faces will be relatively larger on the large figure and small, or even wanting, on the smaller. At the limit, one becomes a tetrahedron of infinitesimal size, while the other reduces to the dodecahedron of the face-centered lattice.



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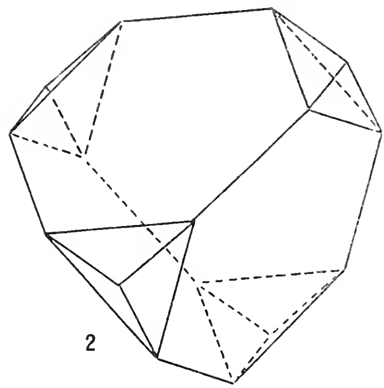

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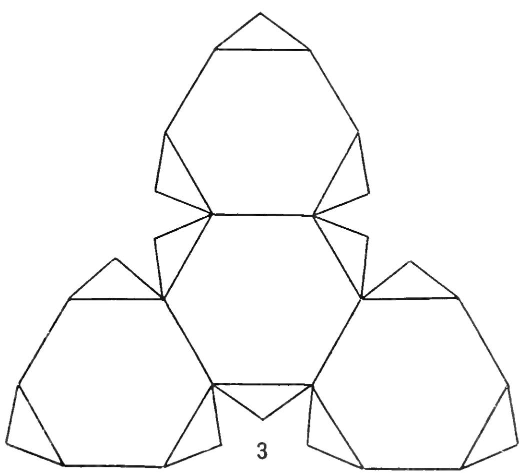

3

Fig. 1. Orthographic projection. Fig. 2. Clinographic projection. Fig. 3. Development of surface; may be used as net for constructing model.

In chalcopyrite,[3] where alternate planes of iron and copper atoms replace the zinc of sphalerite, the axis perpendicular to these planes is unique and the crystal is therefore tetragonal. Replacing alternate iron planes by tin, as in stannite, leaves the system still tetragonal.

[3] Burdick, C. L., and Ellis, J. H., Journ. Amer. Chem. Soc. **39**: 2518. 1917.

BOTANY.—*A synopsis of the Chinese and Formosan species of Albizzia.* P. L. Ricker, Bureau of Plant Industry.

In a study of the specimens of Albizzia collected in China by Mr. Frank N. Meyer, agricultural explorer of the U. S. Department of Agriculture, specimens were found not agreeing with the descriptions of existing species, and, as a further examination of the material in the U. S. National Herbarium and a part of the material in the Arnold Arboretum showed the determinations of many of the specimens to be in a state of confusion, it became necessary to make a critical study of the material in order to determine what names to use. All of the Chinese species thus far reported belong to the subgenus Eualbizzia.

Sect. I. Macrophyllae. Leaves 1–4-pinnate, leaflets 3–6-pinnate, mostly broad and large, 2–4.5 cm. broad and 4–9 cm. long, the costa slightly or not all excentric.

A. Flowers pedicellate.

Albizzia bracteata Dunn, Journ. Linn. Soc. Bot. **35**: 493. 1903.

This species is distinguished from all of the nearest related species by its pedicellate flowers.

China: Yunnan; Meng-tsze, Szemao, *Henry* 9997A–E, 4500-5000 feet altitude.

AA. Flowers sessile.

Albizzia meyeri Ricker, nom nov.

Mimosa lucida Roxb. Fl. Ind. (**2**: 344. 1824?) ed. 2. **2**: 544. 1832. Not Vahl, 1807.

Albizzia lucida Benth. Lond. Journ. Bot. **3**: 86. 1844.

Name in honor of Frank N. Meyer, agricultural explorer of the U. S. Department of Agriculture, in recognition of his valuable botanical explorations in China.

China: Yunnan; Meng-tsze, *Henry* 9373A.

Sect. II. Obtusilobiae. Leaves 2–6 (rarely 8–9)-pinnate, leaflets 4–25-pinnate, ovate or oblong, obtuse, mostly less than 4 cm. long, the base broader or scarcely inequilateral, the costa somewhat excentric.

A. Flowers in pedicellate heads, the peduncle axillary or short racemose; corolla often up to 6 mm. long; leaflets 1–3.5 cm. long.

B. Pods noticeably stalked (5 mm. long), gradually tapering at apex and base.

Albizzia kalkora (Roxb.) Prain, Journ. Asiat. Soc. Beng. **66:** 511. 1897.

Mimosa kalkora Roxb. Hort. Beng. 40. 1814, nom. nud.; Fl. Ind. ed. 2. **2:** 547. 1832.

Acacia macrophylla Bunge, Mém. Sav. Étr. Acad. Sci. St. Petersb. **2:** 135. 1833.

The identity of Roxburgh's name was unknown until it was taken up by Prain who doubtless had opportunity to examine authentic specimens. Bunge's name (type specimen from Pang-shan) has been considered by Forbes and Hemsley a synonym of *A. lebbek* L. The latter species is quite widely cultivated in the tropics, the type being from Egypt. The glands on the leaf are variable. In addition to the glands always found between the middle and base of the petiole, another gland is usually found either just below the lower or upper pairs of pinnae, and on some leaves the gland is found below every pair of pinnae. Some authors have used the position of the gland on the petiole as a character for separating species of Albizzia, but its position is entirely too variable to warrant such use.

CHINA: Province of Shantung; Boshan, *F. N. Meyer* 768a (S. P. I. 21969), Sept., 1907. Province of Chili; Pang-shan, *F. N. Meyer* 865a (S. P. I. 22618), Nov. 23, 1907. Province of Fokien; *Dunn's expedition*, May 25, 1905. Province of Hupeh; *Henry* 1605, 2870A, 6203; *Wilson* 511, May, 1900. Province of Kiangsu; near Nanking, *F. N. Meyer* 1448, June 4, 1915. Province of Shantung; Tsingtau, *Zimmermann* 211, 1901; Laushan, *F. N. Meyer* 305, Aug., 1907.

BB. Pods sessile, acute or obtuse at apex and base.

C. Flowers glabrous except tips of corolla lobes.

Albizzia henryi Ricker, sp. nov.

A large shrub or small tree 2.5–6 meters tall; leaves and pinnae 1–2-pinnate; leaflets 5–10-pinnate, thin, glabrous, oblong or oblong-elliptic, 2–3 cm. long, 1–2 cm. broad, the midvein but slightly excentric; flowers 1 cm. long, many in heads on axillary peduncles 4–9 cm. long, the pedicels 5–6 mm. long, glabrous; calyx 4–4.5 mm. long, glabrous, with shallow teeth; corolla white, puberulent only at the tips of the lobes; pods nearly sessile, 13–14 cm. long, 22–28 mm. wide, coriaceous, abruptly obtuse at both ends, mucronate-pointed; seeds smooth, brown, elliptic, thin, 8–9 mm. long, 4.5–5.5 mm. wide.

CHINA: Yunnan; Meng-tsze, *A. Henry* 10683, in flower May 29, in fruit June 30, 1896. (Type in U. S. Nat. Herb.).

CC. Flowers puberulent throughout.

Albizzia lebbeck (L.) Benth. Lond. Journ. Bot. **3**: 87. 1844.

Mimosa lebbek L. Sp. Pl. 516. 1753.

I have not seen Henry's specimen from Ichang reported by Forbes and Hemsley, but think it probable that it is *A. kalkora*, as are most of the specimens from China that have been named as above. It is doubtful if the true *A. lebbek* is found wild in China except rarely as an escape from cultivation around some of the larger cities. The only apparently genuine specimen I have seen from China was from Hong-kong. *A. macrophylla* Bunge, usually referred here as a synonym, is quite distinct and is a synonym of *A. kalkora*.

AA. Flowers in heads, long pedicelled; heads in subcorymbose racemes; leaflets less than 2.5 cm. long.

Albizzia retusa Benth. Lond. Journ. Bot. **3**: 90. 1844.

This species is distinguished from its nearest relative, *A. pedicellata* Baker, by having its leaflets only 6–10-pinnate instead of 15–20-pinnate as in that species.

FORMOSA: South Cape, *Henry* 992. It is also found in the Philippines.

AAA. Flowers axillary, sessile or very shortly pedicelled, small; corolla 4 or rarely 6 mm. long; peduncles short, fascicled, often in numerous short leafless panicles.

B. Flowers glabrous.

Albizzia corniculata (Lour.) Ricker, nom. nov.

Mimosa corniculata Lour. Fl. Cochinch. 651. 1790.

Albizzia millettii Benth. Lond. Journ. Bot. **3**: 89. 1844.

CHINA: Hong-kong, *Ford; C. Wright* in 1853–56; *Sargent,* Nov. 5, 1903. New Territory, *Mrs. L. Gibbs,* 1909. Lung-chau; Kwang-si, *H. B. Morse* 655.

BB. Flowers pubescent or puberulent.

C. Leaflets 6–8-pinnate.

Albizzia procera (Roxb.) Benth. Journ. Bot. **3:** 89. 1844.

Mimosa procera Roxb. Pl. Corom. **2:** 12. *pl. 121.* 1798.

This species has the costa but slightly excentric and the widest half of the leaflet turned towards the tip of the leaf instead of the narrowest half as is usual in most species.

CHINA: *Henry* 1613.

CC. Leaflets 8–25-pinnate.

Albizzia odoratissima (Willd.) Benth. Lond. Journ. Bot. **3:** 88. 1844.

Mimosa odoratissima Willd. Pl. Corom. **2:** 12. *pl. 120.* 1798.

CHINA: Yunnan; Meng-tsze, *Henry* 9910, 10811A.

Albizzia odoratissima mollis Benth. in Hook. Fl. Brit. Ind. **2:** 299. 1878.

CHINA: Yunnan; Tapin-tze, *Delavay* 658.

Sect. III. FALCIFOLIAE. Leaves many(5–10)-pinnate; leaflets many(10–40)-pinnate, small(5–10 mm. long), often falcate; costa close to the upper margin.

A. Stipules linear, caducous; leaflets 10–20-pinnate.

Albizzia julibrissin Scop. Del. Insubr. 18. *pl. 8.* 1786.

Acacia julibrissin Willd. Sp. Pl. **4:** 1065. 1806.

Forms of this species are occasionally found with the branches, foliage, and inflorescence densely pubescent or even velutinous throughout (*A. julibrissin mollis* (Wall.) Benth.). The commonest form, however, has these parts but slightly pubescent or almost glabrous.

CHINA: Hupeh: *Henry,* without locality, 6185; *Wilson* 792, 1315, 2032 without locality. Chili; Peking, *Sargent,* Sept. 18, 1903; Tientsin, *Meyer* 1001, June 12, 1913.

COREA: Chemulpo, *Faurie,* Sept. 28, 1901; Quelparte, *Faurie* 1695, July, 1907; *Jaquet* 728, without locality, July, 1908.

AA. Stipules broad, coriaceous, caducous; leaflets 20–40-pinnate.

Albizzia chinensis (Osbeck) Merrill, Amer. Journ. Bot. **3:** 575. 1916.

Mimosa chinensis Osbeck, Dagbok Ostind Resa 233. 1838.
Mimosa marginata Lam. Encycl. **1:** 12. 1783.
Mimosa stipulata Roxb. Hort. Beng. 40. 1814, nom. nud.
Acacia stipulata D. C. Prodr. **2:** 469. 1825.
Mimosa stipulacea Roxb. Fl. Ind. ed. 2. **2:** 549. 1832.
Acacia marginata Hamilt.; Wall. Cat. No. 5243. 1832, nom. nud.
Albizzia stipulata Boivin, Encycl. XIX Siecle **2:** 33. 1838.
Albizzia marginata Merrill, Philipp. Journ. Sci. Bot. **5:** 23. 1910.

There are no specimens of this species in the National Herbarium or Arnold Arboretum from China. Osbeck describes it from an island near Wampoa (not far from Canton), where it had probably been introduced from Cochin-china, Siam, Java, or the Philippines, where it is a native.

CHINA: Hong-kong, *Hance;* Hainan, *B. C. Henry.*

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*The work of the National Bureau of Standards on the establishment of color standards and methods of color nomenclature.* IRWIN G. PRIEST. Trans. Illum. Eng. Soc. **13**: 38. February 11, 1918.

This paper deals in a descriptive and enumerative way with the Bureau of Standards "Color Standards Investigation." The present status of color standards and color specification is considered, special emphasis being placed on the lack of standards, established nomenclature, suitable instruments, etc.

A Committee of the Illuminating Engineering Society to cooperate with the Bureau in establishing standards and nomenclature is proposed. I. G. P.

ELECTRICITY.—*A method for testing current transformers.* F. B. SILSBEE. Bureau of Standards Scientific Paper No. 309 (Bull. Bur. Stds. **14**). 1917.

In measuring large amounts of electric power it is usual to employ current transformers which supply to the measuring instruments a small current bearing an accurately known relation to the large current to be measured. Several very accurate methods are available for determining this relation between the two currents but they involve the use of rather sensitive and therefore delicate apparatus.

The present method is intended for the use of the smaller central stations and laboratories which may wish to test current transformers with moderate accuracy but have not the facilities for the more complicated methods. It consists in connecting the transformer under test in series with a standard calibrated transformer of the same nominal ratio, the secondary windings also being connected in series. A measuring circuit is bridged across between the transformers and serves to carry any difference which there may be in the secondary currents.

The detector should be sensitive to 0.00005 ampere. The moving coil of a commercial wattmeter, the current coil of which is separately excited, is suitable for this purpose.

Two modifications of the general method are described in detail in the paper. F. B. S.

PHYSICAL CHEMISTRY.—*Gas interferometer calibration.* J. D. EDWARDS. Bureau of Standards Scientific Paper No. 316. 1917.

The Rayleigh-Zeiss gas interferometer which finds numerous applications in precision and technical gas analysis is usually calibrated by means of gas mixtures analyzed by chemical methods. The new method here proposed requires only the use of a pressure gage and a knowledge of the refractive indices of the gases for which the calibration is desired. It is based upon the relation between the density and the refractivity of a gas and the relation between the composition and refractivity of gas mixtures. J. D. E.

GEOLOGY.—*Phosphatic oil shales near Dell and Dillon, Beaverhead County, Montana.* C. F. BOWEN. U. S. Geological Survey Bulletin 661-I. Pp. 6. 1918.

The oil shale that promises to be valuable occurs south of Dillon, Montana, at about the same horizon as the phosphate deposits of Montana, Idaho, and Wyoming and, in addition to the oil it yields, contains considerable phosphate. Laboratory tests have shown that the phosphate is not driven off by distillation, and the fact that the shale yields oil on distillation and yet retains a notable quantity of phosphate in the ash presents to the technologist a problem whose solution may be of economic value. R. W. STONE.

GEOLOGY.—*Gold placers of the Anvik-Andreafski region, Alaska.* GEORGE L. HARRINGTON. U. S. Geological Survey Bulletin 662-F. Pp. 17, with geologic sketch map. 1917.

Paying placers have been found on both sides of a greenstone ridge intruded by granitic rocks. Quartz veins related in origin to the intrusives are the source of the gold. Other mineral resources are coal and mineral springs. G. L. H.

GEOLOGY.—*Geologic structure of the northwestern part of the Pawhuska quadrangle, Oklahoma.* K. C. Heald. U. S. Geological Survey Bulletin 691-C. Pp. 44, with maps and sections. 1918.

This paper describes those geologic features of a portion of the Pawhuska quadrangle, Oklahoma, which bear on the occurrence, discovery, and development of commercial quantities of oil or gas. The rocks that crops out in the area are shown in a generalized stratigraphic section, but the characteristics and extent of certain beds of value in mapping the structure of the region are described fully. The probable character of the rocks to a depth of 4000 feet below the surface is also described, and some evidence is given by graphic representation of well records and stratigraphic sections. R. W. Stone.

GEOLOGY.—*The Flaxville gravel and its relation to other terrace gravels of the northern Great Plains.* Arthur J. Collier and W. T. Thom, Jr. U. S. Geological Survey Professional Paper 108-J. Pp. 5. 1918.

The Flaxville gravel in Montana is from a few feet to 100 feet thick and is composed of well-rounded quartzite and argillite pebbles from the Rocky Mountains but it contains also sand, clay, marl, and volcanic ash. It rests upon a series of plateaus which are cut on the Fort Union, Lance, and Bearpaw formations and which range in altitude from 2600 feet at the east to 3200 feet at the west. Fragmentary fossils collected at 25 well-distributed localities show that the formation can not be older than Miocene nor younger than early Pliocene.

R. W. Stone

GEOLOGY.—*The Dunkleberg mining district, Granite County, Montana.* J. T. Pardee. U. S. Geological Survey Bulletin 660-G. Pp. 7, with 1 plate and 1 figure. 1917.

The ore deposits, which have been worked intermittently during the last 30 years and have produced $200,000 worth of silver and lead, occur in limestone, sandstone, and shale of Cretaceous age and also in diorite sills that have invaded these rocks. Except one, which is a contact-metamorphic body of zinc ore, the deposits are simple quartz veins in fissures that follow inclined bedding planes or cut across the sedimentary beds and the sills. Silver-bearing galena and carbonate derived from it are the most valuable minerals, though zinc blende is locally abundant. J. T. P.

TECHNOLOGY.—*The properties of Portland cement having a high magnesia content.* P. H. BATES. Bureau of Standards Technologic Paper No. 102. Pp. 42. January 19, 1918.

The question of the maximum amount of magnesia allowable in Portland cement is one of the most interesting encountered in the study of this complex material. There is still much diversity of opinion. Magnesia in amounts not greater than 8 per cent is believed by many to be harmless, whereas others consider amounts greater than 4 per cent injurious.

It was considered very desirable to investigate the subject because failures of mortars and concrete were attributed to high magnesia content and especially so since all investigations to date have been somewhat at fault.

A series of cements have been burned in the experimental rotary kiln of the Bureau in which the limestone used in the raw material was replaced in part or in whole by dolomite. Cements were thus obtained in which the magnesia content varied from 1.77 per cent to 25.53 per cent. The results obtained show that cements when containing not more than approximately 8 per cent magnesia will produce concretes with satisfactory strength at the end of one and one-half years. At this amount of magnesia, monticellite and spinel (constitutents not present in cement of lower magnesia content) appear; and those cements seem to hydrate with a large increase in volume.

P. H. B.

TECHNOLOGY.—*The determination of absolute viscosity by short-tube viscosimeters.* WINSLOW H. HERSCHEL. Bureau of Standards Technologic Paper No. 100. Pp. 55. November 9, 1917.

The Engler and the Saybolt Universal viscosimeters, which are the instruments usually employed in the oil trade, have such short outlet tubes that the equation for the flow through long capillary tubes is not applicable without correction factors. The literature has been carefully reviewed and further experimental work has been done. The conclusion is reached that water is not a suitable liquid for use in finding the relation between viscosity and time of discharge for short-tube viscosimeters, and that Ubbelohde's equation, and all others based upon it, are seriously in error.

W. H. H

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on Monday, March 25, 1918. A majority of the committee appointed at the preceding meeting to consider the project of publishing reviews of articles from foreign journals on problems connected with the war reported adversely on the project, principally on account of the lack of editorial facilities for such purposes. A committee consisting of Messrs. MAXON, KNOPF, DORSEY, SOSMAN, and SCOFIELD was appointed to offer plans for making the JOURNAL more systematically and equally representative of the different branches of science, and more useful to the affiliated societies. A committee consisting of Messrs. SOSMAN, KEARNEY, and BARTSCH was appointed to confer with the Board of Management of the Cosmos Club on facilities for the scientific society meetings in the new assembly hall of the Club.

ROBERT B. SOSMAN, *Corresponding Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 800th meeting was held at the Cosmos Club, February 2, 1918; Vice-President HUMPHREYS in the chair; 19 persons present. The minutes of the 800th meeting were read in abstract and approved.

Mr. W. S. GORTON presented a paper on *X-ray protective materials.* The importance of the purpose served by X-ray protective materials is generally recognized. A thorough comprehension of the subject involves knowledge of both the physical and physiological properties of X-rays.

X-rays are generated by the stoppage of cathode rays by matter. They may be classified as soft and hard; synonyms for these terms are "easily absorbed" and "penetrating." It is now known that X-rays are like light waves but of shorter wave length. The penetrating power increases with decreasing wave-length. Methods of measuring quality are as follows: 1, absorption in some substance, generally aluminum; 2, parallel spark gap; 3, wave length; 4, Benoist penetrometer. The last device has been shown (at the Bureau of Standards) to be of practically no use with a modern transformer outfit.

The physiological effects of X-rays may be classified as superficial and deep-seated. The former class comprises X-ray "burns." These burns are due to the absorption of very soft rays by the skin. They have frequently led to loss of life. Cancer has also resulted from X-ray burns. The latter class comprises the destruction of the lymphocytes and of the tissue forming them, with consequent deleterious effect on the bodily economy. The former class of lesion is the more important practically.

The absorption coefficient of a substance is defined as the quantity λ in the expression:

$$I = I_0 e^{-\lambda d}$$

for the intensity I of a homogeneous beam of X-rays at a point d centimeters below the surface. λ increases with increasing wave length. X-ray absorption is independent of the state of chemical combination of the absorbing elements. Weight for weight, elements of high atomic weight are more efficient absorbers than those of low atomic weight.

Of the elements of high atomic weight lead is, for practical reasons, always used for protection from X-rays. It is used in the metallic state and also as the oxide in glass and rubber. Silk loaded with a lead salt has also been used.

There is no general agreement as to the thickness of lead necessary to give adequate protection. The amount, of course, would depend upon the quantity and quality of the rays against which protection is necessary. For long exposures the German Röntgen Society advocates one of the following: metallic lead, 2 mm. thick; lead rubber, 8 mm. thick; lead glass, 10 to 20 mm. thick.

In estimating the protection offered by protective materials it is much more convenient to ascertain the amount of lead contained in the material than to measure the absorption coefficient. This latter varies with the hardness of the rays used and with the constitution of the beam. Lead is a standard and easily reproducible substance and a knowledge of the lead content of a piece of protective material will enable the user to estimate easily the protection offered at any time when investigations may have rendered our knowledge of the necessary protection more exact.

The absorption of a piece of protective material is due principally to the lead content. The absorption of the remaining constituents is equivalent, for practical purposes, to that of a certain small additional thickness of lead. The whole piece, therefore, is equivalent to a certain thickness of lead. This statement has been verified experimentally. The simplest method for estimating the protection, and the one used at the Bureau of Standards, is to place the substance to be measured on an X-ray plate beside a series of thicknesses of lead. The density of the plate under the material is then matched with the density of one of the thicknesses of lead. This thickness is termed "the equivalent thickness of lead" for the material. It has been shown experimentally that it is independent of all conditions and is the same if a fluorescent screen is used instead of an X-ray plate. The ratio of the equivalent thickness of lead to the thickness of the material is termed the "protective coefficient" of the material.

The Bureau of Standards purchased in the open market twelve pieces of lead glass for X-ray protective purposes. No information could be obtained about them other than that "the protection is adequate." These pieces averaged about 5 mm. thick. The average protective coefficient was 10 per cent, i.e., on the average each piece of glass was equivalent to 0.5 mm. lead. Two pieces (the most expensive of the lot) had each a protective coefficient of 0.9 per cent and so were worthless for X-ray protection. They were replaced by the vendor.

Samples of lead rubber showed an average protective coefficient of 22 per cent. One piece went as high as 32 per cent.

Correspondence was carried on with several firms relative to the improvements to be desired in protective materials. The results have been most gratifying. It is now possible to obtain materials with the following properties:

SUBSTANCE	PROTECTIVE COEFFICIENT	LEAD CONTENT (BY WEIGHT)	EQUIVALENT LEAD FOR PARTICULAR SAMPLE
	per cent	*per cent*	*mm.*
Plate glass	18	50	1.16
Rubber	48	94	1.17
Bowl (tube holder)	16	47	1.40 (minimum)

The density of practically every sample of protective material received at the Bureau of Standards has been determined. It has been shown that there is a linear (approximately) relation between the density and the protective coefficient.

Discussion: The paper was discussed by Messrs. SILSBEE, SOSMAN, BRIGGS, HUMPHREYS, and WEBSTER.

Mr. P. T. WEEKS then presented a paper on *The efficiency of production of X-rays.*

The term efficiency of production of X-rays is ordinarily taken to mean the ratio of the total energy of the X-rays emitted either from the tube or from the target to the energy supplied to the tube. The value of this efficiency has been found by actual measurement to be of the order of one tenth of one per cent. It has been found to be nearly proportional to the atomic weight of the target. A simple theory of the method of production of X-rays would indicate that the efficiency should be proportional to the potential applied to the tube, and experiments have verified this conclusion so far as it is applied to the general X-radiation. The manner in which the energy of the characteristic radiation varies with the voltage has been only partly determined.

In general two effects have been used for measuring X-ray energy, the ionization produced in a gas and the heating effect on absorption. In most of the determinations of the efficiency only a small energy input could be used and widely varying results were obtained by different observers. The author used a Coolidge tube with much larger energy input and determined the value by a bolometer method. His results indicate that the total X-ray energy emitted, including both that of the characteristics and of the general radiation, is approximately proportional to the third power of the potential, or that the efficiency is proportional to the square of the potential. The actual value found for the efficiency agrees with that found by other observers using the same method.

A consideration of the results obtained by the ionization and bolometer methods indicates that only a fraction of the X-ray energy absorbed by a gas is actually used in the production of ions. The fact that the amount of energy absorbed per ion produced is a variable quantity brings into question the validity of the ionization method of measuring X-ray energy. There is need of further detailed investigation of this particular point.

Discussion: This paper was discussed by Messrs. SOSMAN and WEBSTER.

The 801st meeting was held at the Cosmos Club, February 16, 1918; President BURGESS in the chair; 41 persons present.

Mr. H. E. MERWIN presented a paper on *Complementary colors and the properties of pigments.* The paper was illustrated by samples of pigments.

Consideration must be given to refractive index, pleochroism, and shape of grain as well as to the more commonly considered properties of pigments. Diffusing power is determined primarily by refractive index and size of grain. The blue of scattered light is a prominent constituent of some grays and purples. The optimum size of grain of colored pigments depends upon the manner in which the color is diffused —whether by the colored grains or by admixed grains or by a subjacent diffusing surface.

The refractive index of grains of a black pigment should be equal to the refractive index of the vehicle surrounding the grains. A white pigment should differ as much as possible from its vehicle in this respect.

Mixing white or black with a colored pigment, causes a shifting of hue which depends upon several factors, one of the chief of which concerns the character of the boundary between light that is strongly absorbed and that which is freely transmitted.

The coloring efficiency of a pigment in mixtures producing tints may be very different from its efficiency in mixtures producing shades. A given amount of colored material will "go farther" as a glazing color than in mixtures.

Discussion: The paper was discussed by Messrs. SOSMAN, BANCROFT, and PRIEST.

Mr. I. G. PRIEST then presented a paper on *A precision method for producing artificial daylight,* which was illustrated by lantern slides.

Light having a spectral distribution of energy closely approximating that of daylight (black body at 5000° abs., sun at the earth's surface or sun outside the earth's atmosphere), may be produced by passing the light from an artificial source (acetylene flame, vacuum tungsten lamp, or gas-filled tungsten lamp) through two nicol prisms with a crystalline quartz plate between them, the path of the light being parallel to the optic axis of the quartz, and the thickness of the quartz as well as the angle between the principal planes of the nicols being properly chosen. If three nicols are placed in series in the beam, one quartz plate being placed between the first and second nicols and another quartz plate between the second and third nicols, the approximation to a desired spectral energy distribution may be made still closer.

The rotatory dispersion of quartz has been previously used by others in "chromoscopes," etc. The novelty of the present communication consists solely in showing how the method may be used in producing "artificial daylight," and in presenting precise specifications for producing results.

This method, of course, is not adapted to illuminating large surfaces and so is not a commercial competitor with the blue-glass method or other "artificial daylight." It is, however, very well adapted to use with instruments (photometers, microscopes, etc.) where the quartz-nicol system may be inserted between the eyepiece of the instrument and the observer's eye.

The chief advantages of this method over the blue-glass method are:

1. A much more accurate reproduction of the desired spectral energy distribution. The distributions obtained by the use of blue glass (e.g., Luckiesh's "Trutint" or Corning "Daylight") are always distorted from the desired distribution by a sharp maximum at $\lambda = 570\ \mu\mu$ as well as by a rise in the red for λ greater than $660\ \mu\mu$.

2. Certain reproducibility and definiteness of specifications.

3. Adjustability. By varying the angle between the principal planes of the nicols, the distribution may be slowly changed by known amounts.

Discussion: The paper was discussed by Messrs. Sosman, Crittenden, Burgess, and White.

The third paper, on *A simplified form of Robinson's anemometer,* was presented by Mr. B. C. Kadel. This paper was illustrated by lantern slides.

To begin with, the observer is assumed to have a watch or clock available with which to measure a suitable time interval. The next step is to arrange the anemometer to make electric contact at short intervals, the signal being made audible to the observer by means of a door bell, buzzer, or telephone receiver. The most convenient interval is found as follows:

$$\frac{\text{Distance}}{\text{Time}} = \frac{\text{distance}}{\text{time}} \text{ or } \frac{D}{T} = \frac{d}{t} \text{ in which}$$

D = the linear unit chosen as a measure.
d = the travel of the wind between signals.
T = the time unit chosen as a measure.
t = the time the signals are to be counted.

Whence $d = \frac{tD}{T}$.

Now selecting the customary unit—miles per hour—and letting t be one minute for convenience, we have:

$d = \frac{1 \times 5280}{60} = 88$ feet, which must be the travel between contacts in order that the number of contacts per minute shall be equal to the velocity in miles per hour.

We may now write $t = \frac{dT}{D}$.

We have, therefore, the following rule for the use of the instrument, the same construction answering for any unit of measurement desired:

"The number of signals in 60 seconds equals the velocity of the wind in statute miles per hour.

The number of signals in 52 seconds equals the velocity of the wind in knots per hour.

The number of signals in 27 seconds equals the velocity of the wind in metres per second.

The number of signals in 97 seconds equals the velocity of the wind in kilometers per hour."

It is evident that the customary dial mechanism may be omitted from the instrument entirely, thus eliminating tedious and expensive construction work and lessening the cost. The standard cups, spindle, and bearings have been retained in order to preserve the present relation between wind movement and cup movement; but the framework of the instrument has been made of materials easily available to manufacturers, instead of the tapered tubing used in the old pattern, which requires special orders through the mills for its production.

Gustiness of the wind is indicated in a general way by the variation in the frequency of signal, and the anemometer thus gives information that is lacking in the ordinary one-mile registration.

A similar device has been manufactured by Richard, Paris, for many years, but the contacts are made to actuate a pen arm upon a sheet to produce a continuous record. Mr. Friez, of Baltimore, has marketed an anemometer that makes contact every ½ mile, but it required a table for interpretation of the signals.

The price of the new model is not yet definitely known, but should not exceed \$25 for a complete equipment, as compared with \$100 for standard anemometer and register.

Discussion: This paper was discussed by Messrs. Burgess, Schlink, Herschel, Humphreys, and Briggs.

H. L. Curtis, *Recording Secretary.*

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 523rd meeting of the Society was held in the West Study Room of the Public Library on Tuesday evening, March 12, 1918, at 8 p.m. The speaker of the evening was Mr. Edward T. Williams, Chief of the Division of Far Eastern Affairs, Department of State, who presented a paper on *The origins of the Chinese*. Mr. Williams outlined four theories regarding the origin of the Chinese that deserve examination.

The first, advocated by Dr. L. Wieger, a missionary of the Society of Jesus, is that they originated in the Indo-Chinese Peninsula. His reasons for so believing are, briefly, that

1. The Chinese ideograms have existed since 3000 B.C. and the most ancient represent tropical animals and plants, thus pointing to a tropical country as the place of origin for the race.

But the oldest Chinese ideograms known to the world are not older than 1200 B.C., when the Chinese were already settled in the valley of the Yellow River and in constant intercourse with their neighbors to the south. These ancient ideograms, moreover, represent animals and plants of the temperate zone rather than of the tropics. Those for sheep and cattle are found, too, in many root words, indicating that the early Chinese were shepherds and herdsmen, pursuits not found in tropical countries.

2. Other reasons given for a tropical origin are that the oldest form of the Chinese language is found in southern China today.

3. The Chinese language is purest in the south and grows more and more corrupt as one approaches the north.

4. The Chinese language is tonal, as are the languages of Indo-China, and is therefore most nearly related to these.

It is not necessary, however, to assume a southern origin for the race to account for these facts, which are just as easily explained by the arrival of the Chinese from the north in successive waves of migration, the later comers crowding the earlier further and further towards the south, so that the oldest and purest forms of Chinese would be found just where they are The tonal languages of the Indo-Chinese Peninsula in that case are to be regarded as the languages of the vanguard of the migration.

As a matter of history it is now known that many tribes of Cambodia, Siam, and Burma came from the north, the Tibeto-Burmans from a region as far north as the Tien Shan. Some social or physical change forced these tribes to migrate. The dominant element in the population of Burma did not reach that land until about two or three thousand years ago, while the tribes of Cambodia arrived in their present habitat about 215 B.C. and the Shans, progenitors of the Siamese, ruled southern China until the thirteenth century of the Christian era. The movement of races therefore has been from north to south and not vice versa.

The second theory is that the Chinese originated on the Ame ican continent. This theory does not require much attention. There have been movements of population, it is true, from America to Siberia, even in historical times, and there is cultural and physical similarity if not identity of the peoples on the opposite shores of the northern Pacific. But the tribes of which this is true lie to northeast of China and differ strikingly from the Chinese in physical appearance, language, and social institutions.

The third theory is held by a number of distinguished scholars and declares that the Chinese are autochthonous and their civilization indigenous. It must be admitted that the oldest existing records of China seem to know no other region as the home of the Chinese forefathers than the valley of the Yellow River, and it is held accordingly that they gave up nomadic habits and settled as agriculturists there in an unknown antiquity and that it was there that they developed their civilization, including their written language. As to the last-mentioned the theory is almost certainly wrong. This civilization, including the use of the ideograms, appears to have been shared by surrounding tribes, from among whom in fact some of their most famous rulers came.

One of these tribes, the Chou, headed a league of nine tribes from the west which subdued the Shang Dynasty about 1200 B.C. These tribes were amalgamated with the earlier and much of the culture of China must be ascribed to the Chou. This fact and the enforced migration of the Mon-Khmer, Tibeto-Burmans, and Shans to the south because of some disturbance apparently in central Asia gives plausibility to the fourth theory.

This theory would place the origin of the race in central or in western Asia. A number of distinguished scholars have held this view. Pumpelly's explorations in central Asia have shown that that region was the seat of an ancient civilization as old as 8250 B.C. Great climatic changes have there converted what was once a moist and fertile land into an arid desert and caused the inhabitants to migrate to other parts of the world. It was this perhaps that drove the Sumerians into the Euphrates valley and that forced other peoples down upon the Tibeto-Burmans and caused the movements of population in China. The earliest Sumerian monuments show that people to have been Turanian, not Semitic, and to have had obliquely-set eyes. Dr. C. J. Ball, of Oxford, has shown that there are striking resemblances between the earliest Sumerian ideograms and those of the Chinese. He has also published a vocabulary of more than a thousand words which show similarities of sound and meaning in Chinese and Sumerian. This lends weight to the theory that both have a common origin and that the peoples were probably related. Most of the mounds of central Asia remain to be explored and it is not too much to hope that, in the not far distant future, evidence may be found establishing conclusively that the Chinese race originated in that locality.

In the discussion which followed the paper Dr. Aleš Hrdlička called especial attention to the importance of the whole subject and the urgent need of archeological and anthropological investigations in these regions. Others who discussed the paper were Dr. John R. Swanton, Mr. James Mooney, and Mr. Henry Farquhar.

The 524th meeting of the Society was held in the West Study Room of the Public Library on Tuesday evening, March 26, 1918, at 8 p.m.

A paper on *The origins of the Italian people*, especially prepared for the Anthropological Society of Washington by Dr. V. Giuffrida-Ruggeri, Professor of Anthropology, University of Naples, was presented by Dr. Austin H. Clark, U. S. National Museum.

The author leaves aside all that relates to the Paleolithic age, in the remains of which Italy is less favored than other regions of Western Europe. A more solid ground is encountered in the Neolithic epoch. From the Lombard plains to the Ionic shore of Italy archeologists have repeatedly found circular foundations of huts half buried in the earth, the remains of dwellings of a Neolithic pastoral people. The huts were hollowed in the ground on purpose, perhaps to afford shelter from the wind, and they were entered either by means of steps, or an inclined plane, or a shaft made close to the hut. In the hollows that remain are found weapons of polished stone and various remains of domestic handicraft, including pottery of advanced technique, form, and decoration.

After describing the burials in natural and artificial caves, the author notes the coming of a new people into Italy from the east. These people came in canoes, and, having crossed the Mediterranean, landed on the southern shores of the Italian peninsula as well as in Sicily and Sardinia. They are called Ligures (Liguri) by historians. The Siculi belonged to the same race as the Ligures, and both were physically of the Mediterranean type.

In western Sicily are found similarities to the Iberian civilization, attributable to "that great wave of influence which touched the coast districts of western Europe, bringing with it the dolmen and the dolmen-pottery." The evolution of the "domus de janas" in Sardinia reached its highest development about 2000–1500 B.C. These burials belong to the "Eneolithic" age in which copper was used a well as stone. Whilst the civilization of the dolmen and megalithic monuments flourished in Western Europe and in the Mediterranean region there was a different civilization in Central Europe. There we find evidences of a people who lived in the lake-regions on pile-structures (*palafitte*), a people whose history is written only in the refuse of their daily lives, covered today by water and peat-bogs. This refuse shows us a primitive pottery, the cultivation of flax and grain, and a pastoral life." . . . . "Toward the end of the second millenium B.C. there took place a great movement of peoples into Italy from the north, and the pine-dwellings of eastern Lombary, as well as the hut-dwellings of the Ligures, were deserted by their inhabitants." Later the Umbrians and the Etruscans entered Italy.

The question as to who were the "*Italici*" seems superfluous to the author "for there were no special people of that name. Italy is a historic formation and all the antecedent races who contributed to her making are equally 'Italian' . . . . The population of the 'Eternal City' was *composita*. It probably embraced from early times the representatives of all the three main races of Europe,—the *H. mediterraneus*, *H. alpinus*, and *H. nordicus*."

Frances Densmore, *Secretary*.

SCIENTIFIC NOTES AND NEWS

Professor Henry Adams, one of the charter members of the Academy, died at his residence, 1603 H Street, on March 27, 1918, at the age of eighty years. Mr. Adams was born in Boston, February 16, 1838, the third son of the late Charles Francis Adams, American minister to England during the Civil War. He was a professor of history at Harvard University from 1870 to 1877, and was the author of a number of historical works. He was a member of the Philosophical and Anthropological Societies of Washington, and one of the founders of the Cosmos Club. He had been a resident of Washington since 1877.

Professor Marston T. Bogert, formerly Chairman of the Chemistry Committee of the National Research Council, has been commissioned a lieutenant colonel in the Chemical Service Section, National Army. He succeeds Lieutenant Colonel Wm. H. Walker, who has been commissioned as colonel and has been placed in charge of the new gas-shell plant of the Ordnance Department, near Baltimore. Dr. John Johnston, Executive Secretary of the National Research Council, is acting chairmanof the Chemistry Committee.

Mr. Edmund Heller, of the American Museum of Natural History, has recently returned from an exploring expedition in western China, near the borders of Burma and Tibet, under the auspices of the Museum.

Dr. E. Lester Jones, Superintendent of the U. S. Coast and Geodetic Survey, has been commissioned a lieutenant colonel in the Signal Corps.

Dr. William H. Nichols, of the General Chemical Company, and Prof. C. K. Leith, chairman of the mineral imports committee, were before the House Committee on Mines and Mining on March 27, 1918, to urge action on the bill giving the President power to guarantee prices for war minerals and to provide for governmental control of such minerals. The members of the Committee on Mineral Imports and Exports, representing the Shipping, War Trade, and War Industries Boards, are C. K. Leith, Pope Yeatman, and J. E. Spurr.

Representative B. G. Humphreys introduced in the House of Representatives on March 22, 1918, a bill (H. R. 10954) changing the name of the U. S. Naval Observatory to the U. S. National Observatory, and placing the Observatory under the control of the Secretary and Regents of the Smithsonian Institution. The bill was referred to the Committee on Naval Affairs.

An experimental laboratory has been established in which representatives of the Food Administration and of the Department of Agriculture will cooperate in standardizing war-time recipes and putting them out in the form in which they will be most useful. The work is in line with the laboratory work which the Department of Agriculture has been doing in testing the nutritive value of foods.

The central hall and auditorium of the National Museum have been turned over to the Bureau of War Risk Insurance, which is also occupying a part of the main floor of the Museum. It will be necessary, therefore, to hold the scientific sessions of the National Academy this year in the hall of the Smithsonian Institution.

The spring meeting of the American Physical Society, which has been held in Washington each year (excepting 1912) for the past twelve years, has been transferred to New York this year on account of the difficulty of obtaining accommodations in Washington. The meeting will be held at Columbia University on Saturday, April 27, 1918.

The annual conference of State Geologists was held in Washington at the U. S. Geological Survey on April 3 and 4, 1918. A reception to the geologists was given by the Geological Society of Washington at the Interior Department on the night of Thursday, April 4.

Dr. F. L. Ransome, of the Geological Survey, has recently returned from an extended field investigation of the quicksilver resources of the nation.

The following persons have become members of the Academy since the last issue of the Journal: Mr. Andrew Nelson Caudell, U. S. National Museum, Washington, D. C.; Dr. Charles Wythe Cooke, U. S. Geological Survey, Washington, D. C.; Mr. Harlan W. Fisk, Department of Terrestrial Magnetism of the Carnegie Institution of Washington, Washington, D. C.; Capt. Edward Elway Free, Inspection Division of the Ordnance Department, War Department, Washington, D. C.; Mr. John B. Henderson, 16th St. and Florida Ave., Washington, D. C.; Dr. Charles Dwight Marsh, Bureau of Animal Industry, Department of Agriculture, Washington, D. C.; Mr. P. L. Ricker, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

THE PETROLOGISTS' CLUB OF WASHINGTON

The fiftieth meeting of the Petrologists' Club, held on February 19, 1918, at the home of Whitman Cross, seems a fitting occasion to review briefly the work of the Club during its first eight years of existence, particularly as no report of its meetings and discussions has heretofore been published.

The Petrologists' Club of Washington was organized on January 25, 1910, by a small group of representatives from the Geological Survey and the Geophysical Laboratory. The purpose of the organizers was to provide for the discussion of petrologic problems from all points of view, including those of the physicist and chemist as well as those of the geologist and petrologist; to make the discussion much more informal than was felt to be possible in the public meetings of the

Geological Society, which are devoted rather to the reading and discussion of stated papers on geological subjects; and to include in the discussion problems and hypotheses which were still in an unfinished or only partly developed state.

Meetings have been held regularly at the homes of members, on which account the membership has had to be restricted to forty-five. The following brief list gives some of the subjects selected for discussion, and will serve not only to show the kind of problems considered but also to indicate the direction of petrologic thought and research in recent years:

Eutectics, in the laboratory, in the field, and in their relation to rock classification.

The rôle of mineralizers in magmas.

Ore bodies of magmatic origin.

Water as a primary agent in mineral and rock formation.

The relation between igneous activity and movements of the earth's crust, with especial reference to differentiation, the cause of "petrographic provinces," and the hypothesis of Atlantic and Pacific kindred.

The textures of metamorphic rocks.

The tools and methods of petrography.

The weathering of rocks.

The assimilation of rocks by magmas.

The theory of magmatic stoping.

The forms of silica.

The volume change of rocks on fusion.

The mode of escape of mineralizers from deep-seated bodies of magma.

The origin of large intrusive rock bodies.

Isostasy in its relations to petrographic provinces.

The description of minerals, and of sedimentary, igneous, and metamorphic rocks.

The areal distribution of igneous rocks and of their chemical constituents.

The minor constituents of meteorites.

Pegmatitic rocks and minerals.

The secondary enrichment of ores.

Volcanic gases.

The nature and sequence of magmatic emanations, as shown by pegmatites, volcanic emanations, contact deposits, and mineral veins.

The determination of opaque minerals.

The origin of the Kiruna ores.

The sampling and chemical analysis of rocks.

Some of the meetings have been devoted to reviews of petrologic literature, such as Harker's *Natural History of Igneous Rocks* and Bowen's Later Stages of the Evolution of the Igneous Rocks. Short reports of work in progress have also been given, and the discussion of the results from the field and laboratory points of view has never failed to bring out aspects of interest and thus to add to the value of field observations and laboratory experiments. The hopes of the organizers of the Club have been abundantly justified by the results.

R. B. S.

THE ONE HUNDREDTH ANNIVERSARY OF THE FOUNDING OF THE AMERICAN JOURNAL OF SCIENCE.

Dr. George F. Becker, of the Geological Survey, has written the following letter to Prof. E. S. Dana on the occasion of the one-hundredth anniversary of the founding of the *American Journal of Science*.

March 9, 1918.

Dear Dana:

That a scientific journal should have lasted one hundred years is much: that for a century it should have been conducted by only the founder, his son-in-law, and his grandson is, I believe, unexampled. To me it is appalling to reflect upon the drudgery your family has undergone in order that students of science might teach what they know and learn what their fellows thought. With all possible allowances for pride of achievement and for satisfaction in the respect of every member of the scientific public, you and your kin must have been sorely afflicted with the New England conscience.

Up to about the time of our Civil War *Silliman's Journal* was partly devoted to reproducing in full important papers which appeared in European journals, to which few American readers had access. This was a function on which Louis Agassiz laid stress, considering it however as a matter of course. The younger men of today would incline to regard such a policy as provincial; but it was not. In the first half of the last century the number of scientific workers in the whole world was very limited, and papers recognized as important were reproduced in extenso in most of the great journals such as the *Philosophical Magazine*, the *Annales de Chemie et de Physique*, *Poggendorff*, etc. It was assumed that the representative reader had access to no other similar periodicals and was entitled to the news of the day. Neither were bits of useful information then excluded. In hunting up a translation by Thomas Young in the *Philosophical Magazine* of a paper by Laplace on the construction of curves by their radii of curvature (a method afterwards reinvented by Kelvin), I came upon a serious discussion of how best to keep your razors sharp when your beard becomes wiry!

To me, and I fancy to a large part of the retiring generation, the file of the American Journal seems a monument to James D. Dana. Who but he was industrious enough and nearly enough omniscient to deal with the whole range of scientific thought? Young men in this Survey think of him as a mineralogist, or a geologist, and do not know that he began his career as an instructor in mathematics and in early life achieved fame as a zoologist. Louis Agassiz in 1847 wrote as follows to Milne-Edwards:

"Among the zoologists of this country I would place Mr. Dana at the head. He is still very young, fertile in ideas, rich in facts, equally able as a geologist and mineralogist. When his work on corals is completed, you can better judge of him. One of these days you will make him a correspondent of the Institute, unless he kills himself with work too early."

This prediction was fulfilled twenty six years later. Dana became a corresponding member of the Institute in 1873, not as a geologist or mineralogist, but in the section of anatomy and zoology; and I am told that for the most part the conclusions he drew from his studies of the crustacea nearly 80 years ago are still accepted.

Dana's kindness and helpfulness to his old pupils has often been recorded. This goodness was not confined to them: it was extended to me whom he never saw and it heartened me when I needed encouragement. His very last letter was spontaneous and without other occasion than to inform me of a favorable opinion by H. A. Newton on a bit of my work. He could have saved himself the trouble of writing, but preferred to give pleasure.

Berzelius is said to have remarked that he was the last chemist who would know all chemistry, the idea being that no younger man could catch up. The anecdote is at least "ben trovato," and Berzelius was the man to realize the fact. Dana in 1879 may be said to have been a complete master of geology, but he did not realize his loneliness. Just at the time Clarence King appointed me on this Survey, Dana counseled him to choose no assistant who could not do his own stratigraphy, paleontology, mineralogy, and lithology! Fortunately, King saw the impossibility of setting up a standard that would have excluded everybody but Dana.

The Journal has exerted a potent influence on science in America. Its banner afforded a rallying point for a few idealists when there was imminent danger that Philistinism would gain complete control of a nation struggling with natural resources almost excessive in their abundance. It has been one of the landmarks of our independent nationality, for such a journal could not have thriven in a mere colony. It stimulated the spirit of investigation and helped to guide the development of research along sane and sound lines. For a time it constituted the scientific periodical literature of the country, and if today it is only one of numerous periodicals devoted to science, many of them may well be regarded as offshoots from the *American Journal of Science*.

Salve!

Sincerely yours,

George F. Becker.

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CHEMISTRY.—*Crystals of barium disilicate in optical glass.*
N. L. Bowen, Geophysical Laboratory. (Communicated by J. C. Hostetter.)

In optical glass of the variety known as "barium crown," and especially in those types rich in barium, there frequently form in the melting furnace numerous six-sided crystal plates

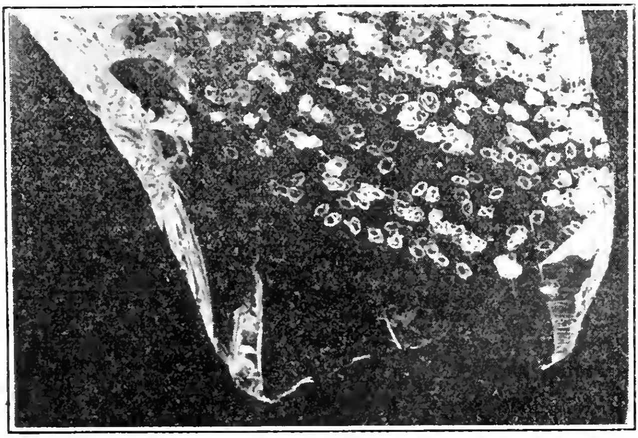

Fig. 1. Fragment of barium crown glass showing crystals of $BaSi_2O_5$ with "frayed" edges. (Natural size.)

upwards of 3 mm. in diameter. These crystals are colorless and transparent in their central portions but are surrounded by white opaque rims that render them very conspicuous (see photograph, fig. 1). A piece of glass containing these crystals, with their marked symmetry of outline and their common arrangement with greater dimensions parallel to flow lines in the glass, constitutes a specimen of much beauty and perhaps of some interest to the mineralogist, though nothing could be more ruinous to the glass for optical purposes than this incipient crystallization. Even glass which comes from the melting furnace free from this defect may devitrify during subsequent heat treatment with formation of crystals of the same nature, though in this case of much smaller dimensions. One step in an investigation designed to discover the best conditions for avoiding the formation of these crystals involved a determination of their nature.

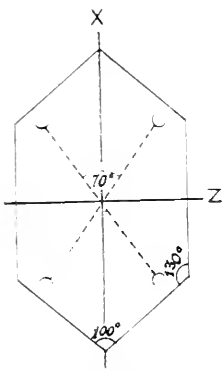

Fig. 2. $BaSi_2O_5$ showing optical orientation.

Under the microscope the larger crystal plates that form in the melting furnace are found to be about 0.03 mm. thick in the transparent central portion, which is a single crystalline unit of uniform orientation. Around the edges of the larger crystal, however, innumerable tiny crystals, each identical in nature and in habit with the larger crystal, have sprouted out in all directions. These tiny crystals with their interstitial glass, giving diffusion of light, constitute the white opaque rims of the larger crystals. The arrangement recalls the feldspar microlites with fibrous edges sometimes seen in rocks.[1]

The crystal plates have the shape of an elongated hexagon as shown in figure 2, and are about 3 mm. long and 2 mm. wide. The terminal angles as measured under the microscope are approximately 100° and the lateral angles 130°. As shown by their symmetry, taken together with their optical properties, the crystals are orthorhombic. There is a good cleavage parallel to the elongation. The elongation is always negative. The plane of the optic axes is parallel to the platy development and the optical character negative with $2V = 70°$ approximately. The refractive indices are: $\gamma = 1.613$ and $\alpha = 1.595$, as measured in immersion liquids under the microscope.

[1] Figured by J. P. Iddings in Rock Minerals, p. 215, 1911.

The optical properties correspond with those of no crystals hitherto described. In casting about for a possible composition for the crystals the orthorhombic symmetry of $K_2Si_2O_5$ was recalled together with the general tendency towards isomorphism of potassium and barium compounds and it was thought possible that the crystals might be $BaSi_2O_5$. Accordingly a mixture of that composition was made up and melted in a platinum crucible and this was found to give on cooling a homogeneous crystalline mass having optical and crystallographic properties identical with those exhibited by the crystals in the glass. The refractive indices were determined on this pure material, on which they can be determined with greater accuracy than on the very thin crystals embedded in glass. They are as follows: $\gamma = 1.617$, $\alpha = 1.598$.

It is probable that the slightly lower values given for the crystals in the glass represent a real difference and that when formed from the glass they take a small amount of alkaline disilicate into solid solution, but this cannot be definitely decided without measurements on larger crystals that will permit of greater accuracy. The very minute crystals formed by devitrification of the glass at low temperatures appear to have indices that are even somewhat lower still, suggesting that they have a larger amount of alkaline disilicate in solid solution. The probability of solid solution between barium disilicate and potassium disilicate is very great, for they show a striking degree of isomorphism, the corresponding angles of potassium disilicate being, within the limits of error of measurement under the microscope, exactly the same as those here found for barium disilicate.[2] In subsequent work a detailed study of solid solution between these compounds will be made.

Barium disilicate appears not to have been prepared and studied before and this note has been written to place its properties on record. To make it more complete the melting point has been determined. It was found to melt congruently at 1426°C., as determined with a platinum-rhodium thermo-element and potentiometer system. The only reference in the literature to

[2] See crystals figured by Fenner in a paper by G. W. Morey (*New crystalline silicates of potassium and sodium.* Journ. Amer. Chem. Soc. 33: 228, fig. 4. 1914.)

$BaO. 2SiO_2$ is given in Gmelin-Kraut, where it is stated that a mixture of that composition melts to a clear glass.[3] This observation was confirmed and the refractive index of the glass was measured and found to be 1.606.

J. W. French describes a crystal enclosed in "optical flint glass" which is hexagonal and beautifully regular and shows "stream lines" about its edges.[4] From the general description I would consider it possible that his crystal was identical with those of barium disilicate here described were it not for the fact that he noted no colors in polarized light. This may, however, have been due to the extreme thinness of his crystals. It is true the glass is called a flint glass which, in speaking of optical glass, means a lead glass; but it is also stated that the source of the glass and its composition are unknown.

I am indebted to Mr. L. H. Adams for the photograph of the glass specimen, to Mr. Olaf Andersen for a survey of the literature in search of previous information on barium disilicate, and to Mr. G. W. Morey for calling to my attention the article by French.

GEOLOGY.—*Correlation of the Tertiary geologic formations of the southeastern United States, Central America, and the West Indies.*[1] THOMAS WAYLAND VAUGHAN, Geological Survey.

The present paper contains tabular statements of the results derived from prolonged investigations of the stratigraphic equivalence of the Tertiary geologic formations in the South Atlantic and Gulf Coastal Plain of the United States, Mexico, Central America, and the West Indies. The tables are excerpted from two larger papers I now have in course of publication, referred to in the foot-note below,[2] but as the two papers men-

[3] GMELIN-KRAUT, Handbuch der Anorganischen Chemie, **3**[1]: 237–238.

[4] Trans. Optical Soc. **16**: 224. 1916.

[1] Published by permission of the Director of the U. S. Geological Survey.

[2] VAUGHAN, T. W., *The biologic character and geologic correlation of the sedimentary formation of Panama in their relation to the geologic history of Central America and the West Indies.* U. S. Nat. Mus. Bull. 103 (in press); *Cenozoic history of Central America and the West Indies.* Geol. Soc. Amer. Bull., vol. 29 (ready for press).

tioned are not likely to be distributed within less than twelve months and as there is considerable demand among geologists for the stratigraphic results contained in them, it is desirable at least to publish promptly the tabular summaries.

Tables such as those here given are necessarily based on the work of many men, and I wish to express my indebtedness to E. W. Berry, J. E. Brantly, C. W. Cooke, J. A. Cushman, W. H. Dall, Alexander Deussen, E. T. Dumble, E. N. Lowe, W. C. Mansfield, G. C. Matson, G. S. Rogers, E. H. Sellards, E. W. Shaw, H. K. Shearer, and L. W. Stephenson, who have contributed to the literature on the Tertiary formations of the southeastern and southern United States during the past six years. I have also had the benefit of the unpublished results of F. Canu and R. S. Bassler on the Tertiary Bryozoa of the Coastal Plain of the United States and of Miss Julia Gardner on the Mollusca of the upper Miocene of Virginia and North Carolina and of the lower Miocene (the Alum Bluff formation and its members) of Florida. More specific referrences to the contributions of these investigators will not be made in this place.

Recently the Director of the U. S. Geological Survey, in fulfilment of a cooperative agreement between the Geological Survey, the Canal Commission, and the Smithsonian Institution, transmitted to the Secretary of the Smithsonian Institution the manuscript and illustrations for a volume entitled *Contributions to the Geology and Paleontology of the Canal Zone, Panama, and Geologically Related Areas in Central America and the West Indies. Prepared under the direction of T. W. Vaughan.* This volume contains the following papers: Preface, by T. W. VAUGHAN; On Some Fossil and Recent Lithonamnicae of the Panama Canal Zone, by M. A. HOWE; The Fossil Higher Plants from the Canal Zone, by E. W. BERRY; The Smaller Fossil Foraminifera of the Panama Canal Zone, by J. A. CUSHMAN; The Larger Fossil Foraminifera of the Panama Canal, by J. A. CUSHMAN; Fossil Echini of the Panama Canal Zone and Costa Rica, by R. T. JACKSON; Fossil Bryozoa from the Canal Zone and Costa Rica, by F. CANU and R. S. BASSLER; Crustacea Decapoda from the Panamanian Region, by M. J. RATHBUN; Cirripedia from the Panama Canal

Zone, by H. A. PILSBRY; Fossil Corals from Central America, Cuba, and Porto Rico, with an Account of the American Tertiary, Pleistocene, and Recent Coral Reefs, by T. W. VAUGHAN; The Sedimentary Formations of the Panama Canal Zone with especial reference to the Stratigraphic Relations of the Fossiliferous Beds, by D. F. MACDONALD; The Biologic Character and Geologic Correlation of the Sedimentary Formations of Panama, in their relation to the Geologic History of Central America and the West Indies, by T. W. VAUGHAN. These memoirs are in press as Bulletin 103 of the U. S. National Museum.

A set of memoirs on the Lesser Antilles and Cuba, similar to that on the Canal Zone, is almost complete, and will be submitted to the Carnegie Institution of Washington for publication. The stratigraphic results procured from the West Indian investigations have been utilized in making geologic correlations.

CORRELATION OF THE TERTIARY FORMATION OF THE SOUTH ATLANTIC AND EASTERN GULF COASTAL PLAIN

Table 1 indicates the present status of the correlation of these formations, and although it may have to be modified to accord with the results of additional investigations, there seems to be every reason to believe that subsequent changes will be only in matters of minor refinement. However, I wish to say that in my opinion four paleontologic zones will be discriminated and defined in the Chattahoochee formation, and that the collections on which to base these subdivisions have already been made and in large part described, but I will not now discuss those details. I confidently expect the Ocala limestone also to be subdivided into two or more zones, for the genus *Orthophragmina* so abundantly represented in the lower part of the formation appears to be absent in the upper beds.

CORRELATION OF THE TERTIARY SEDIMENTARY FORMATIONS OF PANAMA AND THE WEST INDIES

Three new stratigraphic terms introduced in table 2 need to be briefly defined in this place. More comprehensive definitions are given in my paper on the fossil corals from Central America, Cuba, and Porto Rico.

St. Bartholomew limestone. This formation is of upper Eocene age and is paleontologically characterized by species of *Orthophragmina*, one of which is of stellate form, similar to those recently described by Cushman[3] from the Ocala limestone of Georgia and Florida; by about 30 species of corals, among which the genera *Stylophora*, *Astrocoenia*, *Antilloseris*, *Physoseris*, and *Actinacis* are conspicuous; by many echinoids, which were described by Cotteau; and by some Mollusca and Brachipoda described by C. W. Cooke in a manuscript now awaiting publication. The formation is typically exposed along the shore of St. Bartholomew northwest of St. Jean Bay for a distance of about one and a half miles. The rock is a hard bluish limestone, interbedded at its base with volcanic tuffs and water-worn volcanic fragments.

Anguilla formation. This formation is uppermost Oligocene, if the Aquitanian of Europe is correctly referred to the Oligocene. In the opinion of some paleontologists it would be classified as earliest Miocene. It is paleontologically characterized by certain Foraminifera, described by J. A. Cushman in a report not yet published; by numerous species of corals, among which are the genera *Stylophora*, *Stylocoenia*, *Antillia*, *Orbicella*, *Siderastrea*, and *Goniopora;* by echinoids described by Guppy or by Cotteau, among which are *Echinolampas semiorbis* Guppy, *E. lycopersicus* Cotteau, and *Agasizzia clevei* Cotteau; and by a number of species of Mollusca, described in manuscript by C. W. Cooke. The Mollusca include *Amusium lyonii* Gabb and *Orthaulax pugnax* (Heilprin). I obtained no specimens of *Lepidocyclina* in Anguilla. The type exposure is along the southeast and south shore of Crocus Bay. The material consists of calcareous clay, argillaceous limestone, and more or less pure limestone. The formation unconformably overlies basic igneous rock.

[3] Cushman, J. A., *Orbitoid foraminifera of the genus* Orthophragmina *from Georgia and Florida.* U. S. Geol. Survey Prof. Paper 108: 115-124, pls. 40-44. Dec. 12, 1917.

TABLE

A Provisional Correlation Table of the Tertiary Geologic Formations of

Age of deposits		North Carolina (South of Hatteras axis)	South Carolina (Santee drainage)	South Carolina and Georgia (Savannah drainage)	Georgia (Chattahoochee drainage)
Pliocene		Waccamaw marl	Waccamaw marl	(Not recognized)	
Miocene	upper	Duplin marl Unconformity	Duplin marl ——Unconformity—— Edisto marl	Duplin marl ——Unconformity—— Marks Head marl	
Miocene	middle	(Absent)		——Unconformity——	
Miocene	lower			Alum Bluff formation	Alum Bluff formation
Oligocene	upper middle			Chattahoochee formation	Chattahoochee formation ——Unconformity——
Oligocene	lower				Vicksburg formation
Eocene	upper	Castle Hayne limestone Trent marl	Cooper marl | Barnwell formation	Barnwell formation (with Twiggs clay member)	Ocala limestone
Eocene	middle		McBean formation	McBean formation	McBean formation
Eocene	lower		Congaree shales of Sloan Williamsburg formation	(Probably overlapped)	Wilcox formation
Eocene	lower		Black Mingo formation	(Probably overlapped)	Midway formation

FLORIDA		ALABAMA		MISSISSIPPI	LOUISIANA
Caloosahatchee marl, Nashua marl, Alachua clay, and Bone Valley gravel (largely contemporaneous)	Citronelle formation	Citronelle formation		Citronelle formation	Citronelle formation
Jacksonville formation	Choctawhatchee marl	Pascagoula clay		Pascagoula clay	Pascagoula clay
(Absent)	(Absent)				
— Unconformity —					
Alum Bluff formation	Shoal River marl member Oak Grove sand member Chipola marl member	Alum Bluff formation	Hattiesburg clay	Hattiesburg clay	Hattiesburg clay
Tampa formation	Chattahoochee formation	Chattahoochee formation	Catahoula sandstone	Catahoula sandstone	Catahoula sandstone
Vicksburg group	Marianna limestone (western Florida)	Vicksburg group	Marianna limestone (with Glendon limestone member). Red Bluff clay	Vicksburg group: Byram calc. marl Marianna limestone (with Glendon limestone and Mint Spring calc. marl members). Red Bluff clay	Vicksburg limestone
Ocala limestone		Ocala limestone	Jackson formation	Jackson formation (with Yazoo clay member and Moodys calc. marl member)	Jackson formation
(Buried)		Claiborne group	Gosport sand Lisbon formation Tallahatta buhrstone	Claiborne group: Yegua formation Lisbon formation Tallahatta buhrstone	Claiborne group: Yegua formation St. Maurice formation
(Buried)		Wilcox group	Hatchetigbee formation Bashi formation Tuscahoma formation Nanafalia formation	Wilcox group: Grenada formation Holly Springs sand Ackerman formation	Wilcox formation
(Buried)		Midway group	Naheola formation Sucarnochee clay Clayton limestone	Midway group: Tippah sandstone of Lowe Porters Creek clay Clayton limestone absent or replaced by sand	Midway formation

TABLE

A PROVISIONAL CORRELATION TABLE OF THE TERTIARY

AMERICAN TIME SUBDIVISIONS		PANAMA		JAMAICA	OTHER ANTILLES			
Pliocene		Toro limestone		Manchioneal formation Kingston formation	Pliocene of Guantanamo, Cuba			
Miocene	upper							
	middle	Gatun formation			La Cruz marl (Cuba)	Upper horizon in Martinique	Upper horizon in Santo Domingo	
	lower			Bowden marl	Marl at Baracoa, Cuba	Lower horizon in Martinique	Zones G, H, and I in Santo Domingo (of Miss C. J. Maury)	
Oligocene	upper	Emperador limestone Culebra formation: Upper part of Culebra			Anguilla formation (Anguilla), and beds at many localities in Cuba			
	middle	Culebra formation: Lower part of Culebra and limestone at Tonosi			Coral reef at Guantanamo, Cuba	Antigua formation (Antigua)	Pepino formation (Porto Rico)	Lower horizon in Santo Domingo
	lower	Limestone with *Orthophragmina*, on Haut Chagres[a] and limestone at David (contemporaneous)[b]	Bohio congl[c]	Montpelier white limestone				
Eocene	upper			Cambridge formation Richmond formation	St. Bartholomew limestone (St. Bartholomew) Extensively distributed in Cuba			
	middle	Eocene of Tonosi						
	lower							

[a] Reported by H. Douvillé and referred to "Stampien inférieur" = Vicksburgian = Lattorfian.

[b] May be upper Eocene instead of lower Oligocene.

<table>
<tr><th colspan="2">MEXICO AND CENTRAL AMERICA</th><th colspan="2">SOUTHEASTERN UNITED STATES</th><th>EUROPEAN TIME SUBDIVISIONS</th></tr>
<tr><td colspan="2">Pliocene of Yucatan and Limon, Costa Rica</td><td colspan="2">Waccamaw marl, Nashua marl, and Caloosahatchee marl (nearly contemporaneous)</td><td>Sicilian
Astian
Plaisancian</td></tr>
<tr><td colspan="2" rowspan="2">.</td><td colspan="2">Yorktown formation, Duplin marl, and Choctawhatchee marl (nearly contemporaneous)</td><td>Pontian
Sarmatian</td></tr>
<tr><td>St. Marys formation
Choptank formation
Calvert formation</td><td>Marks Head marl</td><td>Tortonian</td></tr>
<tr><td colspan="2" rowspan="2">Gatun formation (Costa Rica)
Pacific Coast of Nicaragua
Exposures on Isthmus of Tehuantepec</td><td colspan="2"></td><td>Helvetian</td></tr>
<tr><td>Alum Bluff formation</td><td>Shoal River marl member
Oak Grove sand member
Chipola marl member</td><td>Burdigalian</td></tr>
<tr><td colspan="2" rowspan="2">San Rafael formation</td><td rowspan="2">Chattahoochee formation</td><td>Tampa formation</td><td>Aquitanian
Chattian</td></tr>
<tr><td></td><td>Rupelian</td></tr>
<tr><td colspan="2">Manzanilla[b], Costa Rica, and deposits with Pecten aff: P. poulsoni and large discoid orbitoids, Mexico</td><td>Vicksburg group</td><td>Byram calcareous marl
Marianna limestone
Red Bluff clay</td><td>Lattorfian (Sannoisian)</td></tr>
<tr><td>Brito formation of Nicaragua (typical Brito)</td><td>Frio clay
Fayette ss.</td><td>Jackson formation</td><td>Ocala limestone</td><td>Ludian (Priabonian)
Bartonian</td></tr>
<tr><td>Claiborne group</td><td rowspan="3">Near the Texas border</td><td>Claiborne group</td><td>Gosport sand
Lisbon formation
Tallahatta buhrstone</td><td>Auversian
Lutetian</td></tr>
<tr><td>Wilcox formation</td><td>Wilcox group</td><td>Hatchetigbee formation
Bashi formation
Tuscahoma formation
Nanafalia formation</td><td>Ypresian[d]
Sparnacian[d]</td></tr>
<tr><td>Midway formation</td><td>Midway group</td><td>Naheola formation
Sucarnochee clay
Clayton limestone</td><td>Thanetian[d]
Montian[d]</td></tr>
</table>

[c] May belong stratigraphically somewhat higher.
[d] Correlation proposed by E. W. Berry.

La Cruz marl. This marl is of midde Miocene age, as it appears to be slightly higher stratigraphically than the Burdigalian Bowden marl of Jamaica. The fossils obtained in it are described in my paper on the fossil corals of Central America, Cuba, and Porto Rico, and in unpublished manuscripts by J. A. Cushman and C. W. Cooke. Among the corals are the genera *Stylophora, Orbicella, Solenastrea, Thysanus, Siderastrea, Goniopora,* and *Porites. Solenastrea, Siderastrea,* and *Porites* contain species that I have been unable to distinguish from living West Indian species; but the genera *Stylophora, Thysanus,* and *Goniopora* are extinct in the Atlantic Ocean. The type exposure is along the railroad leading east from La Cruz, which is on the east side of Santiago Bay. The formation is well exhibited in the bluffs along the east side of the Bay north of the Morro. The material is a yellowish, very calcareous marl, or an argillaceous limestone, which is as a rule well bedded.

Only one point on the correlation table appears to need special comment, that is whether the limestone containing *Orthophragmina* on Haut Chagres and at David, Panama, should be referred to the uppermost Eocene or to the basal Oligocene. It has been stated above that the Ocala limestone contains large stellate species of *Orthophragmina*, and that I collected a similar species in St. Bartholomew. Of the Eocene age of these deposits, of the typical Brito formation in Nicaragua, and of certain limestones containing *Orthophragmina* in Cuba there seems to be no reasonable doubt. But, according to Douvillé, the small stellate *Orthophragmina* (subgenus *Asterodiscus*) ranges upward into the lower Oligocene. The association of *Asterodiscus*, and small, even non-stellate, species of *Orthophragmina*, with species of *Lepidocyclina* that at some localities are associated with a coral fauna of middle Oligocene affinities has inclined me to the opinion that certain peculiar species of *Orthophragmina* occur in deposits of early Oligocene age. Dr. Cushman, however, is disposed to regard the beds in which these species of *Orthophragmina* were found as of Eocene age. At present the evidence is not decisive, and additional studies are needed.

CRYSTALLOGRAPHY.—*Certain relations between crystalline form, chemical constitution, and optical properties in organic compounds,—I.* EDGAR T. WHERRY, Bureau of Chemistry.

That definite relations can be traced between the refractive indices and chemical constitution of substances has long been recognized. Most work has been done with organic liquids, and it has been found that each element possesses a characteristic refractivity, that the sum of the refractivities of the constituents, modified by their manner of combination, is equal to the molecular refractivity of the compound, and that from this in turn the refractive index can be derived.[1] Data for crystalline inorganic salts have been collected[2] and the relations shown to be similar; in systems other than the cubic (isometric) the mean refractive indices are usually employed. There is of course every reason to expect that the mean indices of crystalline organic compounds could be applied in like manner;[3] but it seemed desirable to inquire into the possibility of correlating the several indices of a given substance with its crystal structure instead of concealing in mean indices whatever relations may exist[4].

The refractive indices of substances may be connected with other properties by various formulas, of which the Lorentz-Lorenz expression, which may be used in the form $\frac{n^2 - 1}{n^2 + 2} = \frac{M \times \rho}{W}$, is the most satisfactory. For short the left hand term may be referred to as the "refraction," and denoted by the letter R. If the refractive indices in different directions in a single anisotropic substance be substituted for n, directional values of R will be obtained; these may be called R_a, R_b, and R_c, the first two of course being identical in uniaxial crystals.

[1] An excellent summary of this work has been prepared by Eisenlohr (Spektrochemie Organischer Verbindungen. Leipzig, 1912).

[2] Especially by Pope (Journ. Chem. Soc. **69**: 1530. 1896).

[3] The refractivities of a few crystalline organic compounds have been calculated by Taubert (Zeits. Kryst. Min. **44**: 313. 1910).

[4] The theoretical relations between the refractivities shown in the different directions in anisotropic substances and the electrical interaction of the atoms have recently been discussed by Silberstein (Phil. Mag. **33**: 92. 1917).

The atomic weight W being always, and the refractivity M usually the same throughout, the several values of R must be proportional to those of the density ρ, or factors corresponding to it, in the several directions. The ratio of the R's, which may be termed the "refraction ratio," should therefore give some information as to the structure of the substance.

Because of the existence of dispersion of double refraction or change in double refraction with wave length of light, the refraction ratio is not constant throughout the spectrum; but the following list of the approximate dispersions of a few typical substances, obtained mostly by extrapolation from recorded data, indicates that the effect of this phenomenon is ordinarily negligible, the variation in the ratio rarely exceeding the probable error of the data, 3 units in the third decimal place, over practically the whole visible spectrum. The relation will not hold, of course, in the ultra-violet, where these substances show absorption bands; but this does not affect the conclusions reached in this paper, for the atoms themselves are anisotropic for these short wave lengths.

TABLE I

APPROXIMATE DISPERSIONS OF DOUBLE REFRACTION OF SELECTED ORGANIC SUBSTANCES

UNIAXIAL	ω		ϵ		DOUBLE REFRACTION		REFRACTION RATIO	
Wave lengths	400	700	400	700	400	700	400	700
i-Erythrite	1.558	1.541	1.535	1.517	0.023	0.024	1.036:1	1.039:1
Guanidine carbonate	1.514	1.492	1.505	1.482	0.009	0.010	1.015:1	1.018:1
Urea[a]	1.504	1.480	1.625	1.597	0.121	0.117	0.837:1	0.834:1
BIAXIAL	α		γ		MAXIMUM DOUBLE REFRACTION		EXTREME REFRACTION RATIO	
Calcium formate	1.526	1.507	1.599	1.573	0.073	0.066	0.899:1	0.904:1
Cane sugar	1.551	1.537	1.582	1.569	0.031	0.032	0.956:1	0.954:1
Oxalic acid (anhyd.)[a]	1.465	1.440	1.650	1.620	0.185	0.180	0.758:1	0.750:1

[a] Extrapolated from new measurements by the writer, made by the immersion method.

The studies of crystals by X-rays which have been carried on in recent years have shown that it is possible to regard the atoms as lying in definite layers; in simple substances planes pass through the centers of gravity of the atoms in these layers, while in more complex ones, the centers of gravity may be alternately slightly to one side or the other of planes.[5] The spacings between the planes prove to be more or less connected with the crystallographic axial ratios and other properties of the substances. The less the spacing of the atomic planes in any direction in an anisotropic substance, the greater should be the refraction in that direction. In fact, if the layers in the different directions are all close-packed, the difference in spacing may be the only cause of anisotropism, and the factor ρ will then be inversely proportional to the spacing d. It therefore appears probable that an exact inverse relation may exist in some cases between the refraction ratio and the crystallographic axial ratio of a substance.

Crystallographic axial ratios (which will be referred to hereafter simply as "axial ratios") are usually stated to the fourth decimal place. A variation of one minute in an angle, however, produces on the average a change of one unit in the third place, and crystals are rarely perfect enough for measurements to agree more closely than $\pm$ 5′. The fourth decimal is therefore usually entirely fictitious, and even the third often of doubtful significance. Refractive indices also are often stated to the fourth place, although the results of different observers usually differ one or two units in the third place. The refraction ratios are, accordingly, likewise obtainable with a certainty of but two or three units in the third place. In general, therefore, inverse agreement between the two ratios to one unit in the second place may be regarded as complete.

Furthermore it can not be assumed that the standard axial ratio is a definite thing. Crystallographers are obliged in general to choose one out of several possible forms as the unit, and to take the axial ratio as inversely proportional to the intercepts of that form on the axes. The criteria for selecting unit forms are limited in number, comprising prominence, presence of cleavage, and the yielding of simple symbols to the other forms present by the derived ratio. The Fedorov rule, that substances

[5] The latter arrangement appears, for instance, in the Bragg diagram of calcite (X-rays and Crystal Structure, p. 117).

with tabular habit and basal cleavage are likely to have a positive axial ratio (c greater than a) and those with prismatic habit and cleavage a negative one (c less than a) is also useful. All these features are, however, likely to be connected only with the larger atoms, and the presence of layers of smaller ones to be shown only by the appearance of minor forms, or even not to have any external expression at all. But as all the layers combine in the production of refractive effects, it is essential, before any comparison can be made, that the true axial ratio, based on all the atomic planes, be ascertained.

In the few anisotropic inorganic substances thus far studied by means of X-rays the standard axial ratios appear in fact to be produced only by certain of the larger atoms, smaller ones, such as oxygen, failing to find expression in them. But it seems likely that in organic compounds, where the relative sizes of the atoms do not differ so markedly, all might share in the location of the prominent forms, and the true axial ratio be identical with the standard one. This class of substances has therefore been investigated first, their refraction ratios and axial ratios being compared in order to ascertain whether inverse relations really exist; later papers will take up inorganic compounds. And at the start only those that crystallize in the tetragonal system will be considered, since its geometrical relations are the simplest, and will therefore form a good foundation upon which to base future studies in other systems.

Exact inverse relations can of course not be expected to hold in all cases. For instance, if the atoms in a layer are alternately considerably above and below the central plane, yet not far enough to become close-packed into new layers, the effect of the spacing on the refraction will be modified. Variations of several units in the second decimal place might be attributable to this cause. Further, if any of the constituent atoms are themselves anisotropic, which is probably the case with those giving rise to intense colors, as well as with those present in asymmetrical combination or position, the value of the refractivity, M, in the formula will vary with the direction, and even the first decimal place of the refraction ratio may be affected. While these sources of variation render the method of study here proposed of little value in connection with the more complex compounds, it seems likely to be useful for simple ones.

Certain features of the tetragonal system may now be briefly reviewed. The classes it includes, with their symmetry and typical representatives, are listed in table 2.

TABLE 2

Tetragonal System

	Class		Symmetry			Organic representative
	Standard name	Common name	Planes	Axes	Center	
1	Ditetragonal-bipyramidal..	Normal	4 vert. 1 hor.	1-4, 4-2	1	Mellite
2	Ditetragonal-pyramidal....	Hemimorphic	4 vert.	1-4	0	Penta-erythrite
3	Tetragonal-bipyramidal....	Pyramidal	1 hor.	1-4	1	*i*-Erythrite
4	Tetragonal-pyramidal......	Pyr.-hemi.	0	1-4	0	Barium-antimony tartrate monohydrate.
5	Scalenohedral..............	Sphenoidal	2 vert.	1-2,2-2	0	Urea
6	Trapezohedral.............	Trapezohedral.	0	1-4,4-2	0	Guanidine carbonate
7	Bisphenoidal...............	Tetartohedral.	0	1-2	0	(No representative known).

Classes 4, 6, and probably 7 rotate the plane of polarized light, indicating the presence of some asymmetrical arrangement of atoms, and their refraction and axial ratios are therefore likely to show poor agreement. In class 5 the positions of the horizontal axes are fixed by the symmetry, so good agreement between the two ratios is possible in the crystals belonging to it. In classes 1, 2, and 3, however, there is a choice between the two sets of horizontal axes, and there is no fundamental reason why the closeness of packing in the layers, which is apparently what determines the refractive effect exhibited all the way around a uniaxial crystal, should be greater in one of these directions than in the other. Though often greatest in the layers perpendicular to the one selected as a,—calling the most prominent pyramid (111),— it may be greatest in those along the alternate one, a', which is obtained by making this pyramid (101), the relation between the two being: $a' = a\sqrt{2}$; or, if the structure is so simple that the arrangement is about the same in the layers of atoms traversed in both directions, the refractive effect may even be the mean of those along the two axes, and a hypothetical value $a'' = \frac{a + a'}{2}$ must be used.

In the course of the preparation of this paper many helpful suggestions have been received from Dr. H. E. Merwin, of the Geophysical Laboratory, Dr. E. Q. Adams, of the Bureau of Chemistry, and others, to all of whom the writer's warmest thanks are herewith extended.

REFRACTION RELATIONS OF ORGANIC COMPOUNDS

Urea

$CO(NH_2)_2$ Tetragonal-scalenohedral; $a : c = 1 : 0.833$

The simplest organic compound known to crystallize tetragonal is urea, or carbamide; it was accordingly selected as the first subject for study. The refractive indices of this substance

TABLE 3

REFRACTION RELATIONS OF UREA

REFRACTIVE INDICES		REFRACTION RATIO	AXIAL RATIO
ω	ϵ	$R\omega/R\epsilon$	c/a
1.484 ±0.002	1.602 ±0.002	0.834	0.833

Refractivity, based on mean $n_D = \sqrt[3]{\omega^2\epsilon} = 1.522$ and $\rho = 1.33$: $M_D = 13.77$.
Refractivity, calculated from data obtained from liquids: $M_D = 13.67$.

were determined by the immersion method by using essential oils, in which it is but slightly soluble. The results are shown in table 3, which includes (1) the refractive indices for D, and their probable errors; (2) the ratio of the refractions, R, in the horizontal and vertical directions a and c, that is, $\frac{\omega^2 - 1}{\omega^2 + 2} \Big/ \frac{\epsilon^2 - 1}{\epsilon^2 + 2}$;

and (3) the axial ratio of the substance. The two ratios are always used in the opposite order; that is, if the one refers to a/c, the other is taken as c/a.

The agreement of the two ratios is very exact, and indicates that in urea the standard axial ratio is identical with the true one, all of the atoms having a part in determining the position of the unit sphenoid.

The information at hand now seems sufficient to warrant the working out of the probable space-lattice of the substance, which may be accomplished by bearing in mind the following points:

Since no change from one isomer into another is ever caused by crystallization, molecules must be preserved in crystallized organic compounds better than in most of the inorganic ones that have been studied with X-rays. The chemical molecule should therefore be retained as far as possible. It should be spread out in one plane, somewhat like this: $\begin{matrix} & & \mathrm{O} & & \\ \mathrm{H} & & & & \mathrm{H} \\ & \mathrm{N} & \mathrm{C} & \mathrm{N} & \\ \mathrm{H} & & & & \mathrm{H} \end{matrix}$ and partial interpenetration of these groups is likely to occur.

Since urea shows cleavage in three directions at right angles, the lattice should have a general cubic plan. But since the crystal class is scalenohedral, there must be some alternation of groupings, corresponding to that shown by the sulfur atoms in the tetrahedral mineral sphalerite. The lattice should possess a vertical axis of alternating four-fold symmetry, two horizontal axes of two-fold symmetry, and two symmetry planes. The atoms must be equally represented in the layers in all three directions in space, and the average distance between their planes vertically be 0.833 times that horizontally. Some explanation of this difference in spacing should be seen in the atomic arrangement.

A space-lattice fulfilling these requirements proves to be very easy to construct; and a portion of it containing five layers of atoms in each direction is shown in figure 1. Four chemical molecules are represented in this cell, as may be seen when it is remembered that of each atom lying on outer surfaces only half belongs to it. The oxygen atoms in the top and bottom layers may be regarded as belonging alternately to carbon atoms shown, and to others lying in adjacent cells; interlocking thus occurs in these oxygen layers. It also occurs in the nitrogen layers shown, and in both cases is probably associated with residual affinity or secondary valence of these elements.

In the writer's opinion the valency-volume hypothesis, according to which the volumes of atoms are proportional to their valences, which is much used in the study of molecular structure, is

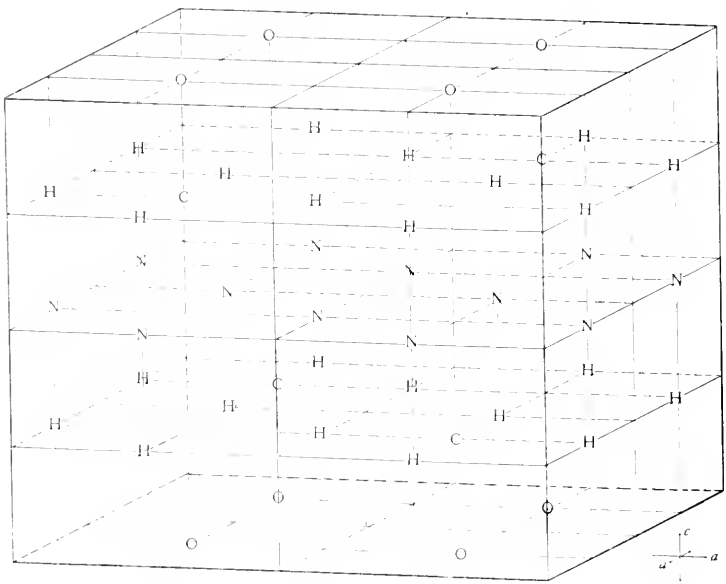

Fig. 1. Space-lattice of urea.

fallacious. Kopp's data on atomic volumes in the liquid state yield the diameters: H, 2.20; O′, 2.45; C, 2.75; O″, 2.85; N, 2.95; or, if the diameter of the H atom is taken as 1.25×10^{-8} cm., those of the others are O′, 1.40; C, 1.55; O″, 1.60; and N, 1.70, all $\times 10^{-8}$ cm. There is no reason to expect marked changes from these values in solids.

In the two horizontal directions, front-back and right-left—which are of course equivalent, as required by the symmetry—

oxygen or nitrogen atoms are present in all the layers and the planes of the layers are therefore regarded as approximately equally spaced. In the vertical direction, however, there are layers containing hydrogen + carbon atoms, alternating with others made up of oxygen and of nitrogen alone. In the first kind the carbon atoms lie over vacant spaces in adjoining layers, into which they can extend, so that the space occupied by these layers is determined by the hydrogen atoms, which are distinctly less in diameter than any of the others. The reason that urea has a negative axial ratio is thus evidently the presence of layers containing hydrogen atoms alternating with others made up of thicker nitrogen and oxygen atoms in the vertical direction, while all the layers contain the latter atoms in the horizontal one.

The next step is to calculate the spacing of the planes in centimeters, which may be done by the formula $d_a = \sqrt[3]{\frac{x \times W \times m}{y \times \rho \times c}}$ where d_a is the distance between the planes in the horizontal direction, x the number of chemical molecules in the portion of the space-lattice studied, W the molecular weight referred to hydrogen, m the mass of an atom of hydrogen, y the number of unit cells in the larger one, ρ the density, and c the vertical crystal axial value. In the case of urea the values are: $x = 4$, $W = 59.57$, $m = 1.64 \times 10^{-24}$ gram, $y = 64$, ρ averages 1.33, and $c = 0.833$. Substituting, $d_a = 1.77 \times 10^{-8}$ cm., which is very slightly greater than the average diameter of the atoms concerned, in liquids. Correspondingly, $d_c = c \times d_a = 1.47 \times 10^{-8}$ cm. In the cell figured there are vertically 1 N layer, 2 H layers, and 2 half O layers; the total $d = 4 \times 1.47 = 5.88 \times 10^{-8}$ cm. If the vertical thickness of an O layer is 2 per cent greater than in liquids, or 1.63, and of N 1.73, total 3.36, the thickness of an H layer $= \frac{5.88 - 3.36}{2} = 1.26$; this barely exceeds the diameter of a hydrogen atom adopted above. The structure assigned to urea thus agrees quantitatively with all available data.

ANTHROPOLOGY.—*Anthropology as a corrective of provincialism.* JOHN R. SWANTON, Bureau of Ethnology.

Anthropology is distinctly the study of man in society. It is by its attention to the group or social idea that physical anthropology differs from anatomy and physiology, comparative philology from the mere study of vocal expression, and culture history from psychology. And it is apparent that the well being of the individual depends, always and in an ever increasing degree, upon the well being of the group of which he forms a part and the harmonious relations between himself and that particular group. Of course anthropology is not the only science which considers man primarily as a social being. The same is true of history, sociology, economics, and various others. But history, at least that of the older orthodox type, limits itself for the most part to those peoples and those periods of which there are scriptorial records, sociology places its emphasis on mankind in the so-called civilized nations, and economics and similar sciences consider man with particular reference to his material environment or else some special phase of his social relations. In particular it is to be observed that each of these sciences is concerned with the peoples of that one great culture center, which, beginning in the immediate neighborhood of the eastern Mediterranean, gradually spread westward until it came to be represented by the so-called civilized nations of today. Anthropology, considering ethnology and ethnography as subordinate branches, is the only science which, professedly and from the very beginning, has taken cognizance of all human societies whether they be conventionally called "civilized" or "uncivilized."

The importance of this fact appears when it is known that what we call civilization has sprung up independently at a number of distinct points or "culture centers," and that no two of these culture centers has consisted of the same elements, has undergone the same institutional or psychical development, has enjoyed, or suffered from, the same environment. Thus the history which each center presents, the expression of its life, the social organizations and institutions which have developed within it are different, and the peculiar outlook on life which an inhabitant of any one may happen to have needs correction by a study of the outlook of individuals belonging to other centers. Thus in pre-Columbian North America we find that there was a culture center in the eastern woodlands, one on the North Pacific coast, one in the semi-arid Southwest, one, or perhaps, two, in Mexico and Central America, and one in the West Indies. In South America were two or three scattered along the Andean chain and one in the region of Guiana. Turning to the Old World, we are at once arrested by a few well-known culture centers like those of China, India, and the eastern Mediterranean, while centers more obscure may be detected in Polynesia and north-east Africa. On examining some of these we note the further interesting fact that they were originally complex, having resulted from the fusion of several originally independent centers. This is true in a way of the center in the eastern woodlands of North America and those on the Andean plateau, but the most conspicuous example of the kind is to be found in that great east Mediterranean culture center from which our own civilization is descended. This is found to have incorporated a center in the Nile valley, another in the valleys of the Euphrates and Tigris, a third on the island of Crete, and probably a fourth in eastern Asia Minor. These facts show that we must not consider culture centers as so many water-tight—or rather influence-tight—compartments having no meaning for one another. On the contrary it is not likely that a single one could be pointed out which had been affected in no degree by at least one other, and there is reason to believe that there has never been a time when thought vibrations have not been able to reach all parts of the human race, no people that may be said to have been intellectually sterilized. Each of these centers is to be regarded as the result of a particular running-together or complex of thought waves, a systematization of ideas found in their crude and dissociated condition among all human beings, or at least among many more than those constituting the particular center.

At the same time anthropology does not lose sight of or ignore peoples not included in culture centers. Viewed in one way they may be divided up and attached to the several centers as so many parts of a "culture area," since each center influences the more primitive people by whom it is surrounded, but it would probably be truer to consider these primitive or "savage" peoples as comprising the raw material, the people of dissociated ideas and institutions, out of which the several culture centers have been built, the lowlands of culture from which the centers of civilization project like so many mountain peaks. The subsequent reaction of the culture centers upon them should not obscure the fact of their originally fundamental position.

And now as to the importance of all this for us. We know how, even in the comparatively limited horizon of one nation or one state, individuals tend to assume that to be right and just to which they themselves and their immediate associates are accustomed and that to be wrong which is foreign to their ways of thought. We call such an attitude "provincial," and we laugh at the man from the back township or the mountain county, who thus exhibits his narrow prejudices and the limited mental outlook of the community from which he sprang. But we should be warned that provincialism is relative. One may be "cosmopolitan" as regards counties or towns and make fun of the provincial with only the county or town outlook but be equally provincial himself with relation to views entertained in the next state. Again he may be cosmopolitan as between states but provincial when it comes to another nation, or cosmopolitan as between nations of approximately the same type of civilization but provincial when confronted with nations or peoples of a different cultural or racial type. Even the broadest of us is prone to consider, or rather assume—for such things are often imbedded too deeply in our subconscious natures to be made matters of consideration—that certain ideas, customs, technical processes, forms of government are best, or rather that they are essential, as much part and parcel of humanity as hand or foot or eye, yet we may be absolutely deceiving ourselves. It is the especial function and peculiar privilege of anthropology systematically to study and record ideas, technical processes, customs, and so on wherever found, to the end that mankind may constantly become less provincial, more cosmopolitan in his outlook, may discern more clearly what are the essential accompaniments of human life and human association, what are its nonessentials, also what institutions have been worked out by different peoples and found of benefit, what have been found harmful, what laws seem to be justified by the experience of mankind in other parts of the world and in other periods. In this way anthropology paves the way for a broader outlook on the questions which every culture center, every people, nay every individual, has to face. It renders available as guides, not merely the experience of our immediate ancestors, of related peoples, of our cultural forebears who happened to be possessed of the art of writing, but the experience and experiments of all peoples without any limit other than that set by the boundaries of the globe or the extent to which human memorials have been preserved.

And in the very processes that this study sets at work there is involved a most important corollary. As the more intelligent of all nations seize upon data provided in this manner the cosmopolitanization of thought is certain to extend until mutual toleration and appreciation take the place of mutual repugnance, dislike, and hostility, and much of the psychology that now ultimates itself in war passes away. An obsession that the good of the world requires that its culture shall be all German, or French, or English, or American is but the display on a wider field of the provincialism which holds that it should be patterned on that of Jones county or Smithville. It is an obsession that the prosecution of anthropological studies and the diffusion of the results of such studies are certain to destroy, and I presume that no reasonable human being will, in the light of current history, consider such destruction of other than practical value.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Ore deposits of the northwestern part of the Garnet Range, Montana.* J. T. PARDEE. U. S. Geological Survey Bulletin 660-F. Pp. 80, with 4 plates and 10 figures. 1918.

The report describes the quartz lodes and placer gravels and the principal features of the physiography and the geology in an area of about 400 square miles north of Clark Fork River and east of Missoula. The lodes are considered by districts, those of the Garnet, Coloma, and Elk Creek districts, which are valuable chiefly for gold, being classified as filled fissures and replacement veins in granodiorite and schist. In the Top o'Deep district there are contact-metamorphic replacements in limestone valuable for copper, and quartz veins that contain gold. In the Copper Cliff district mineralized fault breccias, and in the Clinton district composite veins or shear zones in granodiorite, are valuable for copper. Outlying deposits consist in part of silver-bearing galena that has replaced limestone.

Under placer deposits is given a brief historical sketch of Bear and Elk creeks, which produced between $6,000,000 and $10,000,000 in placer gold in the "early days," and the origin of the gold-bearing gravels is discussed.

Under geology there are condensed descriptions of the rocks, which include 5000 feet of Belt strata, chiefly quartzite and shale; 4000 feet of Paleozoic strata, mostly limestone; early Tertiary or late Cretaceous intrusive granodiorite; and middle Tertiary extrusive rocks. Folds and faults involve the strata, one of the chief structural features being a large overthrust fault that has carried a great mass of Belt rocks from the west over Paleozoic and younger formations.

Under physiography the elevated remnants of a peneplain are described and their correlation with an erosion surface of Eocene age known in the adjacent regions is indicated.

J. T. P.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The 121st meeting of the Academy was held in the Assembly Room of the Cosmos Club the evening of Thursday, February 21, 1918, with President BRIGGS presiding, the occasion being the second lecture of the series on Science in Relation to the War, by Dr. GEORGE E. HALE, Director of the Mt. Wilson Solar Observatory of the Carnegie Institution of Washington, and Chairman of the National Research Council. The subject of the address was *Astronomy and war—some examples of the close parallelism between the methods and work of the astronomer and those of the military engineer.* The lecture, which was abundantly illustrated with lantern slides and moving pictures, was aimed to show that men of science in any field, no matter how remote apparently from that of military affairs, are prepared by the usual demands of their scientific investigations to deal with problems pertaining to the war.

The 122d meeting of the Academy was held in the Assembly Room of the Cosmos Club the evening of Thursday, March 7, 1918, with President BRIGGS presiding. The third lecture of the series on Science in Relation to the War was delivered by Col. C. F. LEE, Commanding Officer, British Aviation Mission, his subject being *Aviation and the war.* The address, which dealt essentially with the more practical phases of aviation work, has been published in this JOURNAL (**8**: 225–232. April 19, 1918). Colonel LEE was followed by Major GILMORE of the Royal British Flying Corps, who spoke appreciatively of the work of American flyers and dwelt upon the necessity of expert training in gunnery, as well as in actual flying, and the personal qualifications which combine to make a successful and resourceful flyer.

The 123d meeting of the Academy was held in the Assembly Room of the Cosmos Club on the evening of Wednesday, April 3, 1918, with President BRIGGS presiding. The occasion was the fourth lecture of the series on Science in Relation to the War, by Maj. Gen. JOHN HEADLAM, C.B., D.S.O., in charge of the British Artillery Mission, entitled *The development of artillery during the war.* A summary of the lecture will appear in a later number of the JOURNAL.

WILLIAM R. MAXON, *Recording Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 802d meeting was held at the Cosmos Club, March 2, 1918. Vice-President Humphreys in the chair; 40 persons present. The minutes of the 801st meeting were read in abstract and approved.

Lieut. D. L. Webster presented a paper on *Emission quanta phenomena in X-rays*, illustrated by lantern slides. The paper was a brief account of the work on this subject that has appeared in the past three years in the *Physical Review* and the *Proceedings of the National Academy of Sciences*.

In the general radiation spectrum, the frequency whose quantum is the energy of one cathode electron was found by Duane and Hunt, and by Hull, to have an upper limit, at which the spectrum ends. It was shown by Webster that the existence of such a limit to the spectrum is direct evidence that the rays are trains of periodic waves rather than pulses; and with further experimental work, that if atoms in the anticathode could be struck only by electrons of a definite velocity, any atom's chance of emitting rays of a given frequency jumps from zero discontinuously to a finite value as the energy of the cathode electron is raised continuously past the quantum value of that frequency. A further continuous increase of energy of the cathode electron would produce a continuous decrease of intensity of rays of that frequency.

For the characteristic rays of the K series, it was found by Webster that no such rays are produced until the cathode electron's energy reaches the quantum value of the highest frequency of the series, at which point all the lines of the series appear together. Their intensities increase by the same law for all lines, but this law is very different from that holding for any given frequency in the general radiation. These phenomena are all consistent with the hypothesis that the primary characteristic rays produced by cathode rays come from the same atomic mechanism as the secondary characteristic rays occurring in fluorescence. This statement holds, whatever that mechanism may be.

For the L series it was found by Webster and Clark that the laws are similar to those of the K series except that the lines must be considered as belonging to at least two, and probably three, separate series, each of which behaves like the K series.

Discussion: This paper was discussed by Messrs. Swann, White, and Foote.

The second paper, on *Determination of the constant C_2 of Planck's law*, was presented by Major C. E. Mendenhall. It was illustrated by lantern slides. No abstract furnished. A paper of the same title was published in the *Physical Review*, **15**: 515. November, 1917.

Discussion: This paper was discussed by Messrs. Crittenden, Abbott, Coblentz, Foote, Sosman, White, Swann, and Webster.

H. L. Curtis, *Recording Secretary*.

The 803d meeting was held at the Cosmos Club, March 16, 1918. President BURGESS in the chair; 39 persons present. The minutes of the 802d meeting were read in abstract and approved.

A paper on *Thermal expansion of alpha and of beta brass* by P. D. MERICA and L. W. SCHAD was presented by Mr. Merica. This paper was illustrated by lantern slides. Within the past four years an investigation has been in progress at the Bureau of Standards of the cracking or fracturing of cast and wrought brass, particularly of the type composition, 60 per cent of copper and 40 per cent of zinc. It has been found that in most failures of such brasses in service the cracking can be ascribed to the presence of initial stresses in conjunction with surface corrosion. These initial stresses may be produced either in the mechanical working of the material, such as drawing or rolling or by shrinkage, as in the case of cast metal. As, however, a number of instances of cracking in brass of this type have come to the attention of the authors for which such explanations cannot be applicable, it was their intention to ascertain whether local internal stresses could not be produced in brass of this composition by heat treatment such as it might receive in manufacture.

Brasses of this type are heterogeneous, consisting of the mechanical mixture of two constituents, called respectively, the alpha and the beta constituents. Measurements of the linear thermal expansion of these two constituents have shown that of the beta constitutent to be considerably in excess of that of the alpha. So great is this difference that rough calculations have shown the possibility of the development of average stresses due to the sudden cooling by quenching of the brass containing these constituents equal to approximately 15,000 pounds per square inch.

Experiments showed that these stresses were probably responsible for the lowering of the proportional limit of such brasses amounting to as much as 25 per cent.

The thermal expansion curves illustrate also very well the nature of the thermal transformations in the beta constituent varying about 1460°C.

Discussion: This paper was discussed by Messrs. WHITE, BRIGGS, and BURGESS.

A paper on *The principles of electrical measurements at radio frequencies* was presented by Mr. J. H. DELLINGER. The principles of radio or high-frequency measurements are coextensive with the principles of radio engineering to an extent not true in other fields. This is typified in the wavemeter, which is a complete radio transmitting and receiving station, albeit in miniature. The principles of ordinary alternating current theory apply with little change to the phenomena at very high frequencies. This was not true a few years ago, when damped waves were universally used in radio work, but the introduction of satisfactory sources of undamped currents has largely eliminated the specialized theory that went with damped waves.

While precision measurements with direct current are commonly made by null methods, high-frequency measurements on the other hand use the opposite critical phenomenon, a maximum rather than minimum of current. Resonance or tuning is thus the basis of radio measurements as well as of wave transmission and reception. At resonance the reactances due to capacity and to inductance annul each other and the current is limited by resistance only. As resistances are small in comparison with reactances at radio frequencies, the current is relatively very great at resonance, i.e., the resonance is very sharp and is thus a suitable basis for measurements.

The wavemeter is a resonance instrument, and is used to measure capacity and inductance as well as wave length. The other most generally useful radio instrument is the ammeter. With these two, measurements are made of current, resistance, power, and associated quantities, in addition to the quantities above mentioned. In general the best methods are those which are the least complicated. This is particularly true because of the disturbing effects of small inductances and capacities in lead wires and accessory apparatus. Small capacities in and near the measuring circuits are especially troublesome. They include the capacities of instrument cases, table tops, walls, and the observer, and they cannot always be determined or eliminated.

While resistance is of distinctly less importance in determining the flow of currents at high frequencies than at low, nevertheless resistance is the measure of power consumption. As it varies rapidly with ratio frequencies, its measurement is very necessary. The same measurement gives resistance and the associated quantities, sharpness of resonance, phase difference, and decrement.

Great advances in the precision of all these measurements have recently been made possible by the introduction of electron tubes as sources of current. They have the very great advantage of giving a steady current, and as the current is undamped the simple sine wave theory of alternating currents may be used.

Discussion: The paper was discussed by Messrs. WHITE, BICHOWSKY, and SWANN.

Mr. G. W. VINAL then gave a paper on *Some electrical properties of silver sulphide.* Silver sulphide may be prepared in the form of short wires or thin strips like a metal. The wire, which must be drawn hot, has been found to conduct electricity like a metal of high specific resistance and practically zero temperature coefficient. The strip of sulphide, rolled at room temperature, has a large temperature coefficient and shows both metallic and electrolytic conduction at the same time. It has a volt-ampere curve characteristic of a pyroelectric conductor. The resistance of these strips has been examined with both alternating and direct current, with the result that the alternating-current resistance was nearly always found to be higher than that with the direct current, and the passage of a small alternating current of a frequency as low as 60 cycles increased temporarily the resistance of the sulphide, while a small direct current produced the opposite effect.

Experiments were made to find the electrochemical decomposition due to the electrolytic conduction of the strips of sulphide. A strip in air (5.5 by 0.3 by 0.01 cm.) with silver-plated ends was soldered to copper leads and put in a direct-current circuit. The initial current of 25 milliamperes was passed through it for nearly an hour without visible change. The current was increased by steps of 50 milliamperes at 10-minute intervals until with 200 milliamperes a discoloration of the plating at the anode end was noticed. A further increase to 300 milliamperes completed the destruction of the silver plating at the anode end and finally burned off the terminal, but before this happened a myriad of little shiny silver crystals appeared on the black surface of the sulphide. The appearance of these crystals was carefully studied under the microscope, and it was found that they occurred even to within a small fraction of a millimeter of the anode terminal. They appeared in various forms, some of which suggested that they had been expelled from the interior of the sulphide by considerable force.

Discussion: The paper was discussed by Messrs. Buckingham, Honaman, Bichowsky, Sosman, and Burgess.

E. C. Crittenden, *Corresponding Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

The 128th regular meeting of the Society was held at the Cosmos Club at 8.00 p.m., Tuesday, April 2, 1918. There were 28 members and 4 guests present. Messrs. L. L. C. Krieger, H. F. Bergman, G. A. Meckstroth, and Wm. N. Ankeney were elected to membership. The following scientific program was given:

Carleton R. Ball: *The grain sorghums: a botanical grouping of varieties cultivated in the United States* (with lantern). There are two chief centers of origin for the sorghums, Africa and India. The principal groups cultivated in the United States are kafir, milo (including feterita), and durra. All of these are of African origin. The kafir varieties mostly were obtained from the native tribes in Natal, South Africa. The Guinea kafir, however, probably was derived from the West Coast of Africa, whence it was brought as food for slaves during their long voyage to America. It is now cultivated in several islands of the West Indies. The milo varieties probably are of Egyptian origin. Very similar forms are grown in Egypt today under the names Durra Beda (white), Durra Safra (yellow), and Durra Ahmar (brown). Feterita was derived from the British Egyptian Sudan. The durra varieties, white and brown, probably came from North Africa, where they are still found among the native tribes. These are the varieties known in California as "White Egyptian corn" and "Brown Egyptian corn," respectively. The white variety has been grown in the Great Plains area under the name "Jerusalem corn." The kaoliang varieties are derived from North China and Manchuria. The different groups are clearly separated by botanical characters. The speaker exhibited charts showing by means of keys the classification of the sorghums.

The chief groups of the sorghums are Broomcorn, Sorgo, Kaoliang, Kafir, Shallu, Durra, and Milo. Keys were given showing the relation of the varieties of the Kafir group and of the Durra-Milo group.

F. V. RAND: *The Shaw aquatic gardens* (with lantern). The Shaw Aquatic Gardens, near Washington, were started several years ago as a matter of curiosity and recreation. Beginning with a half-dozen roots of the native white waterlily set in a little dug-out pond in the swamps of the Anacostia River the gardens have increased in size until there are over five acres under water. In these ponds are grown nearly all varieties of water plants that will live in our climate. They are sold all over the United States and even in the Hawaiian Islands. The business has been an artistic and financial success from the start; but has not been without its difficulties. Turtles, muskrats, and various insects offer each their special brand of tribulation. The biology and successful control of a serious fungus disease of pond lilies (caused by *Helicosporium nymphaearum* n. sp.) have been worked out by the writer; and a fungous leaf spot of Egyptian lotus (caused by an *Alternaria*) is under study.

Following Mr. Rand's paper, Mrs. FOWLER, the Manager of the Shaw Gardens, invited the members of the Society to visit the gardens and pointed out that June is one of the best times to inspect them.

H. N. VINALL, *Corresponding Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 581st regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, March 9, 1918; called to order at 8 p.m. by President ROSE; 30 persons present.

On recommendation of the Council Miss E. E. STEVENSON was elected to membership.

Two informal communications were presented:

T. S. PALMER made remarks on the systematic feeding of quail in the city of Washington during the past winter. A census of these birds showed 60 coveys with a total of 1235 individuals. Discussed by Gen. T. E. WILCOX.

R. W. SHUFELDT showed lantern slide X-ray picture of the double-headed tortoise exhibited at the previous meeting of the Society. Major Shufeldt also exhibited two living specimens of the whip-tailed scorpion, *Thelyphonus giganteus*, collected by Mr. Nelson R. Wood, at Auburndale, Florida. Reference was made to its geographic distribution, Florida and West Indies, its habits in capitivity, its structure, and its systematic position. Its popular names were stated to be vinegerone, vinaigner, mulekiller, and vinegar maker.

The regular program consisted of three communications:

JOHN T. ZIMMER: *An intensive feeding habit in young herons.* Read by the Recording Secretary in the author's absence in New Guinea. This note will appear in full in the Proceedings of the Society. It was discussed by Dr. T. S. PALMER and ALEX. WETMORE.

E. P. CHURCHILL, JR.: *The life history of the blue crab.* Various features of the life history of this form were studied by means of observations and experiments carried on during the interval from July 1, 1916, to December 1, 1917, especial attention being given to the crab of Chesapeake Bay. The eggs of the crab were found to measure about 1/100 of an inch in diameter. As they are laid they become attached to the endopodites of the four anterior pairs of swimmerets, forming the "sponge." About 1,750,000 eggs are laid at one time. They remain upon the swimmerets until they hatch, which event occurs within about fifteen days after they are laid. Upon hatching the young leave the female at once and do not cling to her as has often been supposed. Most of the spawning in Chesapeake Bay is accomplished from the first of June to the first of August and occurs mostly in the southern part of the bay.

About one month is required in which to pass the zoeal and the megalops stages. After the latter stage is passed the crab molts about fifteen times before the adult condition is reached. Most probably it does not molt after reaching maturity. The young, which are hatched in the southern part of the bay, migrate to Maryland waters and reach maturity and mate there. There is a cessation of growth and molting during the winter. Maturity is reached during the second summer, at the age of about twelve to fourteen months. Mating occurs during July and August. Mating takes place in the female at the time of her last molting, at which time the abdomen changes from a triangular to a broad rounded form. Most of the females do not lay the eggs the same season in which mating occurs but migrate to the southern part of the bay, lie on the bottom in deep water there, and spawn the following season. The males do not migrate southward to as great an extent as do the females, but remain in more northerly waters. The crabs do not bury in the substratum during the winter as has been commonly supposed.

At least two and probably three batches of eggs are laid by the females. Some lay their first lot late in the summer and another lot the next season. Some lay two batches during the same summer. At the time of the only copulation which occurs during the life of the female, enough spermatozoa are deposited by the male in the sperm sacs of the female to fertilize all the eggs which she lays during her life time. The females die shortly after the last batch of eggs is laid, death usually occurring during the late summer or early fall. The usual length of life of the crab is about three years.

The paper was illustrated by lantern slides. It was discussed by W. P. HAY and Dr. T. S. PALMER.

R. H. TRUE: *Notes on the early history of the pecan in America.* The earliest account of the pecan is probably that by Cabeza de Vaca, who saw it in 1533 on the lower course of the Guadaloupe River in Texas. De Soto found it in use by the Indians in 1540–42 along the Mississippi River from near the mouth of the Illinois River and southward. The pecan seems to have been first introduced into the English colonies by Captain Bouquet and John Bartram in September 1761. Daniel Clark of New Orleans sent nuts to Vice President Jefferson in 1799. The first botanical description is by Jefferson in his *Notes on Virginia*, in 1782. The name "pecan" was found in use by De Soto about 1540 and by Pénicault, 1704, among the tribes of the Mississippi Valley; probably not used by the Texas tribes west of this region. The pecan was probably cultivated in Spain at an early date, but the first ascertained record of its introduction into Europe was by John Bartram who sent pecans to Peter Collinson in England early in 1761. First introduction into France was probably through Jefferson in 1787. The earliest cultivation in America probably took place in Mexico about 200 years ago. William Prince succeeded on Long Island with nuts planted in 1772. Abner Landrum successfully budded the pecan on common hickory at Edgefield, S. C., in 1822.

The paper was discussed by Gen. T. E. Wilcox and Major R. W. Shufeldt.

The 582d regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, March 23, 1918; called to order at 8 p.m. by President Rose; 65 persons present.

The regular program consisted of an illustrated lecture by Edmund Heller entitled *The Chinese borderland of Tibet and Burma.* Mr. Heller gave an account of his recent collecting trip made in conjunction with Mr. Roy Andrews through Japan, China, and northern Burma. He described the route taken, the geographic and geologic features of the country passed through, the characteristics and customs of the people, and the nature of the larger animals encountered. He called particular attention to the deforested conditions of China and the intensive system of agriculture in vogue. The absence of animal life in China was rather conspicuous as contrasted with many of the neighboring and less densely populated countries. The scarcity of birds in some places with no apparent increase in insect pests was noteworthy. His talk was profusely illustrated by lantern slide views of all the features mentioned by him.

Mr. Heller's paper was discussed by the chair, A. S. Hitchcock, and Dr. George W. Field.

M. W. Lyon, Jr., *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 312th regular meeting of the Society was held at the Cosmos Club, April 4, 1918. There were twenty-nine members and four visitors present.

In the absence of President E. R. Sasscer, the Honorary President Mr. E. A. Schwarz occupied the chair.

The following names were favorably acted upon for membership: Dr. J. A. Nelson, Bureau of Entomology; Mr. Oscar H. Basseches, Bureau of Entomology; Mr. L. P. Rockwood, Forest Grove, Oregon;

Mr. C. W. Collins, Gipsy Moth Laboratory, Melrose Highlands, Massachusetts; and Mr. Howard L. Clark, North Farm, Bristol, Rhode Island.

The regular program was as follows:

Harold Morrison: *Notes on the Virgin Islands.* Mr. Morrison discussed briefly the size, location, past history, and the economic development of the islands, giving some notes on the principal agricultural crops and their chief insect enemies. Among the insects mentioned were termites, the different varieties of a species of weevil (*Diaprepes* sp.) the cotton-leaf blister mite, and the sweet-potato weevil (*Euscepes batata*). About thirty species of scale insects were collected, and about twenty-six hundred specimens representing other orders. No fruit flies were found, and fruit was very scarce on the islands due to the great destruction caused by the recent hurricane. Mr. Morrison's communication was discussed by Messrs. Schwarz, Casey, Busck, and Pierce.

R. E. Snodgrass: *The value of pictorial charts in extension entomology.* This paper was illustrated by a number of artistically drawn charts designed to illustrate the life histories of economic insects. The speaker presented a strong argument in favor of this manner of carrying entomological information to the general public. He stated that the charts would attract and hold attention, that they were designed to bring out the most vulnerable points in the life-histories of the insects illustrated; and that they were quickly and easily read. He believed that the essential points in control would be more readily grasped by the reader than from the written page. In discussing Mr. Snodgrass' remarks Dr. L. O. Howard pointed out some of the excellencies of the charts from the artistic standpoint.

W. D. Pierce: *The case of the genera Rhina and Magdalis.* Read by title.

E. A. McGregor: *A new host plant for the cotton-boll weevil.* Read by title.

S. A. Rohwer: *New sawflies of the subfamily Diprioninae.* Read by title.

A. B. Gahan, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. H. Foster Bain has recently returned from China, and has accepted the position of Assistant Director of the Bureau of Mines.

Dr. Graham Edgar, of Throop College, Pasadena, California, has been appointed Technical Assistant to the newly established Research Information Committee, and has entered upon his duties at the office of the National Research Council. Mr. Walter M. Gilbert, of the Carnegie Institution of Washington, is secretary of the local office of the Committee.

Dr. Yogoro Kato, formerly a member of the Research Laboratory of Physical Chemistry at the Massachusetts Institute of Technology, and now professor in the Higher Technical School of Toyko and director of the Nakamura Chemical Research Institute, visited Washington in March.

Dr. E. C. Lathrop, formerly of the Laboratory of Soil Fertility Investigations, left Washington on May 1, 1918, to accept a position in the organic dye research laboratory of E. I. du Pont de Nemours and Co., at Wilmington, Delaware.

Mr. Joseph U. Monroe, chief of the telegraph division of the Weather Bureau, died suddenly on April 13, 1918, after a service with the Bureau of twenty-seven years' duration.

A "Joint Information Board on Minerals and Derivatives" has been formed for the purpose of systematizing the handling of official inquiries regarding minerals and mineral products. This body is intended to serve as a clearing house to secure the prompt preparation and transmittal of data from a single authoritative source without duplication of effort, and is composed of representatives from the various government bureaus, boards, and departments interested. Mr. Pope Yeatman, of the War Industries Board, Division of Raw Materials, is chairman, and Dr. Edson S. Bastin, of the Geological Survey, is secretary of the new Board.

The following persons have become members of the Academy since the last issue of the Journal:

Mr. Sidney F. Blake, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. Joseph Augustine Cushman, Sharon, Massachusetts.

Mr. Ernest G. Fischer, U. S. Coast and Geodetic Survey, Washington, D. C.

Professor William Suddards Franklin, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Mr. Ned Hollister, National Zoological Park, Washington, D. C.

Dr. Raymond Pearl, U. S. Food Administration, Washington, D. C.

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ORDNANCE.—*Developments in artillery during the war.*[1] John Headlam, Major-General, in charge of the British Artillery Mission. (Communicated by L. J. Briggs.)

It is a trying ordeal for a soldier with no pretension to scientific knowledge to address such an audience as this, particularly when he has to commence with an apology for ignorance on that part of his subject which is of most interest at the moment. I must confess to you, gentlemen, that I have not even a theory to advance regarding the Paris gun, and I can only throw myself on the mercy of the court! But I take courage from your well-known kindness so constantly extended to British officers. And if I can not claim to be one of those artillerymen who have invaded the domains of science, I have learned, as an artillery commander in the field, how much we owe to the scientists who have devoted their talents to the solution of the problems which confront us. I think therefore that I may be able to tell you something of the development of artillery during this war, from the user's point of view, which may be of interest. The subject is so vast that it would be quite impossible even to touch on, much less to deal adequately with, all the directions in which these developments have taken place, even if I were to devote myself entirely to the science of artillery.

But this is not everything. To engage the right target from the right place, with the right guns, this is the artilleryman's

[1] A lecture given before the Washington Academy of Sciences on April 3, 1918.

art, without which his *science* is half wasted. In artillery, more than in any arm of the service, tactical and technical considerations are most intimately connected. I shall try to show how the changes in tactics affect technical matters and how the demands of the soldier may upset the plans of the scientist, and I hope that I shall be able to make you understand that the entry of science into war has in no way taken away the glamour of romance however much it may have increased its horror.

I shall not trouble you with any reference to organization. You must accept it from me that every operation in this war has confirmed the necessity for a carefully elaborated scheme for the employment of concentrations of artillery, involving a methodical allotment of tasks from the outset, and largely depending for its successful execution on an effective chain of artillery command.

Field artillery material. It will, I think, be advisable to commence with some brief reference to the various types of artillery employed in the field, without attempting to go into detail regarding any particular nature. Taking *field* artillery first, we stand practically where we were. At one time an idea got abroad that the days of field artillery were numbered, that it had been supplanted by the "heavies." This was a very dangerous heresy, but it is dead. The field artillery is as firmly established in its position as it ever was, the proportion of guns to bayonets has altered little, and the material has changed least of all. The Germans still have their old field gun, made as a breech loader in 1896 and converted into a quick firer in 1906. Our own 18-pounder, which was brought into the service at the beginning of this century, immediately after the South African War, is still in our belief admirably suited for its work. It is no secret that the American artillery has adopted a field gun designed and made by those admirable gunners, the French, in the nineties of the last century.

Shrapnel versus high explosive. But there are two points in connection with field artillery material on which a real difference in opinion and practice exists.

The first is the relative values of shrapnel and high explosive shell. On this the French and ourselves are the great protagonists of the rival schools. Their 75-mm. is primarily designed for the rapid fire of high explosive shell and its "rafales" did marvels in throwing back the first great German advance on the Marne. The English, as befits the country of the inventor, General Shrapnel of the British Army, have always been great shrapnel adherents; our 18-pounder was designed as a shrapnel gun, and has undoubtedly the most powerful shrapnel in existence. I admit that we carried this too far in having no high explosive at all, and you may possibly recall the great outburst of indignation caused by some so-called "revelations" in the press regarding the shortage of high explosive shell in 1915. The question now is not of there being enough high explosive, but of getting the artillery to use the proportion that the manufacturers would like to produce. We saw the effect of our shrapnel on the German infantry in 1914, and we have not forgotten it.

The second is the advisability of including howitzers in field artillery. Here again we join issue with our French friends, who hold that the lowest caliber for the howitzer is the 6-inch. But we know what our howitzers have done for us, and as I see again in memory the many fields on which our 4.5-inch rendered such yeoman service, ever since they first came into action among the slag banks and pitheads at Mons, I can scarcely imagine how we should have fared without them. And here I know that our infantry would back me up.

Use of heavy artillery in the field. When we turn to heavy artillery, in which I include all natures other than field, the story is one of almost miraculous progress. Broadly speaking, it may be said that heavy artillery formed no part of the equipment of modern armies at the commencement of the war. This is not strictly true, for the Germans had a battalion of 6-inch howitzers in each corps, while we had a battery of 60-pounders in each division. But the use of heavy artillery in the field was no new thing, though the whole world gasped in amazement when the Germans brought up their big siege pieces on the Aisne. In modern days, it had been done with success by the Boers, who used the 6-inch guns taken from the fortifications of Pretoria with success against us on many occasions. As soon as Port Arthur fell the Japanese brought their 11-inch howitzers to join the field army in Manchuria, and the mountings of some of your coast defense guns on their way to join the field army in France are modeled on those which our sailors improvised to carry their ship guns across the South African veldt.

Proportion of howitzers. In field artillery we have seen that controversy raged around the inclusion or not of howitzers at all. In heavy artillery all are agreed that both are necessary, but opinion is at variance as to the proportion of each. Here again we find ourselves on the side of the Germans while the French are, or were, all for the gun. But in this matter as in so many others, friendly discussion, and the exchange of experience, has brought us very much to the same point of view. The whole thing really turns on whether howitzers should be used for counter battery work or confined to bombardment. We hold that the howitzer is more accurate against such a target as an enemy's battery; that it is more mobile for the same weight of shell; that its fire can be more easily observed, especially from an aeroplane; that it has a longer life; and that it is easier to place, not only because it can be tucked away into hollows of the ground where it would be impossible to use a gun; but also (and this is a curious development of this war of masses), because it can be used in crowded areas. I have often seen our big howitzers in action in the midst of a mass of congested traffic around some depot of supplies, with troops moving in every direction, wagons loading up with stores, and so forth, under their very muzzles, where the blast of a gun would have swept everything away in front of it. But while controversialists are marshalling such arguments it looks as if the ground would be cut away from under their feet by the disappearance of the distinction between gun and howitzer! The length of the howitzers has gradually grown from 13 calibers to 17, and now in some of the latest to over 20, while the use of varying charges either to reduce the wear, or to allow of the employment of curved fire, is gaining ground for guns.

Trench mortars. At the other end of the scale we have trench mortars, again only a revival of a weapon well known a century or more ago. They also were used extensively by the Japanese in Manchuria, but I am afraid that the artillery as a whole was rather inclined to scoff at them when they first appeared. Those days, however, soon passed. It was recognized that in the form of trench mortars, we could increase our strength for bombardment by utilizing *material and labor not good enough for guns.* The German trench mortars, for instance, were chiefly made by a firm famous the world over for its cream separators! What distinguished officers at one time called "tin pot artillery" thus rose gradually in favor, until in Italy it took the place of horse artillery as a *corps d'élite.* But in those days we were shorter of guns and ammunition than of men. Now the position is reversed. Trench mortars are terribly expensive in men, and more especially in officers, and so just when the material is being perfected, the mortars are dropping to some extent out of use. It is just one of those changes which must be so baffling to the civilian who tries to help us.

Increase in range. With all natures, guns and howitzers, field, heavy, and trench mortars, there has been a continual cry for range, and still greater range. This has been due to many causes, chiefly tactical, but principally to the extension of field of fire given by aeroplane observation. The various expedients which have been resorted to to meet this demand are interesting. In the first place there was the simple lengthening of the howitzers, and the bringing into the field of the long high-velocity naval and coast-defense guns. Then there came the various alterations in form of shell, the general feature of all of which is a great lengthening of the ogive (the pointed nose of the projectile). The radius of curvature of the ogive has been increased from 2 to 6, and in some cases to 8 calibers, but the most notable form is the French "Obus D," so called after General Desailleux, the officer chiefly responsible for the design, and usually designated by us as the "stream line" form. Our experience with this form has not been very encouraging, but it is admitted that the slope of the base has a very important bearing, and must be determined for each nature, and I may mention as an instance of the close cooperation existing between us, that the French have recently designed a shell for trial in our guns with which we hope to get better results. The "false head," another form of the same idea, is largely used by French and Germans in the heavier long range guns, but again it is not so popular with us. It introduces considerable complication in supply and fitting and is suspected of being a possible cause of "prematures." No doubt with the extension of the use of longer-headed shell, the necessity for false heads disappears to a great extent. But I am by no means satisfied that they have not great possibilities when used with shell designed from the commencement for them.

Long-burning fuses. The most difficult problem in connection with range is the provision of a time fuse which will be reliable for long range fire. We should use shrapnel far more than we do, if we could get a good time fuse, reliable at long ranges. Here is an opportunity if ever there was one for the scientists. As you probably know, the fuses in the service now depend on the burning of a train of composition, which must be liable to many inaccuracies, especially when you consider the conditions under which it has to be kept on service. Mechanical fuses have been known for long, and we did our best to encourage inventors nearly twenty years ago, but such fuses only came into real use last year when it was noticed that the Germans were making uncommonly accurate practice at our balloons, at ranges up to over 20,000 yards. Early in the summer we got specimens of their fuse, which turned out to be a clock-work fuse designed in 1916. The Academy of Sciences will be interested to hear that they were at once handed over to the Cambridge Physical Laboratory—it would perhaps be indiscreet to proceed further with my revelations.

Use of guns at close quarters. But if the tendency is always to increase the range of our guns, do not think it is with the object of keeping them back. Far from it, for even if guns are as a rule further apart than they were in the old wars, the men who direct the guns are closer than they were even in Napoleon's time, and there is still as much room as ever for the display of personal enterprise and gallantry. But as a matter of fact, just as this war has seen the revival of hand-to-hand fighting with the bayonet and the butt, so it has seen guns pushed into closer ranges than has occurred for a century at least. On many occasions I have known individual field guns put within 200 yards of the enemy's trenches. This was of course for some special task, such as breaching a parapet or knocking out some particularly obnoxious "nest" of machine guns. With time, ingenuity, and courage, a gun can be got almost anywhere, and the effect of its fire at such ranges is very marked, while its presence affords immense encouragement to the infantry. Great care must of course be taken in working out the preliminary arrangements, and in one case I may mention where a gun had to be brought up over the open, it was moved at night under a canopy, like a dignitary of the Church in high festivals, and the gunners who carried the canopy were trained to drop it on the gun whenever a flare went up. This gun fired its 100 rounds at a range of 70 yards in nine minutes, completely destroying its objective, and the detachment then, strictly against orders, joined in the assault.

Another case I know forms rather a touching story. When I was on the Italian front beyond Gorizia in 1916 I happened one day to see a gun very cleverly concealed in the front line, to be used in much the same way. Curiously enough I met last year the commander of the corps to which this gun belonged, and talking one day he asked me if I remembered it. He said he had been going around after me, and the noncommissioned officer in charge had told him how an English general had shaken his hand and congratulated him on being in the place of honor. Poor fellow, he did his work with complete success next day, but he and all his men were killed.

Increase of heavy artillery. But, gentlemen, I am not sure that the real romance of artillery in this war does not lie in the efforts made to furnish us with the material we so urgently needed. At the beginning, as I have said, we had one battery of "heavies" per division, or 24 guns in the whole of our "contemptible little army." On the Aisne we got our first siege howitzers of 6-inch caliber, and I had placed under my command there the same battery which as a young staff officer I had guided to its first position against the Boers at Pardeberg. During the winter of 1914, a few more heavy guns and howitzers began to arrive, but by midsummer of 1915, we had only about 70 all told. The summer of 1916, however, saw this number increased just tenfold, while by last summer it had been more than doubled again. How was this done? In the first place by utilizing every gun, whether designed for a fort or a ship, that we could lay hands on. The mounting of such guns, for work in the field, either on railway trucks or carriages, has given great scope for ingenuity, especially as the task has become more and more complicated by the necessity for economy in metals and in skilled labor. But all along the great consideration has been *time*, and this of course has been especially true of new manufacture. It is to that element of time that I would like to draw your special attention, because it is one which, if you will pardon me for saying so, the scientist is perhaps a little inclined to overlook. It is only natural that he should be absorbed in the perfecting of his design, but the poor soldier facing the German can not wait for the fairy tales of science and the long results of time, but wants something, anything, and quickly, that will shoot.

National efforts. And then Mr. Lloyd George, like a new Peter the Hermit, led a crusade to stir up the people at large to the manufacture of guns and shells. We perpetuated designs which we knew to be out of date. We adopted, with our eyes open, new designs which were in many points based on considerations of facility of manufacture, rather than of perfection, and we risked the omission of many of the regular stages of trial hitherto considered essential. It was a gamble, but it was the only way to get the numbers required, and it was justified by success. In this connection I may perhaps mention a most remarkable instance of adherence to antiquated pattern, in order to avoid any delay to output, afforded by the Germans. The outbreak of war found Germany, as I have already mentioned, with an obsolescent field gun, but as I personally discovered in the battle of the Somme, she directed all her energies, not to remedying its defects, but to developing production. I happened by accident to examine these two captured guns which were standing side by side. One, No. 40, had been made twenty years before and converted from breech loading to quick firing; the other, No. 6173, had only been made the previous year, but there was not a rivet's difference between them; only, in the new gun, time had been saved by omitting engraving the Imperial cipher on the breech!

Ammunition. As with the guns, so with the ammunition, but perhaps to a still greater extent, production has been the great problem, for from early in the first autumn of the war our stocks of ammunition were practically exhausted, and we gunners had over and over to turn a deaf ear to the calls for help from our almost exhausted infantry. Everything possible was done to expedite output. National shell factories were set up all over the country, for the smallest shop could at least make 18-pounder shrapnel bodies, and delicate women toiled long hours at the lathes. We adopted designs which were not the best but which were the easiest to make, and then faced the danger of "prematures."

Prematures. This bursting of guns by the premature explosion of the shells is almost inevitable when one has to depend on hurried and unskilled production: it is one of the risks which must be run when shells have to be rushed out to the front. But the loss of guns and men may be serious, and it is always a trying ordeal to the artillery. The French with their large expenditure of high explosive shell were the first to suffer severely from it. I remember seeing many of their wrecked 75's when we were fighting side by side at Ypres at the time of the first gas attack, but they bore it with the calm fortitude which has been their attitude through all these long years of trial, and when our own time came, their experts placed all their experience at our disposal, and rendered us invaluable assistance in getting through our trials, and I would like especially to mention here the names of General Gossot, an artilleryman who has gained more than a national reputation as a contributor to science, and General St. Claire Deville, whose name is a household word in France as "the father of the seventy-five." It will do no harm now, and may do good, to tell you how serious our position was at one time. [The ratio of prematures, at first irregular, then rapidly decreasing, was shown by tables.]

There will always be prematures, and loss of life from them, while high explosive shells are used, but we look to science to apply its methods to the investigation of every case, and to guard us, as far as human ingenuity can, against them.

But what did we gain by accepting these risks? The average number of tons of ammunition fired away per week in France will probably be the simplest way of putting it. [The figures, in tons per week, showed the immense increase in output attained since the war began.]

Economy of materials. It was not until our production was assured that we were able to set ourselves to improving our designs, and then came the necessity of economizing materials, to dampen the enthusiasm of our designers again. We have had to reduce the capacity of our favorite 18-pounder shrapnel to allow of the use of lower grade steel. We have had to replace our well tried propellant, cordite, by nitro-cellulose; to reduce the percentage of T.N.T. in our explosives; to let brass displace aluminum, and cast iron displace brass, in our fuses; and to change the form of our driving bands to economize copper. But everywhere again science has come to our aid once the need has been fairly put.

Production. Judging from our experience, the guiding rules in order to insure production would appear to be to develop to the utmost the production of what can be got easiest—remembering always that there will certainly be a demand for changes, and to press on research in the meantime so as to be ready to change to more efficient patterns as soon as the position allows of it, watching always the tactical changes so as to be able to anticipate demands. Thus the business man and the scientist have full fields for their activity, but both will have many discouragements to face, for in war they must be controlled by the needs of the soldier.

When the scientist after weeks of intense study has solved the secret of some wonderful idea for improvement in design, he will be told that it is not worth the loss of output it will entail; for to every change—however fascinating or desirable in itself—must be applied the touchstone "How much will it retard output?" Just when the manufacturer is priding himself upon the introduction of improvements in method which will shortly double his output, he will be told to shut down.

So it is, and so it must be—*war is not, and never will be, a business proposition.*

Wear of guns. The output of new guns has not only to provide the numbers required to bring the army up to the desired strength, but it has to meet the wastage due to accident, to the enemy's fire, and to wear, of which the last completely overshadows the other two.

As long ago as 1916, General Gossot said in my hearing "Up to this the guns have eaten up shells; we shall now see the shells eat the guns." He was absolutely right. At the beginning we had little anxiety, for so admirable was the material of which our guns were made that their lives proved in practice to be far longer than had ever been anticipated. But as the output of ammunition increased they began to give out, and it may interest you to have some figures as to what the "lives" of the more important natures are. [Tables were presented showing the average life of guns and howitzers].

Needless to say that the search for a cure has been pursued with vigor, and this is a matter in which there is a great field for science; a field which has not been overlooked in this country, as witness the learned paper on the subject by Dr. Howe in the *Transactions of the American Institute of Mining Engineers* of last February. There is no doubt that the intense heat caused by prolonged rapid fire has brought on the guns a strain which was never anticipated, and in France and Russia and Italy I found that deterioration in the quality of the steel used since the war began was thought to have been a contributing cause. With us this latter does not appear to have been the case, except perhaps in individual instances, nor have we been able to determine whether carbon, nickel, or nickel-chrome steel gives the best results.

Reduced charges have now been introduced. Strict rules as to pauses to cool the guns have been promulgated, and various substances are now used for greasing the bore. We hope to get good results from our latest mixture, the composition of which has, needless to say, been communicated to your ordnance authorities.

Repair of guns. But all the above are merely palliatives. We have to face the fact that our guns have all a very limited life under modern conditions. One battle may be enough for some, and so the question of *repair* has become one of great and growing importance. Facility for relining must ever be in the mind of the designer, the provision of sufficient plant for repair must be included in the outfit for war, and a regular system of withdrawal in rotation instituted. Just as in a fleet some ships must always be in dock if the docks are not to be congested by a sudden rush, so must a regular system of sending guns for relining be maintained.

With the ocean between your guns and your arsenals, the problem is a very difficult one for you.

Wear of carriages. And the same thing applies to the carriages. The delicate mechanism which is an essential feature of a modern carriage, even in field artillery, requires skilled and careful handling, especially when called upon for such a strain as is imposed by long continued rapid fire, with its consequent heating of all the parts, expansion of oil in the buffers, and so forth. It has always been the boast of artillery officers to know and care for their equipments, but the entry into action of large bodies of newly-raised artillery in 1916, synchronizing as it did with the enormous development in ammunition supply, undoubtedly led to a considerable amount of preventable damage. Where this struck us particularly was in the springs of our field carriages, and in the air recuperators of some of our heavier mountings. One divisional artillery commander told me in August that his guns had fired 7,500 rounds in six weeks, and that since the beginning of the action he had had on an average 25 per cent of his guns always out of action from this cause. All the spring-makers in England were called into conclave—representatives of the design departments of all the great gun making firms were taken over to France, to see on the spot where the failures were. But no doubt the chief damage was due to the fact that in the heat of battle, inexperienced personnel had forgotten the constant attention buffers require. Great attention has since been paid to this part of the training, and after visiting many of the field workshops a few days after the commencement of the attack in Flanders, I was able to report that preventable damage was practically dead. But there are still, alas, some cases of prematures, and with the counter battery work that goes on now many cases of damage from the enemy's fire, so that our field workshops are still kept busy. Close up to the front you will find everywhere installed in ruined farms or under a tarpaulin shelter these ordnance workshops, containing a heterogeneous collection of damaged guns and carriages. From thestore of "spares" it may be possible to put the damage right with some adjustment, or from three such "lame ducks" it may be possible for one or two to be made complete, and so the work goes on all night, and by dawn the guns are in their places in the line again. The work done by the officers and men who man these workshops is a very material factor in the great artillery struggle, but nothing can compensate for the daily care of the gunners, and I always think the mottoes inscribed on the French 155-mm. Filloux guns should be on every gunner's heart:

"Le Canon bien tendu en vaut deux." "Soyez bons pour les freins."

I hope, gentlemen, that you will not think I have devoted too much of your time to this subject of production and repair, but it is one of absolutely vital importance to the efficiency of an army in the field, and it is one in which science has a great part to play.

Accuracy of fire. I had intended to tell you something of the development of the work of artillery in the field, of counter battery work, and of the "barrage," a word which seems to have captured the American imagination almost as much as "camouflage." But time does not permit, so I will confine myself as far as work in the field is concerned to giving you an idea of what has been done in the way of developing the *accuracy* of artillery fire during the war.

Accuracy of fire is of course the first essential to success in the artillery, and the first thing therefore that the good gunner does is to get as good a platform for his gun as he possibly can, and that probably means much heavy labor in digging deep, and gathering material—rubble, bricks, timber—from a distance. This search for materials sometimes leads to amusing scenes.

Care of ammunition. But however solidly a gun may be supported it can not be expected to give uniform results unless the ammunition is in good order. Powder and fuses must be protected from the weather, and this entails much labor and constant care. We had, for instance, great trouble when we first adopted nitro-cellulose powder because we did not realize how sensitive it was to damp.

Protection from the weather is not, however, all that has to be done to insure good shooting from the ammunition. Cartridges and fuses are made in *lots*, and no "adjustment" can quite get over the differences between these. Every effort is made to keep lots together, and the system of doing so is at this moment being greatly developed, but even with all possible care, lots will inevitably get mixed in their passage from the factory to the ship, from the ship to the depots, from these to the dumps, and so through the various échelons of supply till they reach the guns. Cartridges and fuses must therefore be sorted in the batteries, and the necessary allowances made when using the different lots. Somewhat the same thing has to be done with the shell, for when a large output of ammunition is to be obtained from all sorts of factories it is out of the question to reject all which are not exactly within the strict limits of weight. They are accepted but with the weight marked upon them, and these again must be sorted and the necessary allowances made.

Calibration of guns. The next thing the artilleryman has to think of is the age of his gun, or rather how hard it has lived! As a gun wears, its accuracy and its range fall off. The former can not be calculated, though it must be allowed for; the latter can, and the loss of muzzle velocity in each gun must be found and allowed for. This is what we call "calibration," and it has to be repeated with each propellant, and, in a howitzer, with each charge. It is usually carried out on the front, because we prefer, whenever possible, that every shell should have at any rate a chance of killing a German. To enable it to be done the topographical sections provide batteries with maps, mounted so as to avoid errors due to shrinkage or warping, and showing accurately not only the positions of the guns and observing stations, but also such datum points as may be desired in the enemy's lines.

Error of the day. Having by this means found the errors of the guns, a battery commander has next to think of the error of the day, or rather of the moment. He must ascertain and allow for the height of the barometer, the temperature of the air, the temperature of the charge, and the force and direction of the wind for a given time of flight, and here he has to depend on his scientific friend "Meteor" who sends to him every few hours cryptic telegrams.

Error of the gun. And yet after all this meticulous care, we have to recognize that a series of rounds fired at the same elevation will not fall on the same spot, but will cover a rectangle varying in size with the gun and the range. The size of the "50 per cent zone"—the length and breadth of which are a quarter of those of the 100 per cent zone—is given in the range table of each gun, and this has to be continually in the mind of the battery commander, for without a thorough realization of it he can not judge how many rounds will be required to accomplish such a task as, for instance, the destruction of an enemy's battery. But its most important use is perhaps to avoid danger of shelling one's own troops. Nothing is so distressing to an artillery general as to receive complaints from the infantry that his shells are falling in their trenches, and yet whatever the skill of his batteries this must happen sometimes, with the lines as close together as they are, unless this inherent quality in the gun is recognized and allowed for.

Difficulty of applying calculations in the field. I will not pursue the subject further, but remember that though the calculations may appear very simple to you, they are not so easy, given the conditions under which they have to be made—the absence of any conveniences, the presence of every disturbing element. It is very easy then to make an error which may have fatal results. One of my best battery commanders was killed by a shell from his own battery when himself conducting the fire from a trench from which he had cleared the infantry.

Observation of fire. But however confident he may be of the accuracy of the information furnished to him by his scientific assistants, and of the correctness of his own calculations, the good artilleryman will always do everything in his power to insure his fire being *observed*. The possibility of sending artillery officers forward with the advancing infantry had been hotly debated before the war and in some cases practised as far as this could be done in peace, so it did not take long to fall into the idea when the first halt on the Aisne gave the opportunity—and the demands that the work made on the enterprise and ingenuity of our officers caused it to be taken up with enthusiasm. The following example may bring home to you some idea of what this meant.

At one point on the Western Front there was a low ridge between the opposing front lines of trenches. Beyond the end of this ridge there was an offset in both lines. There were ammunition dumps behind the ridge, and beyond the offset stood the ruins of a farm-house, from which a good view could be had of the German positions behind the ridge. One of our battery commanders discovered that he could get up to that farmhouse at night. He went up one night and explored it and found that there was a gable still standing, and that the end of the gable had been knocked out by a shell, but that there were strips of drying tobacco hanging in the opening which he thought would give him shelter. So he got his telephone up there the next day, after many difficulties; he was only about 150 yards from the German lines. There he carried out a shoot which is a good instance of what I said about the importance of accuracy. Here was the ridge, and our trenches were just short of the crest. He wanted to shoot at the point beyond the crest. It was extremely difficult from the gunner's point of view to get a shell which would clear this crest and hit the objectives desired, for there was danger that the shell would hit the crest or drop into our own trenches. He succeeded through his control of the fire by direct observation, although he had to carry all that out in a place where he could not move and where he was really in full view of the Germans within almost pistol range. It was one of the sort of problems that artillery officers are continually attacking and solving in this war.

Aeroplane observation. Almost simultaneously the aeroplane observer entered the field. The story of how the present system of communication between aeroplanes and artillery has been gradually developed is in itself a subject for a lecture. Now not only does the observer in the air observe our fire, he also proves the correctness of his observation by bringing in a photograph of the result, which is used also by comparison with the zone of the guns to check the accuracy of the work of the battery. I need hardly refer to the science that has been devoted to developing the means of communication and prefecting the system, but all those who have had real experience, whether they belong to the Flying Corps or the Artillery, will I am sure agree that success will never be attained without the closest possible personal touch and sympathy between the observer in the air and the gunner below. They must know each other—without the personal equation, half the benefit of science is lost.

But practical experience showed the danger of relying too exclusively on aeroplane observation as liable to be put out of action by bad weather, while in any case the number of machines which can work on any given front is strictly limited. Great efforts are now therefore being made to develop all other possible means of observation. The balloon—the first cousin to the aeroplane—is of course very restricted in its zone, but it has the great advantage that the observer in it is in direct telephonic communication with the artillery—indeed it is nothing but an observing station in the air, which can be occupied by any artillery officer.

Observing stations. The ordinary observing stations have been developed in the one direction by camouflage which was first directed to this end, rather than to the concealment of the guns themselves; then to their elaboration—instead of the officer covering behind his precarious screen of tobacco leaves, he would be in a comfortable splinter-proof tower which had been ingeniously built inside the ruins; or sitting in the cellar, with his eye to a giant periscope, or perhaps a camera obscura.

Flash-spotting and sound-ranging. In the elaborately equipped observatories of the "flash spotters" the burst of every round may be accurately recorded by the intersections of three widely separated observers, and instantaneously transmitted to the plotting stations. There too will be registered the position of any gun that is foolish enough to open fire from an insufficiently masked position when the clouds are dark behind it.

Then the "sound ranger" too plays his part, as with his delicate instruments he registers the discharge of the enemy's gun,—also, often enough, the burst of the enemy's shells. Their work must be done far to the front, and often with little or no protection, and I would like to bear witness to the gallantry of the distinguished savants who have let no consideration of personal safety or comfort interfere with the accuracy of their observations.

Gentlemen, I commenced by making one confession—that I had no information to give you about the new German gun, and I must conclude on the same note, for I am not going to attempt to say anything about what is by far the most interesting scientific development of artillery during the war—I mean anti-aircraft gunnery. The study of the ballistics of shell fired at such angles, the effect of high altitudes on the burning of the fuses, the invention of the wonderful instruments in the way of height-finders and so forth required for the direction of the fire, have opened up entirely new fields of scientific research. I have just had the pleasure of handing to your experts the results of a series of very exhaustive experiments which have been conducted in England. But it is wise to recognize one's own limitations; I very soon discovered that anti-aircraft gunnery had reached an atmosphere too rarified for me. You must therefore find younger and more scientific brains to tell you the wonders of the new science still in its infancy, but progressing by leaps and bounds. If you think that the results attained have been small, that with all the expenditure of talent and material devoted to it the proportion of aeroplanes brought to bag is insignificant. you must remember the difficulties of the task. An aeroplane covers more than half a mile while the shell is in the air, and I leave it to the sportsmen among you to say how many ducks they would pick up under such conditions.

Gas shell, the other great real novelty in artillery, has already been ably dealt with by my friend Major Auld, with whom "over there" I have so often discussed their development and effect. There are indeed some other directions in which science is, I hope, even now on the threshold of discoveries, which if they will not "revolutionize warfare" will at least greatly increase the power of the artillery. A famous speaker is credited with the advice to a beginner, that if he could not be interesting he could at any rate always be indiscreet. But in war time one is denied even this resource. And so I am afraid that my contribution to your series of lectures on science in relation to the war has been a story of gradual development rather than of sensational advances. Even so, I hope that I have been able to show you that we artillerymen have maintained our traditional interest in science, and that it is not in vain that the famous statue of "Armed Science" has been for so many years the presiding genius of our mess room at Woolwich. I have shown you also a little of what men of science have done for us not only in the study but in the field. I am sure that you will come forward as freely, and that my brother officers of the American artillery will welcome as we have done all the assistance that science can give them.

CRYSTALLOGRAPHY.—*Certain relations between crystalline form, chemical constitution, and optical properties in organic compounds,—II.*[6] EDGAR T. WHERRY, Bureau of Chemistry.

Penta-erythrite

$C(CH_2OH)_4$ Ditetragonal-pyramidal; $a : c = 1 : 1.024$.

The optical data given by Groth[7] are tabulated here in the same manner as were those of urea. (See table 4, p. 321.)

The refraction and axial ratios agree within the limits of error of measurement, so in this substance, as in urea, the standard axial ratio is also the true one.

The chemical molecule of penta-erythrite can be brought into agreement with the observed symmetry if spread out around a central carbon atom with all the OH groups pointing in one direc-

[6] Continued from page 285.

[7] Chemische Krystallographie III: 385. 1910.

tion, bringing out thereby the lack of a horizontal symmetry plane. The space-lattice shows cube-centered arrangement within the smallest cells, as well as in the whole structure. These features are incorporated into figure 2.

As this substance possesses a rather complicated space-lattice, certain simplifications are introduced, such as the grouping of the H atoms and the OH radicals. In addition, the symbols are

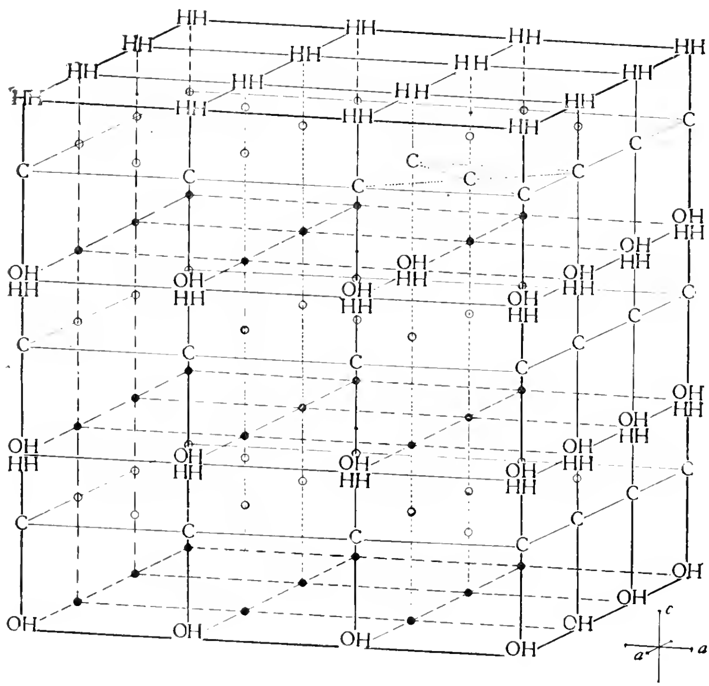

Fig. 2. Partial space-lattice of penta-erythrite.

given only for atoms that occur on the surface, except in the upper right forward cell, which is labeled completely; it is understood that all the points in any one horizontal plane indicated by dots or rings are occupied by the same atoms or groups that occur where the planes reach the front of the diagram. The space-lattice shown should be increased one-third in each horizontal direction to attain completeness. It will then contain 11 chemical molecules and $8^3 = 512$ of the smallest cells, and the spacing of the cells can be determined by applying the same formula as was used for urea. Here x = 11, W = 135.02, m = 1.64×10^{-24} gm., v = 512, ρ = 1.40, c = 1.024. Solving, d_a = 1.49×10^{-8} cm., and d_c = 1.52×10^{-8} cm. The arrangement is too complicated for this to be interpreted in terms of the thick-

TABLE 4

Refraction Relations of Penta-erythrite

REFRACTIVE INDICES		REFRACTION RATIO	AXIAL RATIO
ω	ϵ	$R\omega / R\epsilon$	c / a
1.559	1.548	1.0 7	1.024

ness of any one kind of atoms, but the values are not far from those of urea in the direction in which hydrogen layers appear, indicating that the spaces occupied by the several kinds of atoms in the two substances are about the same.

Mellite

$Al_2(C.COO)_6.18H_2O$ Ditetragonal-bipyramidal; $a : c = 1 : 0.746$.

If the alternate axial ratio of this peculiar mineral is used, the axial and refraction ratios show approximate inverse agreement, as brought out in table 5.

TABLE 5

Refraction Relations of Mellite

REFRACTIVE INDICES		REFRACTION RATIO	AXIAL RATIO
ω	ϵ	$R\omega / R\epsilon$	c / a
1.539	1.511	1.046	1.055

In this substance complete working out of the space-lattice is impracticable, as the dispositions of the atoms in the organic radicals are uncertain. But the partial structure shown in figure 3 has several points of interest. In it R stands for (C.COO) and the heavy dots for H_2O. The fact that a compound in which certain groups appear in threes or multiples of three should crystallize tetragonal seems at first sight anomalous; but when the number of atoms represented in a square occupied at both corners and centers of edges is figured out, it is found to be three; or if the atoms are moved from the corners part way toward the center—in the figure they are half way—, six prove to be present. The latter arrangement seems to fill the requirements in the present case the best.

The R groups are regarded, then, as lying in planes, with the Al atoms arranged, as required by the symmetry, along the verti-

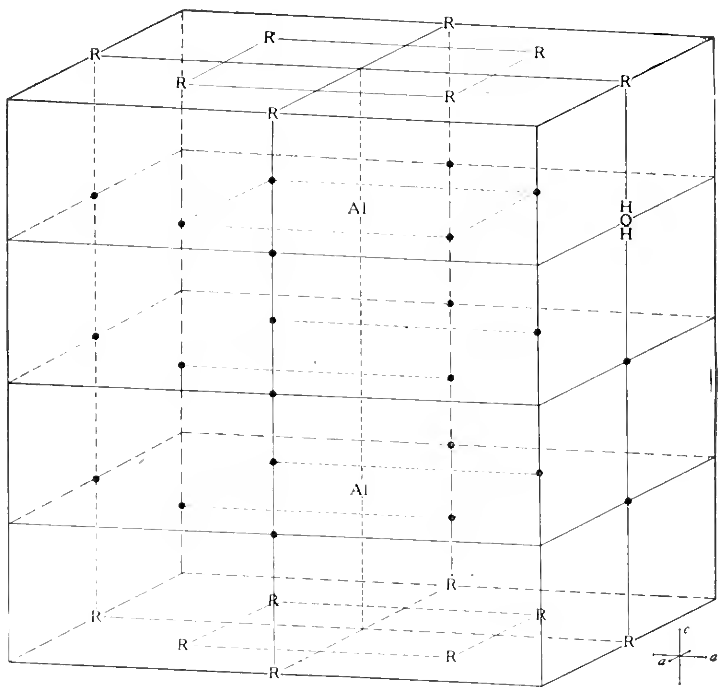

Fig. 3. Space-lattice of mellite.

cal axis between them. A sort of spool-shaped structure is thereby produced, and it is only natural that water of crystallization should, as it were, take the place of the thread. The 18 molecules of this can best be arranged in three layers of six each.

If the atoms of the (C.COO) group are actually spread out in the same vertical layers, occupying nodes where these intersect horizontal ones shown, the spacing of the planes of the layers may be calculated in the usual way. In mellite $x = 1$, $W = 62.95$, $m = 1.64 \times 10^{-24}$, $y = 64$, $\rho = 1.64$, and $c' = 1.055$, whence $d_a = 2.10 \times 10^{-8}$ and $d_c = 2.22 \times 10^{-8}$ cm. The somewhat greater values obtained in this case are what would be anticipated from the presence of the relatively large aluminium atoms, although the structure is too complicated and too uncertain for exact valuation of the effects of the several atoms.

The double propionate group.

The crystallographic and optical data in the literature[8] upon the double propionates of calcium with strontium, barium, and

TABLE 6

REFRACTION RELATIONS OF DOUBLE PROPIONATES

METALS	REFRACTIVE INDICES		REFRACTION RATIOS	AXIAL RATIOS
	ω	ϵ	R_ω / R_ϵ	c/a
Ca_2Sr	1.487	1.496	0.984	0.976
Ca_2Pb	1.526	1.540	0.978	0.979
$Ca_2(Pb, Ba)$	1.510	1.522	0.981	0.981
	1.485	1.498	0.978	0.986
	1.457	1.457	1.000	1.000
Ca_2Ba	1.444	1.444	1.000	1.000

lead respectively, show fair inverse agreement to exist between their crystallographic-axial and refraction ratios, as brought out in table 6. The barium salt is cubic, but this may be looked upon as a limiting case of the tetragonal system, where axis $c = 1$, and the refraction ratio is of course also 1.

The refractive indices and axial ratios have been accurately determined for a large number of isomorphous mixtures of the lead and barium salts; three of these are here listed as typical. Toward either end of the series the refraction and axial ratios show inverse agreement, but they deviate through the middle portion. Evidently the irregularities in the layers of atoms that

[8] GROTH, op. cit., p. 203.

result when large numbers of both barium and lead atoms are present disturb the refraction effects of the layers in which they lie in one direction, whereas when atoms of one kind are in considerable excess the layers, as it were, smooth out, and their effect on the refraction is normal.

One of several possible interpretations of the structure of these salts is shown in figure 4. It is easy enough to arrange two metal

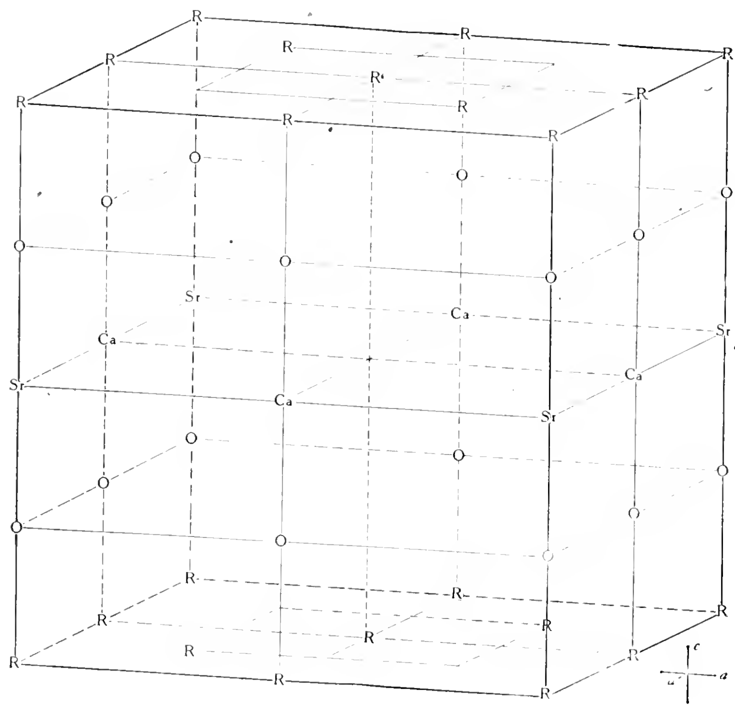

Fig. 4. Space-lattice of Ca-Sr propionate.

atoms of one kind and one of another kind into a group with tetragonal symmetry—the latter may occupy the corners of a square, the former the centers of its edges (only $\frac{1}{2}$ of the first and $\frac{1}{4}$ of the second belonging to the square). But the propionic acid radical $CH_3.CH_2.CO$ is rather clumsy to handle in a space-lattice. The mean positions it probably occupies are indicated by R in the figure, but speculation as to the arrangement of the atoms within this group seems profitless.

Exceptions

It now seemed desirable to inquire into the relations in cases where inverse proportionality of the axes and the refractions fails to hold, and five illustrations of this were found among the 50 representatives of the tetragonal system listed by Groth,[9] namely: calcium-cupric acetate, ammonium-uranyl acetate, *i*-erythrite, β-methyl-glucoside, and guanidine carbonate.

In calcium-cupric acetate the inverse refraction ratio is 1.088 and the standard axial ratio 1.032. These are apparently too far apart for observational errors to cause their divergence, so it is concluded that in this substance either the atoms are irregularly arranged in one direction, or that a marked anisotropism of the copper atoms is associated with the coloring and pleochroism of the substance.

In ammonium-uranyl acetate the inverse refraction ratio is 0.979, and the standard axial ratio 1.412. If the form usually called (102) is made (111), the latter ratio becomes 0.998, approaching the former one. Probably some layers of atoms have no effect in fixing the position of the prominent form (111) on which the standard axial ratio is based, and yet their existence finds expression in the appearance of the subordinate form known as (102). The crystallographic measurements of this substance made by different observers vary nearly one degree, which may explain the lack of more exact agreement; and moreover some anisotropism of the uranium atoms is probably present as well.

In *i*-erythrite the inverse refraction ratio is 1.037, the standard axial ratio 0.376; but if the form taken as (111) is really (102) the latter ratio would be 1.068, which is nearer, yet still not identical with, the refraction ratio. However, the substance must possess a rather complicated structure, containing two asymmetric

[9] Chemische Krystallographie III (also a few in I and II).

carbon atoms, which are no doubt anisotropic; a deviation of the two ratios is thus not unexpected.

In the case of β-methyl-glucoside the situation is similar to the preceding. Here, however, the change needed in the standard axial ratio is merely the use of the alternate value for c, and the tabular habit and basal cleavage point to the fundamental correctness of this value, for in accordance with Fedorov's principle c should exceed a in such circumstances. The ratios are then: refraction, 1.035; crystallographic, 1.137. The complication of the structure, and the presence of several asymmetric carbons, are probably sufficient explanation of the divergence.

In guanidine carbonate the refraction ratio is 1.020, while the standard axial is 0.991. The numerical deviation is not very great, but is remarkable because the two lie on opposite sides of unity. However, crystals of this substance exhibit rotation of the plane of polarized light and abnormal dispersion of double refraction—showing a minimum around 589 and increasing both directions therefrom—, thus offering evidence of possible reasons for the above unusual relation.

The exceptions to the inverse relation of refraction and crystallographic axial ratios are thus readily explainable, although no data are as yet available that would permit the evaluation of the disturbance caused by each of the several factors which may be represented.

Preliminary observations have also been made on several other organic compounds that possess simple formulas and crystallize in fairly symmetrical systems and classes, comprising oxalic acid, iodoform, acetamide, both stable and unstable forms, and aldehyde-ammonia. For various reasons the measurements of the indices which it has thus far been possible to make are not particularly accurate, and although simple numerical relations appear to exist between the crystallographic and refraction ratios in many instances, the details of the structures are so complicated that no satisfactory space-lattices have yet been worked out. Further study of these and other compounds is planned, however, and will be reported from time to time as definite results are obtained.

SUMMARY

In this paper the study of the "refraction ratios" of crystallized organic compounds is suggested, these ratios being obtained by substituting in the standard refractivity formula the refractive indices exhibited in different directions. It is pointed out that these ratios as well as the crystallographic axial ratios are connected with the spacing of the planes of atoms in the space-lattices of the substances, and that comparison of the two ratios may be expected to throw considerable light on the type of space-lattice represented in each case. Such a comparison is made for the substances urea, penta-erythrite, mellite, and three double propionates, and their refraction ratios prove to be the exact inverse of the crystallographic axial ratios. The relations in several other substances are also discussed, and deviations from inverse proportionality are shown to be connected with atomic anisotropism, asymmetry of carbon atoms, etc. Further work on other substances is planned.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*Resonance and ionization potentials for electrons in cadmium vapor.* P. D. FOOTE and J. T. TATE. Bur. Stand. Sci. Paper No. 317. Pp. 17. 1918.

The object of this investigation has been the determination of the resonance and ionization potentials for electrons in cadmium vapor. Resonance collision of the electron with the atom was observed at 3.88 volts and inelastic impact resulting in ionization was observed at 8.92 volts. The single line spectrum of cadmium is $\lambda = 3260.17$. If we substitute the frequency corresponding to this wave length in the relation $h\nu = eV$, where $h = 6.56.10^{-27}$ erg. sec., e the electronic charge, and V the resonance potential, we obtain $V = 3.79$ volts, in good agreement with the above. On the basis of Bohr's theory the ionization potential should be 8.97, in most excellent agreement with the experimentally determined value. P. D. F.

GEOCHEMISTRY.—*The ferrous iron content and magnetic susceptibility of some artificial and natural oxides of iron.* R. B. SOSMAN and J. C. HOSTETTER. Bull. Amer. Inst. Min. Eng. 907–931. June, 1917.

The percentage of ferrous iron and the relative magnetic susceptibility in powder form have been determined on a number of art fic al and natural oxides of iron. Artificial oxides made at 1100° and 1200° consist of a solid solution of Fe_3O_4 in Fe_2O_3. Their relative magnetic susceptibility is approximately proportional to their percentage of FeO, from Fe_2O_3 over to Fe_3O_4. The deviations may be partly accounted for by the effect of various factors, of which the fineness of grain of the powdered oxide is the most important, especially in the case of the more ferromagnetic members of the series. The colors of the powdered oxides depend both on their chemical composition and on their physical constitution, especially the fineness of grain.

In addition to the oxides whose susceptibility depends upon their content of FeO, there exists also a highly ferromagnetic form of Fe_2O_3, which appears to be rare in natural occurrence.

The natural iron-oxide minerals are similar to the artificial in that many are solid solutions of Fe_3O_4 in Fe_2O_3. Others are mixtures of Fe_3O_4 and Fe_2O_3. If the ferrous iron is not in solid solution or in magnetite admixture, the magnetic susceptibility falls below the norma'.

Some natural oxides can be magnetically fractionated; and the less magnetic portions are found to deviate more widely from normal than the more magnetic. The cause of this deviation is not yet entirely clear.

Martite is a pseudomorph after magnetite, but its constituent granules or fibers consist usually of a solid solution of Fe_3O_4 in Fe_2O_3. The ferrous iron content and the magnetic susceptibility of the specimens examined suggest that they have been produced at temperatures considerably higher that atmospheric.

R. B. S.

GEOCHEMISTRY.—*Zonal growth in hematite, and its bearing on the origin of certain iron ores.* R. B. Sosman and J. C. Hostetter. Bull. Amer. Inst. Min. Eng. 933–943. June, 1917.

The powdered oxide from certain crystals of hematite from Elba contains considerable FeO and can also be fractionated magnetically. It is therefore not homogeneous, as would be the case if the crystal were a uniform solid solution throughout. Analyses and magnetic measurements on a cross-section of an Elba crystal showed that the magnetic susceptibility and percentage of FeO vary, not irregularly, but continuously, being highest at the base and lowest at the free-growing tip of the crystal. The crystal is therefore zoned with respect to its FeO content.

Since Fe_3O_4 goes into solid solution in Fe_2O_3, forming a single solid phase of varying composition and properties, a zonal distribution of FeO is to be expected in an oxide of iron depositing from a vapor or solution. The occurrence of such zonal growth indicates continuously changing conditions of temperature, pressure, and concentration during the formation of the crystals. Several ore deposits of contact-metamorphic origin show a zonal distribution of ferrous iron, probably arising from the same causes as the zoning of the single crystals.

R. B. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on April 29, 1918. Upon the recommendation of the special committee on the JOURNAL, it was decided to discontinue the lists of references which have been published in the JOURNAL from time to time, and to appoint a group of assistant editors to supplement the present editorial board of three members. The ACADEMY's membership in the American Metric Association was continued for the present year. Ten resident and five nonresident members were elected.

ROBERT B. SOSMAN, *Corresponding Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 583d regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 6, 1918; called to order at 8 p.m. by President ROSE; 37 persons present.

On recommendation of the Council, Miss CRYSTAL THOMPSON and Mr. NORMAN A. WOOD, both of the Museum of Zoology, Ann Arbor, Michigan, were elected to membership.

The following informal communications were presented;

W. L. MCATEE remarked on the contents of birds' stomachs and exhibited the stomach of a merganser containing an embedded fish hook, which undoubtedly had been in a swallowed fish.

Gen. T. E. WILCOX remarked that he had once found an Indian arrow head in the stomach of a grouse.

Dr. L. O. HOWARD called attention to efforts made to limit the spread of pink boll-worm by the establishment of cotton-free zone in Texas.

WILLIAM PALMER exhibited some fossil teeth and bones lately obtained by him from the Calvert Cliffs, near Chespeake Beach, Maryland: tooth of *Hexanchus primigenius;* fragment of bone of *Puffinus;* tooth of *Champsodelphis acutidens;* tooth of a sirenian; tooth of *Delphinodon*, n.s.; tooth of *Thinotherium annulatum.* His remarks were discussed by Dr. L. O. HOWARD and Capt. M. W. LYON, JR.

The regular program consisted of two communications;

C. D. MARSH: *The cause of milk sickness or trembles.* The first publication in regard to milk sickness was in 1810, but it had been known as far back as the Revolutionary War. The disease was especially common in the early days in the states of Ohio, Indiana, and Illinois, but has rarely been recognized in publications upon diseases as a disease with a specific entity. The most noticeable symptoms are pronounced nausea, with vomiting, extreme constipation, and trembling. The disease was said to affect particularly cattle and was transmitted through the milk to human beings. A good deal of mystery has been attached to the etiology of the disease and among the suggestions as to the cause have been fungi, insect-borne germs, emanations from the soil, and a number of supposed poisonous plants. The plant to which suspicion has been particularly directed has been *Eupatorium urticaefolium*, commonly known as white snake root. The work of Jordan and Harris in 1909 seems to prove that the disease is produced by a distinct bacillus, and the publication of Crawford in 1908 seemed to negative the possibility of Eupatorium being the cause of the disease. It seemed best, however, on account of the suspicion which still attached to this plant for the Department of Agriculture to make a series of feeding experiments. These experiments proved conclusively that *Eupatorium urticaefolium* is poisonous to both cattle and sheep. The knowledge thus acquired in connection with other published statements seems to make it certain, not only that the Eupatorium is poisonous to both cattle and sheep, but that it is the cause of many, if not almost all of the so-called cases of milk sickness in cattle and sheep.

Dr. Marsh's paper was illustrated by lantern slides showing characteristic attitudes of poisoned animals.

J. W. Gidley: *Segregation an important factor in evolution with its special bearing on the origin and distribution of mammals.* (No abstract.)

Mr. Gidley's paper was discussed by Prof. Bradley M. Davis, Dr. T. S. Palmer, Mr. William Palmer, and Capt. M. W. Lyon, Jr.

M. W. Lyon, Jr., *Recording Secretary.*

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 525th meeting of the Society was held in the Lecture Hall of the Public Library on Tuesday, April 9, at 8 p.m. Dr. Paul Haupt, W. W. Spence Professor of Semitic Languages and Director of the Oriental Seminary at Johns Hopkins University, Baltimore, Maryland, gave an address upon *Mesopotamia and Palestine.*

"The early civilization of Babylonia was Sumerian. The Sumerian language appears to be related to Georgian in Russian Transcaucasia. Mesopotamia passed successively under the sway of the Sumerians, Accadians, Hittites, Cassites, Assyrians, Chaldeans, Persians, Macedonians, Parthians, Romans, Sassanians, Arabs, Mongols, Tartars, and Turks. Since 1638 it has been a part of the Turkish Empire.

"In 1902 the Turkish Government granted to a German syndicate a charter for the construction of a railway from Constantinople through Asia Minor to Bagdad, and afterwards to Basra. This through line from Hamburg to the Persian Gulf, which threatened the British dominion of India, was one of the most important factors which led to the world war.

"In 1886 I recommended colonization of Mesopotamia, construction of the Euphrates Railway, and restoration of the ancient system of irrigation. In 1887 I prepared a memorandum concerning a national expedition to Mesopotamia under the auspices of the Smithsonian Institution. In 1892 I suggested settlement of the Russian Jews in Mesopotamia. My plan was afterward advocated by Israel Zangwill.[1] The restoration of the ancient system of irrigation, which would make Babylonia again the chief granary of the world, was taken up in 1909 by Sir William Willcocks.

"The relations between Mesopotamia and Palestine are very close. The ancestors of the Israelites came from Mesopotamia. The Israelites were settled in Palestine when the Edomite ancestors of the Jews were in Egypt. Judah was not a tribe but a religious association of worshippers of Jahveh, including not only Edomites, but also Horites, Canaanites, Ishmaelites, Moabites, Hittites, Amorites, Philistines, Egyptians, and Ethiopians, *i.e.*, a mixture of Asiatic, African, and European elements.

"It will perhaps be possible to solve the complicated ethnological problems in Palestine with the help of the new sero-diagnostic methods based on deviation of complement whereby the lytic action of a hemolysing fluid is prevented. Hansemann made some experiments with Egyptian mummies. Friedenthal tested the blood and flesh of a mammoth which had been found in 1902, imbedded in the ice of Siberia. The reaction showed the near relation of the extinct mammoth to the existing Indian elephant.

"Palestine (both Western and Eastern) is nearly as large (9840 sq. m.) as Sicily (9860 sq. m.), but it has only about 750,000 inhabitants, (Mesopotamia about 1,500,000). Like Sicily, which was the bridge between Europe and Africa, Palestine, the connecting link between Mesopotamia and Egypt, never was the land of a single nation and probably never will be. Certainly the Jews can claim only Judea, not the northern districts, Samaria and Galilee, or the country east of the Jordan. The majority of the colonists whom the Assyrian kings sent to Galilee were Aryans, *i.e.*, Iranians, so that the founders of Christianity may not have been Jews by race.

"With the passing away of anti-Semitism Jewish nationalism will disappear. The Jews in this country will be Americans, the Jews in France will be Frenchmen, but they will continue to regard Jerusalem as their spiritual mother."

The 39th annual meeting (526th regular meeting) of the Society was held in the West Study Room of the Public Library, April 23, at 8 p.m.; President BABCOCK in the chair. The following officers were elected for the ensuing year: *President*, Mr. E. T. WILLIAMS; *Vice-president*, Dr. TRUMAN MICHELSON; *Secretary*, Mr. FELIX NEUMANN; *Treasurer*, Mr. J. N. B. HEWITT; *Councillors*, Mr. J. P. HARRINGTON, Mr. FRANCIS

[1] See The American Hebrew, May 21, 1909.

LaFlesche, Rev. John M. Cooper, Dr. E. D. Morgan, Miss Frances Densmore. The society then listened to the address of the retiring president, Mr. W. H. Babcock, on *Some anthropological and national factors in the present war.*

The speaker reviewed the series of papers on national subjects which had been delivered before the society during the past year.

"The war is a contest of nations, conditions, and racial aspirations; between the central Teutonic empires, with originally Turanian adherents, and the surrounding republics or liberal monarchies, chiefly Latins, Slavs, and the English-speaking peoples. But the difference in kinds of government had less to do with beginning the war than the vehement hostility of races and national ambitions.

"A 'race' and 'nation' are variable terms. Language does not always accord with either. No people is homogeneous. What counts for most is a conviction of national identity and racial affiliation sustained emotionally by an ideal of patriotism. When this is violently overridden, a sense of outrage and sacrilege is evoked—the most fruitful source of devastating wars. The best preventive would be such political redistribution as would end alien oppression and make aggression very difficult."

The speaker sketched the human movements which have evolved and defined the peoples of Europe; also the special changes needed. The same victorious powers of civilization which must effect the latter could also maintain them. The prospect of a general and lasting peace was never so good as now; for the world is nearly full and well under control, excepting as yet the Central Powers and their auxiliaries. There would be no danger from outside barbarians, such as wrecked the long continued, but territorially restricted, dominion of Rome.

Frances Densmore, *Secretary.*

SCIENTIFIC NOTES AND NEWS

At the meeting of the National Academy of Sciences, held in Washington on April 22–24, 1918, the following fifteen persons were elected to membership: ROBERT GRANT AITKEN, astronomer, Lick Observatory, California; GEORGE FRANCIS ATKINSON, botanist, Cornell University, Ithaca, N. Y.; GEORGE DAVID BIRKHOFF, mathematician, Harvard University, Cambridge, Mass.; PERCY WILLIAMS BRIDGMAN, physicist, Harvard University, Cambridge, Mass.; STEPHEN ALFRED FORBES, zoologist, University of Illinois, Urbana, Ill.; JOHN RIPLEY FREEMAN, engineer, Providence, Rhode Island; LUDVIG HEKTOEN, pathologist, University of Chicago, Chicago, Ill.; CHARLES JUDSON HERRICK, neurologist, University of Chicago, Chicago, Ill.; FRANK BALDWIN JEWETT, engineer, Western Electric Company, New York, N. Y.; WALTER JONES, physiologist, Johns Hopkins University, Baltimore, Md.; IRVING LANGMUIR, chemist, General Electric Company, Schenectady, N. Y.; CHARLES ELWOOD MENDENHALL, physicist, University of Wisconsin, Madison, Wis.; JOHN CAMPBELL MERRIAM, paleontologist, University of California, Berkeley, Cal.; HENRY NORRIS RUSSELL, astronomer, Princeton University, Princeton, N. J.; DAVID WATSON TAYLOR, engineer, rear-admiral and chief of the bureau of construction and repair, United States Navy.

Prizes and medals were awarded as follows: The Comstock prize of \$1500, for discoveries in magnetism and electricity, awarded to SAMUEL JACKSON BARNETT, Ohio State University, Columbus, Ohio.

The Draper medal, for discoveries in astronomical physics, awarded to WALTER SYDNEY ADAMS, Mount Wilson Solar Observatory, Pasadena, California.

The Daniel Giraud Elliot medal and honorarium for work in paleontology and zoology, awarded to FRANK M. CHAPMAN, American Museum of Natural History, New York.

A special train left Washington on Monday evening, April 29, carrying members of the American Electrochemical Society on a six days' trip through the Appalachian South, to visit some of the more important electrochemical, electro-thermal, and power developments in that part of the country.

Dr. W. L. ARGO, of the University of California, has been engaged in researches on gas masks at the Geophysical Laboratory and the Catholic University.

Dr. LOUIS A. BAUER has been elected Foreign Corresponding Member of the Royal Society of Natural Sciences of Netherlands India.

Mr. ALBERT BURCH, of the Bureau of Mines, and Mr. E. F. BURCHARD, of the Geological Survey, have recently returned from Cuba, where they went to ascertain the possibility of Cuba supplying a portion of the United States' requirements of manganese ore and chromite. They found that it is probable that Cuba will be able to furnish a portion of the manganese ore and chromite formerly imported from other foreign sources.

Mr. F. S. DURSTON, of the Bureau of Standards, has been commissioned a lieutenant in the U. S. Naval Reserve Forces.

Professor L. C. GRATON is on leave of absence from Harvard University and is in charge of the work of the Copper Producers' Committee in New York.

Professor F. R. MOULTON, of the University of Chicago, is in Washington on leave of absence and has been commissioned a major in the Ordnance Reserve Corps.

Professor KANOICHIRO SUIDZU, of the Department of Organic Chemistry, Tokyo Higher Technological College, visited Washington in April.

Professor DAVID G. THOMPSON, of Goucher College, Baltimore, is on leave of absence and spent the past summer on field work with the party of O. E. MEINZER, of the U. S. Geological Survey, locating and marking watering places in the deserts of the Southwest near the Mexican border.

Professor RICHARD C. TOLMAN, of the University of Illinois, is on leave of absence to do war research in Washington. He is temporarily stationed at the laboratories of the Catholic University.

News was received on April 18, 1918, that Captain ERNEST WEIBEL had died of wounds at a hospital in France. Captain Weibel became a member of the staff of the Bureau of Standards in 1910. He was commissioned a captain in the Engineers Corps after the declaration of war by the United States, and was soon afterward sent to France, where he was engaged in the sound-ranging service. He was a member of the Philosophical Society of Washington, and author of several papers in collaboration with F. WENNER and F. B. SILSBEE on time-constants and inductance of low-resistance standards, the use of the Thomson bridge, and the testing of potentiometers. He also published, in collaboration with A. L. THURAS, a paper in this JOURNAL of March 19, 1918, on *An electrical instrument for recording sea-water salinity.*

Dr. H. O. WOOD, formerly of the Hawaiian Volcano Observatory, has been commissioned a captain in the Engineer Officers' Reserve Corps and is engaged in special research work at the Bureau of Standards.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL:

Surgeon General RUPERT BLUE, U. S. Public Health Service, Washington, D. C.

Professor HENRY EDWARD CRAMPTON, Barnard College, Columbia University, New York City.

Dr. HEINRICH HASSELBRING, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. GEORGE GRANT HEDGCOCK, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. GEORGE SAMUEL JAMIESON, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

Professor ARTHUR BECKET LAMB, Harvard College, Cambridge, Mass., and American University Experiment Station of the Bureau of Mines, Washington, D. C.

Mr. S. J. MAUCHLY, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D. C.

The Executive Committee of the Entomological Society of Washington has recently adopted the following rules and suggestions governing articles published in the *Proceedings of the Society:*

Rules

Rule 1. No description of a new genus, or subgenus, will be published unless there is cited as a genotype a species which is established in accordance with current practice of zoological nomenclature.

Rule 2. In all cases a new genus, or subgenus, must be characterized and if it is based on an undescribed species the two must be characterized separately.

Rule 3. No description of a species, subspecies, variety, or form will be published unless it is accompanied by a statement which includes the following information, where known: (1) the type locality; (2) of what the type material consists—with statement of sex, full data on localities, dates, collectors, etc.; (3) present location of type material.

Rule 4. No unsigned articles, or articles signed by pseudonyms or initials will be published.

Rule 5. The ordinal position of the group treated in any paper must be clearly given in the title or in parentheses following the title.

Suggestions

1. All illustrations, accompanying an article, should be mentioned in the text and preferably in places where the object illustrated is discussed.

It is desirable in describing new genera and species that their taxonomic relationship be discussed, and that distinguishing characters be pointed out.

3. In discussion of type material modern terms indicating its precise nature will be found useful. Examples of these terms are type (or holotype), allotype, paratype, cotype, lectotype, neotype, etc.

4. In all cases in the serial treatment of genera or species and where first used in general articles the authority for the species or genus should be given; and the name of the authority should not be abbreviated.

5. Where the title of any publication referred to is not written in full, standard abbreviations should be used.

6. When a species discussed has been determined by some one other than the author it is impor.ant that reference be made to the worker making the identification.

WAR ORGANIZATION OF THE NATIONAL RESEARCH COUNCIL

Because of the urgent necessity of improving means of dealing promptly and effectively with all problems bearing on the war, a reorganization of the National Research Council was effected on April 1, 1918, a summary of which follows.

The Executive Board has established eight divisions, each under the charge of a chairman who shall give all, or the greater part, of his time and attention to the affairs of his division, so as to be in a position to give immediate consideration to any problems which may arise. The following statement indicates the steps thus far taken.

Each of the eight divisions is to have an Executive Committee, to include members representing the several committees of the Council included within the Division. All of the former committees that are still active are retained under the new organization and additional committees will be established as the needs of the work may demand. The final organization of the Council may differ materially from the one indicated, both in the grouping of the various subjects into divisions and in the organization of sections and committees within the divisions.

General Officers

George E. Hale, Chairman
Charles D. Walcott, First Vice-Chairman
Gano Dunn, Second Vice-Chairman
Robert A. Millikan, Third Vice-Chairman
John Johnston, Executive Secretary
Whitman Cross, Treasurer
Walter M. Gilbert, Assistant Secretary
Alfred D. Flinn, Assistant Secretary

Executive Board

(Consists of Officers, Chairmen and Vice-Chairmen of Divisions, Chairmen of Sections of Administrative Division, and members at large)

JOHN J. CARTY, Chairman

WHITMAN CROSS	ROBERT A. MILLIKAN
GANO DUNN	ARTHUR A. NOYES
WALTER S. GIFFORD	RICHARD M. PEARCE
GEORGE E. HALE	MICHAEL I. PUPIN
HENRY M. HOWE	S. W. STRATTON
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VAN H. MANNING	WILLIAM H. WELCH
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J. C. MERRIAM	ROBERT M. YERKES

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London Committee.........	Military Attaché, or his representative Naval Attaché, or his representative Scientific Attaché, H. A. BUMSTEAD S. W. FARNSWORTH, Technical Assistant
Paris Committee...........	Military Attaché, or his representative Naval Attaché, or his representative Scientific Attaché, W. F. DURAND K. T. COMPTON, Technical Assistant

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WALTER S. GIFFORD	REAR-ADMIRAL DAVID W. TAYLOR
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CHARLES E. MENDENHALL, Vice-Chairman

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WHITMAN CROSS, Vice-Chairman

Division of Medicine and Related Sciences

RICHARD M. PEARCE, Chairman
ROBERT M. YERKES, Vice-Chairman

Division of Agriculture, Botany, and Zoology

VERNON KELLOGG, Chairman

RESEARCH INFORMATION COMMITTEE

The chief functions of the Washington office of the Research Information Committee have been defined as follows:

(a) To provide means of ready cooperation with the London and Paris offices of the Committee by:

1. Receiving, collating, and disseminating information forwarded from these offices.

2. Rendering available such evidence and documents as may be collected by the National Research Council relative to re-

search in the United States, so as to formulate replies to inquiries sent from abroad.

3. Communicating to foreign offices needs for additional information relating to problems originating in the United States.

(b) Classification, cataloging, and filing of papers and reports received from various sources at the request of the National Research Council, and record of researches in progress concerning which detailed information may be obtained elsewhere.

(c) Issue of lists of available information and preparation of digests of such information for distribution to properly accredited persons.

(d) Maintenance of contact with various research agencies in the United States.

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BIOLOGY.—*Biology and war.*[1] Raymond Pearl, U. S. Food Administration.

Science is playing a part in the conduct of the present world war far beyond anything ever dreamed of as a possibility before its beginning. The physicist and the chemist have been called into consultation with regard to practically every sort of military activity, both offensive and defensive. They have been asked on the one hand, to devise new mechanisms of destruction, and on the other hand to provide effective means of defense against such measures of annihilation as the enemy has been able to put into operation. The response to these demands has been generous, timely, and effective in all of the countries at war. In view of his contributions in these directions the university professor of physics or chemistry seems in a fair way to attain, when the war is over, a position of respectability and esteem in the world's affairs never before imagined in his wildest dreams. The submarine, the aeroplane, gas warfare, as indeed practically all of the new fighting methods which have been put into operation in the last few years, are highly recondite developments of physical science, using the term in a broad sense to include chemistry, mathematics, and even astronomy, as was pointed out to the Academy in an earlier lecture in this series by Doctor Hale.

One has heard very little about the immediate help rendered by biology in the conduct of the war, except in relation to the

[1] A lecture given before the Washington Academy of Sciences on May 9, 1918.

medical sciences, where the contribution is directly to the salvaging of the human wreckage with which the pathway of war is strewn, and only rather indirectly towards its winning. It is generally taken for granted, and to a considerable extent even by professional biologists, that in the nature of things the biological sciences, other than the medical, can have only rather a remote and indirect relation to the conduct of war.

One purpose of this paper is to make some examination of the biological philosophy of war. It has seemed to me that if one does this, he is likely to come to the conclusion that the ordinary valuation of the relative significance of the physical and chemical problems connected with war as compared with the biological problems is substantially the reverse of the true valuation. To begin with, we should remind ourselves of a distinction which is often forgotten when one attempts to evaluate in military terms the potential contributions of the different sciences to war. Essentially what the physicist and the chemist contribute is towards the creation, development, or perfection of some destructive or protective *mechanism*—at best an inanimate, impersonal machine. But the very essence of a fight is that it is between *living* things. A 120-kilometer gun, or a submarine, or a tank, cannot of and by itself make war. All such engines of destruction are only the secondary implements of war. The primary implements are biological entities—men. Without these entities there neither would nor could be any war. So then, obviously, the primary problems of war are biological problems. They are such problems as why men fight; what kinds of men make the best fighters; what conditions, both internal and external, biological and environmental, conduce to the most effective fighting; and what are the probable biological consequences (including physiological, social, and genetic) of the fight, both to the winner and the loser. This is the sort of problems to which the biological sciences can alone make any significant contribution and they are clearly much more fundamental than those entailed in the designing of a new aeroplane or submarine.

Furthermore, it admits of no doubt that the accumulated knowledge in the field of biology could be utilized in a way to be of large strategic value. The biological analysis of the events of the war as they pass might be made of direct military importance in the forecasting of the future course of events. An illustration here is found in what has happened in Russia. The collapse of Russia was at bottom not due to any shortage of powder or shot or other secondary requirements of military activity, but it came esseni-ally because a Russian is, in certain respects, a totally different kind of animal from an Englishman, a Frenchman, an Italian, or an American. Because he is a different kind of animal he has throughout his past history reacted to certain sorts of stimuli in a different way than would or did the individual of the other nations mentioned. Any thoughtful student of the biological aspects of history—that neglected branch of science which Frederick Adams Woods has been trying for years to interest people in, under the somewhat forbidding label "historiometry"—could have foretold with considerable precision both as to time and event, or better eventuality, just what Russia's contribution to the cause of the Allies would be.

What I have so far said will serve as a general indication, I hope, of the fact that we have signally failed to make effective use of the contribution to war that biological science, in the broadest sense, is potentially able to make. The indictment here, if there be any, falls upon the class to which I professionally belong. What I wish to do in the remainder of the time at my disposal is to discuss a few of the more important biological problems of war, in the hope that such discussion may serve in some sl ght degree at least to arouse interest in these problems on the part of many biologists much more capable of dealing with them than I am. If this can in any way be accomplished I feel that biology will make to the cause in which we are all vitally interested a contribution second to none.

WHY MEN FIGHT

War constitutes a gigantic experiment in human evolution. For the experimental study of evolution in lower organisms we have many laboratories and institutes. In such laboratories one studies the effect on the race of modifications in the environment, of crossing the different races, and of various other factors which may be supposed to have a determinative influence in bringing about evolutionary change or modification. A great war performs all these experiments on a stupendous scale with the human organism as material.

In saying this I am not at the moment referring to the relation of natural selection to war. That is a topic to which I shall come later. I am here referring to a very much broader aspect of the question. War is not merely selective (if it be so at all) through elimination by death of men at the front. Its biological effect on the human species is much more profound than anything which could possibly result from any merely selective process. War makes a most complete and far-reaching change in the whole biological environment of the human beings of the countries engaged in it, and if the number of these countries is sufficiently large it affects the whole world. In this regard, it is most nearly comparable to what the geologist calls a catastrophic change in evolutionary history. The reason why war induces so profound a change in human environment is that it disturbs every psychological and social relation of men with each other. For modern civilized man the environment does not mean primarily the climate, the flora, or the geological structure of the place in which he lives. To a very considerable extent civilized man controls and modifies the impingement of the direct physical elements in his environment. The important elements of human environment are those which grow out of the activities of the human mind, or as one may broadly say, the psychological and social elements. These include all the social relations which are built up during years of peace. But war, in and of itself, brings about an entirely new revaluation of all existing social, economic, intellectual, and moral relations. This is true not alone for the combatants, but for all the non-combatant or neutral nations. In a war such as the present one men everywhere begin to reconsider their thought and action about such things as what constitutes proper education for their children, what is a desirable mode of activity for the church, what sort of activities in the conduct of business may be tolerated, and a thousand other of the complex and manifold relations between human beings.

True evolutionary change in a strict philosophical sense means a definite and permanent alteration in a group of organisms, both in the group as a whole and in the individuals composing it, as individuals. When one uses the term "permanent" in this connection it should, of course, be understood always to carry the qualification, permanent until the conditions which produced the initial evolutionary change themselves become altered. Now human social evolutionary change rests upon two broad general bases instead of the one upon which the organic evolution of lower forms of life depends. Lack of recognition of this fact has been a fruitful source of failure to arrive at philosophically sound conclusions in many discussions of the social evolution of man, undertaken from the biological point of view.

The basic element and limiting factor in organic evolution is the germ plasm. It is at once the race stabilizer and the race initiator. The germ plasm is the physical basis of inheritance in general. Borne in the reproductive cells of the organism it is the one thing which preserves physical continuity between successive generations of organisms. If successive generations are to differ from one another biologically there must be concomitant and equivalent changes in the germ plasm. Genetic and eugenic research has abundantly proven that the germ plasm plays the same rôle in human inheritance and human evolutionary changes that it does in lower organisms. Here one needs only to mention the studies of Galton, Pearson, and Davenport by way of illustration. Many others might be added to the list.

Besides this strictly biological base of the germ plasm there is also another underlying factor in human social evolution which is nearly, if not quite, of as great significance. I refer to that complex of ideas and actions which has been rather badly called "social inheritance." This factor operates in somewhat the following manner. Starting from a germ-plasmic base the individuals composing any social group are biologically differentiated from those forming other social groups. On this account they develop social relations and social institutions of a sort in some degree unique and peculiar to the group. Once started, these social relations and institutions acquire a sort of inertia which in and of itself tends to stabilize them quite without any conscious activity looking towards stabilization on the part of any of the component individuals in the group. This inertia extends within the group in an extraordinary degree to every sort of social relation, including even the minor conventions. It makes the whole social fabric, which, as we have seen, constitutes a very important element of human environment, extremely resistant to change or alteration of any sort. Ordinary social forces produce but little effect. It requires years of unremitting effort to bring about even mild and minor social reforms or changes in the ordinary normal course of human events. It has taken nearly seventy-five years to get as far forward as we are with the prohibition movement in this country. More strongly socially inherited institutions would be still more difficult to alter. To illustrate the point, let us consider the social-economic institution of interest. It is entirely possible, not to say easy, to conceive a society so organized that credit and the interchange of credit would be effected without the institution of interest. But try to conceive the concrete possibility of putting into actual operation in the civilized world today a system which would do away with interest charges. The mind balks at the thought. The inertia of this institution, its social inheritance, is so strong that to change it would be a task of commensurate relative magnitude somewhat approaching to the task of so changing the germ plasm of the human race that man would have, for example, no vermiform appendix. Both are extremely stable things which cannot be easily or quickly changed by the operation of ordinary forces. Both changes involve an alteration in stably equilibrated systems, and it is a general characteristic of such systems that they do not change either frequently or easily. The inertia of social relations, which is I think a better term than social inheritance, is simply a special case of the general phenomenon of the natural occurrence of systems in stable equilibrium, the manifestations of which in the inorganic world have been so brilliantly expounded by Lawrence J. Henderson in his book *The Order of Nature*. It is precisely homologous to germ-plasmic inheritance in the biological realm and not less potent in its influence as a stabilizing factor in human social evolution.

The one outstanding cause in present-day civilization which can quickly break the inertia of social institutions and induce changes, and by so doing perform a function in the scheme of social inheritance analogous to that of mutation in physical inheritance, is war. It operates to direct sharp and searching attention to the real significance of every social institution, from the standpoint of national efficiency, national economy, and national well-being. If under such stressed examination change or reform appears to be necessary it rather quickly follows. The inertia of the long established is broken by the conditions of war.

If it would not take us so far afield into philosophy and perhaps even metaphysics I should like to pursue this point further, but I think that perhaps enough has been said to make clear the only thing which is requisite here, which is that if we are profitably to discuss the biological philosophy of war we must recognize that besides the influence of the germ plasm in human affairs we have to deal with another general factor of a social but still essentially biological character, namely the inertia of social relations and institutions themselves, which stabilizes them against sudden or rapid alteration by any but the most catastrophic causes such as great wars.

As a concrete example of the application of what we have been discussing to present conditions, we may take the case of England. Already since the beginning of the war England has passed and ended a stage in its social evolution to which it can never return. The institutions and people of that country in all their outlook on social relations in the widest sense have been essentially and fundamentally changed, and however the war may end, will be permanently different from what they were five years ago. Anyone who will take the trouble to read the recently promulgated program of the English labor party will realize how profound the alteration has been. Or, again, consider the whole history of the Home Rule question. More progress has been made towards its solution since the beginning of the war than in all the previous struggles with it.

To bring about such changes, which constitute a real and definite step in social evolution, it is not at all necessary that the enemy should win a war. It is war itself which accomplishes these alterations in human relations and human beings. It only need be sufficiently comprehensive in its magnitude, and sufficiently long continued in time, to produce definite and permanent evolutionary changes through alterations of social relations and institutions.

There is a further side to the evolutionary aspect of war which we have not yet considered. If we view the matter in terms of nations, not of individuals, it is at once apparent that war is a deliberately planned struggle between biologically unlike groups of individuals for the purpose of maintaining or bettering their status in the general hierarchy of group domination or precedence. A modern war is not entered into casually and without some degree of both spiritual and material preparation. In the nature of the thing itself it cannot be so entered. To make a whole nation want to fight, including all the ignorant, because uninformed, people in it, it is necessary that their emotions be stirred, either by some act or supposed act of an offending nation or else by deliberate emotional propaganda. At the outstart of any war this emotional incentive to belligerency is wholly lacking in a very considerable portion of the populations of the nations involved. It has to be worked up, a process in which the enemy always renders most efficient service, by such things in these latter days as air raids over inoffensive towns, sinking passenger vessels without notice, or in other ways too revolting to mention. Pending the general distribution of rage in the involved populations, the business of war has to be planned and executed by the nation's leaders in as detached and impersonal a manner as any other great business enterprise. This fact, which to a resident of another planet not accustomed to our ways might seem strange, raises two questions: In the first place, why do national leaders enter so coolly, and yet under certain conditions so eagerly, upon such a ghastly business as war; and in the second place, why do the common people not only permit them to do so, but follow them with all their energies when once the business is well under way? Some biological facts will help us to understand the answers to these questions.

The general biological fact of individual variation is, of course, familiar. No two individual animals of any sort, human or other, are precisely alike. Individuals vary or differ among themselves. Of these variations or differences some are superficial and transitory, but, on the other hand, many have a deep-rooted and ineradicable germinal basis. Perhaps the most general result of modern genetics is to show the extent to which variations, often slight in their external manifestations, have a definite germinal basis, reappearing unaltered again and again in the successive generations arising from the same germinal stock. The same fact of variation holds equally true in respect of races and national groups, provided in the latter case they have existed as socially isolated entities sufficiently long for a distinct feeling of nationality to develop. The variation in national groups involves, as in the individual, all sorts of characters, psychological, social, and moral, as well as physical. In new nations, changes in the psychological, social, and moral characters appear and become fixed by the process of social inheritance sooner than in the strictly physical characters. The fact is that the groups of people, which, in political terminology, are called nations, in the great majority of cases become rather quickly biologically differentiated if they are not so from the beginning of their national life. A German is different from a Frenchman or an Englishman or an Italian. These differences are not merely physical. They involve every mental attitude, appetite, and responsibility, which are the factors governing action.

To recognize the fact of biological differentiation or variation is in no sense to assert difference of position in the evolutionary scale. There is no evidence that among these larger and more developed national groups it is proper to speak of one as superior or inferior to another. Philosophically, all such comparisons of races or national groups are untenable, for the reason that they all involve by implication comparison or measurement with some absolute and unique base or yardstick. But no such absolute base of social evolutionary comparison exists. For example, even at this late date, someone might conceivably contend that the Germans were superior to the Hottentots, but it would be a difficult thing to prove in general or absolute terms. Measured by common sense standards one would no doubt find that in some respect—physical, or moral, or even perhaps intellectual—the Hottentot is a relatively better man in his environment than the German is in his. Plainly, in order to be just to either the Hottentot or the Hun each should be measured by a different yardstick. But this quite prevents saying in any absolute terms which of the two is the superior race. Like so many other things "it all depends." But this logical difficulty only makes it all the clearer that Hottentots are *different* from Germans.

Not only are the different races and national groups generally different, but broadly speaking, they all want to stay so, and this is what causes all that special sort of trouble, which is war. The resentment against the high-handed imposition of that Prussian "Kultur" which we are all so strenuously opposing, arises not so much from any logically proved defects in this particular brand of Kultur (though parenthetically one may remark that they appear to be sufficiently numerous), but rather because, being different, the people of other nations simply do not want it. They prefer their own particular brand of thought and action. The one fundamental thing which an Englishman or a Frenchman will fight against to the last ditch is any attempt to make him over into a German.

The same feeling is exemplified in every war. We fought bitterly for it in the Civil War. The people who originally settled in the southern portion of the United States were biologically and socially different in several important particulars from those who settled in the northern part. The Southerner fought hard and well for four years to keep from being dominated by the Northerner. He had a strong feeling, which was to a certain extent justifiable, that domination meant the obliteration, for all practical purposes, of certain differences which had up to that time existed between him and his Northern neighbor. The same feeling was a potent factor in making the Revolution. There was a dawning national consciousness in the colonies which was based upon a beginning of social and biological differentiation. The mother country very unwisely refused to recognize, or foster, or even tolerate these differences. In consequence, she lost her colonies.

In general, why men deliberately plan wars is because they are different biologically, in structure, habits, mental outlook, thought, or other ways, and wish to preserve intact their differentiations. The more truly conscious they become of these group differences, the more likely they are to fight as groups. As soon as they attain the first glimmerings of such consciousness they are apt to see, or to think they see, something in the behavior of their neighbors which threatens the maintenance of that which begins to mark them as a nationality. It is the business of their national leaders to be on the lookout for such things. They may merely fancy that they detect some danger to the maintenance of even their present status in something that a neighboring nation does. It may be a very intangible thing, and the interpretation of its significance may be entirely wrong, but that does not matter. The fighting promptly follows.

But someone will ask: *Why* does fighting follow? Why not arbitration or some other peaceful means of settling what is in many cases, at least, merely a trivial difference at the start? The biological answer is again clear. The human animal, in common with other higher vertebrates, has come to be endowed with emotions, of which rage is a very important one. In the intercourse of men and nations such things as insults, real or fancied, triflings with honor, either individual or national, attempted interference with natural or vested rights, larceny of territory or other goods—all these and similar sorts of activity vastly too numerous to catalog, tend to call forth the emotions of anger or rage. More particularly are acts of the sort mentioned sure to stir the emotions of a people if they are perpetrated by foreigners, those who do not belong to the same group. People of one's own kind may with impunity do things which another kind of people cannot do without exciting very violent emotions. The significant biological fact is that, however induced, the emotion of rage automatically and inevitably causes certain definite bodily changes and activities, as has been demonstrated by the brilliant researches of Dr. Walter B. Cannon, described in his remarkable book entitled *Bodily Changes in Pain, Hunger, Fear and Rage.* The bodily changes induced by rage are precisely those which make the organism ready for a fight. They are the visceral preparation for the translation of emotion into action. The researches of Cannon have shown, as he says, "a number of unsuspected ways in which muscular action is made more efficient because of emotional disturbances of the viscera. Every one of the visceral changes that have been noted—the cessation of processes in the alimentary canal (thus freeing the energy supply for other parts); the shifting of blood from the abdominal organs, whose activities are deferable, to the organs immediately essential to muscular exertion (the lungs, the heart, the central nervous system); the increased vigor of contraction of the heart; the quick abolition of the effects of muscular fatigue; the mobilizing of energy-giving sugar in the circulation—every one of these visceral changes is *directly serviceable in making the organism more effective in the violent display of energy which fear or rage or pain may involve.*" It is clear that we have here a first class reason why men fight. It is, in short, because they get mad at each other. It is fair to say that this has been suspected for some time past. What the physiologist has shown us that we did not know before, however, is the reason why rage is more generally followed by fighting than by judicial arbitration.

No interested person or nation was ever known publicly to allege any such reasons as those just discussed for participating in war. That fact, however, may with safety be taken not to invalidate the point. Most men are human and a liking for the outward trappings of inner grace is a highly human attribute. As war begins, and while it continues, even on to the final ending around the table of the peace conference, everyone involved alleges a wide variety of highly moral reasons as to why he is participating. As a matter of fact, he perfectly well knows, if he is at all intelligent, and at all given to facing the actual facts as they are, that the high principles have absolutely nothing to do with the *reasons* for his fighting. They serve a wholly different and much more useful and admirable purpose, in that they *justify* instead of explaining his belligerency. The explanation of why men fight is very simple. It is, first, because their kind of people is different from other kinds; second, because they want to make sure that their kind shall either maintain or improve its status in the world, and that which is thought to ensure most certainly the maintenance and extension of group differences in the widest sense is relative politico-social domination by the group; and third, because of a general physiological law that certain emotions tend to lead to *action*. So long as men are capable of becoming enraged there is potential danger of a fight.

THE BIOLOGICAL CONSEQUENCES OF WAR

Any discussion of the consequences of war, from a biological standpoint, demands as a first requisite the consideration of natural selection in relation to war, or, as it is perhaps more commonly put, "Darwinism and war." German philosophers of all degrees of attainment have been particularly addicted to speculation in this field. The view commonly held is that in war we have practically the only existing agency of natural selection operating with full vigor upon the human species. It is contended that when two nations engage in warfare with each other the principle of the survival of the fittest accompanies the operation with all its traditional crudity and finality. No better exposition of this viewpoint can be found than that set forth by my friend and colleague, Vernon Kellogg, in his remarkable book *Headquarters Nights*, from the after-dinner remarks of the distinguished German biologist who figures in the narrative under the name "Professor Von Flussen." Kellogg expounds the philosophy of war after Von Flussen in the following words:

> The creed of the *Allmacht* of a natural selection based on a violent and fatal competitive struggle is the gospel of the German intellectuals; all else is illusion and anathema. The mutual-aid principle is recognized only as restricted to its application within limited groups. For instance, it may and does exist, and to positive biological benefit, within

single ant communities, but the different ant kinds fight desperately with each other, the stronger destroying or enslaving the weaker. Similarly, it may exist to advantage within the limits of organized human groups—as those which are ethnographically, nationally, or otherwise, variously delimited. But as with the different ant species, struggle—bitter, ruthless struggle—is the rule among the different human groups.

This struggle not only must go on, for that is the natural law, but it should go on, so that this natural law may work out in its cruel, inevitable way the salvation of the human species. By its salvation is meant its desirable natural evolution. That human group which is in the most advanced evolutionary stage as regards internal organization and form of social relationship is best, and should, for the sake of the species, be preserved at the expense of the less advanced, the less effective. It should win in the struggle for existence and this struggle should occur precisely that the various types may be tested, and the best not only preserved, but put in position to impose its kind of social organization—its *Kultur*—on the others, or alternatively to destroy and replace them.

That this is a fair and typical exposition of the views of German biological philosophers regarding war will be readily granted without argument by any evolutionist who is familiar with the literature in this field. The principle of natural selection was seized upon by no one with greater avidity than the Germans. The strictly mechanistic features of this doctrine, which Darwin himself seemingly always felt to be a potential source of weakness, were the very things which made the strongest appeal to the Germans. In the hands of Haeckel, and particularly Weismann, natural selection was developed into a complete philosophical system of biology, in which any lack of biological evidence regarding the actual operation in nature of the basic principle was more than compensated for by the wooden finality of the logic.

As years went on the German statesmen and political philosophers became acquainted with the content and possibilities of what their biological confreres had by that time come to call with considerable unction "Neo-Darwinism." They presently saw the great possibilities which the principle of natural selection offered in fostering and developing in the minds of the people the militaristic ideal, the will to conquer. For thirty years every German school boy and girl has been taught what natural selection means. This same glorious principle that the fittest alone shall survive, and its converse that the survivor is the fittest, have been the corner stones on which modern Germany has been built. Various remote and far removed causes have been assigned as contributory to the present conflict, but one highly important cause—perhaps in a philosophical sense the most significant of all—has been very generally overlooked. I believe it to be literally true that the one event in the history of Western Europe which more than any other single one laid the foundation for the situation in which Western Europe finds itself today, was the publication in 1859 of a book called *The Origin of Species.* With what horror would that gentlest and kindest of souls, whose mind conceived and executed this work, have been filled could he have foreseen the frightful welter of blood which has resulted from the gross perversion of his views by German biologists.

Let us examine with some care the meaning of natural selection in its relation to war. In the first place, it must be remembered that nowhere in nature does natural selection, as indicated by modern careful study of the subject, operate with anything like that mechanistic precision which the German political philosophy postulates. In a recent paper read before the American Society of Naturalists, I presented a number of examples from the literature illustrative of this point, and I need not repeat them here. Nature often does not operate on the natural selection basis, though logically—at least in formal logic—it ought to. Much less does natural selection operate in a rigid and mechanical manner with reference to human affairs. It is perfectly clear that no war in this day and age is, in any proper sense of the word, literally a struggle for existence. The German people have from the beginning tried to make it appear that the present war is, from their standpoint, exactly this. They have insisted again and again that their national existence, their continued survival as a nation was threatened by their neighbors, but such a view has only to be stated to any fair-minded, unbiased person to prove its utter absurdity. Could anyone but a German seriously maintain that the French, or the English, or the Italians, or the Russians, would have wished for, or would have attempted if they could, the annihilation of the German people? Theoretically, such a feeling or desire is conceivable, but practically everyone knows that it did not exist. Normal human beings are simply not constituted that way.

Furthermore, military results are not, in fact, measured in terms of biological survival. History shows that defeated nations survive just as definitely and truly as conquering races or nations. No better example could be found of the fallacy of the completely mechanistic natural selection idea with reference to war than our own Civil War, which was the most severely and bitterly fought of any war in recent history before the present conflict. No question of biological survival was involved at any stage; it was a struggle to effect the survival or elimination of certain politico-social ideas held by one group of people and not by the other. These ideas were slavery and secession. One of the contending groups was defeated; no military decision can ever be more complete and final than was that reached in the Civil War. If military conquests or defeats ever mean biological survival or elimination the principle should have been exemplified in the Civil War. Yet as a matter of fact and of course the defeated group was not eliminated in the biological sense, but biologically survived, and not only survived, but has become as a group more active, more progressive, and more distinctly differentiated biologically than it was before the conflict.

Other wars at other times show the same things. Take the case of peoples subjugated by military conquests; they are not eliminated, but on the contrary they survive, using the word in its strict biological signification. The natives participating in the Indian mutiny suffered a stinging military punishment. Yet today the natives of India survive, and their institutions survive. Again, take another example: it was necessary for us some years ago to conquer in a military sense the Filipinos. The unpleasant task was accomplished in a thorough-going manner. A complete military decision was made, but the Filipinos were not biologically eliminated, and today have a significantly stronger and more real national feeling than probably ever before in their history.

Nearer events prove the same point. No more ruthless attempt at the biological elimination of a nation was ever made than that undertaken by the Germans against Belgium in the summer of 1914 and continued to the present time. Yet, does anyone, even a German, delude himself into the belief that the Belgian people and the Belgian national feeling do not survive today, and will not continue to survive?

The plain fact in the matter is that the proudly ruthless philosophy of Treitschke and Bernhardi is not only immorally cruel, but also immortally stupid. This whole crude and mechanistic view of war as a process of natural selection is really most unbiological in that it takes no account of the most fundamental of human biological characteristics—namely, those which distinctively differentiate man from lower organisms, his mental and moral qualities. Biologically, nationality rests on the group spirit of the people, which in turn means differentiant variations ineradicably ingrained in their germ plasm. Nationality can only be eliminated in the biological sense by the complete and total destruction of the germ plasm of the people of the nation, because it depends upon things which are to a substantial degree, at least, unchangeably and permanently determined by that germ plasm. Killing a percentage of the male population on the battlefield is as silly as it is a pitifully sad method of attempting to destroy the germ plasm of a nation. What a defeated nation loses in war is simply its status in the international political hierarchy either temporarily or permanently. It suffers, broadly speaking, no fundamental biological loss. The Chinese today, after a century of hopeless military defeats which left them an inert and pacifist nation are just as truly and completely biologically differentiated as they ever were. A Chinaman is a Chinaman today, and as different from anybody else in the world, as he ever was. Contrast this with real biological elimination with which this Darwinian School of militaristic philosophy draws so false an analogy. What comparison exists between a Chinaman and a dinosaur? Natural selection operated with a real *Allmacht* on the dinosaurs to a finish that made literally true the proverbial statement of the wondering rustic about the giraffe: "There ain't no such animal." But the Chinaman hopelessly defeated and crushed in military affairs is still with us and quite capable of enjoying life in his peculiar way. He stands in the aggregate as a gigantic refutation of the much lauded claim which the Germans have made for the "fundamental biological basis of war."

While we are on this subject of natural selection, it will be well to examine into another aspect of the subject in its relation to war. It has been contended by various persons that war has an unfortunate selective action on the individuals engaged in it. The operation of war is supposed to be selective within the race for the elimination of the best and the preservation of the worst germ plasm. This is alleged on the general ground that the physically, mentally, and morally best of the youth of the nation are those most likely to take part in war in the first place, and in the second place, most likely, because of these characteristics, to be killed in the course of the conflict. Dire pictures have been drawn of the effect upon the race of engaging in war, through the supposed operation of this dysgenic selection. The more one examines the facts, however, the more is it apparent that the case has been very much exaggerated.

Many considerations lead to this conclusion. In the first place, the future of the race, in the narrowly biological sense, is solely dependent upon the continuity of its germ plasm. In the human species the germ plasm of the race is equally borne by both the males and the females. But, putting the very worst complexion on the dysgenic argument, the females of the race are not elimated in war. So that if we were to grant for the moment the contention that the best males of the race are killed off, it would still remain the fact that but very slight deleterious racial effect would result, because there would be left behind in the surviving females at least half of the total racial germ cells of all qualities. Mendel's principles of inheritance teach us that even in such an extremely unlikely circumstance that all the germ plasm borne in spermatozoa was at the end of the war of an inferior quality, it would still be possible through the operation of segregation to have again a preponderant stock of superior individuals after a few generations, provided there were no social restrictions on assortative mating, which, broadly speaking, there are not.

Furthermore, the hypothesis of racial degeneration by elimination of the best tacitly assumes that those males eliminated in battle have not left progeny before their elimination, whereas, as a matter of statistical fact, a considerable portion of them do leave behind such progeny. Again it must not be forgotten that the whole of the population, both male and female, under about twenty years of age is left untouched by war, and available for the perpetuation of the race as they grow older. This means in statistical terms, that about 40 per cent of the total male population existent at any given moment, and in which all qualities of germ plasm, good, bad, and indifferent, are normally distributed, as in a random sample of the whole, are not even involved in war and hence stand no chance to be eliminated by its operation.

In the second place, even in the most destructive of modern wars the proportion of totally eliminated casualties to the whole population is not very great. Indeed, it is always found to be surprisingly small when reviewed dispassionately by the vital statistician after the war is over. To take the case of our own Civil War, the proportion of casualties to the total population was only 2 per cent, and even in proportion to the male population within the likely breeding period (say fifteen to fifty years of age) was slightly under 9 per cent. It is, of course, too early to obtain similar estimates for the present conflict.

In the case of the present war, there are still other considerations which make it clear that any putative, deleterious, selective effect of war on the races concerned will be insignificantly slight. In all of the nations involved the fighting men have been taken practically at random from the whole population so far as germinal variations are concerned. The sound biological principle of conscription operates to leave the distribution curve of germplasmic qualities essentially the same after the fighting men have been taken out as it was before. The high development of the mechanical aspects of the present war operates to the same end. Hand to hand conflicts, man against man, in direct physical struggle, are a relatively small part of the present as compared with earlier wars. The agents of destruction chiefly relied on in the present conflict are entirely impersonal and distribute their effects very largely at random. The whole mode of conduct of the present war operates to make the chances for elimination of the man carrying about within his soma the best germ plasm of the race, not substantially greater than the chances of the individual bearing the poorest germ plasm.

CONCLUSION

Except for lack of time one might go on and consider other essentially biological problems of war. We have not discussed at all those fascinatingly interesting and important problems connected with the individual's part in the actual conduct of war. A nation which would systematically and thoroughly investigate such matters as what sorts of men, physically, psychologically, and morally, make the best fighters; what biological conditions, including internal states, environmental conditions in and behind the lines, conduce to most efficient fighting; how fighters should be fed to obtain the best results; and other like problems, would be in an extremely superior position in any conflict with a group not possessed of definite scientific information on these points. At present our information regarding such matters is very largely empirical. It should be said, however, that since America's entrance into this conflict a brilliant beginning has been made in the scientific study of certain of these problems, initiated and directed in large degree by Major Robert M. Yerkes. The final results of his work will be eagerly awaited not alone for their military value, but also for their purely biological interest and significance.

In conclusion, the thought I most wish to leave with you, and which I hope I have sufficiently elaborated and illustrated, is that while war is a biological business, to the problems of which the trained biologist could contribute much, it is *not* an absolute biological necessity. Nations neither lose nor gain biologically by war. But this does not mean that wars must not and will not be fought. As a biologist I can come to no other conclusion than that wars will occur in the future as they have in the past until such time as civilized man has become a different kind of animal than he now is. Happily every war advances him by some degree on the road to that much-to-be-desired goal.

ZOOLOGY.—*The land shells of the genus Amphidromus from the islands of the Palawan Passage.*[1] PAUL BARTSCH, U. S. National Museum.

My paper on *The Philippine Land Shells of the Genus Amphidromus*[2] has had the usual effect of stimulating collectors to transmit their shells to the United States National Museum for classification. In this instance we have been exceptionally fortunate in receiving a large sending of carefully labeled specimens collected by Mr. C. M. Weber, in the islands of Palawan Passage. These greatly needed shells throw a flood of light on the systematic problem of the complex that inhabits these islands and make it possible to give a positive statement about them. It will be remembered that I was forced to say in the paper above referred to: "I am quite perplexed by the following species [*Amphidromus quadrasi*] and feel at a loss as to the treatment that should be accorded to it."

Mr. Weber's material shows that on some of the islands off southern Palawan these mollusks present a most remarkable range of color variation and, what is more, show that similar types of coloration occur upon several islands. The present collection establishes beyond a doubt the fact that no matter how interesting they may be from a breeder's standpoint, systematically considered these color phases have no more significance than the *unicolor*, *unicincta*, *bicincta*, *tricincta*, amd *quadricincta* forms of *Helicostyla ovoidea* which I have found in a single brood of that species.

The group breaks readily into two divisions. In the first groop the tip is always white and the early whorls are flesh-colored, turning gradually to yellow which becomes intensified as the shell increases and is darkest immediately behind the aperture, or the yellow may be replaced by green. A very narrow light line marks the summit of the turns below which a deep-maroon band encircles the whorls; the base at the columellar border is also edged with this color, while the lip is always white. This is *Amphidromus quadrasi* Hidalgo. This species, so far, is known from three islands, Candaraman, Coxisigan, and Bekin.

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Bull. 100, U. S. Nat. Mus., Vol. 1, pt. 1, pp. 1–47, pl. 1–22, 1917.

Measurements of a large series of specimens from these islands show that there is a decided difference in the size of the specimens obtained on the three islands. The difference is probably best expressed in table 1.

TABLE 1

LOCALITY	NUMBER MEASURED	NUMBER OF WHORLS	ALTITUDE	GREATER DIAMETER
Candaraman	17	6.87	35.91	17.76
Caxisigan	65	6.72	33.53	17.12
Bekin	73	6.42	30.50	15.95

These differences I consider sufficient to demand a trinomial designation. The specimens from Candaraman are *Amphidromus quadrasi quadrasi* Hidalgo, the type locality for this subspecies. Those from Caxisigan may be known as *Amphidromus quadrasi caxisiganensis* Bartsch[3] and those from Bekin as *Amphidromus quadrasi ledyardi* Bartsch.[4]

The second group we may consider typified by *Amphidromus versicolor* Fulton. Specimens of this group always have the extreme tip dark brown; the rest of the turns may be white, pale yellow or wax yellow, or variously variegated; in the latter case the two or two and a half turns succeeding the dark tip are usually uniformly flesh-colored, while the ground color of those following may be white, yellow, green, or red, or sometimes several of these colors, one overlying the other, may be present; in each instance, if otherwise than white, the tint gradually becomes intensified toward the aperture. The whorls between the first two and the last may be unicolor or they may be marked by axial lines, bands, or forked flammulations of chestnut brown. The base may be unicolor or spirally banded with yellow, green, brown, or red. The columellar area may be white or edged with yellow, green, brown, or red. The lip may be white, pink, or purple, while the interior ranges from white through pearl gray, pink, pale purple, to spinel red. The general impression which one gains by looking at a tray of mixed specimens is a rainbow effect.

[3] Type, Cat. No. 215603, U. S. National Museum.

[4] Type, Cat. No. 215606, U. S. National Museum.

Amphidromus versicolor Fulton is now known from Balabac, Mantangule, Bancalan, and southern Palawan, all much larger islands than those occupied by *Amphidromus quadrasi* Hidalgo.

In spite of the great general variability of the color pattern, certain phases of coloration prevail on the separate islands which would enable one thoroughly familiar with these molusks to name with a fair degree of accuracy the island from which a specimen was derived. Measurements of a large series of specimens from the various islands give the results shown in table 2.

TABLE 2

LOCALITY	NUMBER MEASURED	NUMBER OF WHORLS	ALTITUDE	GREATER DIAMETER
Balabac	199	6.65	37.88	18.89
Bancalan	255	6.63	37.44	18.75
Mantangule	63	6.51	34.01	17.33
Palawan Passage	3	6.93	39.86	19.93
Palawan, Brooks Pt	25	6.77	38.26	19.66
Palawan, Mt. Landargung	2	6.80	38.60	20.60

The shell described by me[5] from "Palawan Passage" as *Amphidromus quadrasi palawanensis* yield measurements that agree nearest with those of *Amphidromus versicolor everetti* which comes from southern Palawan. They also agree with this in having a remarkably uniform color pattern and dark coloration both outside and within, but they lack the obsolete peripheral angle characteristic of all the Palawan shells seen. It is unfortunate that we do not have a definite island locality for them.

The dark-colored race from the low lands of southern Palawan will have to be known as *Amphidromus versicolor everetti* Fulton, and it is more than possible that the shell described as *Amphidromus quadrasi solida* Fulton from Palawan will prove to be simply a color phase of this race. I have not seen specimens of it from Palawan. The forms I called *Amphidromus quadrasi solidus* in my paper from Balabac must now be placed with *Amphidromus versicolor versicolor* Fulton. The main coloration of *Amphidromus versicolor everetti* Fulton is very similar to my *Amphidromus*

[5] Bull. 100, U. S. Nat. Mus., Vol. 1, pt. 1, pp. 39–40, pl. I, fig. 15, pl. 20, figs. 1, 4, 6, 9. 1917.

versicolor palawanensis, but the presence of a peripheral angle separates it from that subspecies.

From Mt. Landargung, in the interior of southern Palawan, we have seen two specimens collected at an altitude of 2,500 feet which, while they agree in general coloration with *Amphidromus versicolor everetti*, are nevertheless much lighter in tone than that form, and the interior, instead of being purplish, is white. The edge of the lip is dark purple.

This mountain race deserves to be recognized by a trinomial name, and I will call it *Amphidromus versicolor monticolus*. The type[6] had 6.7 whorls and measures: altitude, 40.3 mm., greater diameter, 21.2 mm.

The greatest range coloration is presented in the forms from Vancalan Island, which may be known as *Amphidromus versicolor higginsi* Bartsch.[7] A selected series shows no less than twenty-eight types of coloring, which I shall describe briefly.

1. Tip dark, the ground color white, with a greenish suffusion which is most pronounced on the parietal callus.
2. Wax-yellow, a little lighter on the early whorls, with a greenish tint on the last; tip dark.
3. Midway in coloration between the last two but with an obsolete angle at the periphery.
4. Tip dark, the next white with a yellowish suffusion; last whorl gradually turning green; edge of the lip maroon.
5. Like the last. In addition, however, all but the first two and a half and the last one and a half turns, are marked by axial flammulations of chestnut brown.
6. Like no. 4, but with the early whorls wax-yellow, and the lip white.
7. Like the last, but the first three postnuclear turns show faint, light brown axial flammulations in addition.
8. Tip dark, the first two and a half turns flesh-colored; the two and a half succeeding these with flesh-colored ground upon which strong, axial, branching flammulations of chestnut brown are placed; the rest is wax-yellow turning greenish on the last turn. The last two and a half turns are encircled by a narrow zone of carmine at the suture, which color also surrounds the insertion of the columella.
9. Tip dark; all but the last four-fifths of the turns pale wax-yellow, the last portion marked by closely spaced dense axial streaks of varying

[6] Cat. No. 218795, U. S. National Museum.

[7] Type, Cat. No. 218420, U. S. National Museum.

shades of brown overlaid with a suffusion of pale green; lip maroon; umbilical area wax-yellow.

10. Like the above, but the dark coloration extends attenuatedly back over the last one and a quarter turns. The lip, also, is white.

11. Like no. 9, but with very pale yellow ground color. The space between the second and the last three-quarters of the last turn is marked by axial flammulations.

12. Like the above, excepting that the ground color and the lip are white. Columellar callus pale yellow and the solid color of the last portion of the shell extending over one and a quarter turns.

13. Tip dark; early whorls flesh-colored, those succeeding pinkish flesh-colored with obsolete axial flammulations of pale brown; last turn grenadine pink with a yellowish suffusion. Inside of aperture pale hermosa pink; edge of peristome dark purplish brown.

14. Tip dark; next two whorls flesh-colored, the two and a half succeeding flesh-colored with light chestnut brown axial flammulations; last turn wax-yellow; periphery angulated; base with two equally wide chestnut brown spiral bands of which one is immediately anterior to the periphery while the other is situated a little anterior to the middle of the base. These bands do not extend over the last half of the base. Peristome and interior white.

15. Like the last, but with the last turn deep wax-yellow gradually turning to green near the aperture. The two basal bands scarcely extend beyond the edge of the lip.

16. Like no. 13, but with a broad, wax-yellow spiral band whose posterior edge touches the posterior angle of the aperture. A second wax-yellow band marks the columellar area.

17. Like the last in coloration of the spire; base wax-yellow except the narrow band of grenadine pink immediately below the angulate periphery and a second one of the same color, which is situated on the cente· of the base, which evanesces before it reaches the middle of the last half turn.

18. Tip dark; the next two turns flesh-colored; all the rest except the last three-quarter turns of the last whorl flesh-colored with many axial, chestnut brown flammulations and a narrow subsutural wax-yellow zone. The last turn gradually darkens to olive green near the aperture. Aperture pale grayish blue within; peristome edged with blackish purple. A broad yellow band encircles the base at the posterior angle of the aperture and extends a little beyond its outer lip.

19. Like th· last, but with the peristome white.

20 Similar to the last, but with the last whorl of much lighter color.

21. Similar to the last, but with the last whorl much lighter in color, greenish, purplish, and yellowish shades prevailing. The base, also, is wax-yellow and the lip is white with a purplish tint.

22. Tip dark; the next two turns flesh-colored; the rest at first with flesh-colored ground color which gradually gives way to yellowish, marked by many chestnut brown axial flamulations. On the last turn the axial color bands gradually become fused resulting in a dingy brown-

olive patch on the middle of the turn behind the aperture. The area near the summit of the whorls remains pale wax-yellow. Base with a narrow spiral chestnut brown band whose posterior border touches the posterior angle of the aperture; this is succeeded by a broad, yellow spiral zone, and this in turn by an equally wide spiral brown band, while the columellar area is a greenish and pinkish yellow. Lip white.

23. Like the last, but with the subperipheral spiral band double.

24. Like no. 22, but with the base dark chestnut-brown and a spiral mid-basal wax-yellow band, the columella area wax-yellow.

25. Tip dark; the two first turns flesh-colored; the ground color of the rest pale wax-yellow excepting the last turn, which is wax-yellow. All except the first two, and the last half of the last turn are marked by axial chestnut-colored flamulations. The last turn has fine spiral lines of chestnut brown. Base with a subperipheral and median band of dark chestnut brown, the rest wax-yellow excepting a pinkish line at the insertion of the columella. This line is also carried around the inner lip of the aperture, the inside of which is pale pinkish white.

26. Tip dark; the first two whorls flesh-colored; the ground color of the succeeding turns flesh-colored, this on the last whorl slowly giving way to pale yellow. All but the first two whorls marked by chestnut-brown axial flamulations, which, on the last turn, do not terminate at the periphery but extend over the base. These axial markings become condensed immediately behind the lip and render this portion almost unicolor. The inside of the aperture shows the dark color bands of the exterior. The peristome is white, but the inner edge of the lip is marked by purplish dark chestnut-brown bands.

27. Similar to the last, but of much more yellowish color, and with the axial flammulations much broader. These axial broad bands form an angle as they pass over the periphery. The insertion of the columella is encircled by a dark chestnut band.

28. Similar to the last but with the base largely dark excepting a broad pinkish band a little anterior to the periphery. This band becomes evanescent before it encircles half of the last turn.

The shells from Mantangule Island, which may be called *Amphidromus versicolor weberi*,[8] are by far the most brilliantly colored of all the known races of *Amphidromus versicolor*. However, we have here a much more uniform color pattern than in the specimens in the races from Balabac and Bancalan. All the specimens have a dark tip which is succeeded by two or more flesh-colored turns. The ground color of the succeeding turns may be flesh-colored, tinged with yellow or wax-yellow. In the one type of coloration no axial flammulations of chestnut brown are present on these whorls, while in the other they are strongly marked.

[8] Type, Cat. No. 218422, U. S. National Museum.

The last turn is usually light near the summit, then girdled with a broad, dark area which is of the same color as the dark area of the base but is separated from this by a narrow light zone at the periphery. The dark coloration of the last turn may be green or light coral-red or the latter overlaid with green. The base may be unicolor, i. e., white, yellow, green, red, or brown, or it may have one or two bands of yellow, brown, or red. The portion of the last whorl adjoining the columellar callus is usually coral-red. The interior is white, bluish, or pinkish, the peristome white or edged with purplish brown.

The table on page 363 gives additional data as to number of whorls and shell measurements.

The specimens which I have seen from Balabac Island show a lesser variability in coloration than those from Bancalan, to which they bear the greatest resemblance. There is here a much greater tendency to spiral banding of the base than in the shells from any of the other islands. All of the specimens of *Amphidromus versicolor weberi* examined have a white peristome but in *Amphidromus versicolor higginsi* this is frequently dark. In measurements they agree best with the shells from Bancalan Island, i.e., *Amphidromus versicolor higginsi*.

The present sending by no means completes the survey of the Palawan Passage region, for as yet we know nothing of the *Amphidromus* inhabitants of the three large islands Bugsuk, Pandanan, and Ramos, nor do we know anything about the group on the lesser islands of Apo, Bowne, Canimeran, Patongong, Gabung, Byan, Canabungan, Secam, Malinsono, Sanz, and Paz. Then, too, the many islands off the north coast of Borneo should contribute a large amount of information that should tell us something of the derivation of the forms in our domain which are undoubtedly of Bornean stock.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

ELECTRICITY.—*Radio instruments and measurements.* Bur. Stand. Circ. 74. Pp. 330. 1918.

The Bureau of Standards has issued a treatise on radio measurements, for use by Government officers, radio engineers, and others concerned. The circular includes a development of the essential theory of high-frequency measurements from simple but precise low-frequency theory, the use of reactance curves in the rapid solution of problems, descriptions of radio instruments, and formulas and data for radio work. The full treatment of fundamental principles will make this circular serve as a foundation for later publications which may be issued by the Bureau on the general subject of radio communication.

J. H. D.

TECHNOLOGY.—*Stabilized-platform weighing scale of novel design.* F. J. SCHLINK. Bur. Stand. Tech. Paper No. 106. Pp. 28. 1918.

In this new scale the usual stabilizing element consisting of a pin-and-link connection is replaced by a flexible elastic tape, band, or wire. This design eliminates practically all the friction inherent in existing stabilizing mechanisms. In stabilized-platform scales made after the new design, friction is reduced to a very small amount, and is unaffected by the position of the load.

In the paper the earlier types of stabilizing elements are illustrated and the limitations of each set forth. The theoretical considerations underlying the conditions of equilibrium in weighing scales of the stabilized-platform type are defined and the methods used in carrying out the adjustment of such a scale are outlined. A discussion of the effects of static friction on the indications of scales is included and the effect of the elimination of this friction in enhancing the accuracy of weighings is shown. The paper includes nearly a score of illustrations of weighing scales and scale details.

F. J. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 804th meeting of the Society was held at the Cosmos Club, March 30, 1918; Vice-President HUMPHREYS in the chair; 53 persons present. The minutes of the 803d meeting were read in abstract and approved.

Mr. D. L. HAZARD presented the first paper, on *The magnetic survey of the United States.* The magnetic survey of the United States may be said to have had its beginning in 1843, when a plan for the reorganization of the survey of the coast was adopted which provided for making magnetic observations, but progress was slow up to 1899, because of lack of funds. Beginning with that year an annual appropriation of $25,000 has made possible a systematic survey of the whole country. The plan under which the work has been executed provides for magnetic observations at places 30 to 40 miles apart on the average; a subsequent more detailed investigation of areas of local disturbance; the occupation of a sufficient number of repeat stations to determine the secular change of the magnetic elements; and the operation of magnetic observatories.

The work has progressed to the point where observations have been made at all but about 150 county seats, results being available for about 5,500 stations, and attention is now being directed more especially to the investigation of areas of local disturbance and the occupation of repeat stations. Magnetic surveys have been made of Porto Rico, Hawaii, and the Philippines and the accessible portions of Alaska. Observations at sea have been made on some of the vessels of the Survey. Meridian lines have been established at many stations, and at most of the others the necessary information has been secured to enable local surveyors to test their compasses.

The results of the survey have been published from time to time, as the work progressed, in the form of magnetic tables and magnetic charts, the latest publication, just issued, being *Magnetic Tables and Magnetic Charts for 1915*, containing the accumulated results to the end of 1915.

While the survey had its origin in the needs of the navigator and surveyor, yet the importance of the scientific side has been kept in view from the outset and due attention has been given to securing the data needed for a comprehensive study of the earth's magnetism, with a view to determining its origin and the cause of its fluctuations.

The paper was discussed by Messrs. BAUER and HUMPHREYS.

The second paper was presented by J. P. Ault, on *Cruises III and IV of the yacht "Carnegie" in the Arctic and Sub-Antarctic regions, 1914 to 1917.* Motion pictures were shown of the different operations on board the vessel, of her passage through the Panama Canal, and of the rough seas and large icebergs encountered during the Sub-Antarctic cruise.

A brief summary was given of the origin and development of the science of terrestial magnetism, of its relation to the other sciences, and of its use and importance in present day activities. The work of the Department of Terrestrial Magnetism of the Carnegie Institute was described and a chart was exhibited which showed the region thus far surveyed, both on land and at sea. The general magnetic survey of the globe has been practically completed so that an early publication of new and accurate magnetic charts is contemplated.

For the ocean survey work a special vessel, the yacht *Carnegie*, was designed and built, being constructed wholly of nonmagnetic material. The results of observations made on board this vessel do not require corrections on account of magnetic material in the vessel. The *Carnegie* has completed four cruises since her launching in 1909, and has covered over 240,000 nautical miles. Cruises III and IV were planned to fill in the unsurveyed regions in the Arctic and Sub-Antarctic oceans, which are accessible to a sailing vessel of her construction. In 1914 during Cruise III, the vessel reached the high northerly latitude of 80°, west of Spitsbergen, the ports of call being Hammerfest, Norway, and Reykjavik, Iceland. Due to the small number of previous observations made in these regions, the errors in the existing charts were found to be quite large. A brief account was given of the results obtained, methods used, and of the peoples and places visited.

Cruise IV began at New York in March, 1915, and ended at Buenos Aires, Argentina, in March 1917. During this cruise the *Carnegie* passed through the Panama Canal, cruised in the Pacific Ocean from Honolulu to Dutch Harbor, Alaska, and northward into the Bering Sea to 60° north, and thence southward to Lyttelton, New Zealand. From Lyttelton a remarkable circumnavigation cruise was made, the Carnegie sailing eastward for four months, completely circling the Antarctic Continent in one season, returning again to Lyttelton. During this time the vessel was in the iceberg region for three and one-half months and encounterd very stormy weather. Gales of force 7 to 11, Beaufort scale, were experienced on fifty-five days out of 117, and some form of precipitation occurred on one hundred days. In spite of the adverse conditions, observations for magnetic dip and intensity were made every day, and observations for magnetic declination were made every day except one. In one region the chart errors increased to 12° for the British and American charts, and 16° for the German chart, the latter being an older chart than the former two.

The paper was discussed by Messrs. Bauer and Humphreys.

After adjournment at 10 p.m., light refreshments were served.

E. C. Crittenden, *Corresponding Secretary.*

The 805th meeting of the Society was held at the Cosmos Club, April 13, 1918; President BURGESS in the chair; 49 persons present. The minutes of the 804th meeting were read in abstract and approved.

The first paper was presented by S. J. MAUCHLY, on *A study of pressure and temperature effects in earth-current measurements.* (Illustrated by lantern slides). The larger portion of the earth-current data on record, was obtained from observations made on commercial telegraph lines. For lines of considerable length, the fluctuations in the observed current are generally assumed to be very little influenced by local effects at the earth plates, but for measurements made between electrodes not many kilometers apart, this assumption is not valid. Most of the special lines installed for the study of earth-current phenomena are necessarily limited in extent, and the object of the experiments described in this paper was to investigate the nature and order of magnitude of some of the spurious effects which may function under these conditions.

In one group of experiments a method similar to that used by Des Coudres, in his study of the E.M.F. produced by the action of gravity in salt solutions, was used to investigate the possible presence of an effect due to difference of pressure at the electrodes. It was found that a tube filled with soil and provided with an electrode at either end showed a component of the total E.M.F. which tended, when the tube was vertical, to form a cathode at the lower electrode regardless of which electrode was involved. The order of magnitude of this effect was shown to be sufficient to account for certain observed phenomena which appear inconsistent with physical principles, provided the effect exists as a general phenomenon in nature.

The results of continuous measurements of P.D. and temperature difference made on actual underground systems of earth plates for about eight months show that most, if not all, of the diurnal variation which has by some observers been ascribed to a vertical earth current was very probably due to the variations in the temperature difference between the electrodes.

The spurious effects introduced by temperature-difference variations were found to be greatly increased and reversed in sign when the soil in contact with the electrodes was frozen.

While the results are strictly applicable only to the actual installation employed during the experiments, they show that the effects which may result from temperature difference at the electrodes of an earth-current line, and from the variations in this difference, may for short lines be of the same order of magnitude as the quantities to be measured and with which they are associated. Some of the phenomena which various observers have ascribed to a true earth current must be largely influenced by such effects. The employment of nonpolarizable electrodes does not prevent the introduction of temperature-difference effects.

The paper was discussed by Mr. BAUER.

Mr. M. SASULY then presented the second paper, on *A general system of approximate integration formulae.* Several types of quadrature formulas are known for evaluating definite integrals of functions whose primitives are unknown. The most familiar formulas are those developed by Cotes, Lagrange, Euler, and Gauss. In each of these the problem is reduced to finding a certain area under a curve representing the function in rectangular coordinates. This area is given in terms of the interval of integration and several ordinates (values of the function) within that interval. Thus, to a certain degree of approximation,

$$\int_a^b f(x)\,dx = (b-a) \sum_{i=1,2,3,\ldots n.} [k_i \cdot f(x_i)]. \tag{1}$$

The numbers $f(x_i)$ and k_i are ordinates and corresponding "weighting" coefficients in the interval $(a \ldots b)$.

In the formulas of Cotes and Euler the ordinates are equidistant. In those of Lagrange the ordinates may be taken at random. All three types have equal accuracy of a certain kind, namely, a formula using n ordinates gives the exact value of definite integrals of a polynomial function of degree n—1 (or degree n if n is odd). In the formulas of Gauss, however, the ordinates must be taken at certain definite points, and in virtue of this the maximum accuracy is obtained. A formula of n ordinates is exact for the integral of a function of degree 2 n—1.

It can be easily shown that the use of any type of ordinate formula is valid only in the case of analytic functions (i.e., such as can be developed in a convergent power series). From the properties common to all analytic functions, it may be shown that the points x_i and the coefficients k of the corresponding ordinates subsist in a unique functional relation. Thus by a simple transformation, we may put

$$\int_a^b f(x)\,dx = \int_{-1}^{+1} \varphi(t)\,dt. \tag{2}$$

Then, it can be shown that

$$\int_{-1}^{+1} \varphi(t)\,dt \doteq 2 \cdot \sum k_i [\varphi(-r) + \varphi(+r)] \tag{3}$$

$$i = 1, 2, 3, \ldots n,$$

$$0 \leq r_1 < r_2 < r_3 \ldots r_n \leq 1,$$

in which the numbers k_i and r_i are each arbitrary but related as follows:

$$\sum_{q=0,1,2,3\ldots n.} k_i \cdot r_i^{2q} = \frac{1}{2(2q+1)}. \tag{4}$$

This relation determines an infinite number of types of approximate integration formulas, combining maximum accuracy with maximum flexibility. For k_i and r_i may have arbitrary values, consistent with their fundamental relation, and subject only to the condition that the ordinates be selected in pairs symmetrically located in the integration interval. The formulas of Cotes, Euler, and Gauss may be derived as special cases.

The paper was discussed by Messrs. SOSMAN, WHITE, and BURGESS.

A third paper, by P. D. FOOTE and F. L. MOHLER, on *Ionization and resonance potentials for electrons in vapors of magnesium and thallium*, was presented by Mr. Mohler. (Illustrated by lantern slides). Since mercury, magnesium, cadmium, and zinc belong to the same family, one might expect that the behaviour of electrons in vapors of these four elements should be somewhat similar in character. The single line spectrum of mercury is known to be excited at the resonance potential of 4.9 volts. Work of Tate and Foote reported at the Chicago meeting of the Physical Society, shows that the resonance potentials for cadmium and zinc obey the quantum relation $h\nu = Ve$, where ν is the frequency of the single line spectrum. Hence, one would expect the single line spectrum of magnesium to follow a similar relation.

The present writers have employed the method of Franck and Hertz for determining the resonance potential of electrons in magnesium vapor and Tate's modification for determining the ionization potential. The mean of data so far obtained gives 2.65 volts for resonance and 7.75 volts for ionization with an accuracy of possibly 0.1 volt. The theoretical values on the basis of $\lambda = 4{,}571$ and 1,622 are 2.70 volts and 7.75 volts, respectively, while the single line spectrum at $\lambda = 2{,}852$ would require a resonance potential of 4.3 volts. This experiment combined with the confirmed results on the other metals in the same group suggests that the single line spectrum of Mg is $\lambda = 4{,}571$ rather than $\lambda = 2{,}852$. Evidence was obtained in the present work for a series of double points in the current-potential curves similar to those found by Tate and Foote for zinc, but further work now in progress is required properly to interpret these subsidiary points.

The resonance and ionization potentials for electrons in thallium vapor have been measured by the method described in earlier papers, with the modification of the use of a hot equal potential surface instead of a hot wire as a cathode. The cathode was similar in principle to that used by Goucher and consisted of a platinum (or better, a nickel cylinder) insulated from a helix of tungsten wire inside, which was used as the heater. Ionization occurred at an applied potential of 6.6 volts, which when corrected for the initial velocity observed as 0.7 volts gives the final value for the ionization potential of 7.3 volts. The thallium spectrum is characterized by a set of doublet series. The resonance potential of 1.07 volts is given within experimental errors by the quantum relation $h\nu = eV$ when ν is the frequency of the stronger line ($\lambda = 11{,}513$) of the first doublet of the principal series. The theoretical value of the resonance potential computed on this basis is 1.07 volts. We believe this is good evidence that the single line spectrum of thallium is $\lambda = 11{,}513$.

We were unable to detect any sign of ionization accompanying resonance or any resonance due to the line $\lambda = 13{,}014$. If thallium acted in a manner similar to sodium or potassium one would expect from the analagous relations in the series of these elements to find ionization determined by the quantum relation $h\nu = eV$ when ν is the limit of the principal series $\nu = 22{,}786$. This requires a value of $V = 2.81$ volts, which cannot be considered in the light of the experimental data.

We believe that our work enables the prediction of a new series in thallium. It is very possibly of the form $\nu = 1.5\ S - mP$, a single line series of low intensity converging at 1.5 S lying between 57,000 and 60,000. The highest convergence frequency of any series so far known for thallium is 49,263. The present work again brings up the question of the separate excitation of lines constituting a doublet. Thallium appears to offer a fruitful field for work in this regard.

Although the usual time of adjournment had arrived, it was moved and carried that the program be completed, and Mr. P. D. Foote presented a paper on *Electronic frequency and atomic number*, which was discussd by Dr. Swann.

The meeting adjourned at 10.15 p.m.

H. L. Curtis, *Recording Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 584th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 20, 1918; called to order at 8 p.m. by President Rose; 35 persons present.

General T. E. Wilcox stated that he had received a communication from Ex-President Roosevelt in which he said he was presenting to the Society an autograph copy of his book entitled *A Booklover's Holiday in the Open*. Dr. Howard in this connection referred to the 277th meeting of the Society when Theodore Roosevelt, then Assistant Secretary of the Navy, attended for the first and only time a meeting of the Biological Society of Washington.

The regular program was as follows:

Alex. Wetmore: *Lead poisoning in waterfowl*. Mr. Wetmore said that lead poisoning in waterfowl has been known for a number of years and recently has assumed considerable economic importance. Wild ducks, whistling swans and a few other birds subject to this disease pick up and swallow pellets of shot lying in the mud in marshes and shallow lakes about old shooting blinds. These shot are held in the stomach and worn slowly away by grinding against bits of gravel taken to aid digestion, so that small particles of lead are being steadily passed out into the intestine, and in part absorbed. This causes a severe diarrhoea, the feces are stained bright green, the birds are soon unable to fly, and a slow paralysis sets in so that they become unable to stand. Cases of long standing become much emaciated though the birds eat eagerly. By experiment it was found that six number six shot when swallowed were fatal in every instance, while in one instance one shot of that size was sufficient to cause death from lead poisoning. It was also shown that the trouble was due actually to lead and not to arsenic or combinations thereof with lead. In all cases this lead poisoning seemed to result fatally, and on certain marshes a considerable number of waterfowl are destroyed in this manner. The speaker described the symptoms and post-mortem appearances fully and gave details of experiments and observations made in the laboratory and in field work. He also exhibited specimens of shot removed from the gizzards of ducks, showing how they had been worn by muscular action, and also shot dredged from the feeding grounds.

A. S. HITCHCOCK: *Generic types.* The speaker reviewed the tendencies in generic nomenclature of plants and referred to the rules concerning generic types in the American Code of Botanical Nomenclature. He also referred to the rules in the International Code which concern the use of the generic name although these rules do not recognize type species. Precision in the application of generic names is attained only when it is recognized that a genus, however limited as to component species, must include the type species. In other words, the type species of a genus should determine the application of a generic name. It is obvious that the type species is the species or one of the species included in the genus when it was established. It is recommended that the type species be designated when a new genus is published. Since the older authors in most cases did not designate their generic types, it becomes necessary to select the type species for the genera in which the types have not been designated. If there is agreement as to type species there will be agreement as to the application of generic names. Of course it does not follow that there will be agreement as to the limitation of genera. One concerns nomenclature, the other concerns taxonomy. Mr. Hitchcock has investigated 255 generic names of grasses and indicated their type species. Several examples were given illustrating the method of selecting the types.

The paper was discussed by Dr. L. O. HOWARD, W. L. MCATEE, and S. A. ROHWER.

W. W. EGGLESTON: *Thomas Nuttall's trip to Oregon in 1834, with notes on the route.* Thomas Nuttall was a member of Captain N. J. Wyeth's Second Oregon Expedition. Nuttall's data on localities is meager, therefore collections along his route would be useful. Collections should begin at Scotts Bluff and cover the country to the mouth of the Columbia. The more important places to visit are Scotts Bluffs, Nebraska, Laramie Mountains (Black Hills) along Platte River, Granger, Wyoming, Soda Springs, Idaho, Fort Hall (furtraders' fort), Idaho, Wildhorse Creek, Idaho, Blue Mountains, Oregon, and the region around Sauvies Island, Oregon.

In 1916 the Cusick Brothers and the writer studied the route across the Blue Mountains. This Indian trail led up Burnt River and Alder Creek to the vicinity of Pleasant Valley, where the party lost the trail. Proceeding northward the party crossed Powder River about six miles below Big Creek, passed the head of Cusick Creek, and on through Thief Valley, relocating the trail at the Powder River, crossing between North Powder and Telocaset. Thence the trail follows the foothills and along the southern rim of Grande Ronde Valley to Ladd Canyon, thence drops into the Valley west of Hot Lake, and along the base of the rim to Le Grande where it crosses the mountains. The old wagon road from Le Grande through Meacham to Cayuse now marks this part of the trail.

In 1917, the trail west of Fort Hall was traced. It passed along Big Butte to Big Lost River, thence up Big Lost to the vicinity of Arco, Idaho, thence west to Antelope Creek and down the creek to Big Lost River again, thence up Big Lost, the East Fork, and Wildhorse Creek into Thornburg's Ravine. No pass being located here the party returned the next morning to the north fork and crossed the Sawtooth Mountains by the only pass in this vicinity, the pass now used by the wagon road. M. W. LYON, JR., *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 313th meeting of the Society was held at the Cosmos Club, May 2, 1918. The meeting was called to order by President SASSCER, with thirty-two members and three visitors present.

The following names were favorably acted upon for membership: Mr. C. A.WEIGEL and Mr. WM. A. HOFFMAN, both of the Bureau of Entomology.

The regular program was as follows:

W. D. PIERCE: *Medical entomology, a vital factor in the prosecution of the war.* This paper, which will be published in the Proceedings of the Society, deals with insects as disseminators of diseases of man and animals with special reference to the problems of army-camp sanitation. Following the reading of Dr. Pierce's paper the matter of the relation of entomology and entomologists to the health of our army was interestingly discussed by Dr. L. O. HOWARD and Mr. A. N. CAUDELL of the Bureau of Entomology, and Major ALFRED M. LUND, Captain ROBERT H. BROWN, and Lieutenant E. H. GIBSON of the army Sanitary Corps. The remarks of these army officers were especially appreciated, describing, as they did, actual experience in the practical handling of the perplexing problems of sanitary engineering in its entomological phases.

J. A. NELSON: *A microcephalic drone bee.* This interesting description of an extraordinary aberrant drone bee will be published in the Society Proceedings.

R. A. CUSHMAN: *A convenient method of handling large numbers of individuals in life-history studies.* Mr. Cushman described and illustrated the decimal system of keeping records of rearing experiments. His remarks were discussed by Messrs. HYSLOP, PIERCE, CAUDELL, and ROHWER.

H. G. BARBER: *The genus Plinthisus Latreille in the United States.* Read by title. A. B. GAHAN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Maryland-Virginia-District of Columbia section of the Mathematical Association of America held its annual spring meeting on May 4, 1918, at the Catholic University. The following officers were elected for the ensuing year: *President*, A. E. LANDRY, of the Catholic University; *Secretary*, RALPH ROOT, of the Naval Academy; *third member executive committee*, L. F. HULBURT, of Johns Hopkins University.

Professor O. STEELS, of the School of Civil Engineering, University of Ghent, and Professor ALBERT VAN HECKE, of the Faculty of Sciences of the University of Louvain, arrived in Washington in May as members of the Belgian Mission on Industrial Management. Professor STEELS is President of the Mission.

An "Inventions Section" has been added to the organization of the General Staff of the army, "in order to secure prompt and thorough investigation of inventions submitted to the War Department." It is headed by an advisory board of chemical, electrical, and mechanical technologists. D. W. BRUNTON, Chairman of the War Committee of Technical Societies, is chairman of the Advisory Board of the new Section, and Dr. GRAHAM EDGAR and Lieut.-Col. R. A. MILLIKAN, of the National Research Council, are members.

The offices of the Chemical Service Section of the National Army have been removed from the building of the Interior Department to Unit F, Seventh and B Streets.

By an executive order issued May 11, 1918, the President of the United States requests the National Academy of Sciences, under its congressional charter, to perpetuate the National Research Council. The order defines the duties of the Council, which are, briefly: (1) to stimulate research; (2) to survey the larger possibilities of science; (3) to promote cooperation in research; (4) to bring American and foreign investigators into cooperation with the Government; (5) to aid in the solution of war problems; (6) to gather and collate information. The order further provides for the appointment by the President of government representatives as members of the Council, upon nomination by the National Academy, and instructs the heads of government departments to continue to cooperate with the council.

The Department of Terrestrial Magnetism of the Carnegie Institution of Washington, in accordance with a request from Captain ROALD

Amundsen, has supplied for use in his forthcoming arctic expedition a complete set of magnetic instruments, as well as the necessary directions for magnetic measurements and the program of work. Captain Amundsen plans to leave Norway this summer in a new vessel, the *Maud*, built specially for arctic exploration, and has made his arrangements on the expectation that his expedition will require about five years for completion. He will make scientific observations of various kinds in the arctic regions. The final details with regard to the contemplated arctic magnetic observations were arranged at the laboratory of the Department by Dr. Nansen and Captain Amundsen on April 5.

On account of difficulties with transportation, Professor R. F. Griggs, of the Ohio State University, has been obliged to abandon his plan to lead another expedition this summer to Mount Katmai, Alaska, under the auspices of the National Geographic Society. The work planned for this summer has not been entirely abandoned, however, as two members of last year's expedition, Messrs. Sayre and Hagelbarger, left for Alaska on May 2, taking with them pyrometers furnished by the Geophysical Laboratory, with which it is hoped to obtain data on the temperatures of the fumaroles in the "Valley of Ten Thousand Smokes."

Chancellor Samuel Avery, of the University of Nebraska, is now connected with the Division of Chemistry and Chemical Technology of the National Research Council.

Professor Watson Bain, professor of applied chemistry at the University of Toronto, is in Washington as a member of the Canadian War Mission.

Mr. H. A. Baker, chief chemist of the American Can Company, is in charge of problems of tin plate supply at the U. S. Food Administration.

Lieutenant-Colonel Hiram Bingham, formerly Professor of Latin American History at Yale University, is Chief of the Air Personnel Division of the Signal Corps.

Professor W. C. Bray, of the department of chemistry, University of California, came to Washington in May to engage in research on war problems with the Bureau of Mines.

Dr. A. D. Brokaw, assistant professor of mineralogy and chemical geology at the University of Chicago, is on the staff of the U. S. Fuel Administration, in charge of oil production east of the Rocky Mountains.

Dr. Joseph A. Cushman, of Sharon, Massachusetts, was in Washington for a few days in May, after several weeks of geologic field work in the coastal plain of North Carolina.

Mr. FRANCIS C. FRARY, of the Oldbury Electrochemical Company of Niagara Falls, has been commissioned a captain in the Ordnance Officers' Reserve Corps, and is engaged in research with the Trench Warfare Section, Engineering Bureau of the Ordnance Department, in Washington.

Dr. GROVE KARL GILBERT, one of the charter members of the Academy, died at Jackson, Michigan, on May 1, 1918, within a few days of his seventy-fifth birthday. He had been associated with the scientific life of Washington for forty-seven years, having been geologist of the Wheeler and Powell Surveys in 1871 and 1874, and one of the original staff of the present U. S. Geological Survey at its establishment in 1879. Dr. Gilbert was a member of the Geological Society of Washington, of which he was president in 1895 and 1909; the Philosophical Society of Washington, of which he was president in 1892; the National Academy of Sciences; and many other American and foreign scientific organizations. His broad-minded interest in the problems of the earth kept him an active investigator throughout his life, and his published papers cover almost the entire range of modern geological science.

Dr. HERBERT E. IVES, formerly of the United Gas Improvement Company of Philadelphia, has been commissioned a captain in the Signal Corps, and is attached to the Science and Research Division of the Signal Corps at 1023 Sixteenth Street, the headquarters of the National Reseafch Council.

Lieutenant-Colonel C. F. LEE, in charge of the British Aviation Mission in Washington, who lectured before the ACADEMY in March on *Aviation and the war*, has returned to England for six weeks to inspect new models of aircraft.

Dr. VICTOR LENHER, professor of chemistry at the University of Wisconsin, has been commissioned a major in the Chemical Service Section, National Army, and is stationed in Washington.

Mr. P. W. MASON, formerly assistant professor of entomology at Purdue University, was appointed on May 1, 1918, scientific assistant in deciduous fruit insect investigations, in the Bureau of Entomology, Department of Agriculture.

Dr. FRIDTJOF NANSEN, special representative of the Norwegian Government, and an honorary member of the ACADEMY, returned to Norway on May 11, after signing the general commercial agreement between the United States and Norway which has been in negotiation for several months.

To Professor F. H. NEWELL, of the University of Illinois, formerly director of the U. S. Reclamation Service, the American Geographical

Society has awarded the Cullom Geographical Medal. Other recipients of the medal have been: Rear-Admiral PEARY, FRIDTJOF NANSEN, Sir JOHN MURRAY, the DUKE OF THE ABRUZZI, SVEN HEDIN, Sir ERNEST SHACKLETON, and General GOETHALS.

Mr. GEORGE A. RANKIN, formerly of the Geophysical Laboratory, is on leave of absence from the Pittsburgh Plate Glass Company and is engaged in research at the Experiment Station of the Bureau of Mines, at the American University.

Mr. C. E. VAN ORSTRAND, of the Geological Survey, returned in May from a field excursion in Texas, during which he made measurements of the temperatures in a new 4,600-foot well near the Damon salt dome, Damon, Texas.

Mr. RUDOLPH J. WIG has resigned from the Bureau of Standards in order to devote full time to his duties as chief engineer of the concrete-ship department of the Emergency Fleet Corporation.

Major ROBERT M. YERKES, formerly professor of comparative psychology at Harvard University, is attached to the Surgeon General's Office and is in charge of the psychological testing of drafted men for the National Army.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL:

Mr. CARLETON ROY BALL, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. ROBERT ERVIN COKER, Bureau of Fisheries, Washington, D. C.

Mr. BERTRAND LEROY JOHNSON, U. S. Geological Survey, Washington, D. C.

Dr. LEO LOEB, Washington University Medical School, St. Louis, Missouri.

Professor ARCHIBALD BYRON MACALLUM, University of Toronto, Toronto, Canada; and Honorary Advisory Council for Scientific and Industrial Research, Ottawa, Canada.

Mr. DONALD FRANCIS MACDONALD, Ancon, Panama.

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CHEMISTRY.—*The nitrogen problem in relation to the war.*[1]

Arthur A. Noyes, Massachusetts Institute of Technology; Chairman of the Committee on Nitrate Investigations, National Research Council. (Communicated by L. J. Briggs.)

The subject with which I am to deal is so vast that it is impracticable to present more than a brief survey of it. I shall not attempt to go into technical details, but shall rather attempt to give you a general view of the situation, and a brief description of the various methods we have for meeting the demand for nitrogen compounds and of the principles which are involved in those methods.

You all realize the vital importance of an adequate supply of nitrogen compounds, particularly of nitric acid and ammonia, in ensuring our success in this war. From nitric acid are made all the important explosives such as smokeless powder, picric acid, ordinary black powder, dynamite, trinitrotoluol, and ammonium nitrate. This last has recently come into the greatest prominence as one of the most important and valuable of our explosives. In fact, it is reported that the Minister of Munitions of England has said that this war must be won with ammonium nitrate, as no other explosive can be produced in quantity adequate to meet the enormous demands of the Allied armies in

[1] Report of a lecture given before a joint meeting of the Washington Academy of Sciences and the Chemical Society of Washington on May 15, 1918.

Europe. This development of the use of ammonium nitrate has brought about a heavy demand for ammonia. In the early stages of the war it was anticipated that what we must look out for was an adequate supply of nitric acid, but at the present time we are no less interested in a sufficient supply of ammonia.

Let me briefly recall to you what are our sources of these two nitrogen compounds.

Our first source is Chile saltpeter, or sodium nitrate, which is found in a natural state in the dry regions of Chile, and which, until recently, furnished the total supply of nitric acid of the world. We depend for our own nitric acid supply upon the imports of Chile saltpeter into this country, which is a rather precarious source. In the first place, we are dependent on adequate shipping, and ships are scarce. In the second place, there has always been danger that enemy machinations, through interfering with production, destroying the plants, or blowing up the oil supply used for fuel, would reduce the production, or that our supply might be cut off entirely, by the establishment of a submarine base on the Pacific Coast. All of these possibilities make it unsafe to rely for our nitric acid supply on Chile saltpeter alone. But, even if none of these results actually came about, it would still be impracticable to get the huge amount of nitric acid that is going to be needed for the American Army through imports of Chile saltpeter.

Our second source is the ammonia from the by-product gas and coke ovens—the ovens, that is to say, in which coal is heated to produce gas or coke. We have, as I shall describe later, a well-developed process for the conversion of ammonia into nitric acid, so that if we get, from any source, an adequate supply of ammonia, we can convert in into nitric acid. I shall not enter at any length into the production of ammonia from gas and coke ovens. I will only recall to you briefly that for a long time, until within say ten years, this country was producing most of its coke in the so-called "beehive" oven, which is simply a hemispherical kiln. The coal is charged into the oven and set on fire, and the products of the combustion are allowed to pass into the air, so that the ammonia and valuable hydrocarbons that might have been obtained are lost. During the last decade, and especially during the last few years, there has been a very rapid introduction of the so-called "by-product" ovens, in which the coal is heated in closed retorts and the gases are passed through condensers and scrubbers by which the hydrocarbons and the ammonia are recovered. It was alleged by some of those representing the by-product industries that this supply of ammonia would alone suffice to meet the military needs of the Government; but the result has proved that it is utterly inadequate. Even if we produced all of our coke in by-product ovens, the supply would be far from sufficient. Of course, the Government is interested in extending the introduction of by-product ovens as rapidly as possible; but the by-product industry is tied up with the steel industry. It is mainly in the metallurgy of steel that coke finds its use, and we can produce ammonia only in proportion as there is a demand for coke. It is true that in Germany, where in the early stages of the war the need for hydrocarbons was very acute, coal was coked extensively just for its ammonia and hydrocarbons, and great quantities of coke were piled up, to be used after the war. Our Government has not yet felt that our needs warrant such extreme action as this, as the value tied up in the coke is large compared to the value of the by-products, and the difficulties of securing deliveries are serious.

Our third source of these nitrogen compounds is atmospheric nitrogen. During the last fifteen years there have been developed a number of chemical processes by which the nitrogen of the air is "fixed," as we say, whereby ammonia, nitric acid, or sodium cyanide are produced. I wish particularly to speak of the four most important processes which have been operated on a commercial scale. These are the cyanamide process, the cyanide process, the arc process, and the synthetic process.

Let me briefly describe to you the principles involved in these different chemical processes. I shall endeavor to show you what materials are needed and how far power enters as a factor.

1. In the *cyanamide process* we start with lime and powdered coke. The first chemical reaction that takes place results in the formation of calcium carbide, as follows:

$$CaO + 3C = CaC_2 + CO.$$

This is the substance which is used so extensively in the manufacture of acetylene for oxy-acetylene welding. The carbon monoxide escapes as a gas. This first step in the cyanamide process is carried out in huge electric furnaces. The charge of lime and coke in small lumps is fed down through the furnace in the center of which stands a large carbon electrode. The walls of the furnace form the other electrode. The mixture is heated to a very high temperature, and the melted carbide is tapped off at the bottom from time to time and allowed to solidify.

The carbide is then crushed and subjected to the nitrifying process. Namely, it is packed into large basket-shaped containers 3 to 6 feet high and 2 to 3 feet in diameter, which are enclosed in an iron vessel supplied with nitrogen. The basket has holes through the sides, and down the center runs a resistance wire. The reaction is started electrically by heat produced by passing a current through the wire. The reaction which takes place is as follows:

$$CaC_2 + N_2 = CaCN_2 + C.$$

This gives us a product properly called "calcium cyanamide" which contains some unchanged carbide (about 3 per cent), and some lime and carbon.

The cyanamide process was the only one of the fixation processes which was being operated on any considerable scale in this country when we entered the war, and which is being so operated now. There is a plant operated by the American Cyanamid Company at Niagara Falls, Canada, which has been producing something like 20,000 tons of cyanamide a year. The product has been used to a limited extent in agriculture, but unfortunately the large amount of lime which it contains prevents it from being so used in unlimited quantities.

For the production of ammonia the cyanamide has to be treated with steam, whereby the following reaction takes place:

$$CaCN_2 + 3H_2O = CaCO_3 + 2NH_3.$$

This process is carried out in huge autoclaves about 20 or 30 feet high and 4 to 6 feet in diameter. The powdered cyanamide is fed into an alkaline solution and then steam is blown in; the mass is heated, the reaction begins and becomes violent, and the ammonia is allowed to collect up to a pressure of 12 to 15 atmospheres, when it is blown off. Then, after the reaction has spent itself, the residue is again charged with steam so as to get a complete removal of ammonia. When carried out properly, it is practicable to get substantially all of the original nitrogen in the form of ammonia. This gives ammonia free from organic matter, except that it contains some acetylene, coming from the calcium carbide present.

2. I speak next of the *cyanide process*, in which the reaction that takes place is, in its net result, as follows:

$$Na_2CO_3 + 4C + N_2 = 2NaCN + 3CO.$$

A mixture of soda-ash with finely powdered coke and iron is heated at about 1000°C. in nitrogen gas. There is a considerable conversion of the sodium carbonate into sodium cyanide, with evolution of carbon monoxide. The iron acts simply as a catalytic agent. This operation is carried out in a number of different ways. In one of the forms of furnace, so-called "briquets," which are really pencils made by moistening the mixture and squirting it through a die, are fed down through a long tube 8 or 10 feet high, which is heated on the outside by flue gases from the combustion of coal. The heating gases pass around the outside of the tube. The charge feeds slowly down through the heated zone and is drawn out from time to time by a special device at the bottom..

As in the case of cyanamide, so in this case also, to get ammonia we have to treat the product with steam. If we treat it at a low temperature the cyanide gives ammonia and sodium formate:

$$NaCN + 2H_2O = HCOONa + NH_3.$$

When the formate is heated it breaks up, yielding sodium carbonate:

$$2HCOONa = Na_2CO_3 + CO + H_2.$$

Thus the sodium carbonate used in the process is regenerated. Really, all that is consumed is the carbon, and the nitrogen taken from the air.

The nitrogen used in both of the processes just described is obtained ordinarily from liquid air by one of the familiar liquefaction and distillation processes.

It will be noted that the cyanide process accomplishes in a single operation a result which requires two operations in the cyanamide process. By using soda instead of lime, we combine the two steps (conversion of lime to carbide and of carbide to cyanamide) into one. The final steaming is the same in both processes.

3. The *synthetic process* is an extremely simple one chemically, involving the following reaction:

$$N_2 + 3H_2 = 2NH_3.$$

There is a rather interesting history connected with this. The proportion of ammonia which forms from the elements (hydrogen and nitrogen) at atmospheric pressure at any temperature where the rate is rapid enough so that it will form within a reasonable time is extremely small. The proportions (by volume) of ammonia at various temperatures and pressures that are present when a mixture of three volumes of hydrogen and one of nitrogen reaches equilibrium are shown in the table:

	1 ATM.	100 ATM.	200 ATM.
degrees	*per cent*	*per cent*	*per cent*
500	0.13	10.7	18.1
600	0.05	4.5	8.3
700	0.02	2.1	4.1

Thus at 500° we find, from the laboratory investigations that have been made on the equilibrium of this reaction, that there is only 0.13 per cent of the nitrogen converted into ammonia when the mixed gases are at atmospheric pressure, whereas at 200 atmospheres there is 18.1 per cent. As the temperature rises the result is much less favorable. At 600° we get only 0.05 per cent, and at 700° 0.02 per cent, at atmospheric pressure. These unfavorable equilibrium conditions of the reaction, and the known fact that its rate is very slight until the temperature gets high, led to the belief that there was no hope of the development of this reaction into a technical process. However, a German chemist, Haber, demonstrated, by working at high pressures and at the same time at the low temperatures made possible by the discovery of a good catalyst, that this reaction can be carried out on a commercial scale, and this is in fact being done very extensively in Germany.

4. Finally, we have the *arc process*, which, like the synthetic process, involves an extremely simple chemical reaction:

$$N_2 + O_2 = 2NO.$$

At a very high temperature nitrogen and oxygen unite to form nitric oxide. In this case the effect of temperature on the equilibrium is exactly the opposite of its effect on the ammonia equilibrium. The higher the temperature, the more nitric oxide is obtained; but there is very little until the temperature becomes very high. At 1600°, 0.4 per cent (by volume) of a mixture of equal parts nitrogen and oxygen is converted into nitric oxide; at 1900°, 1.0 per cent; and at 2400°, 2.2 per cent. It is clear, then, that we can get a considerable production of nitric oxide only by operating at a high temperature. But not only is it necessary to operate at a high temperature, but the gases must be cooled so quickly that in the process of cooling the reaction does not go back again. The gas must be cooled rapidly to such a temperature that the *rate* of decomposition of nitric oxide into oxygen and nitrogen is made very small. The only really practical way in which this can now be carried out is by using an electric arc. An arc produces locally an extremely high temperature, and the gas can be drawn rapidly away from the arc and quickly cooled.

Before describing the ways in which this reaction is carried out commercially, I shall first call attention to the remaining reactions which are involved in the production of nitric acid by the arc process. The nitric oxide, when the gas cools to below 150°, combines with oxygen to form nitrogen peroxide:

$$2NO + O_2 = 2NO_2.$$

This reaction does not take place instantly and time must be allowed for its completion. The peroxide is then treated with water, three molecules of it forming two molecules of nitric acid and regenerating one of NO. The first reaction has again to produce more NO_2 before the next step can take place, and the fact that these reactions must go on successively explains the great difficulty in absorbing these nitric vapors in the absorption towers. Towers 60 feet high and 16 feet in diameter, placed six or eight in a series, are necessary in order to get 88 to 90 per cent absorption of the nitric vapors. As it does not pay to get the last 10 per cent in this way, this portion is absorbed either in caustic alkali, lime, or soda.

Two of the forms of furnace used may be briefly described. The essence of them all is to form an arc which will have a very large surface so that the gas will be brought into contact with the high temperature and will then cool off very rapidly. Various devices have been used for spreading the arc. The Birkeland-Eyde process, which is the one most used in Norway, uses an electro-magnet. If a magnet is placed at right angles to the arc, the well-known deflection of the electrified particles or electrons passing from one electrode to the other is produced, and thus the arc is drawn out into a disk-shaped flame. Another process for spreading the arc is known as the "Pauling process," an Austrian process, for which a small installation has been erected in this country at Nitrolee, South Carolina. The electrodes are water-cooled metal pipes. The arc forms between them and a blast of air spreads out the arc into the wider portion between the electrodes.

The arc process, when carried out in the manner described, consumes a very large quantity of electric power, and it is interesting to know where that power goes, because in this direction lies the main possibility of substantially improving the process. Of the electric power that is put into the arc only very little (3 or 4 per cent) is consumed in causing the union of nitrogen and oxygen to form nitric oxide. The rest of it is used merely for heating the entering gases from a comparatively low temperature up to the temperature of the arc. Only by devising an adequate preheating system, by which the outgoing gases heat to a fairly high temperature the incoming air, can we hope to increase very greatly the efficiency of the arc process.

Before reviewing the economic status of these different processes and their relation to our needs in the war, I wish to call your attention to one other chemical process, namely, the conversion of ammonia into nitric acid. If we are going to fix nitrogen as ammonia by either of the first three processes, we must convert it into nitric acid, and this is done by the following very simple chemical reaction with the aid of platinum gauze as catalyst:

$$4NH_3 + 5O_2 = 4NO + 6H_2O.$$

Ostwald, some twenty-five years ago, discovered that, when a mixture of air and ammonia is passed over platinum and certain other catalyzers, there is an oxidation of the ammonia in large measure to nitric oxide, which, when the gases are cooled and brought into contact with oxygen and water, goes through the two reactions that have already been described, and nitric acid is produced. This process has been perfected so that it is now a very valuable means for getting nitric acid from ammonia.

Let me now review the situation as to the development of these processes. The cyanamide process uses materials that are nearly universally available: limestone, coke, and nitrogen from the air. The limestone must be of good quality and free from magnesia to work satisfactorily, but there are abundant deposits all over the world of suitable limestone. It uses a moderate quantity of power; this is used especially in the first stage of the process, in the production of the calcium carbide. So, as a result of these conditions—the small amount of power and the availability of the materials—this process has been installed all over the world—in all the countries of Europe, in Japan, and at Niagara Falls, Canada. It is understood that since the beginning of the war the Germans have greatly extended their cyanamide plants, although they have probably been using the product mainly for fertilizer purposes rather than for the manufacture of explosives. At the present time, this is the only process on this continent which has been developed commercially on any considerable scale.

The synthetic process, which had been pretty well developed in Germany before the war, and which has undoubtedly been much improved since, had fortunately been worked upon in this country by the General Chemical Company, and shortly after this country declared war, the company offered to the Government the use of its synthetic process for the production of ammonia. The company stated that they had so far perfected the process—well beyond the point which the Germans had reached before the European war—that they were able to operate at a temperature of about 500° and at a pressure not exceeding 100 atmospheres. The Germans, before the war, were operating at nearer 200 atmospheres and at a considerably higher temperature; and, as we have seen, higher pressures and higher temperatures both add to the difficulties of the process. The Government accepted the offer of the General Chemical Company, and as a result of it a plant is being built to operate this process at Sheffield, Alabama, which will have an output of about 20,000 tons of ammonium nitrate per year. The ammonia produced will be put through the oxidation reaction, converting it into nitric acid, and combined with more ammonia, because ammonium nitrate is the one thing which is needed in very large quantities at the present time.

The arc process would seem especially suitable for the production of nitric acid, as it is as simple as it can be chemically. The installation is somewhat expensive, but the really serious objection to it, particularly under American conditions, is the very large amount of power that is required. While the cyanamide process uses 2.2 horsepower-years per ton of nitrogen, the arc process uses nearer 10 horsepower-years. It can be economical, therefore, only where very cheap power is available. In Norway, where power costs about four dollars per horsepower-year, this arc process is being carried out on a very large scale, and the nitric acid is being sold partly to Germany, but mainly to the Allies.[2] In this country not only would the cost be very great

[2] The export of nitrates to Germany is now limited to 8,000 tons of calcium nitrate per year, while it is estimated that 112,000 tons (metric) per year will be available for export to the United States and Allies. (Agreement signed April 30, 1918, by representatives of the Norwegian Government and the War Trade Board, in effect May 10, 1918.)

because of the large power requirement, but power is not available that we can afford to devote to the process. There is a great scarcity of power in the eastern sections of the country even for the very necessary industries, and while there may be certain cheap powers on the Pacific coast, we have no ammonia there, as coke is not being produced; and we cannot therefore carry out the arc process in the Far West because we would not be able to ship the product in solid form. The arc process in its present form, therefore, does not look promising for use in this emergency; but if it could be perfected by a 50 per cent reduction in the power requirement, it would at once become an extremely valuable process. The arc process, I may add, is available in this country, all details being well known, so that if it were not for this power difficulty it could easily be installed.

There is also developing in this country, as a result of the investigations of Prof. J. E. Bucher, of Brown University, the cyanide process, which I have already described. The chemical reaction involved in it was well known, and the use of iron as a catalyzer had also been discovered; but the first attempt to put the process on a commercial basis was made by the Nitrogen Products Company, which has built a small cyanide plant near the Mathieson Alkali Works, at Saltville, Virginia, where nitrogen is available from the ammonia-soda process. The Government is also building a plant to operate this process under the rights which the Company has given to it. The Bureau of Mines is constructing this plant, which will produce 15 tons of sodium cyanide per day. Sodium cyanide itself is important; in fact, it is so valuable that it will not pay to convert it into ammonia until the market for cyanide has been satisfied; and it is also of some use in poison-gas work. Still, the use of cyanide is limited in gas warfare, and the demand for this purpose is not great.

Another company, the Air Reduction Company, has also worked out a cyanide process on a similar principle, and is prepared to make cyanide on a commercial scale.

Although this process has been put on a semi-industrial basis for the production of cyanide, the next step in it—the steaming of the cyanide for the production of ammonia—is still in the experimental stage. There is no doubt that ammonia can be liberated almost quantitatively by proper steaming, and it is only a question of time when it can be worked on a commercial basis. The Government has no plant for the production of ammonia from cyanide, but it has installed a small plant in Rhode Island for the experimental production of ammonia, in cooperation with the Nitrogen Products Company.

One rather interesting question connected with the cyanide process is whether it will be best to convert the sodium formate, which results from the first reaction of steam on sodium cyanide, into formic acid in order to meet the serious shortage of acetic acid for airplane dope and other purposes; or whether it will be better to regenerate the sodium carbonate and use it over again in the process.

The Government, as I have said, is building a synthetic process plant with a capacity of 20,000 tons of ammonium nitrate a year at Sheffield, Alabama (U. S. Nitrate Plant No. 1). It is also building a cyanamide process plant with a capacity of 110,000 tons of ammonium nitrate at Muscle Shoals, Alabama (U. S. Nitrate Plant No. 2). And a third plant has been authorized for the production of another 110,000 tons of ammonium nitrate per year. It is to be located in Ohio, half of it at Toledo and half at Elizabethtown. It is hoped that the synthetic process in the first mentioned plant will be under way in the course of two or three months and that it may then be assured of success, so that the Government will be able to extend the synthetic plants. It is possible, also, that the cyanide process and the arc process may be developed so that they can be utilized.

Regarding the relative economies of the different processes, it is difficult to say anything very definite. It is clear, however, that the arc process in its present inefficient form is excluded, with power at the high cost that it has when it must be produced from coal. The arc process might be operated in competition with the other processes if power could be obtained at, say, \$10 or \$12 per horsepower-year. The cyanamide process has the advantage that it can be installed in many places in this country and that it requires little power. The cyanide process has a similar advantage in that it, also, requires materials which are readily obtainable—soda ash, carbon, and the nitrogen of the air—and requires no electric power. While we have no very definite information as yet as to the relative costs of producing ammonia by the cyanamide and the synthetic processes, the estimates of those who have developed the latter and the reports that have come from Germany have indicated that the cost of production by the synthetic process in normal times will be very considerably less than that by the cyanamide process. It is true that the synthetic process involves high pressures requiring special machinery, but the other elements in it are more favorable.

The hydrogen that is required in the synthetic process is one of its large elements of cost. It is therefore important to get a cheap method for the production of hydrogen. The general method which has been adopted in Germany is to reduce water with coke, that is, to produce a mixture of hydrogen and carbon monoxide by the action of steam on coke and then to remove the carbon monoxide. This may be done by mixing the gas with steam and passing the mixture through suitable catalyzers, whereby carbon dioxide and hydrogen are formed:

$$CO + H_2O = CO_2 + H_2.$$

The carbon dioxide can then be absorbed out by scrubbing with water under pressure. This is a promising cheap way of getting hydrogen for use in the synthetic process.

Finally, I would say that the nitrogen problem is by no means a simple one, even at present. In order to supply our armies with the necessary amount of explosives, we shall need to use all our resources: (1) to continue and expand our imports on Chile saltpeter; (2) to introduce as rapidly as possible by-product coke-ovens; and (3) to develop at once new fixation processes. The last is our most vital chemical problem. The development of fixation processes is being largely done by the Government through the Nitrate Division of the Ordnance Department. The Bureau of Mines has also been carrying on extended investigations in this direction; thus the oxidation process where the mixed gases are passed over red-hot platinum gauze has been brought to a very high stage of perfection by this Bureau, yields of from 92 to 95 per cent conversion of the ammonia being attained. The process of absorption of the nitric vapors has been much simplified by the work of the Nitrate Division. And all along the line we may hope, as a result of the war, that during the next year or two there will be a very marked development of our processes of nitrogen fixation.

I hope that this brief outline may have served to give you a general survey of the situation with reference to our supply of nitrogen compounds and the means available for meeting the demand for them in this country.

ORNITHOLOGY.—*Diagnosis of a new genus of Timaliidae.*

HARRY C. OBERHOLSER, Bureau of Biological Survey.

The genus *Zosterornis* Grant, a group of *Timaliidae* allied to *Mixornis*, at present comprises seven species, all peculiar to the Philippine Islands. It was originally described[1] by Mr. Ogilvie Grant for the reception of a new bird, *Zosterornis whiteheadi* Grant, discovered by Mr. John Whitehead in the island of Luzon. Since then three more species have been described, and three others originally referred to the genus *Mixornis* have been transferred to the same group. All of these, however, excepting the type of *Zosterornis* and possibly *Zosterornis striatus* Grant, which latter we have not seen, are not congeneric, and it is therefore necessary to provide for them a new generic name.

Sterrhoptilus,[2] gen. nov.

Chars. gen.—Similar to *Zosterornis* Hodgson, but tarsus relatively, as well as actually, much shorter, being less than one and one-half times the length of bill, and only three-tenths or less of the length of the wing; middle toe without claw decidedly shorter than exposed culmen, instead of about equal; tail not almost square, but rounded, even somewhat graduated; first primary (counting from the outermost) about half the length of the second, not decidedly more, as in *Zosterornis;* feathers of pileum narrowed, stiffened, and somewhat pointed, not broad and rounded at their ends as in *Zosterornis*.

Type.—*Mixornis capitalis* Tweeddale.

[1] *Zosterornis* Grant, Bull. Brit. Ornith. Club **3**: No. 19, June 30, 1894, p. 1. [50]. (type by original designation and monotypy, *Zos'erornis whiteheadi*, sp. nov.).

[2] Στεῤῥός, *rigidu* , πτίλον, *penna*.

Remarks.—One of the nearest allies of this genus is *Mixornis* Hodgson, of which the type is *Motacilla rubricapilla* Tickell, but *Sterrhoptilus* differs from this group in the very different shape of the nostrils, which are not rounded as in *Mixornis*, but narrow, almost slit-like, and very strongly aperculate; the rictal bristles are much shorter and weaker; the bill is narrower and more slender; the first primary narrower and about half the length of the second; and the middle toe without claw is shorter than the exposed culmen. All the species here referred to *Sterrhoptilus* have the upper surface more or less streaked, not plain as in *Zosterornis whiteheadi;* and furthermore there is no white eye-ring in any of them. This new genus is of interest as another instance of the wonderful variety of structure among the babblers; and, furthermore, it adds another endemic genus to the avifauna of the Philippine Islands. The species referable to this group are as follows:

Sterrhoptilus capitalis (Tweeddale).
Sterrhoptilus plateni (Blasius).
Sterrhoptilus dennistouni (Grant).
Sterrhoptilus nigrocapitatus (Steere).
Sterrhoptilus pygmaeus (Grant).

TECHNOLOGY.—*Variance of measuring instruments and its relation to accuracy and sensitivity.*[1] FREDERICK J. SCHLINK, Bureau of Standards.

While the general concepts of accuracy and sensitiveness in connection with measuring instruments are well known, certain phases of the meanings of those two terms have not been clearly differentiated, and the factor of variance which bears an important relation to the two just mentioned has not hitherto been given extended discussion or made susceptible of definite numerical expression.

Accuracy and inaccuracy defined. An instrument is accurate when its indications accord with the true values of the quantity being measured. Perfect instrumental accuracy, then, is only an

[1] A brief presentation based on the complete paper now in press, and to appear as a Bureau of Standards Scientific Paper.

ideal, but we may define instrumental accuracy numerically in terms of the error or correction corresponding to various values of the quantity to be measured. The error arising from whatever source, observed in an indication of the instrument, divided by the true value of the measured quantity, may be termed the *inaccuracy* at a given reading, the negative term being justifiable on the basis of custom and ease of application. With this in mind, it is seen that *accuracy* may be expressed as the ratio of the value of the quantity being measured to the error of the instrumental indication at that value (this of course being the reciprocal of the quantity defined above). The ratio expressing instrumental accuracy, while not of value in the ordinary use of instruments, will be of service in rating the performance of an instrument.

Sensitivity defined and distinguished from immediacy of response. Any instrument showing a change of reading for any change, however great, in the quantity being measured may be said to be sensitive. This term again requires expression in numerical terms in order to be of value in studies of measuring instruments. Statements of sensitivity of instruments are often erroneously based upon that change in the value of the measured quantity producing the smallest perceptible response in the indication of the instrument. This method of expression is by no means a satisfactory one, since it disregards the factor of sluggishness or passiveness in instrument performance, a matter more fully discussed later—and moreover involves the error of personal judgment of the observer. The rating of sensitivity on the basis of the purely incidental dimension of some part, such as the length of a pointer or an arbitrarily graduated scale over which the pointer moves, is also unsatisfactory, since the pointer length or the graduation interval is subject to wide change within the discretion of the designer, making comparison of the sensitivity of different instruments unreliable and dependent upon factors of a purely accidental character. A better basis, in instruments having a rotating or oscillating indicator, would be the angular deflection of the indicator per unit change of the measured quantity—for example, in a balance, the angular deflection of the rest position of the beam per unit addition of load to the load pan, the first expressed in radians, and the second in grams. Actual measurements of sensitivity will, of course, be restricted to small deflections so that variations in its value over the range of deflection are negligible.

The frictional resistance to turning or sliding within an instrument has an important bearing upon the concept of sensitiveness. The effect of frictional resistances is to retard or delay the motion of the indicating element for both increasing and decreasing values of the quantity being measured, and to prevent response of the instrument reading to certain small changes in the measured phenomenon. Its existence requires the modification of the ordinary concept of sensitivity since otherwise the determination of the sensitivity of an instrument would depend upon the absolute rather than the relative magnitudes of the quantities entering into the observation. During the period in which change of the measured quantity is proceeding without the occurrence of any motion of the indicator, owing to the effect of static friction, application of the ordinary definition of sensitivity would give a zero value for that quantity. It seems necessary, then, to separate the sluggishness factor from the insensitiveness factor and define sensitivity thus: Sensitivity in an instrument is the rate of change in the indication of such instrument with respect to change in the quantity being measured, it being necessarily assumed for the purposes of this definition that friction and lost motion in the mechanism have been eliminated or are negligible. (A similar postulate applies to the determination of the scale value in instruments graduated directly in the units of the quantity being measured.) We have thus distinguished between passiveness (or sluggishness) and instrumental insensitiveness, a distinction that so far as known to the writer, has not hitherto been set forth. The amount of the least alteration in the value of the measured quantity producing instrumental response, divided by the initial value of the measured quantity may be called the passivity of the instrument at that point.

Variance defined and illustrated. Passiveness, defined above, is a special case of the phenomenon of variance, which is defined as the range, at any given value of the measured quantity, of variation in reading which may be exhibited by the instrument under repeated application of the same value of the quantity being measured, after a steady reading has been attained, the environment remaining unchanged. This quantity represents the range of uncertainty of the indications of the instrument. The specific variance may be defined as the ratio of the range, at any given value of the measured quantity, of variation in reading which may be exhibited by the instrument under repeated application of the same value of the quantity being measured, divided by the measured quantity itself, the same assumptions applying as above as to the attainment of a steady state of indication and as to the maintenance of unchanged environment. This factor has rarely been determined in tests of measuring instruments; ignoring it in their use, as is commonly done, may cause appreciable error, and it is therefore important that it be recognized or expressed.

In the case of the usual direct-reading instrument, the variance is disclosed in the displacement observed between the upward and downward branches of the hysteresis loop obtained by plotting instrument readings (or corrections or errors) against actual values of the measured quantity over a complete cycle of increasing and decreasing values. The amount of the variance will depend upon the previous history of the instrument and upon the immediately precedent cycles of movement which the instrument has undergone. The hysteresis curve obtained by plotting in the manner outlined is a valuable index to the operating characteristics of an instrument and leads to the detection of defects in design and workmanship discoverable with certainty in no other way. Figures 1 and 2 illustrate the effect described. In figure 1 it is to be noted particularly that the instrument contains no force-measuring elements of the elastic type, the scale in question being a pendulum-operated device, so that the loop shown is not the result of hysteresis of inelasticity. The sources of the hysteresis exhibited are all expressible as backlash or are closely analogous to it. The median line of the loop of figure 1 gives the characteristic error of the scale correctable by suitable alterations of the weight of the pendulums and of the contour of the cams about which the load transmitting tapes wrap, while the width of the hysteresis loop gives a good index to the workmanship of bearings and connections.

Backlash an important cause of variance. In a measuring instrument the maintenance of constant or at least determinate

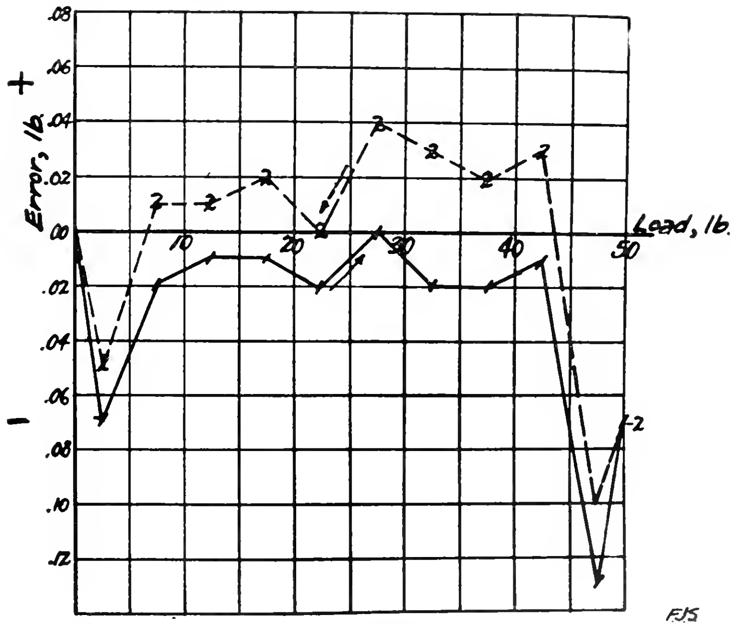

Fig. 1. Hysteresis loop of automatic weighing scale of the cam-pendulum type (comprising no elastic force-measuring elements). Note the manner in which the curve of decreasing readings reflects the aberrations of the curve of increasing readings, with a distinct tendency toward wider separation at the middle of the load range, so that the hysteresis loop would have a distinctly lenticular form, if the median line or mean error curve were rectilinear.

intervals between the parts of the mechanism is essential in the transfer of the forces or motions from the point of their reception to the point of registration or indication. Slack or backlash in the mechanism has the same effect as an equivalent advertent displacement of operating parts, backlash being used to imply looseness of fit resulting in play of the coacting parts. Actually, the action of backlash is not the simple one of producing a hysteresis loop of the rhomboidal form of which the two horizontal sides correspond to the geometrical clearance in the bearing. This type of hysteresis loop may be eliminated from consideration since instrument mechanisms almost invariably comprise an element to provide force-closure of the linkwork, so that the journals tend to remain in contact with the same general faces of the bearings.

In point of fact, the hysteresis loop of an instrument is normally lenticular, this form arising from the progressive relative rolling and slipping of journal within the bearing, permitting the point of contact to occur at successive zones of the interior of the bearing, and permitting at the same time divagation of the

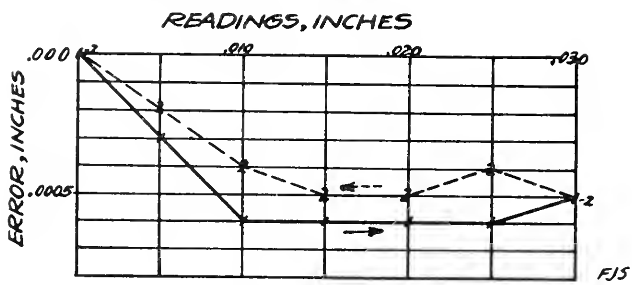

Fig. 2. Hysteresis loop of dial indicator of screw-train type, having high multiplication; an instrument much used for direct reading of small displacements and other linear magnitudes.

center of relative motion from the geometric center of the bearing. This action is suggested in figure 3. The effect of this action in producing variance arises in the modification of the instrument magnification or leverage ratio which it permits. In the case of instruments comprising spring force-resisting elements, a similar loop arising from inelastic actions of the spring will be combined in the calibration curve with that due to backlash.

When the calibration curve fails to form a completely closed loop due to incomplete reversion of the parts of the mechanism the residual deflection may be termed the *set*.

Clearance between engaging teeth of gearing introduces backlash effects of the same general nature as those outlined above.

In gear trains, moreover, there is especial likelihood of the occurrence of the rhomboidal type of hysteresis loop since actual discontinuities in the transference of motion from one part of the train to another will follow directly from any clearance at the pitch line.

Evaluation of irregular variance. In some instruments, especially those characterized by poor workmanship or ill repair, successive hysteresis loops may be far from concordant in their shape or magnitude on account of actual variations in the friction and journal displacements at any particular indication. In cases of this kind, the variance may be expressed or defined by

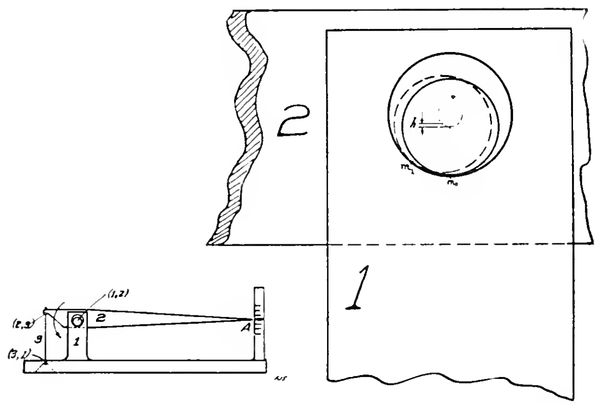

Fig. 3. Illustrating operation of instrumental backlash

plotting frequency curves of the readings or errors obtained for a given value (or for a series of definite values) of the same measured quantity repeatedly applied—one series of points being plotted for increasing readings terminating in the value under investigation, and another set for decreasing values terminating at the same point. Such a curve may exhibit, for example, probability of occurrence of any amount of variation from the mean instrumental reading. A succession of such frequency curves taken over various parts of the reading range will determine a surface enabling one to ascertain the probability of a given error at any point of the reading scale, but its principal utility will be in affording a criterion as to the comparative performance with regard to variance, of instruments of diverse design or workmanship.

Far from being a relatively unimportant source of inaccuracy in measuring instruments, it can be shown that the hysteresis or variance type of error demands consideration in practically every type of instrument, while in some (such as pointer-and-dial types of displacement-indicators) the variance is a preponderant factor in design and actually sets the limit of sensitivity and accuracy practicably obtainable, so limiting the application or utility of the instrument.

The phenomenon of drift, which is a time effect characterized by more or less gradual movement of the indicating element asymptotically to a definite reading, after all conditions external to the instrument have become constant, is one requiring investigation from the point of view of the elastician, and although in the case of some instruments it is an important cause of variance, it cannot be adequately treated in the present paper.

Reducing variance in the mechanism. A few effective means of reducing instrumental variance are readily available. The conical pivot may advantageously be substituted for the cylindrical journal and bearing, thus affording the type of bearing familiar in the balance wheels of alarm clocks and low priced watches. Such a bearing has a low frictional moment, and maintains a practically invariable relation of bearing to journal but cannot, of course, support any considerable load. The use of flexible or ribbon-like connectors secured by simple clamps at their extremities, between members which are to be conjoined, instead of the more usual rigid pin-and-link connectors is ofttimes a very useful device and has the advantage of providing for correction of motion to obtain a linear scale of graduation, by the simple expedient of arranging that one or both ends of the tape shall wind upon a cam of suitable contour. This type of connector contributes very little indeed to the hysteresis of the complete mechanism, since practically the only source of irreversibility in such a tape is the hysteresis of inelasticity, which in absolute value is very small. Simplifications of mechanism are often possible to eliminate the number of links involved and hence the number of bearings at which backlash effects can occur.

The action of vibration in reducing instrumental variance is found to accord well with the principles previously set down. Owing to the minimization in the static friction, occasioned by the vibration, on account of the momentary disengagement or separation of coacting bearings and journals, a considerable reduction of instrumental variance arising in mechanistic causes will normally take place,— thus the energy required to bring the parts to their theoretical equilibrium point is in a sense supplied from without the system.

Variance as a limiting factor in design and adjustment. In designing and constructing instruments, consideration should be given to the effect of variance errors in practically limiting the sensitivity obtainable by adjustment, as well as in determining the optimum interval between graduations or the smallness of the units of graduation. It is suggested that the mean interval of graduation of laboratory instruments should not be less than five times the mean variance, while for commercial or plant instruments the ratio of mean scale interval to mean variance may be of the order of two to one.

Inconsistencies between the values of sensitivity, variancy, and smallness of the units of graduation of instruments are common; tachometers, for example, are often graduated to a single mile per hour, while there may be a variation of reading at a given rotational speed of five miles per hour or more. Similarly weighing scales and balances often show variations of a full graduation or more. Likewise the sensitivity may easily be disadvantageously high, inducing erroneous estimates of the precision of results and requiring special care in the calibration and use of the instrument.

In particular cases in fact, a low inherent sensitivity may actually tend to reduce the absolute amount of the variance as in precision balances, where the advantages gained by the use of a low angular sensitivity and high magnification with the resulting quick period of oscillation, are well known.

The factors of maximum or mean inaccuracy (or accuracy), sensitivity, variancy, and specific set (the amount by which the variance loop may fail of closure, divided by the range of the deflection cycle) may be referred to the total range of graduation instead of to particular values of the measured quantity under observation, as a convenient means of arriving at single significant numbers to be composed into a "figure of merit" for an instrument whose characteristics are being determined. It is most desirable to develop definite numerical means of comparison between different instruments or different types of instruments for the same purpose, and the methods just suggested will afford a satisfactory basis for attaining this end, just as the aeronautic engineer's choice of structural material for a given purpose may be based on a single "figure of merit" involving the unit weight, strength, and stiffness determined by laboratory tests.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEODESY.—*Lambert projection tables for the United States.* OSCAR S. ADAMS. U. S. Coast and Geodetic Survey Spec. Pub. No. 52. Pp. 243, including 33 pp. of text. 1918.

This publication consists of general tables of coordinates for the United States, computed on the Lambert conformal conic projection, with two standard parallels. The coordinates are given in both meters and yards for the intersections of the parallels and meridians at every half degree in both latitude and longitude. Detail tables for local maps in both meters and yards are given in coordinates for the intersection of the parallels and meridians at intervals of 5 minutes in both latitude and longitude; and for two degrees out from a central meridian. The introductory text includes a mathematical development of the formulas of the projection, followed by a full description of the use of the tables in the construction of projections. Eleven diagrams serve to illustrate the manner in which the tables should be used in constructing a map of any section. As a whole, this publication contains the most complete set of tables of the Lambert projection ever issued for any region as extensive as that of the United States. For the construction of a general map of the United States the system is about the best that can be devised. O. S. A.

SPECTROSCOPY.—*The application of dicyanin to stellar spectroscopy.* P. W. MERRILL. Bur. Stand. Sci. Paper No. 318. Pp. 18. 1918.

This paper describes the use of commercial photographic plates sensitized with dicyanin in stellar spectroscopy. The first observations were carried out at the Harvard College Observatory using the 24-inch reflecting telescope and objective prism. Fraunhofer's A band (wave length 0.760 μ) and a considerable region of greater wave length were photographed in numerous stellar spectra. Several new absorption flutings were discovered, the most striking beginning at 0.760 μ nearly coincident with A, and running toward the red. Circumstances indicated that this band might be due to titanium oxide, and experiments since made at the Bureau of Standards have shown a band in this position in the spectrum of the titanium arc. The general conclusions arrived at are as follows:

1. Many stellar spectra possess sufficient intensity in the region of wave length 0.80 μ to enable this portion of the spectrum to be photographed on plates sensitized with dicyanin.
2. In favorable instances stellar spectra can be well observed to wave length 0.85 μ.
3. The region of greater wave length than 0.70 μ contains features of importance, especially in the case of the later spectral types.

P. W. M.

METALLOGRAPHY.—*Typical cases of the deterioration of Muntz metal (60–40 brass) by selective corrosion.* H. S. Rawdon. Bur. Stand. Tech. Paper No. 103. 28 pp. December 15, 1917.

Brass of the type 60-copper and 40-zinc, which is used commercially in a variety of forms, e.g., wrought bolts, sheathing, condenser tubes, extruded forms, etc., often shows a kind of deterioration by which the metal changes its color to copper-red and becomes very weak and brittle although the shape and size apparently remain unchanged. This change of properties is due to a selective corrosion of the alloy, which has a duplex structure, when exposed to the action of some electrolyte, particularly sea-water. The present study includes bolts, boat sheathing, condenser tubes, and parts which were corroded while under stress.

The examination of the microstructure shows clearly the method of the attack, the zinc-rich constituent being electrolytically "leached out" leaving a skeleton of weak pulverulent copper. Later the second constituent may be attacked so that the whole specimen is converted into pulverulent "copper"—the sample becoming so weak that it can be broken into fragments in the fingers.

Conditions that appear to accelerate corrosive attack of this type are: the microstructural composition of the alloy, contact with strongly electronegative metals, the effect of certain adhering deposits of basic zinc chloride resulting from the corrosion, the thoroughness of the later than common. There was a roost of about 500 *Sturnus vulgaris* annealing the sample has previously received, the temperature of the electrolyte, and the stresses to which the specimens are subjected during the corrosive attack.

H. S. R.

ORNITHOLOGY.—*Winter birds about Washington, D. C., 1916–1917.* W. L. McAtee, E. A. Preble, and Alexander Wetmore. Wilson Bull. **29**: 183–187. 1917.

A record winter list of 48 species for one day in the vicinity of Washington was obtained on December 30, 1916. A list of the species, together with the number of individuals of each seen is given in this paper. A list of 33 additional species, all observed during the winter of 1916–1917, is also added. This combined list of 81 species comprises about two-thirds of the known winter birds of the region, and represents the results of unusually favorable conditions, although the list includes very few species that are rare in the District of Columbia.

Harry C. Oberholser.

ORNITHOLOGY.—*An abnormal egg of* Fulica americana. Alexander Wetmore. Condor **19**: 65–66. 1917.

A female of *Fulica americana*, caught alive in the delta of Bear River, Utah, was found on the following morning to have laid an egg of strikingly abnormal coloration, very much darker than the usual eggs of this species. The cause of this abnormality is attributed to the continued excitement and fear of the bird at the time of its capture and the consequent reactions of the nervous system upon the organs of the oviduct.

Harry C. Oberholser.

ORNITHOLOGY.—*Washington region [June to September, 1917]*, Harry C. Oberholser. Bird-Lore **19**: 277; 339–340. 1917.

The unusually late spring migration of birds about Washington, D. C., during 1917 extended well into June, and many migrants remained later than ever known before. Conspicuous among these were *Empidonax minimus*, June 2, *Dendroica castanea*, June 5, and *Oporornis philadelphia*, June 7. A few of the summer residents were also more than ordinarily numerous.

During August and September, 1917, about Washington, D. C., some migratory birds appeared earlier than usual. Most notable among those was *Marila affinis*, seen August 31, of which the earliest previous record was September 25. A number of other birds, however, remained here *vulgaris* in the trees of the Mall, in the city of Washington, whither also 1000 to 5000 individuals of *Quiscalus quiscula quiscula* and for a few weeks several thousand purple martins, *Progne subis subis*, resorted

H. C. O.

ORNITHOLOGY.—*Mutanda ornithologica. II.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **30**: 125–126. 1917.

In this, the second, paper on the nomenclatural status of certain birds the following changes are indicated: The parrot commonly known as *Loriculus inducus* (Gmelin) must hereafter be called *Loriculus asiaticus*) (Latham); *Polytelis barrabandii* (Swainson) must be known as *Polytelis swainsonii* (Desmarest); *Triclaria cyanogastris* (Vieillot) must hereafter be called *Triclaria malachitacea* (Spix); *Pyrrhura bittata* (Shaw) is changed to *Pyrrhura frontalis* (Vieillot); *Nasiterna pygmea* (Quoi and Gaimard) is renamed *Micropsitta chloroxantha* Oberholser; and *Malacoptila torquata* (Wagler) is changed to *Malacoptila strata* (Spix).

H. C. O.

ORNITHOLOGY.—*Descriptions of two new birds from Haiti.* CHARLES W. RICHMOND. Smiths. Misc. Coll. **68**: No. 7, 1–3. 1917.

In this paper there are described two more of Dr. W. L. Abbott's remarkable ornithological discoveries on the island of Santo Domingo. The first and most interesting is a new *Nyctibus*, a genus of big goatsuckers not hitherto recorded from the island of Santo Domingo, and here described as *Nyctibus griseus abbotti*, after its discoverer, the well-known traveller and naturalist. The single specimen was obtained at Port de Pimente, northwestern Haiti. The other new bird is *Vireo crassirostris tortugae*, from Tortuga Island, off the northwestern coast of Haiti. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The relationships of the fossil bird* (Palaeochenöides mioceanus). ALEXANDER WETMORE. Journ. Geol. **25**: 555–557. 1917.

The bird described by Dr. R. W. Shufeldt as *Palaeochenöides mioceanus*, from the distal end of a femur found in South Carolina, was considered by him to be of Anserine affinities. A reexamination of the specimen, however, now shows that it is unmistakably a member of the Steganopodes, and is apparently most closely allied to the Pelecanidae, though it may represent a distinct family. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*On the fauna of Great Salt Lake.* ALEXANDER WETMORE. Amer. Nat. **50**: 753–755. 1917.

Contrary to common belief, the Southern Pacific cut-off on Great Salt Lake has not interfered with the free interchange of water or of aquatic animal life between the portions north and south of this causeway. Brine shrimp (*Artemia fertilis*) and three species of alkali flies of the genus *Ephydra* occur here in great numbers. Several species of water-birds, chiefly *Spagula clypeata*, *Marila affinis*, *Clangula clangula americana*, and *Nettion carolinense*, together with *Steganopus tricolor*, *Lobipes lobatus*, *Recurvirostra americana*, *Himantopus mexicanus*, and doubtless other allied species were feeding on these small animals and doubtless destroyed great numbers of both the shrimp and alkali flies.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*A new cuckoo from New Zealand.* ALEXANDER WETMORE. Proc. Biol. Soc. Wash. **30**: 1–2. 1917.

Representatives of *Urodynamis taitensis* (Sparrman) from New Zealand differ from those of the same species from Polynesia. Since the type locality of *Urodynamis taitensis* has been fixed as Tahiti, the New Zealand bird is here named *Urodynamis taitensis pheletes.*

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*A new honey-eater from the Marianne Islands.* ALEXANDER WERMORE. Proc. Biol. Soc. Wash. **30**: 117–118. 1917.

The form of *Myzomela rubratra* (Lesson), from the island of Guam in the Marianne group, is found to be subspecifically different from *Myzomela rubratra rubratra* of the Caroline Islands, and is here described as *Myzomela rubratra saffordi.* HARRY C. OBERHOLSER.

ORNITHOLOGY.—*On certain secondary sexual characters in the male ruddy duck,* Erismatura jamaicensis (Gmelin). ALEXANDER WETMORE. Proc. U. S. Nat. Mus. **52**: 479–482. 1917.

This paper records the discovery of a tracheal air sac in the male ruddy duck, *Erismatura jamaicensis.* This sac and the peculiar internal structure of the larynx of this species are described. The sac is absent in the females, and functions in the males evidently as an aid in swelling out the neck in sexual display. The discovery of similar structures in other species of the subfamily Erismaturinae is forecast.

HARRY C. OBERHOLSER.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY OF WASHINGTON

The 324th meeting was held in the lecture room of the Cosmos Club on January 9, 1918.

REGULAR PROGRAM

Frank J. Katz: *Pleistocene shore lines in Maine and New Hampshire.* Uplifted beaches and deltas in the coastal counties, Cumberland and York, Maine, and Strafford and Rockingham, New Hampshire, lie near the margins and somewhat higher than adjacent deposits of late Wisconsin marine clays. The shore structures discussed are those at maximum elevations in the several localities and constitute a correlated series rising progressively from 155 feet above sea level in Stratham, New Hampshire, to 300 feet in Pownal, Maine, and higher at points farther west and north. They indicate that the postglacially uplifted surface has been tilted 5 to 6 feet per mile in a direction 40°E. of S., and that the lines of equal elevation approximately parallel the shore of the Gulf of Maine.

M. R. Campbell: *Subdivisions of the Allegheny Plateaus.* No abstract.

The 325th meeting was held in the lecture room of the Cosmos Club on February 13, 1918.

INFORMAL COMMUNICATIONS

Mr. J. Newton Baker presented an appeal for the National War Savings Committee for the purchase of War Savings Stamps by members of the Society.

REGULAR PROGRAM

Bertram L. Johnson: *The Valdez delta.* The Valdez delta is the dominant member of a group of youthful confluent deltas surrounding the head of Port Valdez, Prince William Sound, Alaska. It is an advancing, steep-fronted delta formed in a rugged, mountainous country under glacial or near glacial climatic conditions, the torrential, heavily débris-laden, aggrading streams from the Valdez Glacier in summer dropping their load suddenly and within short distances in deep, quiet, oceanic waters. The subaerial portion of the delta has an area of about 10 square miles. This portion slopes to the southwest from the foot of the Valdez Glacier at an elevation of 250 feet to tide-water, a distance of 4 miles. At the foot of the glacier the delta is $1\frac{1}{4}$ miles across. The lower edge is 4 miles in length. The submarine frontal slope of the delta is steep, ranging from $6\frac{1}{2}$ to 21 degrees. It joins the subaerial portion of the delta at a sharp angle, and before the construction of the present wharves large ocean vessels could at low tide moor in deep water along the delta front and safely discharge their cargo by derrick onto dry land. The junction of this frontal slope with the gently sloping fiord floor is much less abrupt but in some places seems to be quite sharp. The thickness of the delta gravels may be estimated by constructing cross sections of the delta. The delta materials rest on a basement of metamorphic rocks. Intense glacial erosion has impressed on this bedrock a characteristic topography markedly different from the constructional topography of the delta. By a comparison of the delta profiles crossing the junction of these two types of topography it is possible to locate approximately the base of the delta gravels and to determine the thickness of the delta deposits as probably a little over 300 feet.

R. S. Bassler: *Paleozoic rocks and fossils on the Piedmont of Maryland.* The western part of the Piedmont plateau in Maryland and Virginia contains areas of early Paleozoic limestone infolded in the pre-Cambrian crystallines and overlain in part by the Triassic (Newark) series. These limestones outcrop at one point next to the early Cambrian Harpers shale, and hitherto it has been believed that they represented the Shenandoah limestones of the Appalachian Valley, comprising strata from early Cambrian to Middle Ordovician time. Detailed mapping of this area and the discovery of fossils have shown that this Piedmont limestone consists of a lower massive limestone division containing Lower Beekmantown fossils and an upper thin-bedded dark blue limestone with a Chazyan fauna, the two separated by a well-marked disconformity. The Lower Beekmantown division can be correlated directly with strata in the Appalachian Valley but the Chazyan portion has no representative there.

O. E. Meinzer: *The glacial history of Columbia River in the Big Bend region.* In the Glacial epoch a lobe of the ice sheet was pushed down the valley of Okanogan River, in north-central Washington, and across Columbia River, diverting the waters of the Columbia over the upland of central Washington. In its new course the river cut precipitous gorges several hundred feet deep, developed three cataracts, at least one of which was larger than Niagara, formed a large lake in Quincy Valley, and performed an almost incredible amount of work in carrying boulders many miles and gouging out holes as much as 200 feet deep. The upper part of this abandoned channel of the Columbia has been described by T. W. Symons, I. C. Russell, and F. C. Calkins. Both Symons and Russell made vague references to a very large Pleistocene Lake, which Symons called Lake Lewis. In the fall of 1916, A. T. Schwennesen made an investigation of the water resources of Quincy Valley (see

U. S. Geol. Survey Water-Supply Paper 425), and most of the present paper is based on an automobile reconnaissance that the writer made with him in the region through which the abandoned channel passes.

The region is underlain, for the most part, by Yakima basalt. Where the diverted waters reached the monoclinal fold in the basalt that causes the descent into Quincy Valley they apparently formed a cataract, which retreated about 17 miles, cutting through the basalt a gorge several hundred feet deep. The ancient falls resemble Niagara Falls in consisting of two parts separated by an island corresponding to Goat Island. A short distance down stream there is a similar island past which the falls had retreated a little earlier in their history. The ancient falls, which may be called "Grand Falls," as they occur in Grand Coulee, were somewhat wider and higher than Niagara Falls. As an agent of erosion, the Pleistocene Columbia had two great advantages over the present Niagara: (1) It fluctuated much more and in heavy floods probably carried at least three times as much water as the maximum of the modern Niagara. (2) It was much better provided with tools for erosion than the Niagara, as is impressively shown by the great quantity of large boulders in the glacial outwash below the mouth of the gorge. Although the basalt through which Grand Falls retreated was more difficult to excavate than the rocks through which Niagara Falls are retreating, less time was probably required to make this retreat of 17 miles than for Niagara Falls to make its retreat of only 7 miles. At the mouth of the gorge the ancient river discharged, in the early part of its history, into a lake which occupied Quincy Valley, as is indicated by the topography, by fossiliferous stratified deposits, by erratic glacial boulders of granite and quartzite which must have been carried to their present positions by icebergs, and by two ancient water falls along the present gorge of Columbia River obviously caused by the overflow of the lake.

An interesting story of postglacial erosion and deformation is told by the well-developed terraces of the Columbia, which are related in various ways to the glacial features.

The 326th meeting was held in the lecture room of the Cosmos Club on March 13, 1918.

REGULAR PROGRAM

KIRK BRYAN: *Classification of springs.* (Illustrated.) No abstract.

ARTHUR J. COLLIER: *A formation hitherto unaccounted for in North Dakota.* (Illustrated.) In the collection of photographs made by A. L. Beekly in the Culbertson lignite field, there are several very good views of filled valleys in which the filling is being eroded by the present streams which flow through them in narrow canyons or gullies. No statement of the materials or agents filling these valleys is given, and one is left to infer that it is alluvium deposited at some old level of Missouri River.

Filled valleys of this character are rather common features along the Missouri in both eastern Montana and western North Dakota. The material filling the valleys is uniformly fine-grained like much of the alluvium of the present flood plain. It is generally unstratified but in places contains thin layers of débris from the Fort Union formation, which crops out higher up on the valley sides. Where cut by the streams it stands out in nearly vertical light-colored cliffs from a few feet to 30 feet in height, having a tendency to break with vertical joints from top to bottom. That it is not ordinary alluvium is proved by the fact that its surface consists of long even slopes from the valley sides and not of level plains. The material is as unstratified as glacial till, but unlike till it does not contain angular fragments of granite, and in several places it was found resting on glacial till. That the valley fillings are of comparatively recent age is shown by the fact that from one of them the head of a mountain sheep that became extinct in this neighborhood only a few years ago was found at an elevation of 150 feet above the river. While the writer was camped near the Missouri in North Dakota several severe wind storms occurred. The river was low and exposed a great many expanses of sun-dried mud, and the winds gathered up great quantities of dust and carried it high in the air. After a day of such wind the tent floors showed a very perceptible coating of dust. Some of this dust undoubtedly had been carried for long distances and was deposited wherever there was a lodgment free from wind. In the winds there is an agent of deposition which is not accounted for, and the writer believes that such winds are responsible for valley fillings of this character; in other words, that these valleys are filled with loess. If this conclusion is correct, it is probable that a large part of the rich soil of North Dakota and Montana was brought in and is constantly replenished by the wind.

George L. Harrington: *Late Tertiary and Quaternary history of the lower Yukon River region.* (Illustrated.) In the lower Yukon Valley there appears to be no dividing line between the late Tertiary and the Quaternary. No fossils have been found in the unconsolidated silts, sands, and gravels, and interpretations of the geologic history are based on the unconsolidated deposits, high terraces along the river, and horizontal lava flows.

The events of the late Tertiary and Quaternary in this region include subsidence of the land surface, extrusion of basaltic lavas, further subsidence, reelevation, adjustments of drainage in the silt-filled valleys, and erosion by the processes normal to subarctic and arctic regions.

Esper S. Larsen, *Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 585th regular meeting of the Society was held in the Meeting House of the Friend's School, 1809 I Street N.W., Saturday, May 4, 1918; called to order at 8 p.m. by President Rose; 26 persons present.

The President announced that the sixth lecture of the Washington Academy of Sciences on science in relation to the war would be given by Dr. Raymond Pearl, on "Biology and War," Thursday, May 9, 1918.

Under the heading of brief notes and exhibition of specimens Dr. PAUL BARTSCH called attention to the destruction by fire of one of the handsomest rhododendron thickets in the District flora and to the breeding of starlings in a deserted woodpecker's hole in one of the trees of the Howard University grounds, the hole having been lately occupied by a redheaded woodpecker. He also called attention to the habit of a terrestrial spider in covering the opening of its burrow with a leaf during rains.

Mr. ALEX. WETMORE exhibited a fragment of a *Puffinus* bone obtained from Calvert Cliffs, Chesapeake Beach, Maryland.

The regular program was as follows:

MARTHA BREWER LYON; *Fauna of the human eye.* Dr. Lyon had made a careful examination of the literature as indexed in the Surgeon General's Library and the Index Medicus which reveals the following animals occuring in the human eye and its adnexa, the figures after the names indicating the frequency of their occurrence: *Treponema pallidum* infinite; *Taenia solium,* between 300 and 400; *Taenia echinococcus,* 75 to 100; *Opisthorchis felineus,* 1; *Paragonimus ringeri,* 1; *Agamodistoma ophthalmobium,* 1; *Monostomulum lentis,* 1; *Drancunculus medinensis,* 3; *Loa loa,* 30 to 50; *Agamofilaria oculi,* 3; *Filaria equina,* 2; *Filaria conjunctiva,* 3; *Thelazia callipaeda,* 2; *Trichinella spiralis,* 2; *Lepeophtheirus, pectoralis,* 1; *Demodex folliculorum,* 8; *Ixodes ricinus,* 1; *Pediculus capitis,* no cases reported though seen by many ophthalmologists; *Phthirius pubis,* 30 to 50; among the diptera, all larval form, many unidentified, those identified or at least named, *Hypoderma bovis,* 2; *Oestrus ovinus,* 2; *Gastrophilus haemorrhoidalis,* 2; *Musca domestica,* 2; *Wohlfartia magnifica,* 2; *Lucillia macellaria,* 1; *Calliphora vomitoria,* 1; *Sarcophaga* sp., 1; beetle larvae, *Necrobia* sp., 1. The fly larvae are mainly represented by forms which deposit living larvae.

Dr. Lyon touched on the early history, geographic distribution, location in the eye, means of diagnosis, description of parasite, symptoms, and in some cases the probable outcome with treatment. Some interesting observations were brought out as the prevalence of cysticercus cellulosae in Germany before the inspection of pork by the state and its practical elimination since; the many reported cases of pubic lice on the eyelashes of children against very few reported for head lice; the possibilities of the future study of the cause of chalazia by *Demodex folliculorum.* The paper was illustrated by lantern slides. It was discussed by Drs. L. O. HOWARD and PAUL BARTSCH, and by the chair.

MAYNARD M. METCALF: *Opalina and the origin of the Ciliata.* This will appear in a future number of the JOURNAL.

M. W. LYON, JR., *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Office of Public Roads and Rural Engineering, Department of Agriculture, began in May the publication of a monthly 48-page illustrated periodical entitled *Public Roads.*

The Biological Society of Washington has just published, as its Bulletin No. 1, *A sketch of the natural history of the District of Columbia, together with an indexed edition of the U. S. Geological Survey's 1917 map of Washington and vicinity.*[1] The author and editor is Mr. W. L. McAtee, Corresponding Secretary of the Society. The book contains historical sketches, with bibliographies, of the development of various branches of natural science in the District, including the botany, insects, other invertebrates, fishes, batrachians and reptiles, birds, mammals, and records of early man; also three chapters on the distribution of life in the District of Columbia region. A thorough index to the 1917 map of Washington and vicinity, together with a quartered and index-ruled copy of the map, is included.

Dr. Charles W. Burrows, associate physicist at the Bureau of Standards and in charge of the Magnetic Section of the Bureau, has presented his resignation to be in effect July 1, 1918, and will take up commercial research and consultation work in New York. He will have laboratories equipped for research on magnetic materials at Grasmere, Borough of Richmond, New York City.

Professor E. C. Franklin, of Stanford University, California, was in Washington in May in connection with the war work of the Bureau of Mines.

Mr. Walter M. Gilbert has resigned as assistant secretary of the National Research Council, and is now attached to the office of the Secretary of War.

Colonel Henry S. Graves, Chief of the Forest Service, has been elected an honorary member of the Royal Scottish Arboricultural Society of Edinburgh, in recognition of his eminent services to forestry.

[1] Biological Society of Washington, Biological Survey, Department of Agriculture; price $2.00, or $2.15 post-paid.

Professor H. R. Moody, of the College of the City of New York, Professor Samuel A. Tucker, of Columbia University, and Dr. E. R. Weidlein, associate director of the Mellon Institute of Pittsburgh, are members of the consulting staff of the chemicals and explosives section, War Industries Board, Council of National Defense. According to the *Official Bulletin*, the consulting staff has jurisdiction over questions involving inorganic chemicals, electrolysis, electrometallurgy, ceramics and refractories, organic compounds, and dyestuffs.

Professor Arthur A. Noyes, of the Masschusetts Institute of Technology, has been in Washington since May as chairman of the committee on nitrate investigations of the National Research Council, advisory to the Nitrate Division, Ordnance Department. The other members of the committee are Lieutenant-Colonel Alfred H. White, formerly professor of chemical engineering at the University of Michigan, and Dr. John Johnston, executive secretary of the National Research Council.

Professor Miles S. Sherrill, of the department of physical chemistry, Massachusetts Institute of Technology, is in Washington for the summer, and is engaged in work for the Nitrate Division of the Ordnance Department of the Army.

Mr. J. B. Tuttle resigned from the Bureau of Standards on April 15, 1918, and is with the Firestone Tire and Rubber Company of Akron, Ohio.

Captain F. E. Wright has been detailed as Army representative in the section of optical glass and instruments of the War Industries Board, Council of National Defense.

The following persons have become members of the Academy since the last issue of the Journal:

Mr. Albert Victor Bleininger, Bureau of Standards, 40th and Butler Streets, Pittsburgh, Pennsylvania.

Dr. William Wallace Campbell, Lick Observatory, University of California, Mt. Hamilton, California.

Dr. Charles Thom, Microbiological Laboratory, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

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GEOLOGY.—*New geological formations in western Wyoming.*[1] Eliot Blackwelder, Geological Survey.

As a result of the writer's field work in the Owl Creek, Shoshone, Wind River, Gros Ventre, and Teton ranges of western Wyoming, from 1910 to 1913, several new geologic formations have been recognized and the names proposed for them have been adopted by the U. S. Geological Survey. As the preparation of detailed reports on this region awaits the completion of the field studies, which have themselves been deferred for more urgent work elsewhere, several years may elapse before the reports appear in print. It therefore seems advisable to publish, in advance, definitions of these new formations, so that the names may be available for general use. In fact, while this paper was being considered and revised in manuscript, some of the names have already been used in print by other writers.[2]

GROS VENTRE FORMATION

In Peale's[3] original description of the Threeforks (Montana) section, the Cambrian was divided into the Flathead quartzite, Flathead shale, and Gallatin limestone. Later, Hague and his associates used the same terms, but restricted the Gallatin to

[1] Published by permission of the Director of the U. S. Geological Survey.

[2] Tomlinson, C. W., Journ. Geol. **25**: 255–257. 1917. Condit, D. D., U. S. Geol. Survey Prof. Paper 98–O. 1916.

[3] Peale, A. C., U. S. Geol. Survey, Bull. 110. 1893.

narrower limits. The term Flathead has now been reserved for the basal sandstone or quartzite. The use of the term Gallatin has been established in Hague's modified sense; but the present writer does not concur, because he believes Peale's original usage should have been preserved. The intervening greenish and gray calcareous shales, with gray, striped, conglomeratic and oolitic limestones, is here called the *Gros Ventre formation.* Its fossils indicate Middle Cambrian age. A typical section of the formation, exposed in the west slope of Doubletop Peak in the Gros Ventre Range, is as follows:

	Feet.
Gallatin limestone (base)	
Limestone; gray and ocher colored in alternate bands, contains black oolitic granules; rock massive and forms a prominent cliff in association with overlying members of the formation. Rests disconformably on underlying beds..	27+
Gros Ventre formation	
15. Limestone; very massive, dense and gray, top eroded.......	4+
14. Limestone; thin-bedded, gray laminated with olive drab....	13
13. Shale; green shale and flakes of brown-gray limestone, with a few beds of flat-pebble conglomerate and oolite. Much of this part of the section is concealed by talus	350
12. Limestone; thin-bedded, dense, hard blackish-gray rock mottled with drab and ocher, and containing some shale partings. Fragments of trilobites are rather common...	24
11. Shale; largely green shale with thin layers of limestone like the last; largely concealed..........................	26
10. Limestone; like "12." Surfaces of beds are rough, and some of them rather massive. This forms a distinct cliff in the slope..	115
9. Shale; greenish clay-shale with thin plates of limestone. Largely concealed by talus..........................	36
8. Limestone; gray, with irregular laminae and pockets containing siderite (?), and therefore weathering ocher color..	10
7. Limestone; somewhat pisolitic, dark drab limestone weathering blue gray..................................	$2\frac{1}{2}$
6. Shale; gray calcareous shale and shaly limestone; largely concealed	4
5. Limestone; dark drab to bluish limestone, hard but flaggy..	5
4. Shale; gray calcareous shale and shaly limestone; largely concealed	$6\frac{1}{2}$
3. Limestone; hard but flaggy, dark gray-bluish, mottled with light ocher. Contains traces of trilobites, and forms a prominent cliff	52

2. Limestone; buff to gray, weathering tawny brown; thin-bedded, with uneven stratification	26
1. Shale; gray micaceous shale, largely concealed by talus from above	95
	796

Flathead Sandstone

Sandstone; with several beds of sandy shale in the upper part ... about	200

LEIGH DOLOMITE MEMBER OF THE BIGHORN DOLOMITE

From the Teton Range eastward at least to the middle of the Wind River Mountains and north into the Absaroka Range, the massive member of the well-known Bighorn dolomite is overlain by a thin but persistent layer which deserves special recognition. In almost every section it is from 30 to 40 feet thick, and in most, if not in all, localities it is limited both above and below by disconformities. A typical section from the west slope of Dinwoody canyon, on the north side of the Wind River Range is as follows:

Darby formation (Devonian)

	Feet.
12. Basal layer a stratified breccia consisting of small bits of cream-colored dolomite and pink chert in a gray dolomite matrix. Base sharp and slightly uneven	5.0

Leigh dolomite member of Bighorn dolomite

11. Dolomite; pale gray, finely laminated. Contains ostracods and a few small mollusks	3.0
10. Dolomite; thin lavender-gray. Surface checkered with cracks which are stained pinkish	5.6
9. Dolomite; thin, lavender-gray. Rather massive. Contains a few ostracods	3.5
8. Dolomite; massive and thin. Rather brittle and full of blind joints	5.1
7. Shale; finely laminated, pink and maroon. Calcareous	0.3
6. Dolomite; pale gray, finely streaked and spotted with lavender. Very brittle and full of cracks	0.9
5. Shale; calcareous, light to dark red	0.2
4. Dolomite; like No. 3, but streaked and spotted with lavender	4.0
3. Dolomite; like No. 2, but beds 2 to 10 inches thick	3.5

2. Dolomite; dense, slabby, pale gray. Beds 1 to 4 inches thick. Sprinkled with small crinoid stems, and traces of bryozoans (?) Base not visible	2.0

Massive member of Bighorn dolomite (Ordovician)

1. Extremely massive, cream-colored dolomite, mottled with gray in alga-like patterns ... over	100

The Leigh member differs from the rest of the Bighorn in being characterized by thin, dense and brittle, flaggy strata with smooth milk-white surfaces. It is stated verbally by Kirk and Tomlinson that, to the southwest in the Bear River Range of Utah and to the northeast in the Bighorn Range of Wyoming, the thin milk-white dolomites of the Leigh member are interbedded with the very massive rough weathering strata typical of the Bighorn. Nevertheless, it seems probable that correlations with the Leigh may be made in some districts outside of western Wyoming, where it is typically developed.

Although the dolomite generally appears to be barren of organic remains, a characteristic fauna, consisting largely of ostracods with some pelecypods and gastropods, has been found at several localities. This fauna is assigned by Ulrich and Kirk to the Richmond horizon of the late Ordovician. The member takes its name from Leigh Canyon, on the west slope of the Teton Range, for on the south side of that valley there are excellent exposures of the dolomite in its typical condition.

DARBY FORMATION

The introduction of this new term is made necessary because none in present use fits the stratigraphy of western Wyoming. In the Threeforks section Peale gave the name Threeforks shale to the upper division of the Devonian, but included the lower dolomites, which are also Devonian, in his Jefferson limestone. Hague, Weed, and others in the Yellowstone National Park later misused the term "Threeforks" to include also the thin-bedded, dark-colored dolomite of the upper part of Peale's Jefferson, thus limiting the latter term to the very massive beds of gray dolomite below. The Darby formation is apparently equivalent to Peale's Three Forks shale plus the upper part of his

Jefferson limestone. The formation rests disconformably on the Leigh dolomite member of the Bighorn, or in some places on the massive member and is separated from the overlying Madison limestone locally, if not generally, by another eroded surface. Lithologically, it consists of a varied sequence of shales and dolomites in many colors from white to gray, green, lavender, buff, red, brown, and black. Somber colors predominate. Some of the beds are massive, others thin and brittle. Fossils are rare, but have been found in several localities. They indicate Devonian age, but permit no greater refinement in the determination. The name is derived from the canyon of Darby Creek, on the west slope of the Teton Range, where the formation is well exposed. It extends over most of northwestern Wyoming and has been recognized in modified condition as far southwest as the Wasatch Range. There are strata in the Bighorn Range[4] which resemble parts of the Darby formation, but it is not certain that they actually represent it.

A typical section of the Darby formation is exposed in the east slope of Sheep Mountain near the head of Green River.

	Feet.
Madison limestone	
26. Limestone; very massive, hard, dense to crystalline; disconformity at the base indicated by irregular eroded surface and sharp contact	$44\frac{1}{2}$+
Darby formation	
25. Dolomite; gray, weathering brown, with deeply pitted surface; silicified corals and quartz geodes	80
24. Shale and dolomite; interbedded buff-brown dolomite and black to gray calcareous shale; stained reddish on surfaces, and covered with *Spirophyton* markings	$22\frac{1}{2}$
23. Dolomite and shale; interbedded dense gray, brown-weathering dolomite, and drab clay-shale, weathering green	41
22. Shale; pale greenish-gray calcareous shale, with thin beds of shaly dolomite	19
21. Dolomite and shale; light brown sandy dolomite with greenish-gray calcareous shale; ripple marks	$5\frac{1}{2}$
20. Dolomite; dove-color to russet-olive, thin-bedded and shaly	$19\frac{1}{2}$
19. Shale; sandy and calcareous, greenish to lavender	5

[4] Tomlinson, C. W., Journ. Geol. **25**: 47–49. 1917.

18. Dolomite; dense chocolate brown	$1\frac{1}{2}$
17. Shale; pale green sandy shale, with laminae of white sandstone and buff dolomite	$14\frac{1}{2}$
16. Sandstone; strong cross-bedded white sandstone	$\frac{1}{2}$
15. Dolomite and shale; pale drab to brownish dolomite, and calcareous shale	18
14. Dolomite; massive gray to brown	2
13. Shale and dolomite; gray calcareous shale, and slaty brown dolomite	$6\frac{1}{2}$
12. Dolomite; massive, crystalline, sepia brown, rich in petroleum and slightly fossiliferous (Atrypa reticularis, etc.)	$11\frac{1}{2}$
11. Shale; olive gray calcareous, weathering green	4
10. Dolomite; thin bedded to massive, drab-brown, and containing geodes of jet	16
9. Shale; sandy to calcareous drab to gray, weathering green, with thin layers of gray dolomite	$15\frac{1}{2}$
8. Dolomite; dense gray argillaceous dolomite, with one layer of shaly black chert and some geodes like the last	$8\frac{1}{2}$
7. Shale; drab calcareous, and associated with dolomite beds	7
6. Dolomite; slaty, brittle, gray and brown	30
5. Shale; black to gray, calcareous	2
4. Dolomite; dark smoky brown to yellowish, rich in petroleum	30
3. Dolomite; dense, brittle, finely laminated, white and lavender	2
2. Dolomite; olive green, becoming gray above. Probably disconformable at base	22
	$428\frac{1}{2}$

Leigh dolomite member of Bighorn dolomite

1. Dolomite; thin-bedded cream-colored, dense and ringing.

DORWIN SANDSTONE MEMBER OF THE AMSDEN FORMATION

As defined by Darton, the Amsden formation included the sandstones, shales, and dolomites intervening between the Madison limestone below and the Tensleep sandstone above. Throughout western Wyoming the Amsden is divisible into two very distinct parts—an upper division of shales, sandstones, and dolomites of weak character, and a lower, massive, resistant sandstone. On account of their difference in resistance to erosion, the upper member has generally been stripped off, while the lower remains capping the mountains and ridges of Madison limestone. It therefore became advisable in practice to map the two members separately. To the lower sandstone the name

Dorwin sandstone member is given, from Dorwin Peak in the Gros Ventre Range, which is capped by this sandstone. It is separated from the underlying Madison by a distinct disconformity, but graduates into the overlying part of the Amsden. In spite of the absence of fossils, the stratigraphic position of the sandstone indicates that its age is early Pennsylvanian or late Mississippian—probably the former.

The Dorwin sandstone averages about 60 feet thick in the Gros Ventre Range, but dwindles slowly southeastward to the vicinity of Lander, where it is about 15 feet thick. Westward it has been traced in typical condition as far as Teton Pass, but has not been clearly distinguished farther southwest in Idaho. It ranges northward into Yellowstone Park, and northeastward as far as the southern part of the Bighorn Mountains. Elsewhere it is generally represented by reddish sandy shales.

PARK CITY FORMATION

Boutwell[5] gave this name to certain Carboniferous beds in Utah. Having traced them thence, range by range, from near Park City, into central western Wyoming, the writer now desires to indicate their relation to other formations in that region and to show the lithologic variations involved. The rocks are dolomites, shales, limestones, cherts, and phosphatic beds, constituting the lower part of Darton's Embar formation, which is typically developed in the Owl Creek Range. It includes the equivalent of the Phosphoria formation, as defined by Richards and Mansfield[6] in eastern Idaho, but in addition also the upper part of their Wells formation. From the underlying Tensleep sandstone it is separated by a disconformity, but it is concordant with the overlying Dinwoody beds. Its abundant fossils belong to a somewhat unfamiliar fauna which Dr. G. H. Girty assigns to the Pennsylvanian and Permian. Although large collections have been made from the formation in the Wind River Range, they have yet received only preliminary notice in printed form,[7] and many of the species are undescribed.

[5] Boutwell, J. M., Journ. Geol. **15:** 437–458. 1907.

[6] Richards, R. W., and Mansfield, G. R., U. S. Geol. Survey Bull. 577. 1914.

[7] Amer. Journ. Sci. **36:** 177–179. 1913.

A typical and centrally located section of this formation, together with the one next to be described, is exposed in the mountains at the head of the Gros Ventre River and its tributaries, especially north and east of Dorwin Peak.

Chugwater formation	*Feet*
23. Shale; brick red with thin gray laminae, resting on an ill-defined and conformable bottom	10+
Dinwoody formation	
22. Shale; grayish white, with thin calcareous laminae, ripple-marks and sun-cracks	80
21. Dolomite and shale; thin-bedded, argillaceous dolomite interbedded with gray shale and very thin quartzose flags. A few Lingulas and small pelecypods	20
20. Shale; calcareous, olive-gray rock with thin beds of dense gray argillaceous dolomite. Some beds contain Lingulas, and others pelecypods, too poorly preserved for identification.	51
19. Flags and shale; alternating thin brittle beds of dolomite-clay-quartz rocks of pale gray color, but weathering tawny brown. Full of brownish Lingula shells	4
18. Sandstone etc.; olive-gray calcareous sandstone, weathering smoky brown and even black, owing to presence of manganese oxides. Contain laminae and lenses of white chert, occasionally more than a foot thick	20½
Park City formation	
17. Dolomite; light gray, siliceous, with fossils appearing as silicified excrescences: *Spiriferina pulchra*, *Derbya sp.*, Fenestelloid bryozoans	11½
16. Chert; alternating massive and shaly chert. The more massive beds have a peculiar tubular structure	35
15. Shale and chert; black shale with thin laminae of black chert increasing toward the top	10
14. Shale; coal black, slightly phosphatic and containing one 2-inch layer of back oolitic phosphorite	7
13. Dolomite; black, but weathers drab. Saturated with hydrocarbons	2½
12. Shale; black, slightly phosphatic shale	15
11. Phosphorite; hard, black nodular bed, containing phosphatized fossils. Has a stronger odor of hydrocarbons:[8] *Lingulodiscina missouriensis*, *Productus phosphaticus*, *Plagioglypta canna*, *Conularia sp.*	1

[8] Identified by Dr. G. H. Girty.

10. Limestone; gray, petroliferous, crystalline. Filled with poorly preserved bryozoans and gastropods	7
9. Dolomite; gray to white, with white chert nodules	14
8. Sandstone; smoky gray, weathering brown. Contains angular fragments and grains of white chert, and granules of collophane	10
7. Chert; thin bedded and lumpy, gray to white, with greenish shale partings	21½
6. Shale; black, slightly phosphatic	8
5. Phosphorite; soft, crumbling, oolitic; passing upward into shale	4
4. Breccia; fragments of chert imbedded in a brown phosphatic matrix, resting on a sharp irregular surface	2
Tensleep sandstone	
3. Dolomite; light gray, with nodules and laminae of gray chert	4
2. Sandstone; white, pitted, calcareous	2
1. Sandstone; creamy white, weathering light brown to pink	about 300

DINWOODY FORMATION

The upper part of Darton's Embar formation consists in this region of greenish-gray shales, with many thin plates of dense, calcareous sandstone, or argillaceous dolomite, which weathers brown, tawny, and even black. This portion—which is to be distinguished from the lower or Park City portion of the Embar—is 250 feet thick at Dinwoody Creek on the north slope of the Wind River Range, but thins down to less than 50 feet near Lander. In the Owl Creek Mountains it is 75 to 100 feet thick near Anchor. Eastward, near Thermopolis, the formation becomes gypseous, and more or less reddish in color. Mr. D. Dale Condit[9] has traced it into the Bighorn Range, where it merges with the lower part of the Chugwater red-beds. Westward it becomes progressively thicker, more calcareous, and more fossiliferous, and changes by imperceptible gradations horizontally into the Woodside and Thaynes formations of southeastern Idaho. It is about 210 feet thick on Crystal Creek in the Gros Ventre Range, 350 feet thick at the north end of the Hoback Range, and thence into Idaho it rapidly increases in volume.

The Dinwoody formation is conformable both above and below. Although some beds contain abundant Lingulas and poorly pre-

[9] CONDIT, D. DALE, U. S. Geol. Survey Prof. Paper 98-O. 1916.

served pelecypods, no fossils of diagnostic value have been found in it in Wyoming. From its stratigraphic position conformably between the Park City and Chugwater formations, and from its relation to the Woodside and Thaynes formations in Idaho, which are classified as Lower Triassic, it is inferred that the Dinwoody formation is either Permian or Lower Triassic or both. The name is derived from the canyon of Dinwoody Lakes, in the Wind River Range, where the formation is completely exposed, and has been measured in detail.

BOTANY.—*Omiltemia, a new genus of Rubiaceae from Mexico.* Paul C. Standley, U. S. National Museum.[1]

From the large collections of plants obtained in Mexico a few years ago by Mr. E. W. Nelson, of the Biological Survey, many new species have already been described. A large and probably the most interesting portion of the material, however, still remains to be identified. One specimen, in particular, from the State of Guerrero has come to the writer's attention in the course of his revision of the Rubiaceae for the North American Flora. This plant, although not possessing any very unusual characters, can not be placed satisfactorily in any of the known genera of the tribe Rondeletieae, the group to which it evidently belongs. Consequently it is described here as a new genus, *Omiltemia*.

The tribe Rondeletieae is a large group, chiefly North American in distribution, many of whose genera are based upon rather slight differences. *Omiltemia* falls in the subdivision with contorted corolla lobes, and is related as closely to *Deppea* and *Lindenia* as to any genera, from both of which, however, it is distinguished by the long, exserted filaments. *Deppea*, moreover, has a short, funnelform or subrotate corolla, and *Lindenia* a very long, salverform one. In its general appearance *Omiltemia* is very unlike any of the genera of its tribe. The red tubular corolla is suggestive of *Manettia*, to which the type specimen was once referred, but that genus differs widely in its winged seeds and scandent habit.

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Omiltemia Standley, gen. nov.

Branched shrubs, more or less pubescent, the branchlets angulate. Leaves opposite and ternate, petiolate, membranaceous. Stipules minute, deciduous. Flowers of medium size, red, axillary, solitary, long-pedicellate, the pedicels bibracteolate at the base; calyx tube narrowly turbinate, the limb 4-lobate, the lobes linear-subulate, subequal, persistent; corolla tubular, glabrous, the tube elongate, slender and constricted near the base, ampliate in the upper three-fourths, the limb 4-lobate, the lobes short, oblong-ovate, subulate-acuminate, erect or ascending, contorted. Stamens 4, inserted at the base of the ampliate portion of the corolla tube; filaments filiform, exserted; anthers linear, dorsifixed, mucronate, bifid at the base. Disk depressed. Ovary 2-celled; style filiform, exserted, glabrous; stigma fusiform; ovules numerous, imbricate, the placentae oblong, peltately affixed to the septum. Capsule 2-celled, cylindric, elongate, subcoriaceous, costate, loculicidally bivalvate at the apex. Seeds numerous, minute, subglobose, obtusely angulate, the testa lustrous, reticulate; endosperm fleshy.

Type species, *Omiltemia longipes* Standley.

Omiltemia longipes Standley, sp. nov.

Shrub, about 3 meters high, the branches stout, grayish, terete, the branchlets slender, puberulent when young, densely leafy; stipules deltoid, about 1 mm. long; leaves mostly ternate, the petioles slender, 2–6 mm. long, puberulent, often marginate to the base, the blades oblanceolate or oblanceolate-oblong, 3–7 cm. long, 0.8–1.7 cm. wide, acuminate or long-attenuate at the base, acute to long-attenuate at the apex, often abruptly so, thin, bright-green, concolorous, glabrous above or puberulent along the costa, the venation plane, villosulous beneath along the veins or glabrate, inconspicuously striolate, the costa slender, prominent, the lateral veins prominulous, 4–6 on each side, arcuate; pedicels 1.7–3.5 cm. long, filiform, sparsely short-pilose, the bractlets minute, linear, green; calyx very sparsely short-pilose or glabrate, the tube 6–7 mm. long, the lobes 3–4 mm. long; corolla red, about 4 cm. long, the contracted portion of the tube about 1 cm. long and 1.2 mm. thick, the upper portion 5–6 mm. thick, the lobes about 5 mm. long; anthers 7 mm. long, the filaments about 2.5 cm. long; style about 4.5 cm. long; capsule 1.4 cm. long, 2.5–3 mm. thick; seeds brown.

Type in the U. S. National Herbarium, no. 399394, collected at Omilteme, Guerrero, May, 1903, *E. W. Nelson 7054*.

ZOOLOGY.—*Opalina and the origin of the ciliate Infusoria.*[1]

Maynard M. Metcalf, Orchard Laboratory, Oberlin, Ohio. (Communicated by M. W. Lyon, Jr.)

Study of a large amount of material from the United States National Museum collections of frogs and toads shows several

[1] Abridged from a paper read before the Biological Society of Washington, May 4, 1918.

dozen new species of Opalinidae and necessitates revision of the taxonomy in the family and in the Ciliata. The new forms enable us to gain a comprehensve knowledge of the plan of speciation among the Opalinidae and the conditions revealed in this family throw light upon the origin of the Ciliata.

The family Opalinidae comprises properly but two genera—*Protoopalina* (new genus) and *Opalina*. *Protoopalina* has one nucleus or in most species two nuclei. Their nuclei contain two distinct sets of large, flat, superficial chromosomes of constant and characteristic number in each species, and another more central set composed of the same number (in the species thus far studied) of slender chromosomes each consisting of a linear aggregate of granules much as in *Paramecium*, except that the granules are much coarser in these large nuclei. In mitosis the daughter nuclei each receive one-half of each chromosome of each sort (massive and granular).

Opalina has many nuclei (4 to several thousand). Each nucleus contains some (not many) large, flat, superficial chromatin masses of varying number in the different nuclei in the body and also numerous, more central, slender chromosomes, each a linear aggregate of granules. It is probable that these linear chromosomes are of constant number for each species, but they are too numerous for easy study. In the genus *Opalina* the granular chromosomes seem to be as carefully and regularly divided as they are in *Protoopalina*, but the larger masses of chromatin are irregularly divided in mitosis, and some of them may occasionally remain undivided, passing bodily without division into one of the daughter nuclei.

In both *Opalina* and *Protoopalina* the massive chromosomes are trophic, the granular chromosomes reproductive. Each nucleus contains both kinds of chromatin and there is no specialization, as in the higher Ciliata, of whole nuclei as trophic and other whole nuclei as reproductive.

The most characteristic feature of the higher Ciliata is the possession by each individual of a large trophic nucleus and another minute reproductive nucleus. The absence of this character in the Opalinidae justifies placing them as an archaic group, Protociliata, and classing the rest of the Ciliata as Euciliata..

The archaic features of the Protociliata are: (1) the transient character of their pleurinucleate condition, the gametes in the spring becoming uninucleate; (2) the consequent absence of differentiation of whole nuclei for trophic function (macronuclei) and of other whole nuclei for reproduction (micronuclei), each nucleus instead containing chromatin of both sorts; (3) the very primitive nature of the contractile vacuole—merely a temporary fusion of some of the axial alveoles to form an irregular and usually branched tubule opening by a posterior pore; (4) binary fission both longitudinal and transverse; (5) sexual union, the complete fusion of very dissimilar gametes. A secondary feature is the complete absence of a buccal groove. Numerous genera of Euciliata also show this secondary modification—e.g., *Hoplitophrya*, *Anoplophrya*, *Discophrya*, *Chromidina*, etc. In both Protociliata and Euciliata this feature is doubtless due to parasitism.

The author described mitosis in a species of *Protoopalina* (Opalina), discovered by Professor J. H. Powers, whose two nuclei are found resting in a midmitotic condition (anakhase). Awerinzew described an African species whose usually single nucleus rests in a similar midmitotic stage, and because of its uninucleate character named the species *Opalina* [*Protoopalina*] *primordialis*. In the National Musem material is a still more archaic species (as yet unnamed) from *Bufo regularis* whose single nucleus is in an earlier phase of mitosis than is that of *Protoopalina primordialis*. Starting with this unnamed species we may arrange the Opalinidae according to their nuclear condition: first a species with a single nucleus resting in a mitotic condition but little past the critical (mitotic) phase; then *Protoopalina primordialis* with nucleus in an anaphase condition; then several species with each a single nucleus in a late anaphase or a telophase condition; then numerous species each with two distinct resting nuclei; then several species each with two nuclei each of which is just entering upon mitosis; then two or more species each with two nuclei both being in about the critical phase of mitosis; then numerous species each with two nuclei both in an anaphase of mitosis; others with two nuclei each in a telophase of mitosis. All species thus far mentioned in this paragraph are Protoopalinae with characteristic protoopalinid nuclei. Simplest in the genus *Opalina* is *O. lanceolata* (of Bezzenberger) with four nuclei; then *O. mimuta* (new species from *Bufo melanostictus*) with from five to twelve nuclei; then very many species with from one hundred to several thousand nuclei.

It seems evident that the pleurinucleate condition in the Opalinidae is due to some disturbance of the mitotic phenomena and the usual nucleus-cytoplasm relation, nuclear mitosis and body division being inhibited to a less or greater degree in different species. As this strange tendency develops we get finally bodies with a great number of nuclei. Among the Opalinids the culmination of this disturbance of the division phenomena is seen in the new species, *Opalina segmentata*, in which species even the vegetative fissions, which occur from time to time in both multinucleate and binucleate species, are inhibited after they have begun. *Opalina segmentata* is an elongated cylindrical species (snake-shaped) with thousands of nuclei. Numerous fissions which have started at different levels in the body are still incomplete, giving the whole animal a metamerized appearance. Of course this is but pseudo-metamerization for it is not due to apical budding but rather to interrupted transverse fissions which have started at different points along the elongated body.

The Opalinidae are an offshoot from the ancestral Ciliata at a time when mitotic phenomena and the nucleus-cytoplasm relation were becoming disturbed. They have some of them remained in an early stage of this condition. Others have developed the tendency further and have become highly multinucleate. The Euciliata, rising doubtless from such pseudobinucleate forms as the Protoopalinae, have passed on to a permanently binucleate condition, even their gametis being binucleate, when properly analyzed. The permanence of their binuclearity, once established, allowed the differation of one whole nucleus for nutrition (macronucleus) and of the other whole nucleus for reproduction (micronucleus). The Opalinidae as a whole are a group in which the condition of nucleus and cytoplasm as to mitosis are still in flux. The Euciliata, advancing from this condition, have become stereotyped in a definitely binucleate state with secondary nuclear specialization.

Classification of Ciliata

Protociliata
- Opalinidae
  - Protoopalina
  - Opalina

Euciliata

ZOOLOGY.—*Synopsis of the supergeneric groups of Rodents.*[1]

GERRIT S. MILLER, JR., and JAMES W. GIDLEY, U. S. National Museum.

Work on the taxonomy of the Rodents, living and extinct, has occupied much of our time during the past four years. This paper contains a brief synopsis of the results.

The classification which we have adopted is based on the following conception of the evolutionary course followed by the order during its development. This course has been mainly conditioned by the mechanical problem of strengthening a chewing apparatus in which the unusually important cutting function of the incisors is strongly contrasted with the grinding function of the cheekteeth; the highest degree of efficiency to be given always to the incisors and in most instances to the cheekteeth as well. The problem has been solved by five sequences of correlated changes in the masseter muscle and the bones to which this muscle is attached. All of these sequences could originate from the structures present in a generalized mammal, but there is no evidence that any rodent during its development has passed from one to another. The groups characterized by the various sequences are therefore natural. We have treated them as superfamilies: the *Sciuroidae, Myoidae, Dipodoidae, Bathyergoidae*, and *Hystricoidae*. Of the secondary problems the most conspicuous has been the strengthening of the cheekteeth. These teeth, however unlike their structure in extreme instances may appear, have all been developed from some primitive, low-crowned, trituberculear type not essentially different

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from that present in the Eocene *Paramyidae* and in living species of *Sciurus*. During the adjustment of the cheekteeth to increasingly heavy fore-and-aft grinding motion, a process which has taken place in most members of the order, the crown height has been augmented, while the original tubercles and lophs have been made more efficient by (a) increase in complexity, and (b) conversion into transverse ridges and specialized enamel plates, usually with reduction in the number of elements present. In each superfamily the characteristic modifications in the muscles and skull were begun in connection with the development of the incisors. Mechanical improvement of the cheekteeth came later. All rodent teeth have been developed from an essentially uniform original type under the influence of practically identical mechanical forces. Parallelism in highly specialized dental structures between genera and species which are not closely related is therefore frequent enough to be one of the noticeable peculiarities of the order. The history of development extends so far into the past that the essential features of structure are modernized in the oldest known Eocene rodents. No extinct member of the order has yet been found which can be regarded as ancestral to any considerable number of subsequent forms.

The order *Rodentia* may be defined as follows: Terrestrial and fossorial (occasionally arboreal or semiaquatic) placental mammals with both brain and placentation generalized in type; feet unguiculate; elbow joint always permitting free rotary motion of forearm; fibula never articulating with calcaneum; masseter muscle highly specialized, divided into three or more distinct portions having slightly different functions; cecum without spiral fold; dental formula not known to exceed i $\frac{1}{1}$, c $\frac{0}{0}$ pm $\frac{2}{1}$, m $\frac{3}{3}$ = 22 permanent teeth; incisors scalpriform, growing from persistent pulp, the enamel of the upper tooth not extending to posterior surface; distance between mandibular and maxillary toothrows approximately equal, both pairs of rows capable of partial or complete opposition at the same time, the primary motion of the lower jaw in mastication longitudinal or oblique.

Superfamily SCIUROIDAE

Masseter lateralis superficialis with anterior head distinct, this portion of the muscle not attached to any part of the zygoma except occasionally to a point at extreme base of zygomatic plate; zygomatic plate tilted upward, usually broad, with its superior border always above lower margin of infraorbital foramen. Infraorbital foramen inferior, transmittng nerve only; masseter lateralis passing obliquely upward to superior border of rostrum, always to exclusion of masseter medialis.

THREE-CUSPED SERIES

Teeth becoming hypsodont on the basis of a tritubercular structure.

Family SCIURIDAE

Skull never truly fossorial; infraorbital foramen with outer wall usually though not always forming a distinct canal, its orifice protected from muscular action by the presence, at or near its lower border, of an outgrowth for attachment of masseter lateralis superficialis; frontal with decurved postorbital process; cheekteeth brachydont or unilaterally hypsodont, the fundamental tritubercular plan usually (probably always) evident in functional adult teeth that have not undergone considerable wear; external form suited to arboreal or terrestrial life.

The *Sciuridae* of authors.

Subfamily *Sciurinae*.—Orbital region normal, the middle of orbit in front of middle of skull (except in genera with greatly elongated rostrum), the lachrymal bone above or in front of anterior extremity of toothrow, the zygomatic plate not especially emarginate below, the postorbital process indicating an evident boundary between orbit and temporal fossa; no parachute membrane.

The entire family except the members of the two following groups; Oligocene to Recent; Northern Hemisphere, South America, continental Africa.

Subfamily *Nannosciurinae*.—Like the *Sciurinae* but orbital region abnormal, the middle of orbit behind middle of skull (rostrum short), the lachrymal bone above middle of toothrow, the zygomatic plate conspicuously emarginate below, the postorbital process not indicating an evident boundary between large orbit and much reduced temporal fossa.

Nannosciurus of the Malay region, *Myosciurus* of West Africa, and *Sciurillus* of South America (the last not seen); Recent.

Subfamily *Pteromyinae*.—Like the *Sciurinae* but with a well developed parachute membrane present.

The Flying-squirrels; Middle Miocene to Recent; Northern Hemisphere.

Family GEOMYIDAE

Skull fossorial; zygoma robust; infraorbital foramen always at end of a long canal, its orifice protected from muscle pressure by countersinking in an oblique sulcus; frontal without postorbital process; cheekteeth evenly hypsodont or in their extreme development ever-growing, the fundamental tritubercular plan lost in functional adult teeth, the first and second molars of adult consisting of either one or two simple loops. External form in living members of the group highly modified for underground life.

Subfamily *Entoptychinae*.—Angular portion of mandible mostly below alveolar level; cheekteeth rooted, the enamel pattern of first and second molars consisting of two simple loops joined at protomere.[2]

Entoptychus; North American Oligocene.

Subfamily *Geomyinae*.—Angular portion of mandible mostly above alveolar level; cheekteeth ever-growing, the first and second adult molar consisting each of a simple prism, with an enamel plate always present on anterior surface in upper teeth and on posterior surface of lower teeth.

North American pocket gophers; Miocene to Recent.

Family Heteromyidae

Essential characters as in the *Geomyidae* but skull not fossorial; zygoma slender; orifice of infraorbital canal protected from muscle pressure by countersinking in a vacuity which extends transversely through rostrum; external form murine or saltatorial.

North American pocket-mice and kangaroo-rats; Middle Oligocene (*Heliscomys*) to Recent.

FOUR-CUSPED SERIES

Teeth becoming hypsodont on the basis of a quadritubercular structure.

Family Adjidaumidae

Zygomasseteric structure[3] and infraorbital canal as in the *Sciuridae;* cheekteeth $\frac{4}{4}$, slightly hypsodont, the enamel pattern unmodified heptamerous.[4]

Adjidaumo; North American Middle Oligocene.

[2] Protomere = inner side of maxillary cheekteeth and outer side of mandibular cheekteeth.

Paramere = outer side of maxillary cheekteeth and inner side of mandibular cheekteeth.

[3] Zygomasseteric structure = the combined and correlated structures of the masseter muscle and of the skull in the region at which the muscle takes its origin.

[4] Heptamerous pattern = the enamel pattern of a flat-crowned cheektooth in which each of seven original tubercles is represented by a loop (two on the protomere, five on the paramere).

Family Eutypomyidae

Like the *Adjidaumidae* but with cheekteeth somewhat more hypsodont and the heptamerous enamel pattern complicated by the development of a considerable number of secondary closed loops which appear in partially worn teeth as an aggregation of minute enamel lakes covering nearly entire surface of crown.

Eutypomys; North American Middle Oligocene.

Family Chalicomyidae

Like the *Adjidaumidae* but cheekteeth strongly hypsodont and enamel pattern reduced-heptamerous (sometimes paralleling that of the *Hystricidae*) becoming rapidly simplified as the crowns wear away; skull occasionally fossorial; no postorbital process on frontal; no pit-like depression in basioccipital region.

Chalicomys (= *Steneofiber*) and related genera, European Miocene and Pliocene; *Trogontherium,* European Pliocene and Pleistocene; *Palaeocastor, Eucastor* and related genera, North American Upper Oligocene and Lower Pliocene.

Family Castoridae

Skull with rostrum broadened and deepened and braincase narrowed; basioccipital region with conspicuous pit-like depression; cheekteeth not ever-growing but so excessively hypsodont that the slightly reduced-heptamerous pattern (parallel: *Myocastor*) changes little with age and rarely if ever wears out; external form highy modified for aquatic life; caudal vertebrae flattened.

Castor; Lower Pliocene to Recent; Northern Hemisphere.

Family Castoroididae

Zygomasseteric structure modified by the passage of the shaft of the incisor below the infraorbital foramen instead of above it, the ridge formed by the tooth dividing the area of masseteric origin on side of rostrum into two planes; posterior nares divided horizontally by the median fusing of palatine bones over roots of cheekteeth; teeth ever-growing, the enamel pattern a series of 5–7 parallel transverse ridges (parallel: *Dinomyidae*).

Castoroides; North American Pleistocene.

Superfamily MUROIDAE

Zygomasseteric structure as in the *Sciuroidae* except: Infraorbital foramen superior in whole or in part, entered or traversed by muscle as well as nerve; masseter lateralis seldom reaching superior border of rostrum, and never doing this to exclusion of masseter medialis.

THREE-CUSPED SERIES

Modifications of teeth based on an underlying tritubercular structure.

Family Muscardinidae

Skull with no striking modifications of general form; zygomatic root. much as in the *Sciuridae* except that its anterior face is nearly vertical instead of strongly oblique, and the infraorbital foramen extends above median level of orbit, receiving or transmitting a strand of muscle as well as the nerve; no postorbital processes; auditory bullae large, globular, rounded in front; cheekteeth $\frac{4}{4}$, brachydont (in *Leithia* subhypsodont), the enamel pattern reduced-hexamerous in forms with basin-shaped crowns, passing to a system of parellel transverse ridges in those with flat crowns (parallel: *Graphiuridae*); external form showing a combination of murine and sciurine features.

Eliomys, Dyromys, Glis, Muscardinus, Leithia; Old World Middle Miocene to Recent.

FOUR-CUSPED SERIES

Modifications of teeth based on an underlying quadritubercular structure.

Family Ischyromyidae

General characters of the skull as in the *Muscardinidae;* teeth $\frac{5}{4}$, moderately hypsodont, rooted, the fundamental structure quadritubercular, the enamel pattern in worn teeth reduced-heptamerous.

Ischyromys; North American Middle Oligocene.

Family Cricetidae

Fundamental zygomasseteric structure as in the *Muscardinidae* and *Ischyromyidae,* but infraorbital foramen usually enlarged and specialized, consisting of a rounded upper portion for transmission of muscle and a narrow lower portion for transmission of nerve, the zygomatic root developed into a broad, oblique plate; skull varying excessively in form, but always without postorbital process on the frontal; cheekteeth $\frac{3}{3}$, the crown structure showing all stages from brachydont to ever-growing, the fundamental structure quadritubercular, the enamel pattern varying from simple heptamerism to excessive specialization, the tubercles in the maxillary teeth always presenting a longitudinally biserial arrangement and never developing a functional third series on lingual side of crown; external form murine or fossorial.

Subfamily *Cricetinae.*—Skull without special modification, the zygomasseteric structure as usual in the family, the squamosal not developing a postorbital ridge or process; molars rooted, their crowns varying gradually from tubercular and brachydont to flat-crowned and strongly hypsodont, when in the latter condition the prisms not opposite (compare *Gerbillinae*) and the posterior termination of m^1 and m^2 not angular (compare *Microtinae*).

The *Cricetinae, Sigmodontinae, Neotominae,* and *Nesomyinae* of authors; Oligocene to Recent; continental region of the world; Madagascar.

Subfamily *Gerbillinae*.—Auditory bullae and entire posterior portion of skull enlarged; teeth subhypsodont or hypsodont, flat-crowned in adults, with opposite prisms, these tending to form transverse ridges joined at median line, or, in their extreme development, to separate into plates; external form saltatorial.

The *Gerbillinae* of authors; Recent only, unless *Trilophomys* from the Pliocene of France is a member of the group; Asia and Africa.

Subfamily *Microtinae*.—Like the more hypsodont members of the subfamily *Cricetinae* but cheekteeth often growing from a persistent pulp, the enamel pattern always consisting of (at least partially) alternating triangles, the posterior termination of m^1 and m^2 never rounded; squamosal with distinct postorbital ridge or process.

The *Microtinae* of authors; Miocene to Recent; Northern Hemisphere.

Subfamily *Lophiomyinae*.—Like the *Cricetinae* with tubercular, slightly hypsodont teeth, but skull with temporal fossa bridged by a plate formed of laminae arising from the jugal, frontal, and parietal, a structure not known to occur elsewhere among rodents.

Lophiomys; Recent; Africa.

Family Platacanthomyidae

Like the *Cricetidae* but zygomasseteric structure unusual, the infraorbital foramen of normal cricetine form, but zygomatic plate much narrowed, and masseter lateralis profundus extending its line of attachment along upper zygomatic border to side of rostrum above foramen; cheekteeth subhypsodont, the enamel pattern a modified heptamerous with tendency to form parallel oblique cross-ridges (parallel: *Muscardinidae*).

Platacanthomys and *Typhlomys;* Recent; Southern Asia.

Family Rhizomyidae

Like the *Cricetidae* but zygomasseteric structure unusual, the infraorbital foramen with neural portion reduced or obliterated by partial or entire fusion of zygomatic plate with side of rostrum; skull and external form fossorial.

Subfamily *Tachyoryctinae*.—Infraorbital foramen with neural portion reduced to an inconspicuous notch by fusion of the broad zygomatic plate with side of rostrum (outline of plate below foramen usually visible); skull strongly fossorial; cheekteeth closed at base but extremely hypsodont, the enamel pattern not changing in character during adult life; enamel pattern in adult consisting of 2–3 parallel curved cross-ridges (the concave surface directed backward and outward in upper teeth, forward and inward in lower teeth; parallel: *Protechimys*); reduced-heptamerism evident in unworn enamel cap; external form modified, though not excessively, for underground life.

Tachyoryctes; Recent; Africa.

Subfamily *Rhizomyinae*.—Like the *Tachyoryctinae* but peculiarities of infraorbital region carried farther, the neural notch being obliterated and the foramen appearing as a small orifice confined to upper surface of zygomatic root; teeth moderately hypsodont, the enamel pattern obviously heptamerous or reduced-heptamerous and changing rapidly during adult life.

Rhizomys and related genera; Pliocene to Recent; southern Asia.

Subfamily *Braminae*.—Like the *Rhizomyinae* but cheekteeth with definitely prismatic structure.

Bramus; Pleistocene; northern Africa (not seen).

Family Spalacidae

Like the *Cricetidae* but zygomasseteric structure unusual, the zygomatic plate narrowed and turned downward to a nearly horizontal position, thus doing away with the separate neural portion of the opening by a process the exact opposite to that bringing about a similar result in some of the *Rhizomyidae;* skull excessively fossorial, the lambdoid crest carried forward to level of zygomatic root.

Subfamiy *Myospalacinae*.—Mandible scarcely movable at symphysis, a large post-symphyseal buttress early developed; cheekteeth growing from persistent pulps, the crowns elongated, the enamel pattern consisting of alternating triangles, the posterior termination of m^1 and m^2 rounded.

Myospalax; Recent; Asia.

Subfamily *Spalacinae*.—Mandible movable at symphysis throughout life; cheekteeth moderately hypsodont, rooted, subterete, the pattern reduced-heptamerous, changing rapidly with wear; skull with the characters of the family carried to such an extreme as to make it the most fossorial type known among rodents.

Spalax, Recent, *Prospalax*, Upper Pliocene, and an undescribed genus from the upper Oligocene; eastern Mediterranean Region, and southern Europe.

Family Muridae

Skull as in the typical *Cricetidae*; cheekteeth $\frac{3}{3}$, the upper teeth with a functional row of tubercles on lingual side of crown internal to the protocone and hypocone, these tubercles entering conspicuously into the plan of modification of the crowns.

Subfamily *Dendromyinae*.—Upper cheekteeth with triserial arrangement not fully developed; manus with only 3 functional digits.

The *Dendromyinae* of authors; Recent; Africa.

Subfamily *Murinae*.—Upper cheekteeth with fully developed triserial arrangement of tubercles always evident, though frequently varying from the symmetrical plan; crowns brachydont or slightly hypsodont; manus normal.

The *Murinae* of authors; Upper Miocene to Recent; Old World, except Madagascar.

Subfamily *Phloeomyinae*.—Upper cheekteeth with triserial arrangement of elements obscured by flattening out of each trio of tubercles to form a simple, detached, transverse lamina (parallel: *Diplomys*); crowns moderately hypsodont; braincase relatively small and auditory bullae reduced; external form heavy, arboreal.

Phloeomys; Recent; Philippine Islands.

Subfamily *Otomyinae*.—Upper cheekteeth with same modification as in the *Phloeomyinae*, but m^3 tending to become the dominant tooth in the series, its size always greater than that of m^2, and its elements usually reduplicated; external form heavy, terrestrial.

Otomys; Recent; Africa.

Subfamily *Hydromyinae*.—Upper cheekteeth with triserial arrangement obscured by suppression of tubercles of outer series; m^3 vestigial.

The *Hydromyinae* of authors; Recent; Australian Region.

Superfamily DIPODOIDAE

Masseter lateralis superficialis with anterior head not distinct, this portion of the muscle attaching along a considerable area on anterior border of zygoma; zygomatic plate nearly horizontal, always narrow and completely beneath infraorbital foramen. Angular portion of mandible not distorted outward at base to permit free passage of a branch of the masseter lateralis, its general direction not parallel with zygoma.

THREE-CUSPED SERIES

Modifications of teeth based on an underlying tritubercular structure, the hypocone when present not entering into the essential mechanical scheme of the crown.

A.—*Skull with no special peculiarities except that the auditory bullae appear to be imperfect or absent (perhaps merely reduced as in* Phloeomys); *infraorbital foramen not transmitting muscle; cheekteeth brachydont or subhyposodont, their structure essentially as in the less modified Sciuridae.*

Family PARAMYIDAE

Rostrum and braincase approximately equal in width, infraorbital foramen very small, not visible in lateral view of the skull; cheekteeth $\frac{5}{4}$, the upper molars obviously and simply tritubercular in general plan, the hypocone, when present, appearing as a supplement to the original structure of the tooth.

Paramys, *Mysops*, *Prosciurus*, and related genera; North American Lower Eocene to Middle Oligocene.

B.—*Skull and teeth as in the Paramyids except that the auditory bullae are well developed, the infraorbital foramen is enlarged to transmit a small strand of muscle, and the cheekteeth are flattened.*

Family GRAPHIURIDAE

Cheekteeth $\frac{4}{4}$, brachydont, crowns wider than long, basin-shaped with small tubercles and low ridges (parallel: *Muscardinidae*); skull with no special peculiarities, the braincase much wider than rostrum; auditory bullae globular; external form muscardinine.

Graphiurus; Recent; Africa.

C.—*Skull fossorial (except perhaps in the Allomyidae); infraorbital foramen not transmitting muscle; auditory bullae well-developed; cheekteeth brachydont, hypsodont, or ever-growing; modification of crowns based on a structure including well developed protoconule and metaconule, and conspicuously trenchant outer commissures.*

Family ALLOMYIDAE

Cheekteeth $\frac{5}{4}$, brachydont or moderately hypsodont, the tritubercular structure of upper teeth evident in unworn crowns; protoconule and metaconule large; functional cusps in m^1 and m^2; mesostyle appearing in hypsodont forms as a conspicuous median rib on outer surface of crown (parallel: *Pseudosciuridae*).

Allomys, *Haplomys*,[5] *Meniscomys*, *Mylagaulodon;* North American Upper Oligocene and Miocene.

Family APLODONTIIDAE

Like the *Allomyidae* but the skull greatly widened posteriorly, the auditory bullae flask-shaped with neck directed horizontally outward; cheekteeth growing from persistent pulp, the unworn caps showing evident pattern of the *Allomys*-type, this soon wearing away and leaving a simple enamel ring; paramere with conspicuous vertical ridge.

Aplodontia; Pleistocene and Recent; *Liodontia*,[6] Miocene; western North America.

Family CYLINDRODONTIDAE

Skull fossorial with braincase slightly wider than rostrum; cheekteeth $\frac{4}{4}$, subterete, excessively hypsodont but not growing from persistent pulp, the enamel pattern in considerably worn upper teeth consisting of an outer ring and a central lake.

Cylindrodon; North American Lower Oligocene. Position of group doubtful.

[5] New genus, type *Meniscomys liolophus* Cope.

[6] New genus, type *Aplodontia alexandrae* Furlong.

FOUR-CUSPED SERIES

Modifications of teeth based on an underlying quadritubercular structure, the hypocone always entering into the essential mechanical scheme of the crown.

A.—*Skull not specially modified; upper molars with large protoconule and metaconule, and conspicuously trenchant outer commissures, their structure paralleling that of the Allomyidae in the three-cusped series.*

Family Pseudosciuridae

Skull essentially as in the *Sciuravidae* but with larger infraorbital foramen which may have transmitted a strand of muscle.
Pseudosciurus; European Oligocene.

B.—*Skull excessively fossorial; occipital region obliquely truncate, with lambdoid crest moved forward nearly to level of zygomatic root; frontal with short postorbital process; bony horn-cores present on rostrum in two genera, absent in a third; cheekteeth highly modified from a normal heptamerous structure, the grinding function of toothrow in adult almost completely taken over by the greatly enlarged fourth premolar.*

Family Mylagaulidae

General structure of skull much as in the *Aplodontiidae;* cheekteeth $\frac{4}{4}$ or $\frac{2}{3}$; a reduced-heptamerous pattern evident in slightly worn crowns, but this giving place with wear to a system of narrow longitudinal and oblique lakes; molars relatively small, soon crowded out by the premolar, an excessively hypsodont, laterally compressed tooth, closed at the base, and rapidly increasing in crown length from the unworn surface downward. Skeleton highly modified for underground life.
Mylagaulus, Ceratogaulus, and *Epigaulus;* North American Miocene and Pliocene.

C.—*Skull without special peculiarities; infraorbital foramen moderate or very large, transmitting both muscle and nerve; cheekteeth subhypsodont or brachydont, their modifications based on a heptamerous structure in which the ridges are narrow and the reentrant spaces wide* (*parallels:* Funisciurus, *Erethizontidae*); *external form glirine or pteromyine; under side of tail with scaly outgrowths near base.*

Family Anomaluridae

Skull with moderate infraorbital foramen; lower zygomatic root at level immediately in front of anterior cheektooth; anterior point of masseteric insertion on mandible beneath hinder part of m_1; no discrepancy between size of incisors and molars; cheekteeth subhypsodont, their crowns flat, longer than wide; external form pteromyine.
Anomalurus; Recent; Africa.

Family Idiuridae

Like the *Anomaluridae* but skull with infraorbital foramen greatly enlarged, the lower zygomatic root nearer to incisor than to anterior cheektooth; anterior point of masseteric insertion on mandible in front of pm^4; incisors excessively heavy; cheekteeth weak, extremely brachydont, their crowns flat, wider than long.

Subfamily *Idiurinae.*—Flying membrane present; cheekteeth with two complete median transverse ridges.
Idiurus; Recent; Africa.

Subfamily *Zenkerellinae*—Flying-membrane absent; cheekteeth with one complete median transverse ridge.
Zenkerella; Recent; Africa.

D.—*Skull without striking peculiarities other than a tendency to assume a form characterized by broad braincase, large auditory parts, and weak rostrum (parallels; Gerbillinae, Octodontinae); infraorbital foramen transmitting muscle in all members of the group in which the skull is known except probably* Sciuravus; *cheekteeth varying from brachydont to evergrowing, their modifications based on a heptamerous structure in which the ridges are wide and the reentrant spaces narrow.*

Family Sciuravidae

Infraorbital foramen small, but visible in lateral view of skull, probably transmitting nerve only; cheekteeth $\frac{5}{4}$, brachydont; the structure of the upper molars obviously and simply quadritubercular.
Sciuravus; North American Middle Eocene.

Family Zapodidae

Infraorbital foramen large, transmitting muscle as well as nerve; cheekteeth varying in number from $\frac{4}{4}$ in the earlier members of the group to $\frac{3}{3}$ in the most advanced; the quadritubercular crown structure usually though not always much modified; metatarsals not reduced or fused.

Subfamily *Theridomyinae.*—The earlier, less modified members of the family: pm^4 a large, functional tooth; crowns of cheekteeth varying from brachydont and simply quadritubercular (*Sciuroides*) to hypsodont and much reduced heptamerous (*Issiodoromys;* parallel: *Eocardia*).
The *Theridomyidae* of authors; European Lower Eocene to Miocene.

Subfamily *Sicistinae.*—Cheekteeth brachydont, $\frac{4}{3}$, distinctly quadritubercculate, the enamel of moderately worn upper molars with a simple heptamerous pattern; external form murine, the hind legs and feet not lengthened.
Sicista, Recent, Eurasia; *? Eomys,* European Upper Eocene.

Subfamily *Zapodinae*.—Cheekteeth subhypsodont, $\frac{4}{3}$ or $\frac{3}{3}$, flat crowned, the enamel pattern of the upper molars heptamerous, slightly or considerably modified; external form saltatorial, the hind legs and feet lengthened.
Eozapus, Recent, China; *Zapus*, *Napaeozapus*, Pleistocene and Recent, North America.

Family DIPODIDAE

Like the *Zapodidae* but with the inner and outer metatarsals reduced or absent and the three median fused to form a canon bone; cheekteeth hypsodont, the heptamerous enamel pattern undergoing modifications most of which are parallel to those taking place in the teeth of the *Cricetidae* and in the hystricine families.

Subfamily *Protoptychinae*.—Upper cheekteeth 4, moderately hypsodont; pm^4 a large, functional tooth; skull with relatively broad rostrum and narrow braincase.
Protoptychus;[7] North American Upper Eocene.

Subfamily *Dipodinae*.—Cheekteeth $\frac{4}{3}$ or $\frac{3}{3}$, strongly hypsodont; pm^4 vestigial; skull with relatively narrow rostrum and broad braincase.
The *Dipodidae* of authors who recognize the *Zapodidae* as a distinct family; Pleistocene and Recent; Eurasia and northern Africa.

Family CTENODACTYLIDAE

Cheekteeth growing from a persistent pulp, the adult pattern reduced to a simple ring infolded on one or both sides (parallel: *Octodontinae*); external form fossorial.
Ctenodactylus and related genera from the Mediterranean region; Pliocene to Recent.

Family PEDETIDAE

Cheekteeth subterete, growing from a persistent pulp; all trace of the original crown structure lost, the unworn enamel cap transversely cleft, the adult pattern consisting of a narrow median infold from the paramere extending nearly across to opposite side; external form conspicuously saltatorial, but median metatarsals showing no tendency to become reduced or fused.
Pedetes; Recent; Africa.

Superfamily BATHYERGOIDAE

Zygomasseteric structure as in the *Dipodoidae* except: Angular portion of mandible distorted outward to allow passage of a specialized and

[7] While *Protoptychus* is a true dipodid with few primitive characters its exact position is not clear. It may prove to be a member of the *Theridomyinae*; but for the present we prefer to place it in the *Dipodidae* on account of its resemblance to the recent genus *Euchoreutes*.

enlarged distal anterior limb of the masseter lateralis superficialis, its general direction parallel with zygoma. Masseter medialis arising from upper margin of orbit and not passing through small infraorbital foramen.

Family Bathyergidae

Skull and external form with conspicuous fossorial adaptations. Cheekteeth extremely hypsodont, though not ever-growing; enamel pattern in adult a ring with or without a reentrant fold on one or each side (parallel: *Octodontinae*); number of cheekteeth ranging from $\frac{2}{2}$ to $\frac{6}{6}$. (In the genus, *Heliophobius*, with the greatest number of teeth there are never more than $\frac{5}{4}$ functional at one time; the apparent addition of one tooth in the upper jaw and two in the lower jaw to the maximum rodent formula is probably due to a specialized condition of the milk dentition.)

The *Bathyergidae* of authors; Recent; Africa.

Superfamily HYSTRICOIDAE

Zygomasseteric structure as in the *Bathyergoidae* except: Masseter medialis arising from side of rostrum and passing through large infraorbital foramen.

LATERALIS SERIES

Masseter lateralis the chief agent in modifying form of outer side of mandible; an oblique ridge extending forward from lower border of angular process usually present for attachment of this muscle.

A.—*Lachrymal bone small, forming no important part of zygomatic root, its lower portion confined within orbit; lachyrmal canal closed in front of orbit.*

Family Hystricidae

Skull with no special peculiarities other than a tendency (most pronounced in the genus *Hystrix*) to inflation of the rostral and frontal regions; mandibular rami rather freely movable at symphysis; angular process deep, neither produced backward conspicuously behind articular level nor folded inward along lower margin; cheekteeth $\frac{4}{4}$, their enamel pattern slightly removed from the simple heptamerous type, the reentrant folds narrow and not angular.

Old World porcupines; Upper Miocene to Recent.

Subfamily *Hystricinae*.—Base of upper zygomatic root over a point decidedly behind the anterior extremity of toothrow; cheekteeth strongly hypsodont, closed at base but without definite roots; sacral vertebrae 4.

Hystrix, Acanthion, Thecurus; Africa, southern Asia, and Malay region.

Subfamily *Atherurinae*.—Base of upper zygomatic root over anterior extremity of toothrow; cheekteeth subhypsodont, with well developed roots; sacral vertebrae 3.

Atherurus, Trichys; Recent; Malay region.

Family ERETHIZONTIDAE

Like the *Hystricidae* but: Mandibular rami with conspicuous postsymphyseal buttresses which prevent movement at the symphysis; lower border of angular process folded inward; cheekteeth subhypsodont, flat crowned, with reduced-heptamerous enamel pattern characterized by narrow ridges and wide reentrant spaces, the spaces on the paramere tending to become transformed into pits (parallels: *Funisciurus, Anomaluridae*). Upper zygomatic root over anterior part of toothrow; feet noticeably modified for arboreal life.

New World porcupines except *Chaetomys:* Oligocene to Recent. Oligocene of Egypt?[8] Extinct South American genera: *Asteromys, Eosteiromys, Parasteiromys, Steiromys.*

Family ECHIMYIDAE

Like the *Erethizontidae* but lower border of angular process usually with no evident infolding, feet usually not modified for arboreal life, and adult cheekteeth with narrow reentrant folds; cheekteeth varying from brachydont to ever-growing, the structure when hypsodont not multilaminar.

Subfamily *Echimyinae*.—Fossorial specialization usually absent; skull and cheekteeth showing great variety of form; enamel pattern not simplified to a ring with an infold on one or each side.

Tropical America; Miocene to Recent. Spiny-rats (provisionally including *Chaetomys*), Hutias (*Capromys, Plagiodontia*), etc.; also many extinct genera, among them *Acaremys, Boromys, Brotomys, Colpostemma, Eocardia* (parallel: *Issiodoromys*), *Eoctodon, Graphimys, Gyrignophus, Haplostropha, Heteropsomys, Homopsomys, Isolobodon, Prospaniomys, Protadelphomys, Protacaremys, Sciamys, Scleromys, Spaniomys, Stichomys, Strophostephanus, Tribodon.* It is probable that this group needs subdividing.

Subfamily *Octodontinae*.—Fossorial specialization usually present; cheekteeth, except in earliest known genera, with enamel pattern completely simplified to a ring with an infold on one or each side (parallel: *Ctenodactylidae*).

South America; Oligocene to Recent. Recent genera: *Ctenomys, Octodon, Octodontomys, Spalacopus.* Among the fossil genera are: *Cephalomys, Dicoelophorus, Eucoelophorus, Litodontomys, Neophanomys, Palaeoctodon, Phtoramys, Pithanotomys, Plataëomys, Scotomys.*

[8] The genera *Phiomys* and *Metaphiomys*, based on lower jaws and teeth, have no characters by which they can at present be referred to any other family.

Family Petromyidae

In general resembling the *Octodontinae* but crown of each cheektooth margined by two elevations on the protomere, these elevations probably resulting from the unusual obliquity at which the teeth appear to be set. The teeth are rooted, strongly hypsodont; the enamel pattern consists of two transverse lobes united by a median isthmus, the outer edges of the lobes becoming joined in the upper teeth when worn. No specimens examined.[9] Recognized as a family by Tullberg, partly on whose authority we continue to treat it as distinct. The characters of the teeth indicate important mechanical peculiarities of the chewing apparatus. The enamel pattern appears to be of a type which could be directly derived from that present in the relatively low-crowned molars of *Erethizon* and the Oligocene African *Phiomys*.

Petromys, South Africa: Recent.

Family Myocastoridae

In general like the *Erethizontidae* but upper zygomatic root over middle of toothrow, and cheekteeth with structure paralleling that present in *Castor;* lateral process of paroccipital large, projecting freely above base of greatly elongated paroccipital process; in living species external form modified for aquatic life.

Myocastor and related fossil genera; South America; Miocene to Recent.

Family Thryonomyidae

Like the *Myocastoridae* but cheekteeth with structure paralleling that present in some of the *Echimyinae,* and lateral process of paroccipital small, closely applied to base of moderately large paroccipital process; external form not modified for aquatic life.

Thryonomys; Africa; Recent.

Family Dinomyidae

Like the *Echimyidae* but cheekteeth combining a multilaminar structure with excessive hyposodonty (parallel: *Castoroides*); so far as known the external form is robust, terrestrial.

South America and the Greater Antilles; Miocene to Recent. Includes the living *Dinomys* and the extinct genera *Amblyrhiza, Briaromys, Discolomys, Elasmodontomys, Gyriabrus, Megamys, Neoepiblema, Olenopsis, Potamarchus, Tetrastylus.*

Family Cuniculidae

Not essentially different from the *Dinomyidae*, but the jugal and part of the maxillary are expanded to form a conspicuous cheekplate, the surface of this becoming excessively rugose in adult; cheekteeth strongly

[9] Mr. Oldfield Thomas has kindly sent us photographs of a skull in the British Museum (No. 4.2.3.98).

hypsodont, but enamel structure not completely multilaminar; external form robust, terrestrial.

Cuniculus (="*Coelogenys*"); Tropical America; Pleistocene and Recent.

Family Heptaxodontidae

First tooth of maxillary series mechanically dominant, cheekteeth apparently reduced to $\frac{2}{2}$, conditions not known elsewhere in the *Hystricoidae*, and indicating zygomasseteric development along a line different from that followed elsewhere in the group; enamel structure multilaminar with reduplication in the anterior tooth; diagnostic cranial characters unknown.

Heptaxodon; Porto Rico; Pleistocene? The genus *Morenia* from the South American Miocene may be a second member of the family; it is at present known from isolated teeth only.

B.—*Lachrymal bone large, usually forming an important part of zygomatic root, its lower portion extending forward out of orbit to a level in front of anterior margin of infraorbital foramen; some part of lachrymal canal open on side of rostrum in front of orbit.*

Family Dasyproctidae

Skull generalized in structure, closely resembling that of the less specialized *Hystricidae;* cheekteeth hypsodont but with a nearly unmodified heptamerous structure, paralleling that in the *Hystricidae;* external form cursorial, the legs lengthened, the digits 5–3.[10]

The *Dasyproctidae* of authors with *Cuniculus* removed and *Neoreomys* added; South and Middle America; Miocene to Recent.

Family Chinchillidae

Cheekteeth with heptamerous structure excessively modified, the enamel pattern consisting of parallel transverse laminae (parallel: *Dinomyidae*); mandible with no sharply defined ridge for attachment of masseter lateralis; external form saltatorial.

South America; Miocene to Recent. Living genera: *Chinchilla, Lagostomus, Viscaccia.* Extinct genera: *Euphilus, Perimys, Pliolagostomus, Prolagostomus, Scotaëumys, Sphaeromys.*

Family Abrocomidae

Like the *Chinchillidae* but cheekteeth with deep reentrant angles on both sides, and mandible with sharply defined ridge for attachment of masseter lateralis; external form not saltatorial.

Abrocoma; South America; Pliocene to Recent.

[10] The feet of *Neoreomys* are imperfectly known, but there appears to be nothing in the structure of the parts which have been described that indicates the presence of more than three digits in the hind foot.

MEDIALIS SERIES

Masseter medialis the chief agent in modifying form of outer side of mandible; a conspicuous horizontal ridge for the attachment of this muscle present on side of mandible slightly below alveolar level.

Family Caviidae

Posterior cheektooth both above and below without reduplication of elements, the general character of the toothrow normal.

The *Caviidae* of authors with *Hydrochoerus* and its allies removed; South America; Miocene to Recent. Extinct genera: *Anchimys, Neoprocavia, Orthomyctera, Palaeocavia, Phugatherium, Procardiotherium.*

Family Hydrochoeridae

Posterior cheektooth both above and below with conspicuous reduplication of elements, the general character of the toothrow thus rendered abnormal.

Hydrochoerus and its extinct allies *Plexochoerus, Prohydrochoerus* and *Protohydrochoerus;* perhaps *Cardiomys, Caviodon* (=*Diocartherium*) and *Cardiotherium* also; South America, Miocene to Recent; southeastern United States, Pleistocene.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEOGRAPHY.—*Geography of the world's agriculture.* V. C. Finch and O. E. Baker, Office of Farm Management. Pp. 149, including 206 text figures and 2 inserted colored maps. "1917" [April, 1918].

This contribution from the Office of Farm Management is an elaboration of an article by the same authors in the 1916 Yearbook of the Department of Agriculture, and a sort of forerunner of the Atlas of American Agriculture now in preparation by the Office of Farm Management under the immediate direction of Mr. Baker.

Maps in black and white, with the acreage and production of all the more important crops of the world indicated by dots, occupy over half the space, and in addition there are many instructive graphs. The maps of the United States and Europe are naturally more detailed than those of other parts of the world, where statistics are not gathered so systematically. One of the colored maps shows land relief and the other mean annual precipitation for the whole world exclusive of the polar regions; and by comparing the crop maps with these many more or less striking correlations of crops with altitude and moisture can be made out. Our knowledge of soil conditions is as yet far too fragmentary to warrant the preparation of a soil map of the world, but numerous correlations between crops and soils are pointed out in the text.

It is impracticable to go further into details here, but this atlas, or album, probably brings out the salient features of the world's agriculture at the beginning of the great world war better than any other publication, and it will be an indispensable reference book for students of economic geography and all persons interested in the relation of geographic conditions to the distribution of crops and live stock throughout the world.

R. M. Harper.

GEOLOGY.—*Possibilities for manganese ore on certain undeveloped tracts in Shenandoah Valley, Virginia.* D. F. Hewett, G. W. Stose, F. J. Katz, and H. D. Miser. U. S. Geological Survey Bulletin 660-J. Pp. 26, with maps, and sections. 1918.

Most of the manganese deposits occur in banded clays that are believed to have been derived by weathering in place from the lower 200 feet of the Shady dolomite which rests on the Erwin quartzite. In most places the local structure of the adjacent rocks has determined the form of the deposits and in large measure their areal extent and their persistence below the surface. The tracts that are considered favorable for the occurrence of manganese or manganiferous iron ore are underlain by troughs of the upper beds of the Erwin quartzite, from the surface of which the products of decay of the overlying Shady dolomite have not been removed.

The manganese seems to have been originally widely disseminated as carbonate in the limestone and dolomite in the neighborhood of the deposits. It was dissolved as bicarbonate and transported along established channels of circulation to the places where the oxides are now found. The oxides were probably deposited when and where the solutions containing manganese bicarbonate met oxygen-bearing waters. According to the hypothesis structural troughs were the most favorable channels for circulation, and if suitable conditions for oxidation and deposition existed they should be the most favorable places for accumulation.

Six undeveloped tracts along the west front of the Blue Ridge are described in which prospecting with a view to the discovery of manganese deposits is recommended.

R. W. Stone.

GEOLOGY.—*Manganese at Butte, Montana.* J. T. Pardee. U. S. Geol. Survey Bull. 690-E. Pp. 20. 1918.

Rhodochrosite, rhodonite, and manganese oxides are abundant at Butte. Rather curiously, manganese minerals are scarce in the veins that yield copper ore, but in a peripheral zone commonly known as the silver area, manganese minerals are plentiful. The width of the zone in which the veins are strongly manganiferous ranges from 1 to 2 miles approximately, being greatest toward the west.

About half of the manganiferous zone lies north of the copper area and east of the rhyolite. Though manganese is widely distributed in all parts of the zone, it appears to be relatively most abundant in the southwestern section. It occurs abundantly as deep as the workings have gone, though it seems to be less plentiful in the deeper parts of the veins.

Owing to the absence of silica and to the ease with which the carbonate can be changed to an oxide, simple calcination being sufficient to drive off the carbon dioxide, and to the comparative difficulty experienced in decomposing the silicate, the rhodochrosite is by far the more valuable as a source of the metal. Fairly pure rhodochrosite occurs in several places.

A reserve of not more than 2600 tons, as estimated, contains 40 per cent or more manganese, and but little more than one-third of this amount runs less than 10 per cent silica. In addition fairly detailed estimates show totals of about 132,000 tons of material averaging 24 per cent manganese and 50 per cent silica and 270,000 tons averaging 11.5 per cent manganese and 73 per cent silica. Tests of the richer of these two grades so far reported by the mining companies, though not wholly satisfactory, by no means discourage the hope that it can be profitably concentrated.

R. W. Stone.

GEOLOGY.—*The coal fields of the United States. The coal fields of Ohio.* J. A. Bownocker, State Geologist. *With a computation of the original coal content of the fields.* F. R. Clark. U. S. Geol. Survey Prof. Paper 100–B. Pp. 62, with maps and sections. 1917.

A description of the occurrence, composition, and uses of Ohio coals, with a bibliography; includes also an estimate of the original coal content of the Ohio fields. The principal part of the tonnage is contained in seven coal beds. It is estimated that the total original tonnage of all beds in all counties was 87,638,000,000 short tons, and that after deducting the quantity mined and wasted in mining, there remains available 86,552,000,000 short tons.

R. W. Stone.

GEOLOGY.—*Geology and paleontology of the Raton Mesa and other regions in Colorado and New Mexico.* Willis T. Lee and F. H. Knowlton. U. S. Geol. Survey Prof. Paper 101. Pp. 450. 1917.

The principal conclusions arrived at in this report are as follows:

The coal-bearing rocks of the Raton Mesa region, which have formerly been referred to the Laramie, constitute two distinct formations, separated in time by a period of erosion.

The lower formation, to which the name Vermejo is here applied, contains a Montana flora. It is distinct from the Laramie flora of the Denver Basin, and proves that the Vermejo formation is older than Laramie, and that it is more closely related to the Mesaverde of western New Mexico than to any other formation yet examined.

The coal-bearing rocks of the Canon City field are correlated by lithology, stratigraphic position, and fossil plants with the Vermejo of the Raton Mesa region and are designated by the same name. The character of the invertebrates found in the Vermejo of the Canon City field in the midst of the plant-bearing beds suggests that this formation is approximately equivalent in age to the Fox Hills of the Denver Basin.

The upper formation of the Raton Mesa region, to which the name Raton is here applied, is Eocene in age and contains a flora distinct from that of the Laramie of the Denver Basin but similar to that of the post-Laramie formations of that basin and to that of the Eocene Wilcox group of the Gulf Coast.

The unconformity between the Vermejo and Raton formations represents a time interval comparable to that described as separating the Laramie from the Arapahoe of the Denver Basin. Separating, as it does, the youngest Cretaceous of the region from the oldest Eocene, it represents post-Cretaceous erosion and is correlated with the post-Laramie unconformity of the Denver Basin.

Lee's discussion of the geology of Raton Mesa is followed by Knowlton's description of the fossil flora of the Vermejo and Raton formations. The flora is abundantly figured and some of the illustrations are exceptionally large. That the age of the Vermejo formation is Cretaceous is established by its stratigraphic position, its invertebrate fossils, and especially by its plants, which correlate it with the Montana in the approximate position of the Mesaverde formation. The Vermejo is terminated by an unconformity, and so far as is at present known only 4 of the 108 Vermejo species pass over the unconformity and are found in the Raton formation.

The Raton formation is to be correlated with the Wilcox, and probably with the Midway formation of the Gulf region. The Tertiary age of the Midway and Wilcox formations is not questioned. On the basis of the plants the Raton formation is also correlated with the Arapahoe and the Denver formations of the Denver Basin; and the latter is now known to be correlated with, and in fact to be practically continuous with, the Dawson arkose. The conclusion is reached that all these formations are Tertiary (Eocene) in age.

R. W. Stone.

GEOLOGY.—*The Lake Clark-Central Kuskokwim region, Alaska.* Philip S. Smith. U. S. Geol. Survey Bull. 655. Pp. 162, with maps and illustrations. 1917.

This report describes the areal geology of the Lake Clark-Central Kuskokwim region, Alaska. The region is in southwestern Alaska and extends from the Pacific Mountains to the central part of the Yukon Plateau province. The rocks are dominantly sedimentary strata of Mesozoic age, but some Paleozoic limestones are also exposed. Igneous rocks both of intrusive and effusive origin occur at a number of places and certain of them seem to be closely associated with deposits of commercial value, such as gold and quicksilver. Unconsolidated deposits are widespread and throughout much of the region mantle the underlying bedrock. These deposits are mainly of glacial and glacio-fluviatile origin, though lacustrine, fluviatile, and volcanic ash deposits occur also.

P. S. S.

GEOLOGY.—*The structural and ornamental stones of Minnesota.* Oliver Bowles. U. S Geol. Survey Bull. 663. Pp. 225, with maps and illustrations. 1918.

In this bulletin the history of the industry is summarized, the rocks of Minnesota and their constituent minerals are described, and an outline of the geologic history is given. A brief account of the properties essential to the usefulness of stones is followed by a general discussion of the crystalline rocks of Minnesota. Detailed descriptions of the quarries, of their products, mode of operation, equipment, ownership, and means of transportation, form the main body of the report. The stones quarried are granite, gabbro, diabase, limestone, marble, sandstone, and quartzite. As a guide for prospective operators undeveloped outcrops as well as quarries are described.

R. W. Stone.

GEOLOGY.—*A geologic reconnaissance of the Uinta Mountains, northern Utah, with special reference to phosphate.* Alfred R. Schultz. U. S. Geol. Survey Bull. 690-C. Pp. 64, with maps. 1918.

The rocks in the Uinta Mountain region range in age from pre-Cambrian to Quaternary, inclusive. The Park City formation, in which the phosphate deposits occur, and the formations immediately underlying and overlying it are described so that the phosphate-bearing beds and the rocks associated with them may be compared with the phosphate-bearing beds of other localities in the Rocky Mountain region.

The structure of the Uinta uplift, considered as a whole, is comparatively simple. On closer study, however, the long, narrow, flat-topped east-west fold which is here called the Uinta anticline is found to be much more complex and to consist of numerous secondary anticlines and synclines, some parallel to the main axis and others at right angles to it. There are also numerous low cross folds along the flanks of the major fold, expressed in undulations, local sags, and irregularities along both sides of the range. The anticlinal fold is further complicated by many normal faults and some thrust faults, both parallel and transverse to the strike of the beds. The major structural feature of the Uinta Mountains, however, consists of a huge east-west anticlinal arch approximately 100 miles long, and from 35 to 50 miles in width. This huge arch, which consists of rocks ranging in age from pre-Cambrian to Tertiary, separates the Green River Basin on the north from the Uinta Basin on the south.

The distribution of the phosphate beds and the Park City formation, which contains them and which is equivalent to the Phosphoria formation and the upper part of the Wells formation of eastern Idaho in the Bear Lake region, is shown by a map.

The analyses show considerable variation, but they indicate the presence of some high-grade rock that carries approximately the equivalent of 70 per cent of tricalcium phosphate.

No detailed work upon which to base a reliable estimate of tonnage has been done in this field. It is apparent, however, from the reconnaissance examination that a large amount of phosphate is present.

R. W. Stone.

GEOLOGY.—*The gold placers of the Tolovana district, Alaska.* J. B. Mertie, Jr. U. S. Geol. Survey Bull. 662–D. Pp. 221–277, with maps and illustrations. 1917.

The Tolovana district lies in the northwestern part of the Fairbanks quadrangle, in the headwater region of Tolovana River and Hess Creek. The report describes the gold placers of Livengood Creek and near-by streams and the geology and mineral resources of the surrounding territory, designated the Tolovana district. Much emphasis is placed on topographic anomalies in the form of extensive changes in drainage, and on Quaternary deposits and their history, all of which is intimately related to the distribution of the gold. The origin of the gold in its bedrock sources in the vicinity of Livengood Creek is related to the intrusion of siliceous igneous rocks, with the subsequent escape of mineralizing solutions therefrom.

The means and cost of obtaining supplies and the availability of wood, water, and game are mentioned.

R. W. STONE.

GEOLOGY.—*The geology and ore deposits of Ely, Nevada.* ARTHUR C. SPENCER. U. S. Geol. Survey Prof. Paper 96. Pp. 189. 1917.

The great bulk of the rocks of the Ely quadrangle are limestones, quartzites, and shales, which range in age from Ordovician to Carboniferous and which have an aggregate thickness of more than 9000 feet. The sedimentary rocks have been classed under eight formations. They have been greatly disturbed by folding and especially by faulting, so that their areal distribution is very irregular. The six uppermost of the eight formations have been invaded in one place or another by masses of monzonite porphyry.

The igneous rocks of the district include an older set of monzonite porphyry intrusions and a younger set of tuffs, obsidians, and rhyolites. The monzonitic rocks are of particular interest because the genesis of the metallic ores of the district is closely connected with their geologic history. The conclusion is presented that all the coarse-grained intrusive rocks are to be referred to a single epoch of igneous activity, and it is shown that present differences in composition are due in the main to the more or less intense metamorphism which in many places the rocks have suffered.

Two kinds of metamorphism are distinguished. Under igneous metamorphism are included all those alterations that attended or followed the invasion of the sedimentary formations by the magma that eventually crystallized as monzonite porphyry. These alterations have affected the invaded limestones and shales and also the igneous rocks themselves. To this metamorphism is to be attributed the formation of the primary metalliferous deposits of the district. The second kind—atmospheric metamorphism—includes weathering, or decomposition and leaching by oxidizing surface waters, and cementation, or changes involving the deposition of material taken into solution during the process of weathering.

The enriched copper ores of the district have been formed as a result of atmospheric metamorphism. By considering the amount of oxygen that water can absorb by contact with the air under atmospheric pressure at 7000 feet elevation and at the present mean annual temperature of the region, it is found that, even if precipitation in the past has been 25 per cent greater than at present, and that as much as 60 per cent of the rainfall could have penetrated to the ore body, the oxygen required to oxidize 500 feet of ore like that now existing would require the contributions of rainfall during a period longer than physicists and geologists are willing to allow for the entire age of the earth. It is thought, therefore, that a large part of the oxygen must have been derived from air that circulated through the oxidized capping.

A theoretical discussion of the chemical reactions involved in the alterations of the rocks and in the deposition of metallic sulphides in them is presented. The conclusion is reached that if the solutions were originally acidic the metallic minerals were probably deposited only after an alkaline or neutral condition had been attained.

R. W. Stone.

TECHNOLOGY.—*Materials for the household.* Bur. Stand. Circ. No. 70. Pp. 259. Dec. 5, 1917.

This circular describes the more common materials used by the household, comprising paint materials, cement, clay products, lime, plasters and stucco, wood, metals, bituminous roofing, inks and dyes, adhesives, paper, textiles, rubber, leather, cleansers and preservatives, fuels, illuminants, and lubricants, and concludes with a chapter on quantity in the purchasing of materials. Each title is treated under the general heads of composition and definition, sources, properties, uses, tests, preservation, hints as to selection and use, and references.

TECHNOLOGY.—*Gas mantle lighting conditions in ten large cities in the United States.* R. S. McBride and C. E. Reinicker. Bur. Stand. Tech. Paper No. 99. Pp. 37. October 29, 1917.

From a careful inspection of about 4500 gas mantle lamps in service in ten cities, a summary of the condition of mantles, glassware, pilot light, and other particulars was made in order to determine to what extent the customer benefited through periodic maintenance service.

By these observations it is found that a lamp not on regular maintenance is likely to be defective five and one-half times as frequently as a lamp which is regularly maintained. Also it is shown that on the average 1 in 3 of the lamps on regular maintenance was not in good condition whereas the defects noticed in the lamps not so maintained average more than one for every lamp.

The principal defects in maintenance systems were also investigated and one satisfactory system of estimating the expenses for maintenance work together with a set of unit costs is presented, based upon the analysis of the operation of ten gas companies. A suggested table of costs for each type of unit is given. C. E. R.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on June 8, 1918. The President was authorized to appoint Associate Editors for the JOURNAL, on the recommendation of the Board of Editors; the Associate Editors to be selected so as to represent informally the societies that publish proceedings in the JOURNAL. The following Associate Editors have been appointed: J. R. SWANTON, Anthropological Society; N. HOLLISTER, Biological Society; J. B. NORTON, Botanical Society; R. B. SOSMAN, Chemical Society; SIDNEY PAIGE, Geological Society; F. B. SILSBEE, Philosophical Society.

ROBERT B. SOSMAN, *Corresponding Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

The 129th regular meeting of the Society was held at the Cosmos Club at 8 p.m., Tuesday, May 7, 1918; 31 members and 3 guests present. Prof. A. S. HITCHCOCK presided. The following scientific program was given.

WILLIAM A. DAYTON: *Collecting data on National Forest range plants.* For nine years past the Forest Service has conducted a study of the distribution, natural habits, and economic importance of its range flora. Approximately 35,000 plant specimens, representing about 4,800 species, have been collected on National Forests and Purchase Areas. Ecological and economic data have been furnished by the collectors of most of these specimens, and this material has been supplemented by much detailed data procured by grazing experts of the Service. The specimens have been identified by experts of the Bureau of Plant Industry. Economic notes are compiled in the Washington office and distributed among Forest officers. These data have application to many phases of range-management, e.g., intensive range-utilization especially with a view to minimum interference with the requirements of the important forage plants, and the utilization of each type at the time and by the class of stock to which it is best adapted; detection, eradication, fencing, etc. of poisonous-plant areas; natural range reseeding; studies in carrying capacity, plant indicators, plant succession, artificial reseeding, etc.

W. W. EGGLESTON: *Nathaniel Jarvis Wyeth and his influence on western botany, with a sketch of his return trip from Oregon in 1833.* Capt. N. J. Wyeth was born in Cambridge, Massachusetts, in 1802. His father was a Harvard graduate. Captain Wyeth received a business training, was one of the pioneers in the ice business, and an inventor of ice-cutting tools. Brought up in Cambridge, he seems to have taken advantage of his environment, as his letters and journals evidence. His interest in nature was fostered through friendship with Professor Thomas Nuttall of the Harvard Botanic Garden.

Through propaganda for the American colonization of Oregon, Wyeth's patriotic enthusiasm became so aroused that he joined the movement, but disagreeing with the leadership he organized the Pacific Trading Company, which started for Oregon in 1832 and after many discouragements reached Fort Vancouver, Washington, and disbanded.

The following spring Captain Wyeth accompanied the Hudson Bay Brigade to Camas Creek, Idaho, returning home with the Rocky Mountain Fur Company Brigade down the Yellowstone and the Missouri. On this spring trip Wyeth collected many new plants, from which Thomas Nuttall described two genera and fifty-four species. Captain Wyeth acquired such an interest in the country that he immediately planned a larger expedition. His friend Nuttall was induced to join. A stock company, the Columbia River Fishing and Trading Company was organized and an expedition of seventy men set out in the spring of 1834.

Financially this company failed and Wyeth closed the business, returning home in 1836. However, Captain Wyeth's second expedition took the first permanent American settlers to Oregon and blazed the trail for the great exodus to Oregon ten years later. As the result of this expedition J. K. Townsend collected and described many birds and animals. Nuttall described about eighty genera and seven hundred and fifty species of American plants.

V. K. Chesnut: *Papain from Carica Papaya grown in Florida.* Genuine papain of good quality is so rare a product in commerce that the trade, and even most chemists, have been unable to learn its eminent worth as a protein digestant, especially from the manufacturing standpoint. Inability to control the product was thought to be due to a lack of knowledge of the ferment as well as to the need of a method of assay which would exclude pepsin and other enzymes which have been, or may be, used as adulterants. Forty-eight samples representing the latex from every variety and condition of fruit available at the Foreign Seed and Plant Introduction Field Station at Miami were collected by the author and twenty other genuine samples were secured from Honolulu and elsewhere. These were subjected to extended investigation and it was found that the optimal H- ion concentration and field of activity were identical in the case of all the specimens. A method of examination was finally arrived at which enabled the author not only to determine the comparative strength of a commercial sample, but at the same time, to detect the presence of pepsin or other enzymic adulterants. Much of the value of the latex depends upon the stage of ripeness of the fruit and especially the methods used for drying and conservation. Since only 10 mg. are required for an assay, it is now possible for an investigator to study the fruit with a view toward the selection of the varieties best suited for the yield of papain of high quality. The product from Florida was found equal to that from Honolulu and very greatly superior to any found on the market.

H. N. VINALL, *Corresponding Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 314th meeting of the Society was held at the Cosmos Club, June 6, 1918, with 24 members and one visitor in attendance. President E. R. SASSCER presided.

The following were elected to membership: Lieut. L. H. DUNN, of the Army Medical School; Mr. J. E. GRAF, Mr. E. H. DURHAM, and Mr. G. F. MOZNETTE, of the Bureau of Entomology.

The regular program was as follows:

C. H. POPENOE: *Eradication and control of the sweet potato weevil.* This preliminary statement of the work being done for the eradication of this imported pest of sweet potatoes was not intended for publication. Mr. Popenoe gave a very interesting account of the habits, distribution, and food plants of the insect, and extent of damage caused by the pest (*Cylas formicarius* Fabr.)

C. A. MOSIER and T. E. SNYDER: *Notes on gadflies in the Florida Everglades.* Read by title.

J. R. MALLOCH: *Genus* Cnemedon *Egger in North America (Dipt.).* Read by title.

Lieut. L. H. DUNN: *A new mosquito* (Aedes whitmorei) *from Colombia.*

A. B. GAHAN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The solar eclipse of June 8, 1918, was viewed at Baker, Oregon, by a party from the Naval Observatory consisting of Astronomer J. C. HAMMOND, Assistant Astronomer GEORGE H. PETERS, Assistant C. C. WILEY, and Assistant W. A. CONRAD, together with the following invited scientists: Professors S. A. MITCHELL and L. G. HOXTON, of the University of Virginia, Dr. P. W. MERRILL, of the Bureau of Standards, Dr. MARY MURRAY HOPKINS and Miss HARRIET BIGELOW, of Smith College, Mr. EDWARD D. ADAMS amd Mr. KEMPTON ADAMS, of New York City.

Assistant Astronomer H. R. MORGAN and Assistant W. M. HAMILTON, of the Observatory, made observations at Denver, Colorado.

Special measurements were made by observers from the Weather Bureau during the solar eclipse of June 8, 1918. At Goldendale, Washington, were installed a Smithsonian pyranometer for measuring the intensity of both the direct solar radiation and the diffuse sky-radiation, and a pyrgeometer for measuring the intensity of the outgoing radiation. A program of meteorological observations, arranged by Professor H. H. KIMBALL and Mr. S. P. FERGUSSON, and including atmospheric pressure, temperature of the air, direction of the wind, clouds and shadow-bands, was carried out at about fifty-five stations, nearly all of which were west of the Mississippi and within the belt where the sun was 90 per cent eclipsed.

The various parties sent out by the Carnegie Department of Terrestrial Magnetism and the United States Coast and Geodetic Survey, have all reported securing successful series of magnetic observations during the time of the total solar eclipse of June 8. Magnetic observations were made by the Coast and Geodetic Survey at Green River, Wyo., Mena, Ark., and Orlando, Fla. In addition data will be obtained from the various magnetic observatories of the Coast and Geodetic Survey. The stations at which magnetic observations were made by the observers of the Department of Terrestrial Magnetism, were: Goldendale, Wash.; Corono, Colo., at an altitude of 12,000 feet; Moraine Lake, Colo.; Lakin, Kans.; Brewton, Ala.; and Washington, D. C. At Lakin, furthermore, and at Washington, D. C., atmospheric-electric observations were made. Reports on the results obtained will be published in the September issue of the journal *Terrestrial Magnetism and Atmospheric Electricity*. Data will likewise be furnished by the Canadian magnetic observatories and by various universities.

Superintendents of the experiment stations of the Bureau of Mines met in Washington on May 13–16, 1918. Those in attendance were: VAN H. MANNING, Director; L. H. DUSCHAK, Berkeley, Cal.; E. A. HOLBROOK, Urbana, Ill.; J. O. LEWIS, Bartlesville, Okla.; D. A. LYON, Washington; R. B. MOORE, Golden, Col; F. G. MOSES, Salt Lake City, Utah; EDMUND NEWTON, Minneapolis, Minn.; R. T. STULL, Columbus, Ohio; C. E. VAN BARNEVELD, Tucson, Ariz.; THOMAS VARLEY, Seattle, Wash.; A. E. WELLS, Salt Lake City, Utah.

A section on medicines and medical supplies has been added to the War Industries Board, with Lieut.-Col. F. F. SIMPSON as chief of the section. It will be closely coordinated with that section of the Chemical Division which deals with fine chemicals.

The authorized quota for the Chemical Service Section of the National Army has been increased to a total of over 1300.

The Bureau of Yards and Docks, Navy Department, has awarded a contract for the construction of a mine laboratory, to cost $73,000, at the Washington Navy Yard.

The Magnetic Survey Vessel, *Carnegie,* arrived safely at her home port, Washington, D. C., on June 10, where she will be put out of commission probably during the period of the war. During her cruise from Buenos Aires, Argentina, round the Horn to Valparaiso, Chile, Callao, Peru, thence through the Panama Canal to Newport News, she was in command of Dr. N. W. EDMONDS; the other members of the scientific staff aboard were: Messrs. A. D. Power, BRADLEY JONES, L. L. TANGUY, J. M. MCFADDEN, and WALTER E. SCOTT. On Sunday, June 23, she was visited by a number of the scientific men of Washington.

Prof. E. C. FRANKLIN, of Stanford University, California, Mr. WM. HOSKINS, of Chicago, Dr. WM. H. NICHOLS, of the General Chemical Company, Prof. T. W. RICHARDS, of Harvard University, Prof. H. P. TALBOT, of the Massachusetts Institute of Technology, and Prof. S. P. VENABLE, of the University of North Carolina, were in Washington in May in attendance upon the opening conference between the national advisory committee of the Experiment Station of the Bureau of Mines, and the members of the Bureau in charge of the work of the Experiment Station.

Maj. JAMES W. BAGLEY, of the Engineers Corps, National Army, formerly of the Geological Survey, has been assigned to duty at the office of the Chief of Engineers in Washington.

Mr. WILLIAM T. BRIGHAM, director of the Bishop Museum of Honolulu, Hawaii, was in Washington in June, in conference with scientists of various government bureaus.

Mr. E. J. Casselman, formerly engineer of tests of the Washington Steel and Ordnance Company, is assistant chemist with the Hygienic Laboratory for the Public Health Service.

Professor A. D. Cole, professor of physics at Ohio State University, is in Washington for the summer, engaged in research work at the Bureau of Standards.

Professor M. F. Coolbough, of the department of chemistry, Colorado School of Mines, is in Washington on leave of absence and is engaged in war work at the Bureau of Mines.

Dr. Arthur L. Day, director of the Geophysical Laboratory, received the honorary degree of Doctor of Science from Princeton University on June 15, 1918.

Professor Fred Dunlap, of the University of Missouri, formerly with the forest products section of the U. S. Forest Service, was in Washington in June arranging to do special work for the Service in the Mississippi Valley.

Mr. Roy Y. Ferner, associate physicist of the Bureau of Standards, resigned from the Bureau in June, and is now connected with the instrument purchasing section of the Shipping Board, in Philadelphia.

Professor E. C. Franklin, of the department of chemistry, Leland Stanford Junior University, and Professor William S. Franklin, of the department of physics, Massachusetts Institute of Technology, are in Washington for the summer, engaged in research work at the Bureau of Standards.

Mr. Owen B. French, formerly Assistant in the U. S. Coast and Geodetic Survey, has gone to Peking, China, to take the chair of Geodesy and Practical Astronomy in the Government Institute of Military Surveying. He sailed from San Francisco on March 16 and arrived in Peking on April 13, 1918, having spent a few days in Japan. He expects to remain in Peking for somewhat less than two years and will then return to Washington.

Dr. George Gaumer, botanist and ethnologist, of Yucatan, Mexico, was in Washington in May in conference with scientists of the National Museum.

Mr. William J. Hammer, consulting physicist and electrical engineer, of New York, has been commissioned a major in the National Army, and is assigned to duty in Washington with the newly organized Inventions Section of the General Staff.

Mr. John B. Henderson is at Barbados, British West Indies, with Prof. C. C. Nutting's zoological expedition from the University of Iowa.

Mr. Neil M. Judd, assistant curator of anthropology in the National Museum, has recently returned from explorations of the House Rock valley and the Pahreah and Wahalla plateaus, on the north rim of the Grand Canyon in northern Arizona. Several cliff dwellings and ruins were discovered. Since his return to Washington, Mr. Judd has enlisted in the aviation section of the Signal Corps.

Prof L. Komatsu, of the University of Kyoto, and Prof. K. Kitawaki and Dr. Shibusawa, of Tokyo, visited Washington in June.

Mr. E. S. Larsen, Jr., of the Geological Survey, has been examining the tungsten resources of the Western States.

Dr. H. M. Loomis, formerly of the Bureau of Chemistry, Department of Agriculture, has been made chief inspector, for the Food Administration, of the sardine canneries of Maine and Massachusetts.

Mr. Frank N. Meyer, of the office of foreign seed and plant introduction of the Bureau of Plant Industry, and agricultural explorer for the Department of Agriculture, met an accidental death in China on or about June 2, 1918, according to word received in Washington on June 18. He disappeared from a steamer on the Yangtze-Kiang and his body was discovered a week later. Mr. Meyer had been an explorer in China, Siberia, and Turkestan for about ten years past. He was a member of the Botanical Society of Washington, and author of many contributions to botanical and horticultural science, including the discovery of the origin of the chestnut-bark disease and the blight-resistant species of chestnut in China.

Prof. Samuel P. Mulliken, professor of organic chemistry at the Massachusetts Institute of Technology, has been commissioned a major in the Chemical Service Section, National Army.

Dr. James F. Norris, of the Bureau of Mines Experiment Station, and formerly professor of applied chemistry at the Massachusetts Institute of Technology, has been commissioned a lieutenant-colonel and is assigned to the embassy in London.

Dr. William Battle Phillips, consulting mining geologist, of Houston, Texas, and a nonresident member of the Academy, died on June 7, 1918, at the age of 61. Dr. Phillips had been connected during his lifetime with a wide variety of scientific and technical interests, having been on the faculties of the University of North Carolina and the University of Alabama; chemist of the Tennessee Coal and Iron Company; a member of the staff of several technical journals; director of the University of Texas Mining Survey; and president of the Colorado School of Mines. He was the author of nearly three hundred papers and reports on scientific and technical subjects.

Prof. C. A. Skinner, professor of physics at the University of Nebraska, has been on leave of absence since early this year, and is engaged in research at the Bureau of Standards.

Dr. William S. Thayer of Baltimore, a nonresident member of the Academy, is in France as Medical Director with the U. S. Expeditionary Forces. Dr. Thayer returned a few months ago from Russia with the American Red Cross Mission.

Dr. Harry W. Tyler, professor of mathematics at the Massachusetts Institute of Technology, is in Washington for the summer as a special agent in the federal employment service.

Dr. Ralph G. Van Name, of the department of chemistry, Yale University, came to Washington in June for war research at the American University Experiment Station of the Bureau of Mines.

Professor E. W. Washburn, of the department of ceramics, University of Illinois, is in Washington for the summer, engaged in chemical work for the National Research Council.

JOURNAL

OF THE

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Vol. VIII AUGUST 19, 1918 No. 14

ARTILLERY.—*The problem of anti-aircraft firing.*[1] X. Reille. Lieutenant Colonel, Chief of Artillery in the French Advisory Mission. (Communicated by L. J. Briggs.)

At the beginning of the war it was almost impossible to foresee what would be the development of aviation in the army and what developments in anti-aircraft artillery would of necessity follow. The object of artillery against aircraft is above everything else to prevent the enemy machines from fulfilling their mission of observation. Although there are those who seem to think that the present and future rôle of aviation consists mainly in dropping bombs, it must be said that this is a decided error. The principal rôle of aviation is not in the dropping of bombs but in observation.

The flying machine should be considered not so much one of the arms of the artillery as one of its eyes—and that eye the better one.

In fighting the enemy aircraft our guns fight the artillery of the enemy in its most vital part. The artilleryman who fires, or orders firing, against aircraft should never forget the importance of his rôle, which is to render the artillery of the enemy practically useless by blinding it.

At the outbreak of the war there were only a few types of anti-aircraft guns in our army, and as far as we know there was no special anti-aircraft gun in the German army. On both

[1] A lecture given before the Washington Academy of Sciences on April 18, 1918.

sides, the aircraft war was considered as a supplementary duty for the field matériel and this duty had to be fulfilled by whatever means could be improvised (burying the trail of the gun, etc.).

In proportion as the war developed, the invention and extension of a special anti-aircraft matériel have taken on greater and greater importance in the armies of the Allies as well as in the German army, and this in proportion to the importance taken by the means employed for aerial observation.

The object of this lecture is not to study the improvements made in anti-aircraft matériel but to follow in its different stages and up to the point where it is, today, the study of the general problems which anti-aircraft war has presented to the minds of artillerymen.

I

As long as the objectives of artillery were terrestrial targets the interest in the study of the trajectory seemed to be limited:

(*a*) To the initial part of the ascending branch (angle of elevation, angle of jump, angle of projection or departure, clearing angle, etc., etc.). The study of the initial part of the ascending branch was entirely oriented in the double problem of defilade and range.

(*b*) To the terminal part of the descending branch (angle of fall, angle of impact, angle of protection, angle of ricochet; the apparent elevation of the burst, etc.). The study of the terminal part of the descending branch was entirely oriented in the problem of the vulnerability of the target according to its nature or its location.

When it was a question of firing at aerial targets the tendency at first was, and this is easily comprehensible, to argue in regard to these targets as if they were merely terrestrial targets raised to a very high angle of sight. One of the first results of this theory was to erroneously apply to these targets: first, the idea of a normal height of burst (hauteur type) above the target that would give the maximum effect; second, the hypothesis of the rigidity of the trajectory.

In the same manner there was at first transferred to the sphere of firing against aerial targets the general principles of ranging (jump, bracket, etc.), which were in use in firing against terrestrial targets.

Finally, when it was a question not of firing at balloons, but at flying machines, not of firing at fixed objects but at objects in motion, it was first thought that the methods of firing should be similar to those employed against marching troops, against a train, etc.

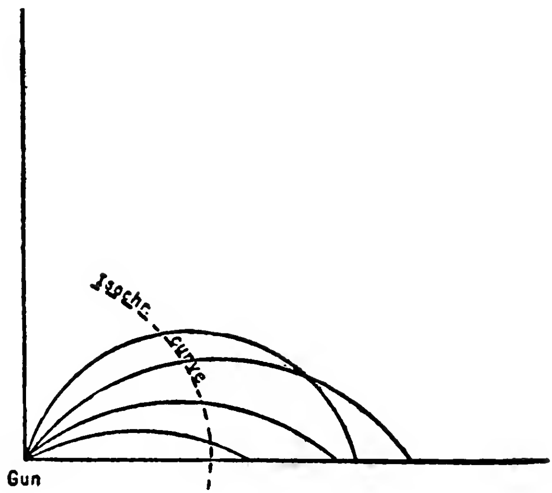


Fig. 1.

From this came the method of ranging called "de la tenaille" and others of the same kind. From this came, too, the considerable efforts made to employ the range finder and to make use of the data obtained through this instrument (that is to say, the actual distance of the target) in order to determine the fuse setting.

Gradually, experience having demonstrated that this very simple method of transposing into the ballistic problems of space solutions which were only appropriate to the ballistic problems of terrain, only led to decided errors and to notorious inefficiency, the following general ideas were reached:

II

(*a*) A point in space taken as a target for a given gun is defined by:

(1) The azimuth in which it is located.

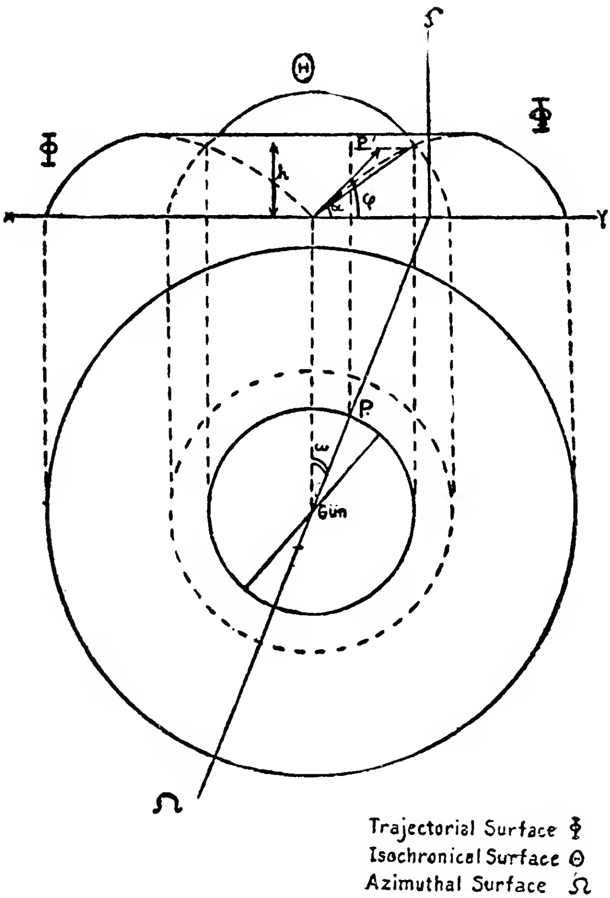


Fig. 2.

(2) The trajectory on which it is located in this azimuth, this trajectory being itself defined for the given gun by the angle of departure.

(3) The setting of the fuse which on the said trajectory will determine the burst at the said point.

If we draw on a vertical plane (fig. 1) the locus of all points of burst obtained on the various trajectories by a given fuse setting, we shall then have a curve. This curve will be the locus of the points which the projectile reaches within a given time (time of fuse) if the fuse is a clock-fuse. For that reason it would be proper to call the curve an isochrone curve.

Now let us turn around through all the azimuths a vertical plane on which has been drawn the diagram showing:

(1) The sheaf of the trajectories from degree to degree of angle of departure.

(2) The sheaf of the isochrone curves from second to second of the time of flight (this supposed to be equal to the time of fuse).

Thus, each trajectory will generate a surface of revolution determined by its angle of departure ϕ; we will call this surface "the surface Φ" (see fig. 2).

Each isochrone curve will generate a surface of revolution determined by its time of flight θ; we will call it "the surface Θ."

Any point in space will be determined by the intersection of three surfaces (fig. 2): azimuthal plane, Ω; trajectorial surface, Φ, isochronic surface, Θ; and will have, as an aerial target, three ballistic coôrdinates: angle of azimuth, ω; angle of departure, ϕ; and time of flight (or of the fuse), θ.

Of these three ballistic coordinates of the point, the azimuth only is at the same time a geometric coordinate.

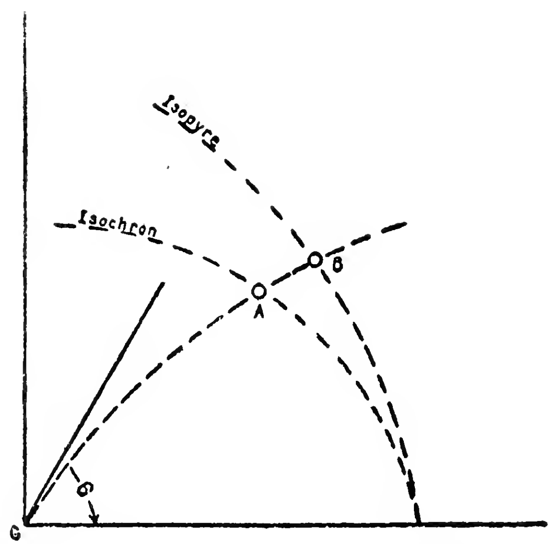
As the geometric coordinates are the only ones that can be obtained by direct measurement, in particular by sighting, the ballistic coordinates ϕ and θ have to be obtained indirectly, by the following means, for instance:

The target will be located in the azimuthal diagram by the measurements of its altitude and of its angle of sight (apparent elevation α) and, once it is thus located in the plane of the diagram, a simple reading will tell on which trajectory and on which isochrone it is.

III

In the preceding paragraphs we have taken for granted that the time at the end of which the shell burst is equal, whatever may be its trajectory, to the time marked on the time-scale of the fuse.

But this is true only for clock-fuse. For the ordinary fuse the time of bursting is determined by the duration of combustion of a certain length of a communicating tube; this tube carries from length to length a time-scale which indicates the time which this combustion will take in the atmosphere near the earth.



A Burst with clock-fuze at time θ
B = " " ordinary fuze set θ

Fig. 3.

For example, a fuse set at ten seconds burns for ten seconds before bursting, if the region in which the combustion takes place is normal. Transport the fuse to another place in which for example, the air is more rare, that is to say, less dense, and instead of lasting ten seconds, the combustion will last eleven or twelve.

It follows from this, that the locus of the points of burst for a given fuse setting is not the isochrone curve corresponding to an equal time of flight. In the high regions of atmosphere the combustion of the fuse is delayed by the dilution of the air, and the burst occurs not on the isochrone curve but further along, on another curve which deviates from the former in proportion to the time during which the projectile, before bursting, has been subjected to a lower barometric pressure. This other curve, depending upon a geometric length of combustible tube and not upon a chronometric length of flight, is sometimes called the "*isopyre curve*" (fig. 3).

Since the beginning of the war the empirical outlining of the isopyrical curves and of the trajectories for high altitudes has been the object of very careful work in which thousands and thousands of projectiles have been used. A standard diagram has been established (Puteau-Arnouville, 1915–16), which, used either in its original form or more or less ingeniously transformed, constitutes the essential instrument of all the methods of firing against aerial targets.

IV

Anti-aircraft firing does not consist merely in firing at an aerial target, but in firing at an aerial target *in motion*. Moreover, this target moves with a speed which cannot be regarded as negligible with reference to the speed of the projectile designed to strike it.

With an average wind, an "observation machine" attains a speed of 35 meters (38.15 yards) per second. At ordinary firing ranges the time of flight of the projectile amounts to twenty seconds. It follows that, under normal conditions, the distance covered by the target, between the moment at which the projectile designed to strike it is fired and the moment at which it bursts is about 700 meters.

What will be its course? How can the gunner locate in advance the position in space where the target and the projectile will meet after both have followed their respective trajections for the same length of time? This is the problem sometimes called, especially by the British, the problem of *prediction*.

The target being an animated one and having, as one might say, its own will-power, it is *a priori* obvious that no absolute and definite solution can be applied to the problem. During twenty seconds a flying machine has time to change its course in various sudden and unexpected ways, both as to altitude and as to direction. The problem has nevertheless a probable solution and this solution belongs to the domain of mathematical *extrapolation* based on the laws of continuity, to wit:

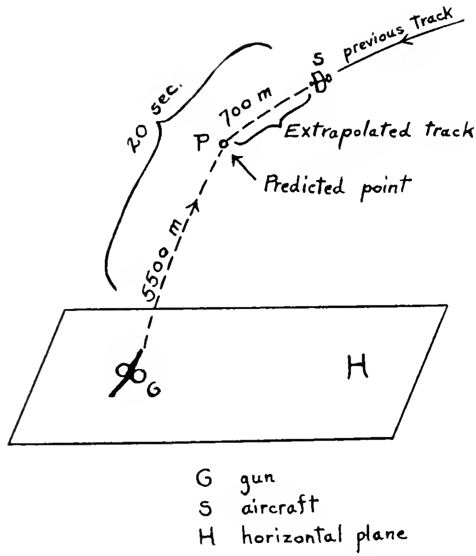


Fig. 4.

A moving body that has covered, with uniform speed, a curve ab in space during the time t should, at the end of a total time $t + dt$, reach a point c, such that $\frac{bc}{ab} = \frac{dt}{t}$. This is nothing else but the equation of uniformity of speed.

If the curve in space ab is given in terms of the parameter t by the equations:

$$x = f_1 (t)$$
$$y = f_2 (t)$$
$$z = f_3 (t)$$

the coördinates of the extrapolated point c will be given by the same equations by replacing t by $t + dt$.

If the curve ab, in the vicinity of b, has no pronounced curvature, the point c can be considered as located on the tangent to that curve drawn from point b in the direction of movement.

The problem of extrapolation with respect to the flying machine (fig. 4) is, with one dimension added, a problem quite similar to the ones commonly dealt with in firing at moving targets at sea, and worked out by the coast artillery by means of the *plotting board:*

The positions s_1, s_2, s_3 of a ship are, by triangulation, registered on the plotting board at the times t_1 t_2, t_3. The point s_4 at which it is necessary to aim in order to reach the ship at the time t_4 is given by a graphical extrapolation of the plotted track s_1, s_2, s_3.

The solutions which have been given to the same problem in space with respect to anti-aircraft firing are of two general kinds:

. (1) Solution by measurements of the angular velocity of the target.

(2) Solution by measurement of its linear velocity.

(1). The angular velocity of a flying machine with reference to the eye of the observer (or with reference to the position of the gun if observation is supposed to be made from this position) may be considered as being the resultant of two angular velocities, measured, one in the plane of deflection, the other in the plane of sight. The instruments which have been invented in order to deal with solution (1) have been mostly based on this resolution of speed.

At this point it is important to note that the angular velocity of a flying machine moving with a uniform linear velocity changes value every minute, except in very exceptional and very improbable cases; for example, the case of a flying machine which might happen to be revolving around a vertical passing through the eye of the observer. Consequently, the measurement of angular velocity taken at a given time can be considered as available only during a very short while.

Supposing even that the angular velocity measured at the very moment of the shot could be applied to extrapolate for the point which the projectile ought to reach, and this is questionable owing to the relatively long duration of the flight, any measurement taken at a moment somewhat prior to the firing of the shot is evidently out of date and has no value whatever regarding the extrapolation desired.

This is the reason why, after the trials made with instruments capable of giving from time to time discontinuous measurements of angular velocities, it has been felt necessary to substitute for them instruments for continuous measurements, such as the galvanometric cinemometer.

This instrument is based on the following principle: A steel armature which turns inside of a solenoid develops a current of induction, the intensity of which is a measure of the velocity of rotation. If the steel armature is secured on the axis of a sighting-telescope pointed at the flying machine, a galvanometer duly graduated will enable one to read constantly the angular velocity of the flying machine.

(2) The solutions of the second kind are based on the measurement of the linear velocity. A very great majority of these solutions have assumed as an hypothesis that the measurement of the horizontal linear velocity gave sufficient data for firing; that is to say, that it could generally be considered that the altitude of a flying machine did not alter much during the time of the flight of the projectile. It goes without saying that these solutions also assume as an hypothesis that the speed of the flying machine in regard to the problem of firing can be considered as uniform. This admitted, a measurement of linear velocity, taken at any moment, remains available.

All the instruments based on the solutions of the second kind have been based on the same principle as that of the *plotting-board.* Some of these have endeavored to draw automatically by simple sighting a continuous track of the course of the flying machine. It seems that it is in line with this idea that the most handy and useful, if not the most complete, instruments will be found.

V

To sum up, the problem of anti-aircraft firing, after many experiments, is at present, if not solved, at least plainly laid out in the following way:

To be preliminarily measured: (1) altitude of the flying machine; (2) its orientation and its velocity (angular or linear); (3) extrapolation or prediction of the point to be aimed at; (4) wherefrom the knowledge of the azimuth of the said point; (5) wherefrom, too, in the azimuth the reading on a diagram of the ballistic coordinates of the said point (trajectory and isopyre) as functions of its geometric coordinates (angle of sight and altitude).

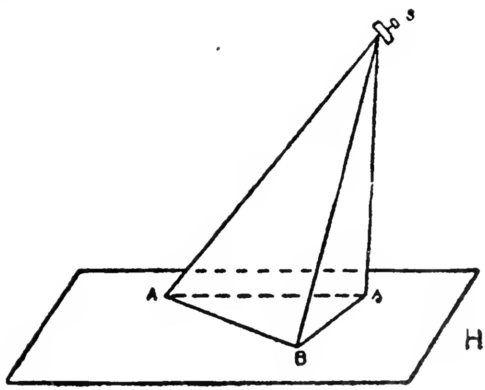


Fig. 5.

Finally, a word in regard to the methods of measuring:

(1). The altitude (h) is measured by triangulation from a large observation base.

The flying machine is the summit of a pyramid occupying the space S. s. A. B. placed on the horizontal plant H (fig. 5). A. B. is the line of measurement called the horizontal base, at the two extremities of which are two posts of observation, the distance between them being known. s is the horizontal projection of the flying machine.

Any triangulation made in order to solve the pyramid will give the knowledge of the altitude h.

Among these methods the one to be pointed out in particular is the direct method which consists in the following:

The observer *B* announces simply by telephonic signal the successive passages of the flying machine in the azimuths 1, 2. 3—determined in advance, for example every ten degrees, starting from the true south.

The observer *A* moves on a plotting-board a vertical rule along the azimuth for which the first signal is expected and this in such a way as to sight the flying machine on the edge of this rule.

At the moment of the telephonic signal the altitude *h* of the machine is given by simply reading the height at which it ap-

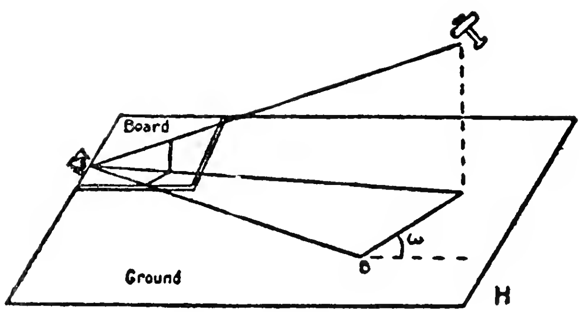


Fig. 6.

pears on the rule; and its horizontal projection is given by the position of the lower end of the rule (fig. 6). The board is supposed to be duly oriented and scaled; the rule to be accordingly scaled.

Remarks. (*a*) This direct method permits the continuous tracing of the flight of the machine, once its altitude is known. If, in fact, after the signal, the observer *A* keeps on moving his vertical rule no longer along the azimuth but in such a way that the flying machine is maintained sighted at the same altitude *h* on the edge of the rule, the lower end of the rule will automatically trace on the board the projection of the flight of the machine (taking for granted, of course, that the machine does not change its altitude).

(*b*) This same method permits one to control or rectify periodically the measurement of the altitude. Thus, suppose the observer *A* operating as has just been said; the signal of observer *B* announcing the passage of the machine in the next azimuth will be heard: either at the same time as the lower end of the rule crosses the said azimuth drawn on the plotting-board, in which case the altitude has not changed; or before the reaching by the lower end of the rule of the azimuth, in which case the machine has gone higher; or after the passage of the lower end of the rule on the azimuth, in which case the machine has come down.

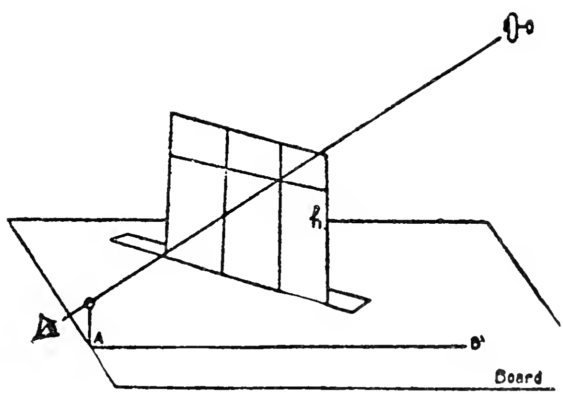


Fig. 7.

In the last two cases the observer *A*, as soon as he hears the signal, will recall or send back his rule along the sighting plane so as to replace it on the azimuth announced; from this will result the rectification of the reading of the altitude and also the rectification of the horizontal projection of the flying machine.

(2) The linear velocity may be measured in the following way (fig. 7):

A given length of a horizontal wire, for instance, 1 cm. representing 100 meters and thus corresponding to a scale of 1/10,000, is stretched across a vertical aperture at such a height above the plane of the board as to represent the altitude of the flying machine (for example, 20 cm. representing 2 kilometers).

The observer A, after having trained the aperture in such a way that the machine aimed at appears as if following the wire, registers the time taken by the machine to cross the aperture from one side to another.

This time gives the measure of the horizontal linear velocity and the bearing of the plane of the aperture indicates the actual direction of the flying machine.

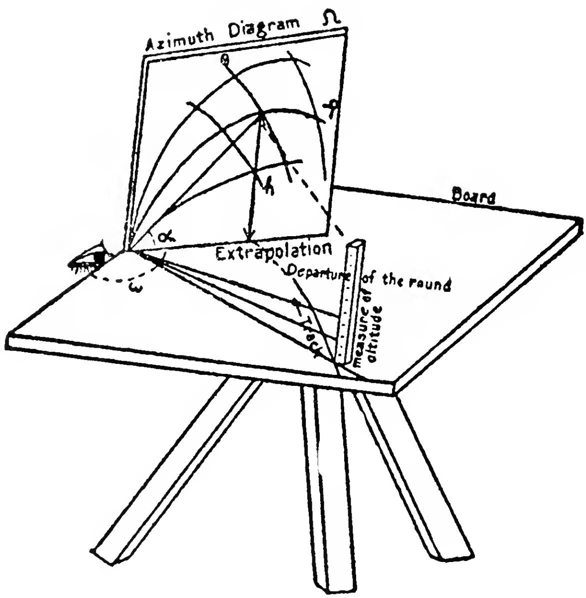


Fig. 8.

(3) The extrapolation or prediction results from the knowledge both of this actual direction and of the linear velocity.

As has already been said, this extrapolation gives the azimuth of the point to be aimed at; and, in this azimuth, the angle of sight (fig. 8).

The altitude of the point to be aimed at in the extrapolated azimuth is supposed to be equal to the last altitude that has been measured. The angle of sight results from the knowledge of the altitude and of the abscissa; the latter is given by the intersection of the azimuth with the extrapolated horizontal direction.

(4) The ballistic coordinates (angle of departure, fuse-setting) are read on the diagram of the trajectorial and isopyrical curves; a diagram on which the point to be aimed at has just been fixed by the knowledge of its angle of sight and of its altitude (or merely of its abscissa and ordinate).

(5). If one proceeds by measurement of angular velocities instead of by measurements of linear velocities the instruments used are the continuous electric cinemometers already mentioned above, and then the extrapolation is determined as follows:

(*a*) *Azimuth.*—The extrapolated azimuth is obtained by the extrapolation of the horizontal angular velocity and this in starting from the last azimuth in which the flying machine has been observed prior to the firing of the shot.

(*b*) *Angle of Sight.*—In the same way, the extrapolated angle of sight is obtained by the extrapolation of the angular velocity in the plane of sight where the flying machine has been observed prior to the firing of the shot.

CONCLUSIONS

In ending this comment, which inevitably is of a very general character, it seems necessary to insist upon the great importance that should be attached to the fact that, as far as possible, the nature of the firing conditions should be such as not to disturb the continuity of the flight of the flying machine between the moment at which the measurements that determine the firing data have been taken and the moment at which the shot reaches its destination.

As has been said, a flying machine may cover about 700 meters during the flight of the projectile. During this period the race is most unequal.

On one hand, the projectile, just carrying away the measurements and the intentions of the battery commander, is merely an inert instrument of a previous will. It clings helplessly to its trajectory and will inevitably burst once the combustion of its fuse has come to an end. On the other hand, the aerial ship has maintained the full power of her free will, her trajectory is not compulsory and may be altered in accordance with her own desires.

Therefore, if she becomes conscious that a projectile intended for her is on the way, she is in a position to baffle all the calculations of which this projectile is the unconscious carrier.

What, then, is any observation worth, even though it be minutely exact, that the gunner can figure out in regard to the deviations between his points of burst and the objective? To what extent do these deviations indicate an error of firing which is subject to rectification? To what extent are they the effect of a modification in the continuity of the flight of the objective, voluntarily brought about by the pilot during the course of the projectile?

The first burst that will take place and which the pilot will see will give him the alarm and from this moment on, what craftiness, what feat of strength in case of need, will he not make use of in order to avoid falling into the net of subsequent trajectories?

Are not these points of interrogation sufficient to make it clearly understood that the systems of anti-aircraft firing based solely on ranging must be condemned as being ineffective and excessively expensive?

Are they not sufficient to show that so long as there shall not have been found a gun of a fantastic muzzle velocity, capable of pouring into space projectiles of a speed infinitely superior to that of the flying machine, the gunner must concentrate all his attention and all his ingenuity in operating sudden and dense barrages on points of extrapolation silently determined by measurements as accurate as possible?

CRYSTALLOGRAPHY.—*The assignment of crystals to symmetry classes.* Edgar T. Wherry, Bureau of Chemistry.

The thirty-two classes of crystals are founded on so firm a basis that it has become customary to regard the assignment of a crystallized substance to one or the other of them as one of the fundamental aims of crystallography. Evidence has been accumulating for some time, however, that certain substances are in a sense intermediate between classes, possessing simultaneously

TABLE 1

EVIDENCE FOR ASSIGNMENT TO CRYSTAL CLASSES

SUBSTANCE	COMPOSITION	ASSIGNMENT BASED ON					
		Habit	Etch-figures	Electric polarity	Optical rotatory power	Automatic structure	
						Space-lattice	Structure-unit
Cubic system							
Diamond	C	Holohedral or tetrahedral	Tetrahedral	Holohedral		Holohedral	Tetrahedral
Sylvite	KCl	Holohedral	Gyrohedral		Holohedral	Holohedral	Gyrohedral
Cuprite	Cu_2O	Holohedral or gyrohedral	Holohedral		Holohedral	Holohedral	Gyrohedral
Pyrite	FeS_2	Pyritohedral or Tetartohedral	Pyritohedral	Tetartohedral	Indeterminate	Pyritohedral	Tetartohedral
Barium nitrate	$Ba(NO_3)_2$	Tetartohedral	Tetartohedral	Pyritohedral	Pyritohedral	Pyritohedral	Tetartohedral
Tetragonal system							
Rutile	TiO_2	Holohedral or trapezohedral	Holohedral	Holohedral	Holohedral	Holohedral	Trapezohedral
Rhombic system							
Sulfur	S	Holohedral or bisphenoidal	Holohedral	Holohedral	Holohedral	Holohedral	Hemihedral
Manganite	$MnO(OH)$	Holohedral or bisphenoidal	Holohedral	Holohedral	Holohedral	Holohedral	Hemihedral

some of the attributes of two of them. In table 1 the data in several instances of this relation are presented, the hemihedrism being in every case weak, according to the classification of Professor Goldschmidt.[1]

Diamond, in the majority of text books of mineralogy, is classed as tetrahedral, and Fersmann and Goldschmidt[2] concluded from a review of extensive data that it actually possesses weak hemihedrism of this type. Attempts to develop piezo- and pyro-electricity have, however, been unsuccessful,[3] which points to holohedrism. In the presence of such conflicting evidence, the assignment of a substance to one class or another has in the past been a matter of opinion on the part of the individual scientist, depending on the relative weights assigned to different features.

When the study of crystal structure by X-rays became, especially through the brilliant work of the Braggs,[4] capable of demonstrating the exact positions of the atoms in crystal space-lattices, there seemed reason to hope that it would be possible to decide such questions, and classify each substance accurately, definitely, and finally. But when the structure of diamond was worked out, it proved, as a whole, to be holohedral, while the structure-units (unit cells of the space-lattice), are tetrahedral in symmetry, leaving the decision as to which class it shall be assigned still in doubt.

If it be admitted that a substance can belong to two classes at the same time, this difficulty vanishes. There being then no longer need for any evaluation of the relative importance of different features in determining the classification of the crystal, the significance of all the physical properties may be considered on an equal footing. Habit, in so far as it represents a condition of equilibrium, should be connected with the structure as a whole; in diamond it should be holohedral, which is actually observed to be the case in the majority of crystals of this sub-

[1] GOLDSCHMIDT and NICOL. Neues Jahrb. Min. Geol. **1904**^{2}: 109; NIES and GOLDSCHMIDT. Op. cit. **1908**^{2}: 99.

[2] Der Diament, 1911.

[3] VAN DER VEEN. Zeitschr. Kryst. Min. **51**: 545. 1909.

[4] X-rays and Crystal Structure, 1915.

stance. When, on the other hand, external conditions prevent equilibrium from being attained, the symmetry of the structure-unit may conceivably find expression in the development of the faces, and, as a matter of fact, a tetrahedral or hextetrahedral habit is too frequently exhibited by diamond to be considered an accident.[5] Etch-figures bring out partial symmetries when they are produced under conditions where attainment of equilibrium is delayed, and in diamond they are actually hemihedral at first, and become holohedral in the later stages of development. The electric polarity, however, should be determined by the structure as a whole, which holds in this case. Rotation of the plane of polarized light, as it could not occur in a tetrahedral substance in any case, has no bearing on the matter. The features of diamond thus agree with its assignment to two different classes at the same time, and its crystallization may be stated in the following manner:

System, cubic; structure, holohedral; structure-unit, tetrahedral.

In sylvite the habit and the absence of optical rotatory power correspond to a holohedral structure, which is found to be present by the X-ray examination. In this case electric polarity could not occur, as no polar axes are present under any interpretation. But on the basis of the gyrohedral symmetry shown by the etch-figures this substance is commonly assigned to that class. As pointed out by the Braggs a very slight distortion, which might have sufficient influence on the growth of the crystal or development of etch-figures to give rise to the gyrohedral symmetry observed, would not affect the X-ray spectra to a recognizable extent; the structure as a whole might then be essentially holohedral, while the structure-units are not. Such a relation was in fact predicted by Barlow and Pope[6] some years before the development of the X-ray methods. They pointed out that if, in a close-packed cubic assemblage of atoms, alternate ones are of slightly different sizes, gyrohedral symmetry would neces-

[5] This word is not to be taken too literally; it is merely a convenient descriptive term for phenomena, the causes of which do not at a given time appear worthy of extended investigation.

[6] Trans. Chem. Soc. **91**: 1179–1187. 1907.

sarily result. As all available data indicate that the atomic volume of potassium is decidedly greater than that of chlorine, this symmetry would be expected with potassium chloride. It may be pointed out here that in the case of sodium chloride the atomic volumes of the two elements are essentially identical, and no gyrohedrism should be exhibited; and as a matter of fact, the etch-figures on this substance, as well as all of its other properties, are completely holohedral. On the other hand, in practically all the other alkali halides, including those of ammonium, a difference of volume must be present, and gyrohedral symmetry is to be expected; and this has been thoroughly confirmed by etching experiments. The crystallization of these halides may therefore be described as:

System, cubic; structure, holohedral; structure-units, gyrohedral.

The relation in the case of cuprite corresponds to that of the halides, except that here for some obscure reason the gyrohedrism is shown by forms occasionally found upon the natural crystals rather than by the etch-figures. The explanation of the symmetry is no doubt the same as with the halides, copper having a less volume than oxygen. The crystallization of this substance may accordingly be described as:

System, cubic; structure, holohedral; structure-unit, gyrohedral.

The pyrite group is a particularly good illustration of the relation here under consideration. Many crystallographers have considered all the members of this group to be tetartohedral, because of occasional tetrahedral development of forms capable of showing it, accompanied by typical dyakis-dodecahedral or "pyritohedral" symmetry of other forms. The thermo-electric behavior is also regarded as tetartohedral in character. The etch-figures appear, however, not to depart from simple pyritohedral relations; and no information can be obtained from optical properties, as no method of measuring optical rotatory power on opaque, metallic, minerals has as yet been developed. The X-ray studies made by the Braggs of three members of this group, pyrite (FeS_2), hauerite (MnS_2), and cobaltite ($CoSAs$), show the space-lattices and crystal molecules (in so far as the structure of the latter affects X-rays) of the first two to have pyritohedral symmetry, while the last is tetartohedral. It is to be inferred that all members of the group in which the two negative atoms are alike would show the first type of symmetry, those in which these atoms are unlike the second. The fact that many specimens of pyrite actually show some tetartohedral features indicates that the two sulfur atoms in these instances at least must be unlike, not sufficiently to affect the X-ray spectra, yet distinctly enough to influence the habit and electrical properties. This could occur if one of the sulfur atoms were tetravalent, the other divalent, the structural formula of the compound (whenever such a formula could apply) being Fe = S = S. On the other hand the tetartohedral properties may be limited to pyrites in which enough of the sulfur atoms, scattered through the mass, are replaced by arsenic or some other element to give the structure the symmetry characteristic of the CoSAs class of compounds. Further work will be necessary to decide between these two possibilities, but it is evident that the crystallization of at least some specimens of pyrite may be described as:

System, cubic; structure, pyritohedral; structure-unit, tetartohedral.

Barium nitrate and the isomorphous strontium and lead salts have been studied by X-rays by Nishikawa and Hudinuki,[7] and their space-lattices found to possess pyritohedral symmetry. The habit and etch-figures are often tetartohedral, however, although neither electric polarity nor optical rotatory power have been observed in the crystals. The structure-units may therefore possess the diminished symmetry, while the structure as a whole is pyritohedral:

System, cubic; structure, pyritohedral; structure-unit, tetartohedral.

The crystal habit of rutile is usually holohedral, but hemihedrism of an apparent trapezohedral type occasionally appears.[8] The two series of observations which have been made

[7] Proc. Tokyo Math. Phys. Soc. II, **9**: 197. 1917.

[8] Schrauf, Zeitschr. Kryst. Min. **9**: 433. 1884.

on this substance with X-rays have yielded contradictory results; Vegard[9] interpreted his data as indicating a sphenoidal arrangement of the oxygen atoms, while Williams[10] worked out a trapezohedral configuration of the structure-unit, the structure as a whole being holohedral. The second view seems on the whole the most reasonable, so the crystallization of rutile, as well as of cassiterite and zircon, which belong to the same group, should probably be stated as:

System, tetragonal; structure, holohedral; structure-unit, trapezohedral.

The structure of sulfur has not been fully worked out by X-rays, as it shows a peculiar abnormality in the spacing of the planes in the direction of the vertical crystal axis. No assignment of the structure-unit to a special symmetry class is possible, but it may be pointed out that the habit of the crystals of this substance is sometimes decidedly bisphenoidal, whereas the remaining properties are holohedral, which indicates a relation similar to that shown by the other substances here considered.

Manganite has not been studied by X-rays at all, and it possesses metallic properties to such an extent that neither electric polarity nor optical rotatory power can be observed. But a bisphenoidal distribution of faces has been observed on crystals of it from many localities, and crystals altered to pyrolusite from Virginia recently studied by the writer[11] show in addition hemimorphism along the right-left crystal axis *b*. The hemimorphism in this case appears to be merely a result of difference in rate of growth, since the forms observed at both ends have essentially the same symbols, and moreover, etching figures on this mineral exhibit holohedral symmetry. It may therefore be suggested that in manganite the structure-unit possess some hemihedral feature not present in the structure as a whole, and this finds expression in the peculiarities observed in the distribution of faces.

The evidence collected in this paper appears to justify the conclusion that both the symmetry of the space-lattice as a

[9] Phil. Mag. VI, **32**: 90. 1916.

[10] Proc. Royal Soc. A. **93**: 418. 1917.

[11] To be described shortly in collaboration with Prof. THOMAS L. WATSON.

whole and that of the crystal-molecules or unit cells of the lattice may find expression in significant physical features, and therefore that both should be taken into account in the assignment of crystals to symmetry classes, even though it may at times be necessary to state two different classes for the same crystal.

BOTANY.—*A sketch of botanical activity in the District of Columbia and vicinity.*—I. P. L. RICKER, Bureau of Plant Industry.

It would perhaps be difficult if not impossible to say who started the first botanical work in the present District of Columbia which, as nearly virgin wilderness, much of it swamp land, was ceded to the United States Government by the State of Maryland in 1788. It would be much more difficult if we included the part in Virginia ceded to the United States in 1789 and the area in Maryland surrounding the District. The fact that Georgetown was settled late in the 17th century, although not formally laid out until 1751, and Alexandria at least as early as 1749, opens up a wide possibility.

Rev. John Banister was probably the first to do much active botanizing in Virginia, where he died about 1692. Ray (see bibliography) makes no definite reference to his collecting near the Potomac, although it is quite probable that he did some collecting within the range of this flora.

John Clayton came to Virginia in 1705. The list of his plants published by Gronovius in 1743 shows that he collected Betula nigra "a cataractis fluminis Potamoc," which might indicate any one of several points from Little Falls to Great Falls.

George Washington began making improvements at Mount Vernon soon after it came into his possession about 1759. It is possible that a careful examination of his voluminous correspondence and diaries at the Library of Congress, which time does not permit at present, might give more definite ideas as to his plantings, many of which were doubtless introduced from Europe. He did however plan for a Botanical Garden in the District. André Michaux, the French botanist, visited Washington at Mount Vernon, June 19, 1786, on his way to New

York where he had planned to start a Botanical Garden.[2] There seems to be no evidence of his collecting specimens in the Potomac region at this time except that as he was on a mission from the King of France to collect seed for the Royal Botanical Garden at Paris it is not at all improbable that some specimens were collected here.

It seems likely that the first local American who had any accurate knowledge of the native plants and their names was Thomas Jefferson, and this knowledge is abundantly proven in his correspondence. He entered Washington's cabinet as Secretary of State in 1789, and although the seat of government was not moved from Philadelphia to the District of Columbia until June, 1800, he was doubtless here frequently on his way to Monticello. That his official duties here were no bar to his collecting plants is well shown by the request of one William Hamilton in 1808 for seed of one of the hollies. After three failures by local amateurs to secure the right seed, Jefferson was forced to do the collecting himself and obtained it at the first attempt.

In view of his well-known interest in plants, Jefferson, on the removal of the government to Washington, was immediately besieged by offers from gardeners[3] to establish a botanical garden in the District. At the time he did not consider it the function of the government to do so. The plan was also opposed in Congress, where the idea of a botanical garden seemed to be an institution to furnish the District with cheap vegetables and flowers.

While none of the early nurserymen of the District gave any attention to the scientific aspect of their subject or of botany, yet, considering them botanists in a broad sense, they have contributed much to the practical side of the science. Thomas Main, a Scotch gardener, who settled at Georgetown about 1804, was probably the first nurseryman of the District. His attention was given almost entirely to raising grapes for wine.

[1] Washington correspondence, Michaux to Washington, June 20, 1796, and Washington's diary of June 19, 1796.

[2] This garden was eventually estalished at Charleston, S. C., by the son, François André Michaux, who came there in 1805.

[3] Jefferson correspondence.

Constantine Samuel Rafinesque-Schmaltz[4] prepared the first list of District plants in 1804, the forthcoming publication of which was announced by him in 1805, but for some unknown reason it never appeared.

The first actually published list of District wild plants was given by David B. Warden[5] in 1816. While there are numerous notes on introduced cultivated plants in this work by Warden the nine pages of local wild plant names relating to 130 species were furnished by José Francisco Correa da Serra[6] Portuguese minister to Washington, but who resided most of the time at Philadelphia and succeeded Benjamin S. Barton as lecturer on botany at the University of Pennsylvania.

In 1817 a sufficient number of residents of the District being interested in botany, a public notice of the intention of forming a Botanical Society was given, and on March 13, 1817, a meeting was held for this purpose at Davis's Tavern. Dr. John A. Brereton, an assistant surgeon in the U. S. Army, was called to the chair and John Underwood appointed Secretary. A committee of three, consisting of Rev. Dr. James Laurie, George Watterson, and Dr. Alexander McWilliams, was appointed to draw up a constitution for the Society, which was called the Botanical Society of Washington.[7] The Society held meetings

[4] FITZPATRICK, T. J. F. Rafinesque, a sketch of his life and bibliography. Des Moines, Iowa, 1911.

[5] WARDEN, DAVID BAILLIE. A chorographical and statistical description of the District of Columbia. Paris, 1816. Dedicated to his friend Mrs. Custis. He had served as a U. S. consul in France.

[6] José Francisco Correa de Serra, born at Serpa, Portugal, in 1750, assisted in founding the Portugese Academy of Sciences and was made perpetual secretary. He left Portugal for France in 1786 on account of political troubles and went to England in 1797 where he became secretary of the Portugese embassy. He came to New York in 1813 and received his appointment to Washington in 1816. He was called home in 1820 and elected to the Cortes. Baldwin's correspondence to Darlington in 1815 says that Philadelphia was much pleased with the lectures of Chev. Correa da Serra.

[7] The records of this society were found by Mr. James Anglin, the predecessor of the present book firm of W. H. Lowdermilk & Co., among some secondhand books and presented to Prof. Lester F. Ward about 1881 or 1882. On the death of Professor Ward in 1913 his library was given to Brown University. The Trustees of that Institution granted a formal request for these records from the present Botanical Society of Washington. After a careful study of the records the writer was authorized by the Society to deposit them for safe keeping in the Manuscript Division of the Library of Congress.

for a time every two weeks. The dues were five dollars a year, and to enforce attendance a fine of one dollar for regular meetings and fifty cents for special meetings was levied against members who did not attend and could not give a satisfactory excuse. The aims were, quoting from the constitution, "to collect, arrange, preserve and describe all the vegetable productions within the limits of the District . . . . to publish quarterly, if deemed necessary, whenever the Society shall have obtained a full knowledge of all the vegetable productions of the said District a Flora with colored plates. . . . ." At one time every member attending was required to bring a plant. The thirteen charter members consisted of John Boyle, W. A. Bradley, Dr. John A. Brereton, Samuel Elliot, Jr., William Elliot, J. W. Hand, Dr. Henry Huntt, Major James Kearney, Rev. Dr. James Laurie, Dr. Alexander McWilliams, J. M. Moore, John Underwood, and George Watterson. During the, life of the Society six other members were elected and a seventh name is given on a committee, but there is no record of this person's election. These were, however, mostly expelled for non-attendance, and on May 6, 1822, Boyle, Brereton, Wm. Elliot, Kearney, McWilliams, and Underwood were the only remaining members. Jacob Bigelow of Boston, William Darlington of New Jersey, and William P. C. Barton of Philadelphia, prominent botanists of that time, were elected honorary members. After 1822 only one meeting a year was held until March 27, 1826, when the books belonging to the Society were ordered deposited in the Washington Library and Dr. McWilliams was authorized to take charge of the herbarium, after which the Society adjourned *sine die*. There is apparently no record of the ultimate disposition of the library and herbarium. The library contained at least 24 volumes listed in the Proceedings of the Society. We are informed by both the District Public Library and the Library of Congress that the copies of these works in their libraries bear no indication of ever having belonged to the Botanical Society of Washington. The plan of publication by the Society never materialized, but the Society did publish in 1819 a Florula Columbiensis of 14 pages, and listing 293 species. What was practically a second edition of this list was published by William Elliot in 1822 in his Washington Guide. The list was furnished by Dr. Brereton and comprised 458 species, and the same list was repeated in editions appearing in 1826 and 1830; the 1837 edition had a few additions by William Rich.

One of the members of the Society, Dr. John A. Brereton, together with William Rich, also published between 1825 and 1830 three parts of the American Botanical Register with 24 colored plates, but these contain no reference to the District. William Rich was a brother of Obadiah Rich[8] of Georgetown, who published in 1814 a synopsis of the genus of American plants which at that time Muhlenberg considered to be an American edition of Persoon's "Genera." It is uncertain whether this referred to Persoon's Synopsis, 1805–1807, or his edition of Linnaeusa Systema Vegetabilium, 1797. Neither of these men belonged to the Botanical Society of Washington, but both were members of the Columbian Institute[9] of Georgetown, organized in 1816, which was more directly interested in agriculture and horticulture. The Botanical Society of Washington was invited to join the Columbian Institute in November, 1817, and agreed, providing the Institute would so alter its constitution as to admit the Society to the Committee on Botany and Agriculture, but this request was apparently refused. Dr. Alexander McWilliams submitted a list of District plants to the Columbian Institute in 1826, but the list was not published.

Following the dissolution of the Botanical Society of Washington in March, 1826, another organization known as the Botanical Club, according to Dr. Brereton's preface, was formed,

[8] Obadiah Rich, born at Truro, Massachusetts, in 1783, was a member of the Massachusetts Horticultural Society at least from March 5, 1805, to January 30, 1810. Under date of April 16, 1812, William Bentley, of Salem, Massachusetts, wrote a letter introducing him to Thomas Jefferson. In 1815 he was appointed U. S. consul at Valencia, Spain. From this until 1827 most of his time was spent there and at Madrid, and in the latter year he tried to sell his valuable collection of books to the Library of Congress, but failing in this most of them went to the New York Public Library. He settled in London in 1828 and died there January 20, 1850. For this note I am indebted to Dr. J. H. Barnhart, of the New York Botanical Garden, and to Dr. R. H. True, of the Department of Agriculture.

[9] For a history of this Institute see RICHARD RATHBUN in U. S. National Museum Bulletin **101**: 1–85. 1917.

consisting of Dr. John A. Brereton, Alexander McWilliams, William Mechlin, William Rich, and Dr. James W. Robbins, the latter removing from the District the next year. In 1830 Dr. Brereton published under the title *Florae Columbianae prodromus*, a contribution listing 860 species of plants with date of flowering and root habit indicated. Mr. George Watterson, who had served as Secretary of the first Botanical Society, evidently felt that its workers had not been given proper credit for their part of the work, as in his papers at the Library of Congress there is one which had evidently been prepared for publication in which he states that Dr. Brereton was lame and unable to do any of the collecting but took charge of the specimens as they were brought in and occasionally ascertained their names. He also states that Brereton's work contained few if any more plants than were recorded in the journal of the Botanical Society. According to Prof. L. F. Ward,[10] this journal contained the names of only 370 plants.

The first Botanical Society passed a resolution on September 12, 1817, petitioning Congress to pass a law authorizing a lottery for the purpose of establishing a Botanical Garden in Washington under the superintendence of the Society, but the petition was without results. According to Dr. Richard Rathbun,[11] the Columbian Institute had received permission from Congress on May 8, 1820, to use five acres of land to establish a Botanical Garden. This was finally located between First and Third streets and Pennsylvania and Maryland avenues. Mr. W. B. Bryan states[12] that as the waters of the Tiber probably came nearly up to that level the ground was somewhat swampy and first had to be drained. On May 26, 1824, the grounds were extended and in 1825 they were inclosed. There seems to be no record of what improvements or plantings were made by the Columbian Institute, which went out of existence about 1836,

[10] See COVILLE, FREDERICK V. *Early botanical activity in the District of Columbia.* Rec. Columb. Hist. Soc. **5**: 193. 1901.

[11] Bull. U. S. Nat. Mus. **101**: 12. 1917.

[12] BRYAN, WILHELMUS B. A history of the National Capital **1**: 314. 1914; **2**: 29, 326. 1916.

the Garden then being taken under government care as a part of the Capitol grounds. The Institute had expended $1500 on the grounds for walks and plantings and asked Congress to be reimbursed, but this request was not granted.

The National Institute was formed in the spring of 1841 with rooms in the Patent Office. The plants of the Wilkes Expedition of 1838 were at once placed in their care, as were all other Government scientific collections. Two small frame hot houses on the northern part of the Patent Office square were used to store part of the botanical collection. This Institute at one time had 1600 members, but went out of existence about 1860 or 1861[13] due to the taking over of the Government collections by the Smithsonian Institution, the National Institute having failed to obtain control of the Smithson fund on account of it being a purely private institute. The Smithsonian Institution was incorporated August 10, 1846. The building was not started until May, 1847, and was completed in 1855. The Government collections, presumably including plants which had previously been at the Patent Office under care of the National Institute, were turned over to the Smithsonian Institution in 1858 and the collections of the National Institute in 1861.[14] The collection of plants was transferred from the Smithsonian Institution to the U. S. Department of Agriculture in 1868 and was returned to the National Museum July 1, 1896. In 1851 the frame buildings above referred to were moved to the present site of the Botanical Garden. This site, which soon came to be recognized officially as the Botanical Garden, was placed in charge of W. D. Breckenridge, botanist of the Wilkes Expedition. William R. Smith, the late Superintendent, came to the Garden from the Kew Gardens in England in 1853 and remained until the date of his death.

[13] Encyclopedia Britannica ed. II. **25**: 274. 1911. Bryan (loc. cit.) states that it went out of existence in 1846 when the Smithsonian Institution was organized and that its collections were then turned over to the new institution. The Proceedings of the National Institute were, however, published as late as January, 1857, a set of which is in the library of the U. S. Department of Agriculture.

[14] Encyclopedia Britannica (loc. cit.). The National Museum was not officially mentioned by Congress until 1875, in connection with caring for the collections from the Philadelphia Centennial. It was erected in 1881.

The second nurseryman in the District, John Adlum,[15] for whom the genus Adlumia was named, like the first, devoted his attention from 1816 to 1836 mostly to grape culture. He owned about 140 acres of land, and his house, which was recently torn down, was located at the southeast corner of the Bureau of Standards, the old well being the only thing left to mark the site. Part of the northern slope of the valley directly south of the Bureau of Standards is still covered with a great tangle of grape vines, some of them being of considerable size. It is also possible to make out fairly well definite rows in which these vines were planted.

Joshua Pierce, from 1823 to 1869, was the first to conduct a general nursery in the District, consisting of about 82 acres located in Rock Creek Park, where the old stone house still stands.

The nursery of John Saul, consisting of about 120 acres, was located on Seventh Street Road from 1854 to 1897. The catalogues of this nursery indicate that the variety of stock was probably far ahead of that of any other nursery in this country at the time. Saul was a member of the District Parking Commission from the time of its origin until his death. On arriving in Washington in 1851 he, under the supervision of Andrew J. Downing, took charge of the improvements of Public Grounds, including the Mall, Smithsonian Grounds, Lafayette Square, and, in conjunction with W. D. Brackenridge, the Smithsonian Grounds. On the death of Downing in 1852 the appropriation by Congress was not renewed and Saul at once went into business for himself at Seventh and N Streets, N. W., where he conducted a seed business for many years.

From 1831 to 1874 the works by Dr. Leonard Gale and by W. D. Haley[16] were the only publications relating to the District flora and apparently very little botanical collecting was done. A small collection made here about 1860 or earlier by Dr. Arthur Schott,[17] an army surgeon, is now at the Field Museum of Natural History in Chicago.

[15] For further details of this and other nurseries see SAUL, JOHN A. Records of the Columbian Historical Society, **10**: 38–62, pls. 2–7. 1907.

[16] See Bibliography. He was chief examiner of patents from 1846–1857. For biography see the Gale Genealogy.

[17] See MILLSPAUGH, C. F. Field Columb. Mus. Pub. Bot. **1**: 281, 345. 1896.

The next renewal of Botanical activity began with the organization of the Potomac Side Naturalists Club[18] on January 29, 1858, which originally consisted of T. R. Peale, Dr. E. Foreman, Dr. G. C. Schaefer, Dr. C. Girard, Dr. F. V. Hayden, Dr. J. G. Cooper, Robert Kennicott, Prof. W. W. Turner, Dr. Wm. Stimpson, and W. R. Smith. Major W. Rich and W. Mechlin were included as the only members of the former Botanical Society and the following were among those later elected: J. S. Newberry, B. G. Wilder, T. H. Rothrock, Elliot Coues, Dr. Arthur Schott, H. Engelmann, M. S. Bebb, E. Bebb, and Thos. Eggleston, Dr. G. Suckley, F. B. Meek, and R. Ostensacken were elected as temporary residents. This society adjourned *sine die* on March 26, 1856, but was resurrected on May 1, 1873, at a meeting of the house of Prof. W. H. Seaman, and included Dr. Arthur Schott, H. Engelmann, M. S. Bebb, E. Bebb, Prof. S. F. Baird, Dr. Theodore Gill, and W. R. Smith, and reached a membership of 58. A committee consisting of Dr. George Vasey, Prof. J. W. Chickering, Dr. E. Foreman, Prof. Wm. H. Seaman, and Mr. Lester F. Ward was appointed to prepare a new District Flora with the result that a catalogue of 1083 species was published in 1876 and 117 additions were made during 1877.[19] The last meeting was held February 11, 1878, and in 1880 the Biological Society of Washington was organized with most of the old members of the Potomac Side Naturalists Club as members. Numerous papers on botany have been since published in their Proceedings.

Previously to 1869 there had been no official government botanist in Washington, although several botanists had been connected officially with various government exploring expeditions, but Charles C. Parry was now appointed botanist of the Department of Agriculture and served until 1871. He was followed on April 1, 1872, by George Vasey, who retained this position until his death March 4, 1893, and was succeeded by the present incumbent, Frederick V. Coville, on March 8, 1893.

[18] See Chickering, J. W., in Science, n. ser. **23:** 264–265, 1906, for detailed history.

[19] See bibliography under Flora Columbiana.

Prof. Lester F. Ward began collecting plants in the District of Columbia in the spring of 1872. It was September, 1880, when he first decided to prepare a catalogue of District plants, and on January 22, 1881, he presented to the Philosophical Society of Washington a paper entitled Field and Closet Notes on the Flora of Washington and Vicinity, in which he outlined his plan for a new catalogue of District plants, the character of his work on the subject for the preceding four years, and presented the manuscript of his catalogue with its introduction for inspection. On May 6, 1881, the same data but in more detail were presented before the Biological Society of Washington. After going over the subject with Prof. S. F. Baird the manuscript was accepted for publication as a bulletin of the U. S. National Museum and went to the printer on June 22, 1881. The check list was added in 1882. Some copies of the completed Flora were issued without the map on March 14, 1882, and not accepted, but it was completed April 12, 1882.[20]

Six supplements to Ward's Flora were published from 1884 to 1901 by Ward, Knowlton, Holm, and Steele and this period marks the beginning of a very large increase in the number of botanists, using the term in a broad sense, in the District of Columbia. This was due to the increase of the staff of the Department of Agriculture. The larger proportion were pathologists engaged primarily in economic work and there did not result any greatly increased activity in making known the District flora.

Dr. Ferdinand Blanchard, a well known botanist of Peacham, Vermont, was employed at the Census Office from 1890 until his death in 1892 and did considerable local collecting. Many of his specimens are in the National herbarium.

At the beginning of this period or about November, 1890, there was organized the Botanical Club of Washington, but for unknown reasons it was short lived, the last meeting being held April 7, 1892. No complete list of members exists, but the records of the bi-monthly meetings[21] refer to at least 39 members, in-

[20] Ward, L. F. Glimpses of the Cosmos, **2**: 448–462. 1913.

[21] The record book is now in the possession of Mr. L. H. Dewey, the last secretary of the Club.

cluding 9 ladies, among whom were Vernon Bailey, J. W. Chickering, F. V. Coville, L. H. Dewey, D. G. Fairchild, B. T. Galloway, J. M. Holzinger, L. O. Howard, F. H. Knowlton, C. L. Marlatt, J. N. Rose, W. H. Seaman, E. F. Smith, Theobald Smith, Effie A. Southworth, C. W. Stiles, W. F. Swingle, W. A. Taylor, George Vasey, wife and daughter, M. B. Waite, L. F. Ward, and T. A. Williams.

The Botanical Seminar, an informal society without regular officers, was organized early in 1893 by Messrs. Waite and Fairchild, including as charters members Frederick V. Coville, D. G. Fairchild, B. T. Galloway, Theodore Holm, E. F. Smith, and M. B. Waite. This society grew rapidly, meeting at the homes of the members, until a limit of 25 was reached. Then, as the members were mostly interested in plant pathology and physiology, those interested in systematic botany met at the home of C. L. Pollard on November 11, 1898, and formed the Washington Botanical Club, with Dr. E. L. Greene as President and Mr. Pollard as Secretary. These meetings also were held at the members' homes, and the rapid growth in the next three years again brought the society to the point of necessity of restricting its membership, if the meetings were to be continued at private residences. As a result a committee consisting of O. F. Cook, M. B. Waite, and H. J. Webber for the Botanical Seminar and W. R. Maxon, C. L. Pollard, and David White for the Botanical Club were appointed to consider a combination of the two organizations and the securing of adequate quarters for caring for the constantly increasing number of botanists in Washington, with the result that the present Botanical Society of Washington was formed in November, 1901, with A. F. Woods, President; Frederick V. Coville, Vice-president; C. L. Pollard, Recording Secretary; H. J. Webber, Corresponding Secretary; and W. H. Evans, Treasurer. At the end of six months the membership was 57, and has constantly increased since, until at the present time it has reached 175. The society is probably the largest local organization composed entirely of professional botanists.

But little known and yet unique was the National Science Club for Women, although national in character, yet most of its activities local. It was incorporated April 8, 1893, and issued from Washington Annual Proceedings and a Monthly Journal, but the club apparently went out of existence the latter part of 1899. Numerous botanical papers were published but none relating specifically to local botany.

Feeling the need of a flora of the District with notes and keys that could be used by local amateurs and by the school teachers and children, Mr. C. L. Pollard issued a prospectus with sample pages of such a flora about 1896, and while many of the families were subsequently written up the project was never completed. In continuation of this idea a number of the systematists in the Botanical Society of Washington formed a Seminar for discussing local flora work early in 1906, and as a basis for such work the writer prepared and issued (letterpress copy) in June of that year a compilation of all reported occurrences of plants in the District together with such additions as members of the Seminar could supply. The cards upon which the list was based were distributed by families to various local botanists who were to prepare these families. The work for the next few years was of a desultory character until 1912 when bi-monthly Seminar meetings for work on the local flora were begun at the instigation of Prof. A. S. Hitchcock, and have been held continuously up to the present time. Assignments of families were made to about thirty botanists, but pressure of official duties has resulted in the withdrawal of a few before the completion of the work.

RADIOTELEGRAPHY.—*Resonance measurements in radiotelegraphy with the oscillating audion.* L. W. AUSTIN, U. S. Naval Radiotelegraphic Laboratory.

For purposes of rough tuning, many workers have doubtless made use of the click heard in the telephones of an oscillating audion circuit when it is brought into resonance with another circuit at proper coupling. As the resonance click has apparently not been mentioned in any of the publications on radiofrequency measurements, it seems probable that it is not generally known that this click offers by far the quickest and simplest means of making nearly all measurements depending on the determination of resonance. The accuracy is quite equal to that obtainable with sensitive thermoelements, and greatly superior to the accuracy of the detector and telephone method.[1]

Since the audion circuit itself is not suited to exact calibration, the substitution method is generally used. The following examples illustrate the procedure:

Capacity of an antenna by substitution. The antenna is loaded with inductance so as to give a wave length of five to ten times the fundamental, then the oscillating audion circuit is coupled to the antenna inductance and the audion tuning condenser varied until a click is heard in the telephones. In general, if the coupling is close, the click will be heard at different points with increasing and decreasing condenser capacity. The coupling should then be loosened until both clicks appear at the same condenser setting, or, if this is impossible, the mean setting is taken provided the points are less than a degree apart. Next, leaving the audion condenser on the resonance point, the ground and antenna are disconnected from the antenna inductance and replaced by the calibrated variable substitution condenser. This last is adjusted to resonance with the audion circuit exactly as described above, and the capacity of the condenser is then equal to that of the antenna, subject to a small correction for the natural antenna inductance.

Wave length of a distant station. The receiving antenna and secondary oscillating circuit are first tuned exactly to the distant station, preferably at loose coupling, the audion tuning condenser being adjusted to give the dead point of the beats in the case of continuous wave reception. Next, without changing anything in the antenna or secondary a wave meter is coupled to the secondary and adjusted to resonance by the click method. The reading of the wave meter gives at once the wave length of the sending station.

In a similar way, wave meters can be compared and condensers and inductances calibrated, either by substitution or by making

[1] Care must be taken regarding harmonics, in all measurements in which bulbs are used for excitation.

use of the well-known relation existing between the product of inductance and capacity and the wave length.

Besides the simplicity and quickness of this method, it has the advantage that it does away with the necessity for all auxiliary apparatus in the wave meter, and enables measurements of the highest accuracy to be taken on shipboard and in other places where the use of sensitive galvanometers is impossible.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Oil shale of the Uinta Basin, northeastern Utah, and results of dry distillation of miscellaneous shale samples.* DEAN E. WINCHESTER. U. S. Geol. Survey Bull. 691–B. Pp. 27–55, with maps, sections, and illustrations. 1918.

The geography and geology of the oil shale are described, and the results of many distillations tests are given, which show yields of oil up to 90 gallons per ton of shale. A great many of the samples tested carried from 20 to 30 gallons of oil per ton of shale. There seems to be ample proof that the oil distilled from the oil shale of the Green River formation is largely obtained as a result of the destruction of the partly bituminized vegetable matter contained in the shale. Invariably the shale showing the larger percentage of vegetable débris will yield the most oil and vice versa, but shale beds occurring between beds of rich oil shale may be fully as compact and fine grained and yet yield no oil on distillation. There appears to be no reason why oil migrating into the shales should not penetrate all alike, and the oil might be expected to follow the beds of least resistance—that is the coarser beds of sandstone which are interbedded with the shales. It seems certain that if the oil had migrated into the shale such porous sands would contain at least small quantities of oil that might be obtained by distillation.

It is probable that the oil shales of the Green River formation may have been the source of all the vein hydrocarbons of the Uinta Basin as well as of the asphaltic material that saturates certain sandstones of the region.

R. W. STONE.

GEOLOGY.—*The Cosna-Nowitna region, Alaska.* Henry M. Eakin. U. S. Geol. Survey Bull. 667. Pp. 54, with maps and illustrations. 1918.

The Cosna-Nowitna region, which lies between Mt. McKinley and Yukon River on the north, is stratigraphically and structurally very complex. The geology presents much variety and many of the rock terranes recognized in this field can not yet be definitely correlated with the formations in other parts of the Yukon basin. Yet the age of at least two formations—the Ordovician and Devonian limestones—has been pretty definitely established, and these determinations will help to solve some of the stratigraphic problems of central Alaska. The correlation of the pre-Ordovician metamorphic sediments of the Cosna-Nowitna region with the Birch Creek schists of the Yukon-Tanana region also seems justified. There are some large areas of volcanic rocks and smaller ones of intrusive granite. The dominant trend of the structural features is northeasterly. The general events of the tectonic history of the region appear to include extensive crustal deformation in pre-Ordovician, post-Ordovician, post-Devonian, and probably late Mesozoic or early Tertiary time. The development of the present topography of the region is discussed.

R. W. Stone.

GEOLOGY.—*The coal fields of the United States. General introduction.* Marius R. Campbell. U. S. Geol. Survey Prof. Paper 100–A. Pp. 1–33. 1917.

A general introduction to a series of papers describing the coalfields of the United States. This paper defines the various kinds of coal, classifies and defines the coal areas, gives the production and estimates the tonnage of coal in the United States, and gives analyses of representative coals from many States.

R. W. Stone.

GEOLOGY.—*Cannel coal in the United States.* George H. Ashley. U. S. Geol. Survey Bull. 659. Pp. 126, with maps, sections, and illustrations. 1918.

This report defines, describes, and classifies cannel coal, and discusses its mode of occurrence, uses, production, value, and distribution. Cannel coal is one of the richest substances in hydrocarbons known, and it was because of the demand for the lighter hydrocarbons for use in chemical industry that this report was prepared.

R. W. Stone.

GEOLOGY—*The structure of parts of the central Great Plains.* N. H. Darton. U. S. Geol. Survey Bull. 691–A. Pp. 26, with maps, sections, and illustrations. 1918.

This report shows the structural features, such as domes and anticlines, that occur at many places in Kansas, Nebraska, South Dakota, Colorado, and Wyoming. While there is no evidence that the strata contain oil or gas in commercial pools these folds are more favorable for the location of tests than the basins or the monoclines. Only the drill can determine whether or not oil is present. It is believed that a presentation of all available facts as to structural conditions in this region is warranted by the prevailing great interest in the possibility of the occurrence of petroleum and gas.

R. W. Stone.

ZOOLOGY.—*The unstalked crinoids of the Siboga expedition.* (Monograph XLII*b* of: Uitkomsten op zoologisch, botanisch, oceanographisch en geologisch gebied verzameld in Nederlandsch Oost-Indie 1899–1900 aan boord H. M. Siboga onder commando van Luitenant ter zee I[e] kl. G. F. Tydeman.) Austin H. Clark, U. S. National Museum. Leiden, March, 1918. Pages i–ix, 1–300. 17 text figures; plates I–XXVIII (except IV and X, the originals of which were lost on the "Laconia"), of which plates I–X are in colors.

This memoir, which is an extension of and a supplement to the *Crinoids of the Indian Ocean* published by the same author (Calcutta, 1912), gives a monographic account of the comatulid fauna of the East Indies. Keys to all the species, genera, and families are included.

The identity of the urinoid fauna of the Arc Islands with that of Australia is mentioned, and the close similarity between the Sumbawa-Moluccas fauna and that of southern Japan is emphasized.

There are known at present 576 species of recent crinoids, distribured in 142 genera; in the course of her explorations the "Siboga" collected 163 species, representing 71 genera; of these 73 species and 3 genera were new to science.

A. H. C.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

A special meeting of the Board of Managers was held on July 15, 1918. Resolutions were passed urging the War Industries Board and all other authorities concerned to grant unrestricted supplies of materials and labor to the publishers of scientific periodicals, in order that this country shall not fall behind its Allies or the enemy contries in this phase of the encouragement of scientific research.

The following persons have become members of the Academy since June:

Mr. James Madison Hill, 2nd, U. S. Geological Survey, Washington, D. C.

Dr. Robert Tracy Jackson, Peterboro, New Hampshire.

Mr. Frank J. Katz, U. S. Geological Survey, Washington, D. C.

Captain Albert Prescott Matthews, University of Chicago, Chicago, Ill.; and Quartermaster's Office, Headquarters of Central Depart-partment, Chicago, Ill.

Mr. H. D. Miser, U. S. Geological Survey, Washington, D. C.

Mr. Ralph Walter Stone, U. S. Geological Survey, Washington, D. C.

Lieut. David L. Wester, National Research Council, 1023 Sixteenth Street, Washington, D. C.

Robert B. Sosman, *Corresponding Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 806th meeting of the Society was held at the Cosmos Club, April 27, 1918. Vice-President Sosman in the chair; 49 persons present. The minutes of the 805th meeting were read in abstract and approved.

The first paper on *Fog and cloud* was presented by W. J. Humphreys. This paper was illustrated by lantern slides.

The deposition of dew and the sweating of ice pitchers are familiar examples of the condensation of atmospheric moisture on relatively cold objects. In exactly the same way condensation takes place on the innumerable dust motes and other nuclei in the atmosphere whenever by expansion or otherwise it is cooled to a temperature below the dewpoint.

Condensation on the nuclei of the atmosphere is divided primarily into fog and cloud, but a sharp distinction between them that would enable one always to say which is which is not possible. In general, however, a fog differs from a cloud only in its location. Both are owing, as explained, to a cooling of the atmosphere to a temperature below its dew point, but in the case of the cloud this cooling usually results from vertical convection, and hence the cloud is nearly always separated from the earth, except on mountain tops. Fog, on the other hand, is induced by relatively low temperatures at and near the surface, and commonly itself extends quite to the surface, at least during the stage of its development. In short, fog consists of water droplets or ice spicules condensed from and floating in the air near the surface; cloud, of water droplets or ice spicules condensed from and floating in the air well above the surface. Fog is a cloud on the earth, cloud a fog in the sky.

Fog may be divided into two types according to the process by which the necessary cooling of the air is produced. These are *radiation fog* and *advection fog*. The first, or radiation fog, occurs during still clear nights when the atmosphere is rather humid. On such occasions the surface of the earth and the lower atmosphere are cooled by radiation to a temperature sufficiently low to induce both surface and volume condensation. Hence the name "radiation fog." The other type, to which the name "advection fog" is given, is the result of the horizontal flow of warm humid air to a colder region or of cold air to a relatively warm humid region.

Clouds cannot be so simply and logically classified as fogs. Their exact mode of production, whether by convection, mixing, or radiation, is not always obvious. Hence they generally are classified according to appearance and position. The fundamental types are: *cirrus, stratus, cumulus*, and *nimbus*. To these are added several alto, fracto, and combination types, such as "alto-stratus," "fracto-stratus," and "cirro-stratus." In addition to all these various special and more or less unusual forms are recognised, such as "billow cloud," "lenticular cloud," "banner cloud," "scarf cloud," "mammato-cumulus," et cetera.

Not all altitudes are equally frequented by clouds. There are five elevations of maximum and five of minimum cloudiness, each of which may be simply explained.

Discussion: Messrs. BAUER and FORD discussed this paper.

The second paper on *Notes on dip-of-horizon measurements made on the "Galilee" and "Carnegie"* was presented by Mr. W. J. PETERS, and was illustrated by lantern slides.

This paper states that while reliable observations have shown the sea-horizon to have been elevated occasionally 10′ to 15′ above its normal position by refraction, such large values are probably confined to the borders of equatorial and polar currents and to small areas of water swept by breezes blowing directly off heated lands or office fields.

In over 3000 observations taken during ten years work at sea by the Department of Terrestrial Magnetism, the refraction at the horizon has never been found to exceed 2.4′ for a height of eye of 18 to 24 feet.

A short description of the Pulfrich dip-measurer was given with an account of the difficulties of observing at sea both with this instrument and all instruments in general.

The paper concluded with an exhibition of the results of an adjustment of all the observations made on the *Galilee* and those made on the recent cruise of the *Carnegie.*

Comparisons with the results of other observers were shown as well as comparisons with the standard tables.

The latter comparisons showed that the standard tables of dip-of-horizon are sufficiently accurate for the navigator and cannot be improved by the introduction of a temperature or a temperature-difference argument when the result is required for the oceans.

The 807th meeting was held at the Cosmos Club, May 11, 1918. President Burgess in the chair; 42 persons present. The minutes of the 806th meeting were read in abstract and approved.

The first paper on *The constitution of the gas ion* was presented by A. Q. Tool. This paper was illustrated by lantern slides.

The mobility of the negative ions was determined by three closely related methods. The first was the usual alternating potential method, which is a modification of Rutherford's original method. This gave values which were larger than that for the so-called normal ions, where the normal ion is defined as the ion whose mobility obeys the law $u = kP$. These large values were shown to be due to numerous fast ions still growing as well as a large number of electrons.

The second method may be considered as the reverse of the one above, the potential in the positive or accelerating half period being maintained constant while that in the negative half period was varied in determining the current curve. A "critical potential" was then found from the break in this curve which gave mobility values as low or lower than that usually obtained for the normal ion. This indicated the presence of ions larger than the normal ion. Their mobility obeyed the law cited above.

The third method made use of the relation existing between the usual saturation current curve and the current curve obtained in Rutherford's method when the alternating potential is produced by a rotary commutator. By this third method it was possible to show something of the mobility distribution of the ions in a gas. Large numbers of normal ions were found to exist at all pressures in air even when carefully dried.

Through the use of these three methods it was possible to detect ion growth, also ion disintegration. This latter was especially marked in air nearly saturated with water vapor. The results strongly supported the complex ion theory.

The second paper, on *Corresponding changes in the earth's magnetic state and in solar activity, 1888–1916,* was presented by Mr. L. A. Bauer and was illustrated by lantern slides.

The prime object of the present investigation is to ascertain to what extent the earth's magnetic state at any time may be dependent upon solar conditions, i.e., upon causes exterior to the earth. The purpose is not to determine anew the relation between fluctuations in the earth's magnetism about some base line or normal value and fluctuations in the sun's activity, but rather to find out whether the base line or normal value itself varies with solar activity, and, if so, how. Thus during periods of intense sun-spot activity, violent fluctuations in the earth's magnetism are known to occur. These fluctuations may continue for a few hours or for a few days and then subside. There is often found to be an after effect, of a quiescent, persistent character, as the result of which the earth's magnetization remains below par for several months, or more, after the apparent cessation of the magnetic storm.

It is a matter of no little interest to know whether the earth's magnetic state ever completely returns to a former state after having experienced such magnetic-storm effects as described. Some previous investigations bearing on this question had been made and reported upon by the author on the basis of data extending over a few years at the most. Now, however, the investigation applies to data extending over a period of about $2\frac{1}{2}$ sun-spot cycles.

It is shown that the absolute values of the magnetic elements that define the earth's magnetic state at any time vary in a definite and in an appreciable manner with change in the sun's activity, as revealed to us by sun-spottedness and by values of the solar constant of radiation. The two sets of measures of solar activity serve to supplement each other in determining the causes for the anomalous changes in the earth's magnetic state from year to year.

The conclusions indicate that in the selection of a common epoch to which the magnetic elements resulting from a magnetic survey shall be reduced, consideration may have to be paid to the position of the epoch with reference to the years of maximum and minimum solar activity.

The conclusions also confirm those reached by the author in a paper presented before the Society in October, 1904, viz, that the secular variation of the earth's magnetism, besides being caused by a system of forces below the earth's surface, is also appreciably caused by a system above the earth's surface, and that the secular variation results not only from changes in the direction of magnetization, but likewise from changes in the intensity of magnetization of the earth.

H. L. Curtis, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

A Washington Section of the American Institute of Mining Engineers was organized on June 20, 1918. The officers elected were: Mr. Herbert Hoover, of the Food Administration, chairman; Dr. H. Foster Bain, of the Bureau of Mines, and Dr. David White, of the U. S. Geological Survey, vice-chairman; Mr. Harvey Mudd, secretary.

The National Research Council, at the request of the Secretary of War and the Secretary of the Navy, has organized a committee on explosives investigations. The membership of the committee is as follows: Dr. Charles E. Munroe, of George Washington University, chairman; Mr. L. L. Summers, of the War Industries Board; Lieut.-Col. W. C. Spruance, Jr., of the Ordnance Department of the Army; and Lieut.-Commander T. S. Wilkinson, of the Ordnance Department of the Navy.

The experimental ammonia plant and laboratory of the Bureau of Soils at Arlington, Virginia, has been transferred to the Nitrate Division of the Ordnance Department of the Army. The work is in charge of Dr. R. O. E. Davis and Mr. L. H. Greathouse.

All of the "gas warfare" work of the Army has been consolidated under a new division of the War Department, the "Chemical Warfare Service," under Major General William L. Sibert. The experimental work heretofore carried on by the Surgeon General's Office and the Ordnance Department are included, as well as the American University Experiment Station of the Bureau of Mines, which, with its entire personnel, civilian and military, is transferred to the control of the War Department for operation under the director of gas service, by executive order of the President dated June 25, 1918. The Chemical Warfare Service also has the responsibility of providing chemists for all branches of the government and of assisting in the procurement of chemists for essential industries. General Pershing has been directed to conform his organization in France to that adopted here.

The former "chemicals and explosives section" of the War Industries Board has been reorganized into two divisions: a "chemicals division" in charge of Mr. Charles N. MacDowell, and an "explosives division," in charge of Mr. M. F. Chase. The chemicals division is subdivided into the following sections: acids and heavy chemicals, artificial and vegetable dyes, alkali and chlorine, chemical glass and stoneware, coal gas products (benzol, toluol, etc.), rare gases, creosote, electrodes and abrasives, ethyl alcohol, ferroalloys (chromium, manganese, tungsten), fine chemicals, nitrates, paints and pigments, platinum, refractories, sulfur and pyrites, tanning materials, wood chemicals. The consulting staff, mentioned in this column of June 19, 1918 (p. 416), consists at present of Dr. E. R. WEIDLEIN, chief, Prof. N. R. MOODY, and Dr. THOMES P. MCCUTCHEON, of the University of Pennsylvania.

The Committee on Mineral Imports and Exports has finished its work of formulating programs for the minimum importation of ores and minerals, and the members of the committee have taken up other work. Prof. C. K. LEITH has been appointed mineral adviser to the War Industries Board from the standpoint of the conservation of shipping, Mr. J. E. SPURR is in charge of the war minerals investigation work of the Bureau of Mines, and Mr. POPE YEATMAN continues in charge of the Non-Ferrous Metals Divisions of the War Industries Board.

The New National Museum has been closed to the public by the board of regents, as all available space in the building has been occupied by the Bureau of War Risk Insurance. It is expected that the Museum will be again opened when the new office building of the Bureau, at Vermont Avenue and H street, is completed.

Dr. CLEVELAND ABBE, meteorologist of the Weather Bureau and editor of the *Monthly Weather Review*, was removed from office by the Secretary of the Interior on July 3, 1918. The chief of the Bureau, Prof. C. F. MARVIN, in transmitting the order, stated that the dismissal resulted from Dr. Abbe's "long-standing and generally well-known friendly sympathies for the imperial German government," and that investigations leading to dismissal were initiated by sources outside of the Bureau and carried forward by the Department of Justice. Dr. Abbe has denied that he is disloyal and has requested an opportunity to reply to any charges presented.

Dr. OLAF ANDERSEN, petrologist at the Geophysical Laboratory, has resigned in order to accept the position of government geologist and director of an experimental silicate laboratory for the Norwegian Government, in Kristiania. Dr. Andersen will leave in September or October.

Dr. S. J. BARNETT has resigned as professor of physics at the Ohio State University and has accepted the post of physicist in change of experimental work in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, beginning his work there on July 15.

Dr. F. E. BREITHUT, assistant professor of chemistry at the College of the City of New York, is on leave of absence and has been commissioned a major in the Chemical Warfare Section.

Dr. Edgar Buckingham, of the Bureau of Standards, has been appointed physical associate to the scientific attaché to the American embassy at Rome.

Mr. George A. Burrell, in charge of the American University Experiment Station of the Bureau of Mines, has been commissioned a colonel in the Chemical Warfare Service, National Army.

Major William B. Greeley, formerly of the Forest Service, has been commissioned a lieutenant colonel. He is at present with the American Expeditionary Forces in France.

The honorary degree of A.M. has been conferred by Harvard University on Mr. Hennen Jennings, consulting mining engineer.

Prof. Lauder W. Jones, formerly of the University of Cincinnati, and recently appointed head of the department of chemistry of the University of Minnesota, is on leave of absence and is engaged in research at the American University Experiment Station.

Dr. Thomas J. Kelley has been appointed professor of gynecology in the Medical School of Georgetown University, as the successor of Dr. Isaac Stone, who resigned in June after twenty-six years of service with the Medical School. Dr. James M. Moser and Dr. John A. Foote have been appointed associate professors of pediatrics.

Prof. A. E. Kennelly, acting head of the department of electrical engineering of the Massachusetts Institute of Technology, is in Washington for the summer on special work for the Signal Corps.

Dr. John Harper Long, Professor of Chemistry at the Northwestern University Medical School, Chicago, Illinois, and a member of the Academy since 1899, died at his home in Evanston on June 14, 1918, in his sixty-first year. He had been with Northwestern University for the past thirty-seven years, and had been active in physiological chemical research as well as in the public service, having been a member of the referee board of the Department of Agriculture, a member of the revision committee of the Pharmacopoeia, and president of the American Chemical Society (in 1903). He was the author of several text-books of chemistry.

President R. C. Maclauren, of the Massachusetts Institute of Technology, came to Washington in July to act as educational head of a students' army training corps, organized to give military instruction to student volunteers who are not yet of draft age.

Mr. Edwin H. Pagenhart, hydrographic and geodetic engineer of the U. S. Coast and Geodetic Survey, has been transferred to the Corps of Engineers (Reserve) of the army, with the rank of Captain.

Dr. Richard Rathbun, a charter member of the Academy, died at his home, 1622 Massachusetts Avenue, on July 16, 1918. Dr. Rathbun was born at Buffalo, New York, January 25, 1852. His earlier years were spent in scientific work for the Boston Society of Natural History, the Imperial Geological Commission of Brazil, the department of zoology of Yale University, and the United States Fish Commission. Since 1897 he had been Assistant Secretary of the Smithsonian Institution, and had been in charge of the National Museum since 1899. His scientific publications were concerned chiefly with Brazilian paleontology and the marine invertebrates and the fisheries of the United States. Dr. Rathbun was a member of the Biological Society of Washington, a past president of the Philosophical Society of Washington, and a past president of the Cosmos Club.

Dr. J. N. Rose, associate curator of the Division of Plants, National Museum, left Washington on July 22 for an extended trip of botanical exploration through Ecuador, under the auspices of the U. S. National Herbarium, the U. S. Department of Agriculture, the New York Botanical Garden, and the Gray Herbarium. His headquarters during the summer will be at Huigra, and his address will be care of American consul at Guayaquil, Ecuador.

The Reverend George Mary Searle, C.S.P., superior general of the Paulist Fathers from 1904 to 1909, and formerly professor of mathematics and director of the astronomical observatory at the Catholic University, died on July 8, 1918, at the age of seventy-nine. He was born in London, England, June 27, 1839, graduated from Harvard University in 1857, and was connected at various times with the Dudley and the Harvard College Observatories, the U. S. Naval Academy, and the U. S. Coast and Geodetic Survey. He was a member of the Philosophical Society of Washington, and had been for many years a member of the Academy, from which he had resigned but a few months ago.

Dr. W. F. G. Swann left the Bureau of Standards on August 1, 1918, to take up his new work as professor of physics at the University of Minnesota.

Dr. Walter T. Taggart, professor of organic chemistry in the University of Pennsylvania, is engaged in war research for the Nitrate Division in Washington.

Prof. A. Tanakadate, professor of physics in the University of Tokyo, and member of the Imperial Academy of Science, visited Washington in July on business connected with certain international scientific commissions whose activity has been interfered with by the war.

Dr. William S. Thayer, of Baltimore, was elected a foreign member of the Académie de Médicine of Paris on July 2, 1918.

Prof. S. W. Young, professor of physical chemistry at Leland Stanford Jr. University, is in Washington for the summer, engaged in war research at the Bureau of Standards.

N. H. Darton, of the Geological Survey, will spend several months in New Mexico continuing his studies of the Redbeds, with special reference to the possibility of their containing potash deposits.

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PHYSICS.—*Low voltage discharge in sodium vapor.* PAUL D. FOOTE and F. L. MOHLER, Bureau of Standards.

The question of separate excitation by electronic impact of the doublet lines of the principal series of thallium was raised by the writers at the New York meeting of the American Physical Society, April 1918. The resonance potential for electrons in thallium vapor was observed to be 1.07 volts. This corresponds on the basis of the quantum relation, $h\nu = eV$, to a frequency $\nu = 8683$ or to a wave length $\lambda = 11513$ Å, the shorter wave-length member of the first term of the principal doublet series. No indication of resonance at 0.95 volts could be detected corresponding to $\lambda = 13014$ Å, the other member of the doublet. The question therefore suggests itself as to whether the line $\lambda = 13014$ is excited at the resonance potential of 1.07 volts. The behavior of thallium in this regard may be very likely similar to that of sodium. Accordingly we might expect the shorter wave length D_2 of the sodium spectrum to appear at the resonance potential 2.10 volts and the wave length D_1 not to appear until the ionization potential of 5.13 volts was attained.

Figure 1 represents the apparatus employed. A is a lime-coated Wehnelt cathode, C the anode, and B a glass tube sealed at both ends with glass plates through which the arc discharge was viewed. The object in using such a tube was to permit observation directly upon the arc without the presence of the absorbing unexcited sodium vapor. The tube was electrically heated to about 300°C. and evacuated to a pressure of about 10^{-3} cm. Hg as registered by a McLeod gauge. For observing the spectral lines a diffraction grating having 15,000 lines to the inch was employed and the observations were made with an eye piece of such magnification that the two *D* lines showed distinctly with a rather wide slit opening. This was necessary on account of the low intensity of the light at small voltages.

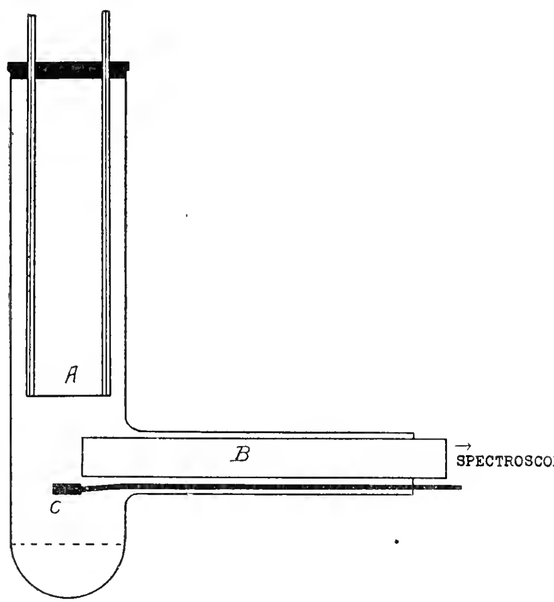

Fig. 1. Diagram of apparatus.

A visible yellow glow could be detected when the accelerating field across *AC* was as low as 0.8 volts. Since the resonance potential is 2.1 volts, the initial velocity of a considerable number of the electrons emitted by the hot cathode must have been about 1.3 volts. As the voltage increased the intensity of the discharge rapidly increased. At an applied potential of 5.2 volts the character of the arc changed entirely, the second subordinate series of sodium appearing, thus indicating ionization; and the arc became very brilliant. The applied potential of 5.2

volts is nearly equal to the ionization potential. This fact shows that the initial velocity of the greater portion of the electrons emitted from the cathode could not have been as high as 1.3 volts. At an applied potential of 2 volts, a true potential certainly not greater than 3.3 volts, the two *D* lines were distinctly visible, and as nearly as could be judged, the ratio of their intensities remained about the same as the applied voltage was decreased to 0.8 volts, when both lines disappeared. Hence our work would indicate that the two *D* lines appear together at the resonance potential.

This observation is not, however, conclusive evidence that the lines were not separately excited by electronic impact. Wood and Mohler[1] have shown that in the excitation of sodium vapor by incident radiation, although it is possible to excite the *D* lines separately, in general both lines appear since the influence of the surrounding vapor may cause a transfer of energy from the excited line to the other component of the doublet. Possibly a similar influence is present in the above observations.

The fact that the higher frequency line of the thallium doublet determines the value of the energy quantum absorbed, on the other hand, may be analogous to the emission of characteristic X-rays under electronic bombardment. D. L. Webster[2] concluded that the *K* group does not appear until the energy of the impacting electrons is greater than that corresponding to the highest frequency of the *K* group, namely, $K\gamma$. At this voltage all of the lines of the *K* group appear and the ratio of the intensity of the lines remains the same when the voltage is further increased. Similarly in the case of collision of the atom of thallium, sodium, etc., with electrons of low velocity, both lines of the doublet may always appear simultaneously, as observed directly for sodium, while the line determining the value of the quantum is the line of higher frequency, as observed directly for thallium. However, if the *K* group is to be looked upon as a series of lines, the above analogy is not justified.

[1] Phys. Rev. **11**: 70. 1918.

[2] Phys. Rev. **7**: 599. 1916.

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BOTANY.—Chenopodium nuttalliae, *a food plant of the Aztecs.* W. E. SAFFORD, Bureau of Plant Industry.

In connection with his study of the economic plants of Mexico the writer has come upon a Chenopodium eaten in the form of a vegetable by the ancient Mexicans, but hitherto unknown to botanists, and incorrectly referred by several Mexican writers to the European *Chenopodium bonus-henricus* L., to which it bears little resemblance. The material from which this species is here described was received by the writer from the well-known archeologist and ethnologist, Mrs. Zelia Nuttall, of Casa Alvarado, Coyoacan, near the city of Mexico, who collected it in response to a request for the seeds of "huauhtli."

Instead of Amaranthus seeds, which he had expected, the writer received the seeds and inflorescence heads of a Cheno-

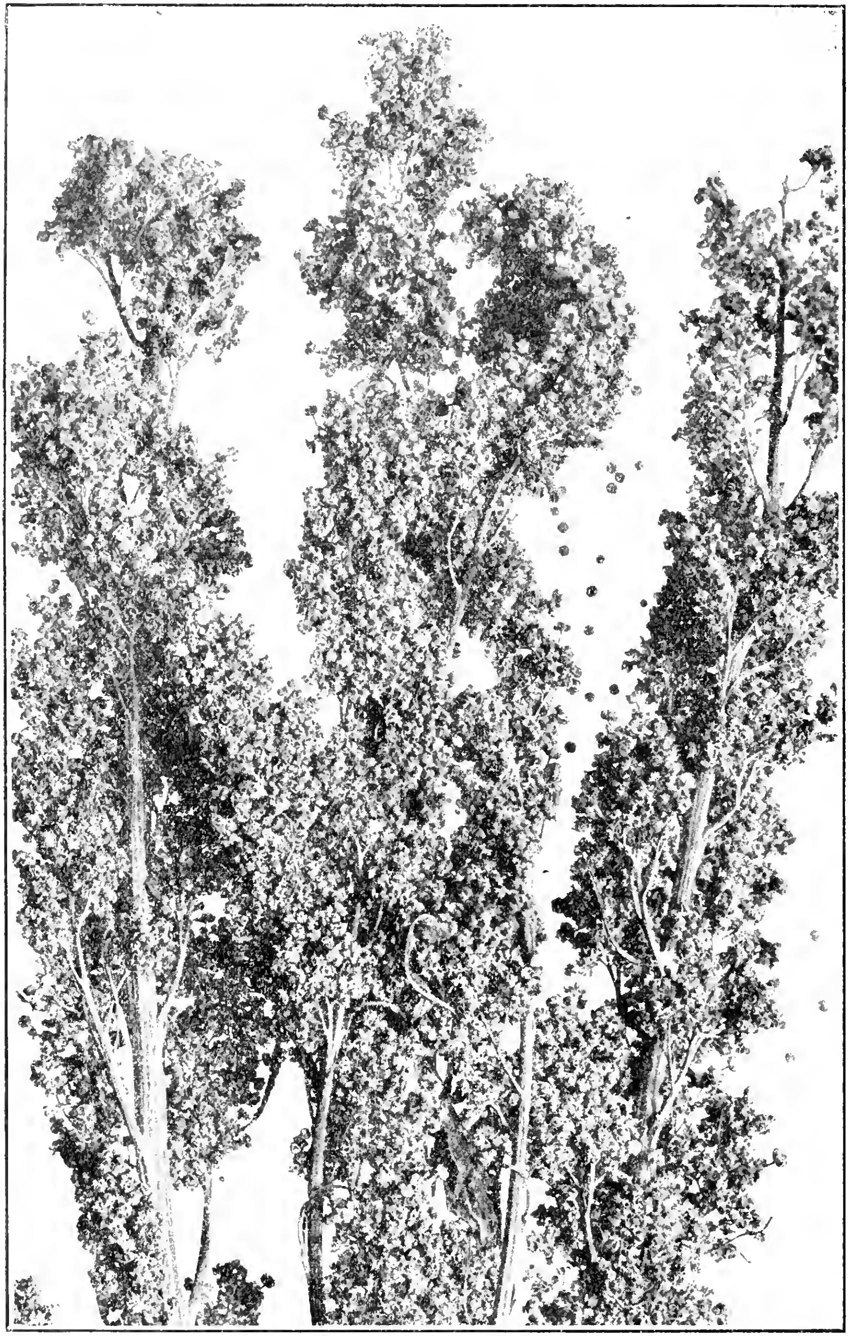

Fig. 1. *Chenopodium nuttalliae* Safford, called Uauhtzontli by the Aztecs. Natural size. Photograph of specimens collected by Mrs. Zelia Nuttall.

podium labeled "*Huautzontli*," which proved to be a species not represented in the United States National Herbarium, nor included in Dr. Urbina's *Catálogo de Plantas Mexicanas del Museo Nacional de México.* More remarkable still, the name *huauzontli* is applied in that work to the European plant, *Chenopodium bonus-henricus*, already mentioned; and in Dr. Urbina's list of food plants, published in *Las plantas comestibles de los antiguos Mexicanos*, neither this nor any other species of Chenopodium is included.[1] The writer ventures, therefore, to describe it as a new species and, in honor of the distinguished lady who has brought it to his notice, he proposes for it the name *Chenopodium nuttalliae.* A more detailed account of this plant, together with several other allied species, will be given in his forthcoming paper on the *Economic chenopods and amaranths of America*, to be published in the *Journal of Heredity.*

Chenopodium nuttalliae Safford, sp. nov.

Uauhtzontli, or Huautzontli, of the Aztecs; Huauzontle, or Guausoncle, of the modern Mexicans. *Chenopodium bonus-henricus* Auct. Mex. (non *C. bonus-henricus* L. Sp. Pl. 218. 1753.).

An odorless herbaceous annual resembling *Chenopodium album*, with upright striate slightly mealy stem and branches and pale green foliage. Leaves alternate, variable in shape; petioles slender, usually equal to the blade in length; blades triangular-ovate or rhomboid, the lower ones sinuate-dentate and somewhat hastate, obtuse and apiculate at the apex, those of the inflorescence lanceolate or rhomboid; flowers on short branches closely crowded and forming dense terminal paniculate clusters; branches of the inflorescence sparsely mealy or scurfy; sepals sparsely mealy, green, white-margined, ovate, keeled, when mature convex and connivent over the fruiting achene; the latter, loosely covered by the calyx, lenticular or discoid, about 2 mm. in diameter with the closely adherent pericarp pale yellow, rose-colored, or orange, or sometimes dark brown and smaller (1.4 mm. in diameter), with a distinct marginal ring; seed horizontal, shaped somewhat like a miniature nautilus shell, in both the brightly tinted and in the dark-brown achenes horn-colored.

Type in the United States National Herbarium, cultivated in the vicinity of Mexico City and purchased in the market at Xochimilco, November 25, 1917, by Mrs. Zelia Nuttall, the distinguished archeologist and authority on Mexican history and ethnology, in honor of whom the species is named.

[1] See Anales del Muséo Nacional, II, **1**: 503–591. 1904.

Range: Unknown in a wild state; said by Mrs. Nuttall to be widely cultivated in the states of Michoacan, Oaxaca, Veracruz, and Tamaulipas, "a species that the Mexicans have been using from time immemorial."

The name Uauhtli, or Huauhtli, was applied by the Aztecs, not only to their seeds but to the plants themselves. The latter, when cooked for "greens" (Aztec, *quilitl*) were called *huauquilitl*. *Uauhtzontli*, which has been modified to *Huausoncle* or *Guausoncle*, may be rendered "seed-heads," or "huautli-crests." It has been given to several other plants beside the one here described. The late Professor Alfredo Dugès of Guanajuato applied it to an ill-smelling Chenopodium called by the Mexicans "quelite hediondo" (stinking greens), of which he wrote: "On en mange les inflorescences cuites, sous le nom de *Guausoncle*, ou *Quauhzontli* en mexicain. Triste légume!" By Fray Agustin Vetancurt (1698) the name was given, in the form Cuauzontli, to *Amaranthus leucospermus* S. Wats., which he described as growing upright in the form of miniature trees, with entire leaves like those of *lengua de vaca* (Rumex) and with terminal purple or yellow plumes bearing minute white sesame-like seeds, used for making certain "small tamales called *tzoales*."[2]

Dr. Robelo of Cuernavaca, following Alcocer and other Mexican writers, referred the plant here discussed, to *Chenopodium bonus-henricus* L., with the following note under the names *Guausoncle* or *Huausoncle*, the original Aztec form of which, *Huautzontli*, he translates as "bledos como cabellos." "A garden plant producing a terminal cluster of whitish flowerets, beneath which are developed spikes of edible seeds. They may be dried and kept for a year. When required for use they are put into water and soaked for a day, and may be eaten the day following."[3] It is only necessary to look at the acompanying illustration showing a leaf of the species here described compared with one of *Chenopodium bonus-henricus* L. (fig. 2) to see the dissimilarity of the two plants, and the difference between the

[2] See Safford, W. E., *A forgotten cereal of ancient America* published in the Proceedings of the Nineteenth Congress of Americanists, pp. 286–297. 1917.

[3] See Robelo, Cecilio A., Diccionario de Aztequismos, pp. 577, 579. 1904.

seeds of the two species is equally great, as shown in figures 3, *c* and 3, *e*.

Accompanying the seeds and inflorescence heads were the following notes of Mrs. Nuttall. On September 27, 1917, she writes:

> This morning I was at the market of Xochimilco and bought fine bunches of Uauhtli in bud, which is eaten as a green vegetable. The spikes are washed and dipped in batter composed of egg, flour, and grated cheese, and then fried in lard. The ends of several spikes are thus held together, and it is the custom to seize the stem and draw them through the teeth, thus detaching the very palatable green buds [unripe achenes], which form thick clusters. The immature inflorescence prepared in the above or in other ways is called Uauhtzontli.

In a subsequent letter, dated November 25, 1917, Mrs. Nuttall writes:

> Huauhzontli combines the properties of a cereal and a vegetable and furnishes a substantial meal. When fresh and the seeds are "in milk" the food is to me delicious. I am told that it is almost as good when prepared from the dried inflorescence.

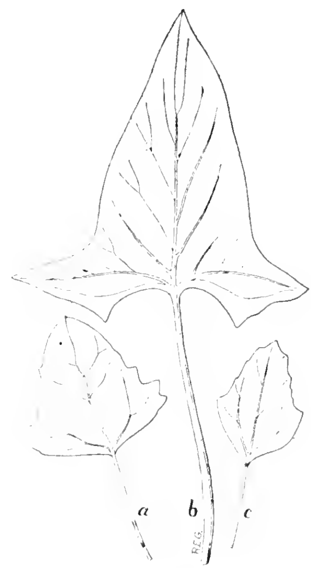

Fig. 2. Leaves of Chenopodium. *a*, *C. nuttalliae* Safford; *b*, *C. bonus-henricus* L.; *c*, *C. quinoa* Willd. × ½.

The accompanying photographs of achenes and seeds (enlarged 6 diameters) of *Chenopodium nuttalliae* and those of *Chenopodium quinoa* Willd., *C. bonus-henricus* L., and *C. album* L., species with which it has been confused, show at a glance the characters of each. Figure 3, *a*, is the common form of the pale yellow, or rose-colored achenes of *C. nuttalliae*, figure 3, *b*, the small dark-brown, or "black" form, and figure 3, *c*, the seeds divested of the pericarp, which in all forms are horn-colored, not ivory white, as in *C. quinoa*, nor black, as in *C. album*, and they are in the form of a flattened spiral, not ven-

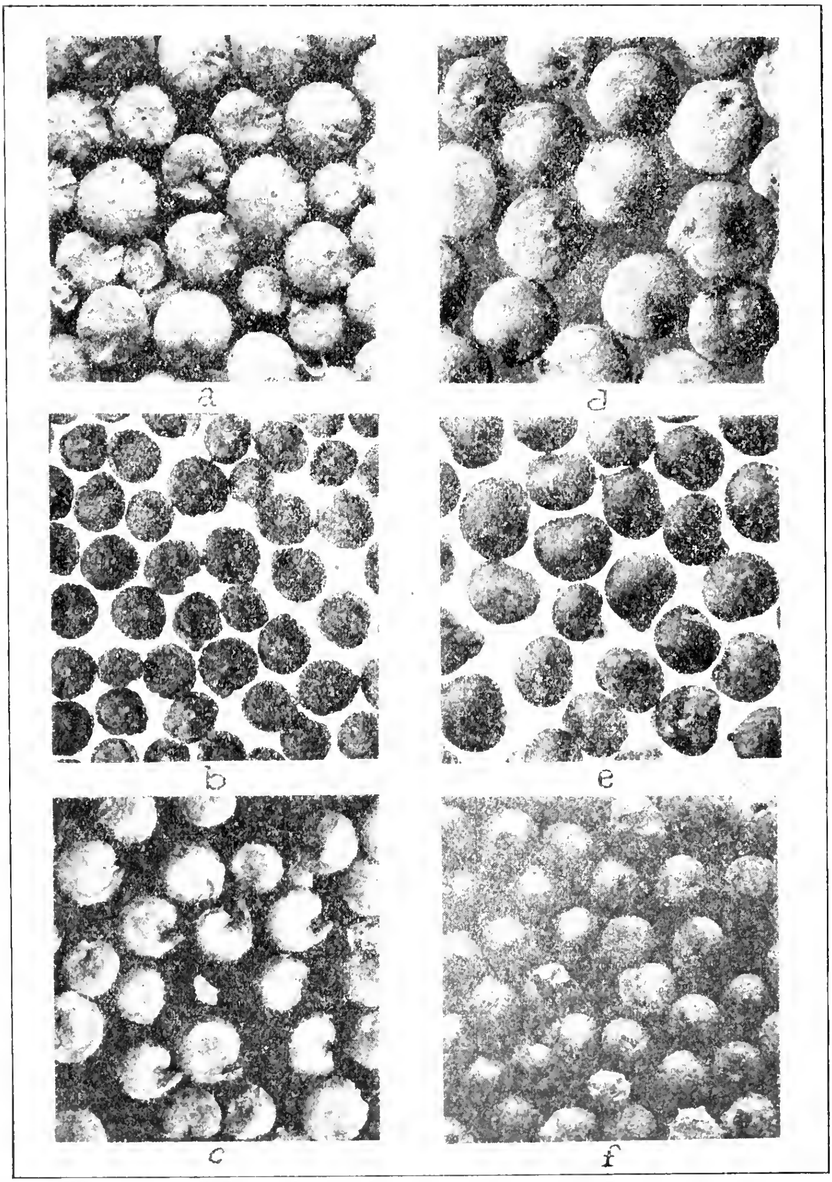

Fig. 3. Achenes and seeds of economic species of Chenopodium enlarged 6 diameters. *a, b, c, C. nuttalliae* Safford; *d, C. quinoa* Willd.; *e, C. bonus-henricus* L.; *f, C. album* L.

tricose, or spheroid, as in *C. bonus-henricus*. Figure 3, *d*, is the white-seeded form of *Chenopodium quinoa* of Peru and Bolivia; figure 3, *e*, the seeds of the European "Good-King-Henry" or "all-good" (*C. bonus-henricus*); and figure 3, *f*, the achenes of lambs-quarter (*C. album*) the black seeds of which are used for food by the Indians of our Southwest, and are grown as a grain-crop in various parts of India.

BIOLOGY.—*The biological significance of false witches'-brooms in Ericaceous plants.* JEAN DUFRENOY, Station Biologique d'Arcachon. (Communicated by G. N. Collins.)

Peculiar shoots showing infection by *Exobasidium unedonis* Maire + *Gloeosporium conviva* Maire, have been recorded by Professor Maire on *Arbutus unedo* in Algeria, and compared by him to witches'-brooms. Other peculiar shoots showing infection by *Glocosperium myrtillus* sp. nov. have been seen by the author and similarly compared.

Witches'-brooms, which had long been considered parasitic infections, are viewed by Vuillemin ('17) as symbiotic associations in which profit is derived by both symbionts, mutually, or at least alternately. "Witches'-brooms are to the shoot what mycorrhizas are to the root."

In view of this new interpretation, the significance of the "false witches'-brooms" in Ericaceae may be discussed here, from biological data rècorded by the author.

I. *Duration of life.* Winter dormancy ends sooner in witches'-brooms than in healthy shoots—as recorded by Schellenberg for Firs, *Betula*, etc. Maire ('16) observed that the false witches'-brooms of *Arbutus* develop in February in Algeri ehen no healthy shoots have appeared, and also die much soonr, being actually wilted before the normal shoots have finished growing. In Arcachon, however, false witches'-brooms were still found living in November. Since the premature death of the brooms in Algeria may be due to lack of water, some discussion of transpiration conditions is necessary.

II. *Transpiration.* It has been assumed that mycelia growing into the vascular strands of witches'-brooms hinder the ascent of water, resulting in partial starvation of leaves, a process which these in turn may resist by means of xerophilous adaptations.

In Ericaceous plants it should be noted however that:

(1). The vessels of the xylem are never obstructed by mycelia, either in brooms of *Arbutus* infected by *Exobasidium unedonis* Maire + *Gloeosporium conviva* Maire, or in brooms of *Vaccinium myrtillus* infected by *Gloeosporium vaccinii* sp. nov. On the contrary the author found the vessels of the *xylem* to be noticeably wider in infected leaves of *Vaccinium* than in sound ones. A reduction of transpiration of brooms, if recorded, should not therefore be ascribed to interference with water ascent.

(2). Infected leaves are rolled up, affording less surface to transpiration.

(3). The infected leaves are often colored red by anthocyan, and such a coloration might be considered to cause a modification of transpiration.

The results from experimental work by the author were as follows:

Leaves of false witches'-brooms of *Arbutus* show greater transpiratory activity than neighboring normal leaves. This is due to the fact that the infected leaves remain "juvenile" while sound leaves mature and become thickly cutinized.

Transpiration, as directly measured by the chloride-cobalt paper, in the sun and in the shade, is shown to be ten times more active for leaves of *Vaccinium myrtillus* and *Arbutus unedo* infected by *Gloeosporium*, than it is for sound leaves, and this quite irrespective of pathological reddening by anthocyan. Cut-off false witches'-brooms may remain living for a week when entirely immersed in water. If, however, the base of the twig only is watered, absorption cannot offset the excessive transpiration of the leaves, which wither and dry up within an hour of exposure to the sun. Transpiration then becomes so restricted that a very small loss of water is indicated by weighing cut twigs during several days, and xerophytic adaptation might falsely be concluded to exist.

III. *Carbohydrates.* The early development of false witches'-brooms is certainly due to the formation of large quantities of soluble osmotic substances in the infected tissues. That they contain much sugar, may be deduced from the appearance of anthocyan in them.

Such a formation of soluble material might be readily explained by the secretion of hydrolysing enzymes by infecting hyphae. Observation proves, moreover, that insoluble carbohydrates are always scarce in false witches'-brooms (see table 1). The Anylolencites in infected leaves of *V. myrtillus* do not color

TABLE 1

Biochemy of Leaves of *V. myrtillus*

	Red leaves (from false wiches'-brooms)			Green leaves (sound)		Etiolated leaves (sound)	
	Anthocyan	Starch grains	Tannin	Starch grains	Tannin	Starch grains	Tannin
Coming from the sun	Abundant	Abundant	Present	Present	Present		Present
After staying five days in dark room	Disappear	Disappear	Present	Disappear	Present	Disappear	Present
After having been replaced 1 day in the sun	Absent	Absent	Persists	Reappear	Persists	Absent	Persists

blue by I + KI, but brown-red, and while, in October, sound leaves of *Arbutus* are crowded with starch grains (blue with I + KI), infected leaves never show this reaction. Assimilation in sound leaves of *A. unedo,* though feeble, may still be demonstrated, oxygen bubbles being evolved by immersed leaves when exposed to full sunlight.

No oxygen is evolved in the shade, where assimilation must be so attenuated as to be superseded by respiration. Leaves of false witches'-brooms of *Arbutus*, contain at least a few chloroplasts. They can assimilate in early spring, at least when they are exposed to full sunlight, but in autumn, they never evolve oxygen. Moreover leaves of false witches'-brooms of *V. myrtil-*

lus do not form any starch grains after they have been severed from healthy shoots.

IV. *Glucosides.* Reddening of leaves of false witches'-brooms is reported in most cases, the intensity increasing with the insolation. Infected leaves of *Vaccinium* from sunny heaths in the Pyrenees show a deep red, while infected leaves of *Arbutus unedo* from the shaded pignada of Arcachon are scarcely tinged with rose.

TABLE 2

EFFECT OF STAINING WITH NITRIC ACID

ORGANS OF A. UNEDO	POSITIVE TISSUES WITH MICROSUBLIMATION	NUMBER OF CELLS STAINING BY HNO_3	
Infected cells of leaves		0	
Young leaves (hairs)		50%	
Leaves	+		
Palisade cells		100% (April)	80% (October)
Spongy parenchyma		80% (April)	20% (October)
Stem 1 year old	+		
Cortex external		100%,	50%
Internal		50%,	10%
Pericyclic fibers		50%,	
Root 1 year old	+		
Corolla (outer and inner rows)	+	50%	30%
Fruit (green or red)	+	50%	
Seed coat		100%	
Albumen and embryo		0%	

The appearance of anthocyan in sound or infected cells has been found to be concomitant with abundant formation of sugar or colorless glucosides (Combes, '09, '18), with the disappearance of starch (Dufrenoy), and with the reduction of tannin. This can scarcely apply however to false witches'-brooms where *brown* rather than *red* pigments prove to be of interest biochemically.

These brown pigments were studied by Rayner in connection with the glucosides of the arbutin group. These glucosides are very widely distributed among the Ericaceous plants, though they may differ somewhat with the different species. No arbutin was obtained by Bourquelot ('13) from leaves of *Arbutus* *unedo.* We were able, however, to separate from fresh tissues, ground in water and microsublimated, volatile glucosides which crystallized in two separate forms. Some of the crystals stained yellow after being treated with vapors of ammonia for half an hour.

The cells containing glucosides stain direct in sections of tissues treated with nitric acid (Molisch's test I) We could thus prove the glucoside to be present in all vegetative *sound* tissues of *A. unedo, while it is lacking from cells infected* by *Gloeosporium* in false witches'-brooms. (See table 2).

In infected cells where the glucoside disappears, the brown pigment appears, and it may be supposed that the fungus *Gloeosporium* secretes an enzyme which brings about the hydrolysis of the glucoside to glucose and hydroquinone, the latter being oxydized to the brown pigment.

The actual production by fungi of an enzyme able to effect the hydrolysis of arbutin has been determined by Rayner ('15) for the endophyte of *Calluna* by transferring pure culture material to tubes containing a 0.5 per cent solution of arbutin. Infected tubes soon showed a browning of the solution, while control tubes remained colorless.

CONCLUSIONS

False witches'-brooms of *Ericaceae* may sometimes show a reduction of transpiration, a feature which may be viewed as advantageous. But, as false witches'-brooms possess very low, if not fully inhibited power of assimilation, and are shorter-lived than are healthy shoots, they cannot be interpreted as symbiotic organs.

Morphological variations due to infection are very slight, but such as are present should be viewed in the light of metaphanic (as concluded by Potonie, '12) rather than progressive variations.

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ZOOLOGY.—*A key to the subspecies of* Leptopoma nitidum *Sowerby of the Philippine Islands.* Paul Bartsch,[1] U. S. National Museum.

In the preparation of the monograph on the Philippine operculate land shells, so many interesting and important facts are presenting themselves that it is deemed wise to publish a synopsis of the various groups and superspecies from time to time, with the hope that these synopses and keys may stimulate collectors to look for material in localities which so far have remained unworked, in order that the final monograph may give us a more complete résumé of the members constituting the Philippine Island faunas. It is for this purpose that the present synopsis and key to the Philippine land shells of the *Leptopoma nitidum* complex have been prepared.

Leptopoma nitidum

Shell polished, shining, white, excepting the tip, which, in some of the subspecies, is dark. The earliest part of the nepionic turns are smooth, while the succeeding portion is marked by slender, equal and equally or sub-equally spaced spiral threads which vary in number from five to eight in the different subspecies. These spiral lirations terminate with the nepionic whorls in some of the subspecies, while in others they extend for almost two turns beyond it. The nepionic whorls are also marked by strong incremental lines which frequently give the summit of the turns a slightly crenulated appearance. Postnepionic whorls strongly inflated, rounded, marked by incremental lines and spiral striations which vary in strength and closeness of spacing in the different subspecies. Suture strongly constricted. Periph-

[1] Published by permission of the Secretary of the Smithsonian Institution.

ery varying from well rounded to feebly, obsoletely angled in the various subspecies. Base umbilicated, well rounded, usually sculptured like the upper portion of the last whorl. Aperture subcircular; outer lip reflected and expanded; inner lip strongly curved and decidedly excavated; parietal wall narrow, covered with a thin callus. Operculum membranaceous.

The size of the shell varies from the huge *Leptopoma nitidum guimarasensis* from Guimaras Island, to the small *Leptopoma nitidum ancilis* from Cebu.

The character of the incised spiral sculpture, particularly that of the last whorl, enables one to separate this complex into three distinct groups. In the first of these, the incised lines are deep and rather distantly spaced. This group embraces, *L. n. siquijorensis* from Siquijor Island, *L. n. guimarasensis* from Guimaras Island, and *L. n. darajuayensis* from Darajuay Island.

The second group has the incised spiral sculpture of the same strength as in the first group, but the striations are more closely placed and these, in connection with the lines of growth, are so arranged as to give the surface of the last whorl the appearance of a cloth-like texture. There are seven subspecies belonging to this group, *L. n. atropos* from Polillo Island, *L. n. cebuensis*, from Cebu Island, *L. n. butauananensis* from Butauanan Island, *L. n. basiaoensis* from Basiao Island, *L. n. maculaboensis* from Maculabo Island, *L. n. leytensis*, from Leyte, and *L. n. nitidum* from northern Luzon. Of these, the first three have an obsolete spiral thread at the periphery while the last four have this portion of the shell evenly rounded. It is interesting to note that in some of these forms the spiral lirations characteristic of the nepionic whorls of all the members of the *nitidum* group, extend beyond the nepionic portion of the shell.

In the third and last group, the spiral sculpture is feeble and consists of feebly incised, wavy lines. This group embraces five subspecies, *L. n. romblonensis* from Romblon Island, *L. n. panayensis* from Panay Island, *L. n. anaitis* from Cebu, *L. n. unionensis* from Luzon, and *L. n. artemisia* from the small island of Panay, of the Catanduanes Group, off Eastern Luzon.

Key to the subspecies of *Leptopoma nitidum* Sowerby

Spiral sculpture consisting of strong, deeply incised lines.
  Spiral striations distantly spaced on the last whorl.
    Nepionic whorls brown.................... 1. *siquijorensis*
    Nepionic whorls white.

Shell more than 20 mm. in diameter... 2. *guimarasensis*
Shell less than 18 mm. in diameter.
Umbilicus more than half covered.. 3. *darajuayensis*
Umbilicus less than half covered..... 4. *samarensis*
Spiral striations closely spaced on the last whorl.
Obsolete peripheral thread present.
Spiral lirations confined to the nepionic whorls
5. *atropos*
Spiral lirations not confined to the nepionic whorls.
Umbilicus more than half covered..... 6. *cebuensis*
Umbilicus less than half covered.. 7. *butauananensis*
Obsolete peripheral thread absent.
Spiral lirations confined to the nepionic whorls.
8. *basiaoensis*
Spiral lirations not confined to the nepionic whorls.
Shell more than 16.5 mm. in diameter.
Umbilicus less than half covered.
9. *maculaboensis*
Umbilicus more than half covered..10. *leytensis*
Shell less than 15 mm. in diameter......11. *nitidum*
Spiral sculpture consisting of weak, feebly incised lines.
Nepionic whorls brown........................12. *romblonensis*
Nepionic whorls white.
Spiral lirations confined to the nepionic whorls.
Shell more than 19 mm. in diameter......13. *panayensis*
Shell less than 14 mm. in diameter...........14. *anaitis*
Spiral lirations not confined to the nepionic whorls.
Shell more than 18 mm. in diameter......15. *unionensis*
Shell less than 16 mm. in diameter.........16. *artemisia*

The type locality, measurements, and disposition of the types are shown in table 1. All of the above subspecies excepting number 11, *L. n. nitidum* Sowerby, are new.

TABLE 1

Type Locality, Disposition, and Measurements of Types

Name	Catalog Number	Collection	Number of Whorls	Altitude	Greater Diameter	Lesser Diameter	Locality	Remarks
1. L. n. siquijorensis	130858	U. S. Nat. Mus.	5.8	16.7	18.7	13.9	Siquijor	Type
2. L. n. guimarasensis	195684	U. S. Nat. Mus.	6.2	20.6	20.4	14.5	Guimaras	Type
3. L. n. darajuayensis	257033	U. S. Nat. Mus.	5.8	17.9	16.7	12.8	Darajuay	Type
4. L. n. samarensis	257051	U. S. Nat. Mus.	5.7	16.8	16.3	12.0	Catbalogan	Type
5. L. n. atropos	219029	U. S. Nat. Mus.	6.0	18.7	17.4	12.3	Polillo	Type
6. L. n. cebuensis	219028	U. S. Nat. Mus.	5.9	17.9	16.8	12.5	Toledo, Cebu	Type
7. L. n. butauananensis	257108	U. S. Nat. Mus.	5.7	16.8	16.3	12.0	Butauanan	Type
8. L. n. basiaoensis	257050	U. S. Nat. Mus.	5.6	13.8	13.8	10.1	Middle Basio	Type
9. L. n. maculaboensis	257138	U. S. Nat. Mus.	6.0	18.2	17.0	13.2	Maculabo	Type
10. L. n. leytensis		Chic. Acad. Sci.	5.6	15.9	15.9	11.8	Tacloban	Type
11. L. n. nitidum	104814	U. S. Nat. Mus.	5.5	14.1	14.0	10.4	Tabanatuan Nueva Vizcaya, Luzon	Cotype
12. L. n. romblonensis	216900	U. S. Nat. Mus.	6.0	15.8	15.8	11.7	Romblon	Type
13. L. n. panayensis	219027	U. S. Nat. Mus.	5.5	20.0	18.7	13.8	Igbara, Panay	Type
14. L. n. anaitis		Chic. Acad. Sci.	5.5	14.1	12.2	9.9	Aloguinsan, Cebu	Type
15. L. n. unionensis	257045	U. S. Nat. Mus.	5.8	18.0	17.7	13.2	La Union, Luzon	Type
16. L. n. artemisia	219026	U. S. Nat. Mus.	5.8	15.5	14.5	11.2	Panay Id., Catanduanes	Type

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

RADIOMETRY.—*The photo-electric cell and other selective radiometers.* W. W. COBLENTZ. Bur. Stand. Sci. Paper., No. 319. Pp. 29. 1918.

This paper deals with the application of special physical and chemical properties of matter, as a means of quantitatively measuring radiant energy.

Certain substances have the property of decreasing in electrical resistance when exposed to radiant energy of short wave-lengths, especially the visible and ultra-violet rays. Crystalline selenium belongs to this class of substances. The sensitivity of the selenium cell varies not only with the wave-length but also with the intensity of the light stimulus; and it recovers but slowly from the effects of the light stimulus. It therefore fails to meet the requirements of a radiometer, except that of high sensitivity.

The application of the photo-chemical action upon a photographic plate, as a means of making quantitative radiometric measurements is considered. While this method of radiometry has been used successfully, its applications seem to be rather limited.

The alkali metals, and especially their hydrides, are very sensitive to light stimuli. Photo-electric cells made of these substances can be constructed and operated so that the response (photo-electric current released) is proportional to the intensity of the stimulus. This meets one of the principal requirements of a satisfactory radiometer. Details of constructions, operation, and characteristics of the photo-electric cell are given, and a satisfactory, high-resistance, iron-clad Thomson galvanometer is described, which may be used successfully with the photo-electric cell.

The advantages of the photo-electric cell over the thermopile are considered and the application of the former is advocated for measurements of radiant energy (especially ratios of intensities) in the violet and ultra-violet parts of the spectrum, where the photo-electric cell greatly exceeds the thermopile and the bolometer in sensitivity

W. W. C.

METALLURGY.—*Copper.* Bur. Stand. Circ. No. 73. Pp. 103. 1918.

A compilation is given of the most accurate published information concerning the physical and mechanical properties of the metal copper, together with data and discussion on the effect of higher and lower temperatures upon the physical properties as well as that of impurities in the metal. The circular is concluded with a comprehensive bibliography of the subject, and some typical standard specifications for the metal in different forms.

This circular is one of a series dealing with properties of metals and alloys.

GEOLOGY.—*The Quaternary geology of southeastern Wisconsin, with a chapter on the older rock formations.* WILLIAM C. ALDEN. U. S. Geol. Survey Prof. Paper 106. Pp. 356, with 39 plates and 21 figures. 1918.

This report treats of the southeastern quarter of the State of Wisconsin, an area of more than ten thousand square miles. The main interest of this paper may be said to center in the phenomena developed by the Green Bay glacier and their relations to surrounding areas. The topographic control of glacial flow is illustrated by many interesting features. On the east this glacier, after surmounting the Niagara escarpment, met the lateral flow of Lake Michigan glacier head-on and the great interlobate Kettle Moraine was formed. At the south the Green Bay ice spread with typical radial flow over the eroded surface of an older drift sheet. It developed a remarkable system of radiating drumlins, with eskers, outwash plains, and recessional moraines. On the west the glacier encroached on the Driftless Area and the relations of the ice to a well-marked erosion topography may be studied in detail.

The Paleozoic rock formations are mapped and described, physiographic development and preglacial topography are discussed, and the configuration of the bed rock and its relations to the many beautiful lakes and the present drainage system are shown on a map.

The glacial phenomena are illustrated by one of the finest maps of glacial deposits ever published. This map, on a scale of about 4 miles per inch, shows in colors the relations of the various drift features to the drainage and roads of each township. The report and accompanying maps should be of interest to general and scientific readers and be of great value to the schools and colleges of Wisconsin and other states. W. C. A.

GEOLOGY.—*The Salt Creek oil field, Wyoming.* CARROLL H. WEGEMANN. U. S. Geol. Survey Bull. 670. Pp. 52, with maps and illustrations. 1918.

This report describes the rock formations from Jurassic to Tertiary in age that are exposed in the field, and depicts the structure in detail. The oil is found in Upper Cretaceous sandstones and was probably derived from the remains of small sea plants or animals which were buried in the thick beds of Cretaceous mud that formed the shales lying below the sandstones in which the oil now is stored. The distribution of oil in the Salt Creek, Shannon, and Teapot pools are given, and the future output is estimated.

R. W. STONE.

GEOLOGY.—*Gravel deposits of the Caddo Gap and De Queen quadrangles, Arkansas.* HUGH D. MISER and A. H. PURDUE. U. S. Geol. Survey Bull. 690-B. Pp. 15, with maps and illustrations. 1918.

The gravels are of Lower Cretaceous, Upper Cretaceous, and Quaternary age, and are composed mainly of pebbles of novaculite (a variety of chert) derived from the Arkansas novaculite exposed in the Ouachita Mountain region, which is north of the Gulf Coastal Plain. The main reasons for the preparation of this report are to present a description of the gravels and to indicate the possibility of their use in tube mills.

R. W. STONE.

GEOLOGY.—*Quicksilver deposits of the Phoenix Mountains, Arizona.* FRANK C. SCHRADER. U. S. Geol. Survey Bull. 690-D. Pp. 15, with maps. 1918.

The quicksilver deposits here described are 10 miles northeast of Phoenix and about the same distance east of Glendale, the nearest railway stations, in the southwest slope of the range. They occur in schist belts, in zones of shearing or fracture that parallel the lamination in the inclosing schist. The deposits consist mainly of portions of the country rock which have been more than normally crushed and made schistose and later mineralized. They contain numerous specks, veinlets, films, small bodies, and crystals of cinnabar and metacinnabarite. A few globules of native quicksilver associated with the cinnabar ore have been reported. The gangue minerals, the chief constituents of certain stringers and veinlets, are quartz, calcite, hematite, and limonite. Kyanite and tourmaline are locally abundant in the ore.

R. W. STONE.

GEOLOGY.—*Geology and oil prospects of the Salinas Valley-Parkfield area, California.* WALTER A. ENGLISH. U. S. Geol. Survey Bull. 691-H. Pp. 32, with maps. 1918.

The rocks of this part of the Coast Ranges are divisible on the basis of their lithologic character and structural reactions into four major units, the pre-Franciscan rocks, largely granitic rocks and schists; the Franciscan formation, with associated basic igneous rocks; Cretaceous dark-colored marine shale and sandstone; and the Tertiary beds, consisting of buff to brown weathering marine shale, sandstone, conglomerate, and fresh-water and subaerial deposits, of variable lithology and thickness.

The pre-Franciscan, Franciscan, and Cretaceous are older than any rocks known to be oil-bearing in this region, and any area over which they crop out may at once be condemned as not oil bearing. The Tertiary is divided into the diatomaceous shale group (Salinas shale and shale of the Santa Margarita formation) and the underlying and overlying beds. The diatomaceous shales are the probable sources of any oil which may be found in this region, and the oil is to be looked for in beds close to the shales, especially those overlying them.

Long anticlinal ridges and synclinal valleys modified by erosion constitute the larger ridges and valleys as they now exist. The San Andreas fault, which produced the San Francisco earthquake, is the dominating structural feature of this region.

R. W. STONE.

GEOLOGY.—*New determinations of carbon dioxide in water of the Gulf of Mexico.* ROGER C. WELLS. U. S. Geol. Survey Prof. Paper 120-A. Pp. 16. 1918.

The determinations of carbon dioxide in water of the Gulf of Mexico recorded in this paper show that the total carbon dioxide increases with depth, that is, with decreasing temperature, and the amounts found are very near though slightly below those required for equilibrium with atmospheric carbon dioxide, as calculated by Fox's equation. Determinations of the total concentration of base held in balance with the carbonate and bicarbonate radicles were also made; this quantity apparently increases slightly with decreasing temperature. The data presented do not permit an exact evaluation of the "free" carbon dioxide in the water, but a consideration of the uncertain factors upon which computation of the free carbon dioxide rests indicates that the amount is probably so small in the Gulf water that no appreciable error is made by expressing the total carbon dioxide found as a mixture of carbonate and bicarbonate.

R. W. STONE.

GEOLOGY.—*Deposits of Claiborne and Jackson age in Georgia.* C. W. COOKE and H. K. SHEARER. U. S. Geol. Survey Prof. Paper 120-C. Pp. 41, with geologic map and figures. 1918.

Intensive field work, supplemented by critical study of the fossils, has resulted in the following changes in the interpretation of the stratigraphy of the Eocene of the Coastal Plain of Georgia:

The deposits of Claiborne age, which had been thought to extend uninterruptedly across the entire width of the State, are restricted to two areas, an eastern area, along Savannah River and McBean Creek, and a western area, between Flint and Chattahoochee Rivers. For the deposits in the eastern area, the name McBean formation is retained; the deposits in the western area are designated Undifferentiated Claiborne. In the intermediate region, the Claiborne beds are overlapped by deposits of Jackson age.

The deposits of Jackson age include the Barnwell formation, which is not of upper Claiborne age as Vaughan was led to believe by a preliminary study of the fossils, and the Ocala limestone, which earlier writers referred to the Vicksburg group. These two formations appear to have been formed at least in part contemporaneously, but differ in lithologic and faunal characters. The Twiggs clay member of the Barnwell formation includes the so-called "Congaree clay member of the McBean formation" and certain clays that were considered a part of the Jackson formation by previous writers. The name Tivola tongue is proposed for a wedge of bryozoan-bearing limestone that projects from the lower part of the Ocala limestone into the Barnwell formation.

An interesting by-product of this investigation is the discovery in the Barnwell formation of a molluscan fauna not previously known to occur east of Arkansas.

C. W. C.

ORNITHOLOGY.—*A Criticism of two recent lists of Iowa birds.* IRA N. GABRIELSON. Wilson Bull. **29**: 97–100. 1917.

Some recent Iowa records of 16 species of birds are here shown to be certainly or probably erroneous. Among these are three species, *Branta nigricans, Hierofalco mexicanus,* and *Cryptoglaux funerea rich-*

ardsoni, of which there is no authentic record for the State of Iowa. All the others treated in this connection are birds of casual or at least very rare and irregular occurrence in the State, and records of any of these to be accepted as valid should be most carefully authenticated.

H. C. O.

ORNITHOLOGY.—*Some notes on Connecticut birds.* IRA N. GABRIELSON. Auk **34**: 461–465. 1917.

Various notes on 42 species of rare or otherwise interesting occurrence in the State of Connecticut are herewith presented. Some of these data relate to breeding and summer occurrence, others to migration or accidental records. Most interesting among these are the Wilson Petrel (*Oceanites oceanicus*), which is recorded for the first time from the State; the Black Tern (*Chlidonias nigra surinamensis*), which is reported for the first time in spring; and the Upland Plover (*Bartramia longicauda*), which was found summering near South Windsor, Connecticut. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Further notes on Alabama birds.* LEWIS S. GOLSAN and ERNEST G. HOLT. Auk **34**: 456–457. 1917.

Notes are here given on ten species of birds, seven of which are additions to the list of Autauga and Montgomery County (Alabama) birds previously published by the same authors. Of these, *Nuttallornis borealis* and *Spinus pinus pinus* are the second published State records; and *Thryomanes bewickii bewickii* probably indicates the southern breeding limit for the species within the State.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Some local names of birds.* W. L. MCATEE. Wilson Bull. **29**: 74–95. 1917.

Local names of birds are of interest, both from a scientific and philological point of view. The present list is a continuation of one previously published by the writer to supplement Gurdon Trumbull's compilation of vernacular names of game birds. Local names of 165 species, about half of them water-birds and shore-birds, are here given, in many cases several names for each bird. A partial bibliography of local bird nomenclature is included, together with an alphabetical index to all the local names mentioned in this paper. HARRY C. OBERHOLSER.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY OF WASHINGTON

The 586th regular meeting of the Society was held in the Meeting House of the Friends' School, 1809 I St. N. W. Saturday, May 18, 1918; called to order at 8.40 p.m. by President ROSE; 50 persons present.

On recommendation of the Council the following named persons were elected to membership in the Society: RUDOLPH MARTIN ANDERSON, Zoologist, Geological Survey, Ottawa, Canada; W. C. HENDERSON, Biological Survey, Washington, D. C.; RALPH V. CHAMBERLIN, Museum Comparative Zoology, Cambridge, Mass.; J. R. DE LA TORRE BUENO, White Plains, N. Y.; AMOS W. BUTLER, Room 93, State House, Indianapolis, Indiana.

President Rose announced that he had received the copy of Ex-President Roosevelt's book *A Booklover's Holiday in the Open* referred to at the 584th meeting. The copy was passed among the members of the Society. President Rose said he would make suitable acknowledgment.

Mr. W. L. MCATEE called attention to the appearance of Bulletin 1, A Sketch of the Natural History of the District of Columbia together with an indexed edition of the U. S. Geological Survey's 1917 Map of Washington and Vicinity. The cost is $2.00 per copy or $2.15 sent by mail. Copies of the bulletin were on hand for distribution. Already 40 copies had been disposed of and it was hoped the work would have a ready sale in order that the Society might recover its investment.

The regular program was an illustrated lecture by Dr. J. C. MERRIAM, *Cave hunting in California.* Dr. Merriam gave a very interesting account of his explorations of certain caves of California. He discussed the bearing of his discoveries in these caves on anthropology and paleontology. There was no evidence of Pleistocene man in his findings.

M. W. LYON, JR., *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

A wireless message from Libbeyville, Alaska, on August 18, 1918, announces that the National Geographic Society's party in the Valley of Ten Thousand Smokes, in charge of Mr. JASPER SAYRE, has made continuous records of the temperature of more than one hundred vents and has extended the map of the area to Bristol Bay.

Dr. W. L. ARGO, formerly of the University of California, has been commissioned a lieutenant in the Chemical Warfare Service and has been sent to France.

Dr. SAMUEL AVERY of the University of Nebraska, who has been for the past several months with the National Research Council, has been commissioned a major in the Chemical Warfare Service and placed in charge of the University Relations Section.

Mr. WILLIAM BOWIE, hydrographic and geodetic engineer, and chief of the division of geodesy of the U. S. Coast and Geodetic Survey, has been commissioned a major in the Engineer Corps, U. S. A., and has been assigned to duty in the department of map making.

Major CHARLES B. DAVENPORT, Sanitary Corps, N. A., formerly director of the Department of Experimental Evolution of the Carnegie Institution, has been placed in charge of thr Section of Anthropology of the Division of Medical Records. This new section, which is organized under the Surgeon General's Office of the Army, was created on July 23, 1918.

Mr. HENRY M. EAKIN, formerly with the Alaska Division of the U. S. Geological Survey, resigned in April to enter the employment of a large lumber company in Alger, Washington, as topographer and forester.

Prof. MOSES GOMBERG, professor of organic chemistry at the University of Michigan, has been commissioned a major in the Ordnance Department and is stationed in Washington.

Prof. A. S. HITCHCOCK, Bureau of Plant Industry, spent the month of August studying and collecting grasses in Arkansas, Oklahoma, Texas, and Colorado.

Prof. EDWARD V. HUNTINGTON is on leave of absence from Harvard University and has been commissioned a major, with assignment to statistical study under the General Staff in Washington.

Capt. John Duer Irving, professor of economic geology at the Sheffield Scientific School of Yale University, died of pneumonia in France in the early part of August, 1918. He was at one time a member of the U. S. Geological Survey, and was actively associated with the work of the Academy and the Geological Society of Washington at that period. He had been at Yale since 1907. A memorial service for Captain Irving was held on Sunday, August 4, by local members of the geological and mining engineering organizations of which he was a member.

Prof. Arthur B. Lamb, of the chemical department of Harvard College, and lately on the staff of the Bureau of Mines at the American University Experiment Station, has been commissioned a Lieutenant-Colonel in the Chemical Warfare Service.

Mr. Robert Christian McKinney, for many years a member of the topographic branch of the U. S. Geological Survey, died on July 27, 1918, at the age of sixty-two.

Dr. Albert Mann, of the Bureau of Plant Industry, has been detailed by the Secretary of Agriculture, at the request of the Secretary of Commerce, for special work on the diatom flora of the Woods Hole region, at the Bureau of Fisheries laboratory at Woods Hole, Massachusetts.

Dr. Alfred R. Schultz has presented his resignation from the U. S. Geological Survey, effective October 1, 1918, and has gone to Hudson, Wisconsin, as manager of a hydro-electric power and milling company.

Prof. Aaron Nichols Skinner, formerly professor of mathematics at the U. S. Naval Academy and assistant astronomer of the Naval Observatory, died on August 14, 1918, in his seventy-fourth year. He had been with the Naval Observatory since 1870, devoting his attention principally to meridian-circle observations. He became professor of mathematics at the Naval Academy in 1898, and retired in 1907. He was the last of the corps who were contemporaries at the Observatory with Newcomb, Hall, Eastman, and Harkness.

Prof. R. C. Tolman, formerly of the University of Illinois, who has been on leave of absence for work at the American University Experiment Station, has been commissioned a major in the Chemical Warfare Service.

Dr. H. S. Washington, of the Geophysical Laboratory, has been appointed chemical associate to the scientific attachés at the American embassies in Paris and Rome.

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PHYSICS.—*Some peculiar thermoelectric effects.* PAUL D. FOOTE and T. R. HARRISON, Bureau of Standards.

Benedicks[1] has recently published a description of experimental work from which the conclusion was drawn that a nonsymmetrical temperature gradient in a homogeneous wire gives rise to a galvanometrically measurable thermoelectric emf. Dr. Benedicks claims priority for this discovery and proposes the following table as a summary of the discoveries in thermoelectricity.

TABLE 1

DISCOVERIES IN THERMOELECTRICITY

	CIRCUIT	
	Heterogeneous	Homogeneous
A difference of temperatures (asymmetrical) produces an electric current.............	Seebeck, 1823	Benedicks, 1916
An electric current produces a difference of temperatures..........................	Peltier, 1834	Thomson, 1856

Effects of the kind described by Benedicks have been long observed at the Geophysical Laboratory of this city, and at the Bureau of Standards especially in connection with the routine homogeneity testing of thermocouples. We have found that thermoelectric emfs may be developed by touching a hot wire to a cold wire of the same material, by crossing two wires and

[1] Compt. Rend. **163**: 751–3. 1916. Compt. Rend. **165**: 391–4. 1917. Rev. d. Metallurgie **15**: 329–32. 1918.

heating one of the wires near the junction, by drawing rapidly a hot wire over a cold wire, by joining two wires of different diameters and heating either wire near the junction, by filing a groove or a v-shaped depression in a metal rod and heating this portion of the rod, by passing a flame over a wire, and by numerous other methods. The avoiding of these parasitic emfs has made homogeneity testing a matter of some difficulty.

All of these effects are well known and were discovered from half a century to a century ago. Many of them are treated in Wiedemann's *Lehre von der Elektricität*, vol. 2. They are still of interest, however, because conclusive evidence has not been given for the causes of the various effects observed. Many reasons have been suggested and have been supported by theory and experiment, and no doubt among these many possible explanations one or more are correct, but the absolute proof of their correctness remains to be demonstrated. Thus, for example, Benedicks presents an experimental proof in which he makes use of a magnetic field. The conditions were such that very likely he observed the well-known Nernst and von Ettingshausen effect instead of the pure thermoelectric effect supposed.

The priority for the discovery of these thermoelectric effects probably belongs to Benjamin Franklin and Cavendish,[2] in 1769, or 147 years prior to Benedick's work. These investigators found that when a hot and a cold bar of the same metal were placed in contact, the cold bar became positively charged, as shown by measurements with an electroscope.

The first evidence of the existence of a current in such a circuit was obtained by Ritter[3] in 1798. In the absence of ammeters a pair of frogs was employed. The twitching of the legs showed that positive current flowed in the circuit, frog leg—cold Zn—(hot Zn–cold Zn)—frog leg.

Since 1800 numerous observers have investigated the subject. Indeed about 1850 these effects were thought by some, possibly rightly, to be more fundamental than the Seebeck effect, and it was believed that their study would lead to an interpretation

[2] Franklin and Cavendish. Experimental Observations on Electricity, p. 403. 1769.

[3] Ritter. Gilb. Ann. **9**: 292. 1801.

of the latter phenomenon. Some interesting names appear in the list of early investigators, for example, Becquerel, 1823; Nobili, 1834; Peltier, 1838; Matteuci, 1838; de Heer, 1840; Gaugain, 1862; Coulomb; Righi, 1875; Knott, 1879; Tomlinson, 1888; Stroud, 1889; etc.

Seebeck, 1826, suggested that the emf developed in a single wire on heating asymmetrically was due to a hardening and softening of different portions of the metal. He found that an emf is developed by heating the junction of two similar wires of different diameters. Magnus, 1851, after a most thorough investigation, believed the emf developed by touching a hot and a cold wire to be due to a change in hardness produced by heating. Jenkin,[4] 1862–3, performed a series of very elaborate experiments identical with those described by Benedicks in 1917. Jenkin concluded that the emf obtained by heating crossed wires was due to an oxide film acting with the metal underneath as an ordinary thermocouple, and that a sufficient temperature gradient existed through the film to account for the very large emfs observed. The magnitude of these was emphasized by the statement "to my surprise it was not until I had added resistance equal to that of 2000 miles of the Red Sea cable, that I reduced the deflections within range of my galvanometer." Jenkin proved that the effect was not chemical or electrolytic. The emf developed by touching hot and cold metal was also explained by a film of oxide. He proved that this latter effect could not be due to static electricity. He recognized that it is questionable to attribute the emfs developed with silver, gold and platinum to surface oxidations and raised the point as to whether the physical property of a metal depends not only upon its temperature but upon the time during which it has been at this temperature. Jenkin further advocated the theory of change in hardening of the two metals placed in contact.

Durham, 1872, observed that the magnitude of the emf developed on placing hot and cold metal in contact was proportional to the original temperature difference of the two metals.

[4] JENKIN. British Ass. Rep. **31**: 39–41. 1862. Idem. **32**: 173–8. 1863.

Trouton, 1886, considered the emf developed by moving a flame along a homogeneous wire. From an interesting experiment he concluded that the emf is a function of $\delta^2\theta/\delta x \, \delta\tau$ i.e., of the rate of change of the temperature gradient along the wire, and that an emf galvanometrically measurable could not be developed by a temperature gradient alone however asymmetrical. He suggests that the effect is due to either a permanent alteration in the wire, or, with some metals, to a temporary alteration which lags behind the temperature change. In this he confirms the opinion of Jenkin.

Steel,[5] 1893, under the title "A new thermoelectric phenomenon" describes several of the above mentioned effects, while Turnbull,[6] 1894, calls attention to the fact that these effects have been known for years. Turnbull suggests that the emfs are due to strain, an explanation given by LeRoux, 1867, and others.

Backhmetieff and Stambolieff,[7] 1895, heated a homogeneous wire by an electric current. The heating current was then cut off and the two ends of the wire were connected to a galvanometer while the wire cooled. "The direction of the current was almost without exception opposite to the direction of the original heating current."(!)

An interesting discussion appeared in the German technical journal *Elektro Teknische Zeitschrift* 1900–4. Egg-Sieberg "discovered" that emfs were developed on heating an iron wire by a moving flame, on touching hot to cold iron, and on heating an iron wire dipping into water—thus causing an asymmetrical temperature gradient. He concluded that since the Thomson effect was established it was quite reasonable to assume that this depended upon the steepness of the temperature gradient. Hence in a homogeneous circuit having an asymmetrical temperature gradient, a measurable emf is developed on account of the gradient coefficient of the Thomson effect.

[5] STEEL. Science, **22**: 256. 1893.

[6] TURNBULL. Science, **23**: 91–2. 1894.

[7] Journ. Russ. Phys. Chem. Soc. **27**: 1–25. 1895.

Schneider, 1904, repeated the above experiments and concluded that the effect was due to oxide. This conclusion was undoubtedly correct, especially in connection with his own work, as the resistance of the wires used increased during heating from 2 ohms to 100,000 ohms, and emfs amounting to a half volt were observed.

Hirschson, 1904, suggested that the above effect was due both to the thermoelectric action of the oxide and metal and to the fact that the oxide acted as a shunt on the iron to which it adhered. He showed that the measured potential difference may be in either direction depending upon the extent of the oxidation.

Rosing[8] investigated the emfs developed by touching hot and cold metals. He observed no emf for lead. For gold, silver, copper, iron, tin and platinum the current flows in one direction, in the reversed direction for palladium and German silver, and in either direction for aluminum depending upon the temperature. He relates the effects for these metals to the thermoelectric power relative to lead. The metals of the first group have a positive thermoelectric power, while those of the second group have a negative thermoelectric power. The thermoelectric power of aluminum is either positive or negative depending upon the temperature.

The only new suggestion which the writers are able to add to the confusion already existing is that the sign of the emfs developed upon touching hot and cold metal appears to have some relation to the sign of the Thomson effect.

The object of the present note has been two-fold. First, to call attention to the fact that the existence of many of these curious thermoelectric forces, "rediscovered" every decade, has been well recognized for over a century, and secondly, to point out that no conclusive evidence for their cause has been advanced although nearly all conceivable causes have at times been suggested.

[8] Rosing. Journ. Russ. Phys. Chem. Soc. **30**: 151. 1898.

GEOLOGY AND MINERALOGY.—*Pyrolusite from Virginia.* THOMAS L. WATSON, University of Virginia, and EDGAR T. WHERRY, Bureau of Chemistry.

PART I. GEOLOGY

Much of the manganese ore mined at Powells Fort on northeast Massanutten Mountain 6 miles north of east of Woodstock, Shenandoah County, Virginia, is crystalline in structure and of a high degree of purity. Prior to mining operations by the present company, the Stockwood Realty Corporation, the mine had been worked at different times for a long period of years, and the ore shipped was described as being remarkably clean and a high grade of soft crystallized pyrolusite. Crystals of the manganese mineral ranging up to more than a millimeter across are plentiful and are more abundant than at any other manganese mine known to the writer.

During the course of recent field investigations of Virginia manganese deposits for the State Geological Survey, collections of both the crystals and crystalline mineral were made by the writer for laboratory study. Specimens of the crystals were submitted to Doctor Edgar T. Wherry, of the Bureau of Chemistry, United States Department of Agriculture, Washington, D. C., for crystallographic study, the results of which form Part II of this paper.

In the known deposits of manganese-oxide ores of the southeast Atlantic states, the important ore minerals are usually given as psilomelane, pyrolusite, manganite, and wad. Braunite, which is reported to be a characteristic mineral in association with psilomelane in the Arkansas deposits, has not, so far as the writer is aware, been definitely identified, in the manganese deposits of the southeastern Atlantic states. In their principal occurrences two or more of these minerals are usually intimately associated, the most common being probably psilomelane and pyrolusite. The manganese-oxide mineral occurring in crystal form in these deposits has been regarded by some as pyrolusite, and by others as manganite. Both may be present, but their identification has been based almost without exception on a few physical tests, rather than established by accurate chemical analysis, or a combination of the two.

The chief object of the present study is definitely to establish the mineral identity both of the crystals and crystalline mineral from the Virginia locality, and to direct attention by way of suggestion to the possible bearing on other occurrences.

Little Fort Valley in which the manganese deposits occur is structurally a synclinal valley composed of Silurian and Devonian sediments. At the Stockwood Realty Corporation's mine where the specimens forming the basis of this study were collected, the manganese oxide ore is associated with Oriskany conglomerate, the quartz pebbles of which range up to half an inch in diameter, and with a fine- to medium-grained sandstone just below, which probably is Salina but may prove upon detailed study to be Oriskany. These are brittle siliceous rocks that have been fractured and brecciated in the trough of the syncline where the manganese ore is concentrated. Most of the ore is apparently in the underlying light-colored sandstone, which is brecciated and replaced by manganese oxide. Where impregnation and replacement of the sandstone by manganese oxide have not reached an advanced stage, the ore is low grade and siliceous.

The sandstone is nearly white when fresh and not mineralized, composed almost entirely of quartz, and weathers to a light rusty brown. Microscopic examination of the mineralized rock shows, besides quartz and manganese oxide, an occasional zircon, and rather frequent hair-like inclusions of rutile. Much of the quartz exhibits pronounced optical disturbance and often granulation. Enlargement of the quartz grains was not observed.

Wad occurs, but most of the ore observed at the time of my visit was crystalline pyrolusite developed largely by replacement of quartz from circulating ground waters, but partly also as a breccia-filling or cement and partly as crusts coating joint surfaces and other spacings in the rocks.

Replacement of the rock by black manganese oxide (pyrolusite) is plainly shown in hand specimens. All stages of replacement are readily traced in thin sections under the microscope, from the incipient stage in which the quartz grains show only slight attack, through advanced stages in which only a few or many scattered small fragments of residuary quartz remain, to the completed stage composed of all pyrolusite without visible quartz. The partly replaced, fine-grained rock of blue-black color is referred to locally as bluestone.

In this connection it is of interest to note that similar replacement of Cambrian quartzite by manganese oxide in the Virginia part of the Piedmont Plateau province is well shown in hand specimens and thin sections from the Myers manganese mine, east of Lynchburg in Campbell County. Also the formation of pyrolusite by replacement of quartzite in the Jubalpur district, Central Provinces, India, has been described in detail by Fermor.[1]

Pyrolusite crystals measuring more than a millimeter across are abundant at the Virginia locality in cavities and spacings in both the ore and the rock. They vary in habit from tabular to wedge-shaped, and frequently form closely interlocking aggregates on the surfaces of joint planes, coatings on crusts of crystalline fibrous or columnar pyrolusite, and linings of small irregular spacings in the blue-black ore; the latter appears amorphous to the unaided eye, but much of it is seen to be minutely crystalline granular under the magnifying lens.

Of the large number of specimens tested, of both the crystals and the crystalline mineral, all exhibited the physical and chemical properties of pyrolusite and none exhibited those of manganite. Although careful search was made and numerous tests applied, not a single specimen indicated the presence of manganite. Without exception the crystals tested were soft, not exceeding 2.5 in hardness, and readily soiled the fingers. Color, steel gray on fresh surfaces, black on other surfaces; luster, metallic; and streak, black to slightly bluish black. Careful determinations of the specific gravity gave 4.748 (crystals) and 4.885[2] (crystalline), values that correspond to those for pyrolusite and are much higher than that for manganite.

[1] Fermor, L. Leigh. Memoirs Geol. Survey India **37**: Pt. IV, pp. 811–814. 1909.

[2] Average of three determinations.

Chemically also the crystals and crystalline mineral correspond to pyrolusite, as shown in analyses of carefully selected samples of each given in columns I and II of table 1. There are given for comparison in columns III and IV analyses of pyrolusite crystals, and in column V "pseudomanganite"[3] from India.[4]

TABLE 1

ANALYSES OF PYROLUSITE CRYSTALS AND PSEUDOMANGANITE

	I	II	III	IV	V
MnO_2	94.30	95.22	96.73	97.04	92.90
MnO	2.25	1.31	0.57	0.43	1.47
Fe_2O_3	0.22	0.17	0.23	0.03	1.88[5]
Al_2O_3	0.14	0.18	0.18	0.17	
BaO	0.33	0.40		0.07	
CaO	0.08	0.11	0.66	0.90	0.86
MgO			0.76	0.47	0.52
SiO_2	0.64	0.63	0.42	0.41	0.47
P_2O_5	0.52	0.58			
H_2O-	0.22	0.16			
H_2O+	1.53	1.46	0.45[6]	0.35	1.94
	100.23	100.22	100.0	99.87	100.04
Specific gravity	4.748	4.885[7]		4.94	4.470

I. Pyrolusite crystals from Stockwood Realty Corporation's mine, 6 miles east of Woodstock, Shenandoah County, Virginia. S. D. Gooch, analyst.

II. Crystalline fibrous pyrolusite from Stockwood Realty Corporation's mine, 6 miles east of Woodstock, Shenandoah County, Virginia. S. D. Gooch, analyst.

[3] The name pseudomanganite was proposed by Fermor (Memoirs Geol. Survey, India **37**: Pt. I, p. 85. 1909) for pyrolusite pseudomorphous after manganite, that occupies both chemically and physically the interval between manganite and pyrolusite. The important physical properties of the three minerals are tabulated by Fermor on p. 86.

[4] For a description of the minerals and a discussion of the analyses, see Fermor (Memoirs Geol. Survey India **37**: Pt. I, pp. 78–86. 1909).

[5] Mostly Al_2O_3.

[6] By difference.

[7] Average of three determinations.

III. Pyrolusite crystals from Bikonhalli, Shimoga district, Mysore. C. S. Fawcitt, analyst. (Memoirs Geol. Survey India, Pt. I, p. 82. 1909.)

IV. Pyrolusite crystals (longish, dull, prismatic crystals of nearly square form) from Ghatia in Banswára State, Rijputána. C. S. Fawcitt, analyst. (Memoirs Geol. Survey India, Pt. I, p. 82. 1909.)

V. Pseudomanganite, bronzy luster, from Sandur Hills, India. C. S. Fawcitt, analyst. (Memoirs Geol. Survey India, Pt. I, p. 84. 1909.)

From the analyses it will be seen that the resemblance in composition of the crystals and crystalline mineral from Virginia is remarkably close, and the correspondence of each to the Indian pyrolusite is evident. The physical characters of each are alike and, as shown above, are those of pyrolusite. Each shows the presence of a small quantity of manganous oxide and about 1.5 per cent of combined water, which would usually be interpreted as the remnants left in the change of the mineral from manganite to pyrolusite, on the basis that the pyrolusite is pseudomorphous after manganite. The water, on the other hand, might be accounted for on the basis of hydration. Such alteration from manganite to pyrolusite has been generally regarded as easily accomplished and involves, chemically, dehydration and oxidation, accompanied by a change of physical characters, the more important of which are increased specific gravity, decreased hardness,[8] and darker (black) streak.

Judged from the few detailed chemical analyses of pyrolusite which the writer has examined, such small percentages of MnO and combined H_2O, when taken alone, are of little value as diagnostic features of the pseudomorphism of pyrolusite after manganite. (See statement on Indian pyrolusite below.) When combined, however, with accurate tests of physical properties, including crystal form, the evidence should be conclusive.

Attention is directed in the table to analyses III and IV of picked specimens of pyrolusite crystals described by Fermor

[8] Alteration to polianite, which has the same composition as pyrolusite and is sometimes pseudomorphous after manganite, would involve not only increased specific gravity but also increased hardness.

from India. No reference is made in the description by Fermor that the pyrolusite crystals represented by the two analyses are of pseudomorphous origin, but are tabulated by him as "Analyses of Indian pyrolusites," the present writer assuming that they are not pseudomorphous after manganite. Both analyses contain around 0.5 per cent each of manganous oxide and combined water, which are less than for pseudomanganite (analysis V) and for the Virginia pyrolusite (analyses I and II). In the same table Fermor gives a detailed analysis of "a piece of the radiate-concentric pyrolusite of Páli in the Nágpur district," which shows 0.41 per cent and 1.46 per cent respectively of MnO and combined H_2O, and specific gravity 4.88. Again the writer assumes this analysis to represent pyrolusite of nonpseudomorphous origin.

On comparing the analyses (I and II) of Virginia pyrolusite with the analysis (V) of pseudomanganite from India, it will be noted that the percentages of manganous oxide and combined water are in fairly close agreement. The same is true for the minor constituents, except that MgO present in pseudomanganite is absent from the Virginia pyrolusite; this, however, has no significance. Fermor[9] states that the pseudomanganite presents considerable differences in physical characters from pyrolusite but shows considerable resemblances to manganite, though chemically close to pyrolusite. The name pseudomanganite as proposed by Fermor is therefore not applicable to the Virginia mineral (pyrolusite crystals, analysis I, and crystalline pyrolusite, analysis II), since, as shown above, it resembles pyrolusite and not manganite both chemically and physically.

It seems entirely clear, on the basis of chemical composition and physical characters, that if the crystals of manganese oxide from Virginia (analysis I) are of pseudomorphous origin after manganite, the associated crystalline fibrous mineral (analysis II) must also be of the same origin. Certain of the facts developed in this study, especially the crystallography (abnormal axial ratio and habit for manganite) are, however, not in har-

[9] FERMOR, L. LEIGH. *Op. cit.*, p. 84.

mony with the view that the crystals and crystalline pyrolusite from Virginia are of pseudomorphous origin; these features may pertain to original pyrolusite. The writer is fully aware of the prevailing view that pyrolusite crystals are pseudomorphous in origin, and that many pyrolusite crystals have the form of manganite. The present study, however, of the material from the Virginia locality suggests the probability that the pyrolusite may be original; that is, it has a distinct crystalline form of its own, and is not secondary in the sense of being derived from manganite by dehydration and oxidation. More extended investigation of the manganese oxide minerals, especially pyrolusite and manganite, is under way by the writer, with the hope that more definite conclusions may be reached as to their genetic relations.

PART II. CRYSTALLOGRAPHY

The specimens examined contain irregular cavities a centimeter or two in diameter, lined with brilliant crystals corresponding in form to manganite,[10] averaging about a millimeter across. The habit varies from tabular, owing to the predominance of the front pinacoid or of prisms vicinal to it, to wedge-shaped, from the combination of prisms and side-domes. Subparallel intergrowth is frequent, causing variations of half a degree or so in the angles, so that comparatively few of the crystals can be used for measurement. The crystals are attached to the matrix in the general direction of the side pinacoid, and are doubly terminated as far as the vertical axis is concerned. The termination is of a type very unusual in manganite, being produced chiefly by side-dome faces, of which five prove to be new. Single faces of two possibly new pyramids, and of one previously noted pyramid, are also present, one on each of three crystals. The development toward the attached end of axis *b* is very

[10] For the sake of simplicity the crystals will be called manganite, even though their physical and chemical properties are those of pyrolusite.

different from that at the free end,[11] although practically the same forms are present at both ends, the difference being in their relative sizes. The mineral is therefore probably not to be regarded as belonging to a hemihedral class, but to be pseudo-hemimorphic along the *b*-axis; the rate of accretion of material was of course greater at the free ends, and less where the crystals are crowded together, and this may account for the different development at the two ends. It may be noted that hemihedral (in part sphenoidal) arrangement of faces has been observed in manganite from many localities, so it is evidently a subtance that is especially sensitive to differences in rate of growth. This is probably to be explained by the presence in its space-lattice of some hemihedral features, which in the structure as a whole compensate each other and make the class holohedral, just as in diamond, which possesses a balanced tetrahedral arrangement of atoms and accordingly often simulates tetrahedral habit, although thought to be fundamentally holohedral.

Twelve crystals were measured on a Goldschmidt two-circle goniometer. Most of the faces present are more or less curved and striated, so that perfect reflections of the signal are rarely obtained. The unit prism sometimes yields excellent images, however, and one of the side domes fairly good ones. Variations in angle of half a degree or more occur from one crystal to another, even with the faces giving the best reflections, because of the subparallel intergrowth. In particular the wedge-shaped crystals tend to show a somewhat greater value for axis *a* than do the tabular ones. The measurements here accepted as characteristic of the occurrence are those obtained from small and apparently single tabular crystals with two or more faces yielding sharp images of the signal. The prism and dome zones generally show long trains of reflections, in which bright nodes indicate the positions of faces, and as these nodes reappear from one crystal to the next with considerable regularity, they undoubtedly represent actual forms.

[11] This habit has apparently not been noted in normal manganite heretofore, but appears in a diagram of pyrolusite given by Dana (System of Mineralogy, 6th ed., fig. 3, p. 244.)

The axial ratio derived from the measurements is clearly different from that usually accepted for manganite, but agrees almost exactly with that obtained by Flink on crystals from the Bölets Mine, Undenäs district, Sweden, $a:b:c = 0.8612:1:0.5629$.[12] From three closely agreeing measurements of the unit prism, its $\phi = 49° 15' \pm 5'$ whence $a = 0.8616 \pm 0.0025$; and from two of

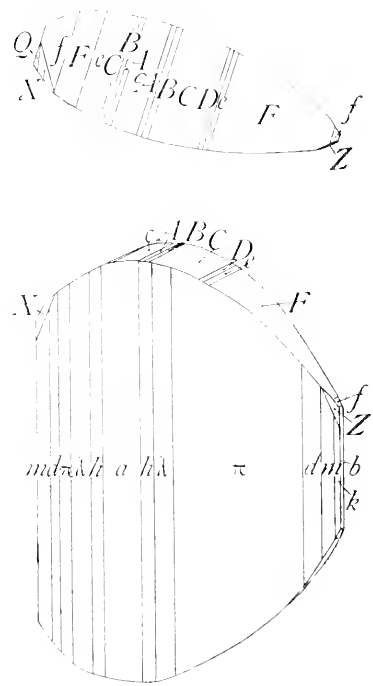

Fig. 1.

dome 032 its $\rho = 40° 10' \pm 5'$, whence $c = 0.5628 \pm 0.0020$. As Flink's crystals were probably better than the present ones, his values are used in calculating the angle-table. The difference between this axial ratio and that usually accepted for manganite, 0.8441 : 1 : 0.5448, is perhaps connected with the loss of hydrogen, corresponding to the change into pyrolusite, taking

[12] Arkiv Kemi Min. Geol. **3**: (35), 101. 1910. No analyses or physical properties of the mineral are given.

place chiefly in the direction of the *b*-axis, so that the greatest shrinkage occurs along this axis.[13]

Figure 1 presents the average development of crystals of this occurrence. Some crystals are even thinner than this, but on

TABLE 2

ANGLES OF PYROLUSITE AFTER MANGANITE FROM POWELLS FORT, VIRGINIA

$a:b:c = 0.8612:1:0.5629$

FORMS, SYMBOLS	DEVELOPMENT	TIMES NOTED		ANGLES							
				Measured				Calculated			
				ϕ		ρ		ϕ		ρ	
				Degrees	Min.	Degrees	Min.	Degrees	Min.	Degrees	Min.
c 001	Poor, irregular	5		0		0		0	00	0	00
b 010	Narrow, dull	8; cleav. 12		0		90		0	00	90	00
a 100	Part of curve	14		90		90		90	00	90	
		Plus	Minus								
h 410	Part of curve	2	2	78		90		77	51	90	00
λ 310	Part of curve	12	4	74		90		73	59	90	
π 520	Flattest part of curve	18	1	71		90		71	00	90	
d 210	Part of curve	10	1	67		90		66	42	90	
m 110	Narrow but bright	12	2	49	15	90		49	16	90	
k 230	Narrow but bright	2	0	37	40	90		37	45	90	
*A 018	Part of curve	2	1	0		4		0	00	4	02
*B 014	Part of curve	2	1	0		8		0		8	01
*C 013	Flat part of curve	20	1	0		10	30	0		10	38
*D 012	Part of curve	4	0	0		16		0		15	43
e 011	Part of curve	8	3	0		29		0		29	23
*F 032	Flattest part of curve	18	2	0		40	10	0		40	11
f 021	Part of curve	8	2	0		48		0		48	23
*Z 566	One curved face, doubtful	1	0	44		38		44	03	38	04
*X 654	One curved face, doubtful	0	1	54		50		54	20	50	21
p 111	May be represented by X and Z	0	0	—		—		49	16	40	47
Q 493	One curved face, obs. by Flink	0	1	27		62		27	18	62	15

[13] It is also possible that this axial ratio belongs to pyrolusite itself, and that the crystals are not pseudomorphs at all, as noted in Part I.

the other hand the wedge-shaped ones are thicker because of greater development of prism *d* or others near it. The height also varies somewhat, the thinner crystals tending to be longer in the *c* direction. The curvature of the faces which is almost universally present is indicated; it is actually the more prominent on the thicker, wedge-shaped crystals. Forms *b*, *m*, and *k* are narrow or lacking on some crystals, and each of the three pyramids has been observed but once, but the other forms, especially those at the right or positive end, are practically constant.

The domes fall excellently into harmonic series N_3, although the two vicinal to the base, 018 and 014, are extra.

Form	001	018	014	013	012	—	011	032	021	—	010
$\frac{k}{l}$	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	—	1	$\frac{3}{2}$	2	—	inf.
N_3	0	—	—	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{2}{3}$	1	$\frac{3}{2}$	2	3	inf.

A list of the forms and their angles is presented in table 2, new ones being marked by an asterisk. The formulas used for calculating ϕ and ρ are as follows:

$$\text{Prisms:} \quad \cot \phi = \frac{k}{h} \cdot a; \quad \text{domes: } \tan \rho = \frac{k}{l} \cdot c;$$

$$\text{Pyramids:} \quad \cot \phi = \frac{n}{k} \cdot a; \quad \tan \rho = \frac{k \cdot c}{l \cos \phi}.$$

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

BOTANY.—*Axillary cleistogenes in some American grasses.* AGNES CHASE. Amer. Journ. Bot. **5**: 254–258, figs. 1–5. 1918.

All the species native in the United States of three genera of grasses, Triplasis, Danthonia, and Cottea, and two species from other genera, *Muhlenbergia microsperma* and *Pappophorum Wrightii*, are found to produce cleistogamous spikelets in the axils of the lower sheaths. These spikelets are enlarged, greatly simplified, usually 1-flowered, and without glumes, and often so strikingly different from the chasmogamous spikelets (that is those borne on the terminal panicle) of the same plant, that if their source were unknown they would not be placed in the same tribe. The grain of the cleistogene is usually more than twice as large as that of the chasmogene. Specimens bearing these cleistogenes usually disjoint at the nodes, the spikelet remaining permanently enclosed in the sheath and the grain germinating within it. In *Muhlenbergia microsperma* the cleistogenes are inclosed in indurate, greatly reduced leaf-sheaths, in shape like tiny inverted cornucopias. These are produced in abundance and readily fall from the expanded sheaths. Four South American and one New Zealand species of Danthonia and one Siberian and one Algerian species of Pappophorum are found to produce these cleistogenes. All species so far found producing them are plants of open ground, most of them are of arid regions or in dry places in humid regions. Since with relatively little investigation so many species have been found with cleistogenes it seems probable that this is not a rare habit in grasses. Any grass with swollen sheath-bases and disjointing culms may repay examination, after the maturity of the terminal panicles. A. C.

BOTANY.—*Generic types with special reference to the grasses of the United States.* A. S. Hitchcock. Amer. Journ. Bot. **5**: 248–253. 1918.

Stability in nomenclature has been aided by the adoption of the idea of types, a genus being based upon a type species and a species upon a type specimen. In the present paper the author summarizes a study that he has made in applying the principle of types to 255 generic names of grasses. In 8 genera the type species has been designated. Of those in which no type was designated at the time of publication, 150 were based upon single species. In the remaining cases types have been selected on the principle that the type must be one of the species included in the genus as originally published and should be the species or one of the species that the author had chiefly in mind at that time. The difficulties are greatest in the Linnaean genera. Several examples are given illustrating the methods used in the selection of the type species. A. S. H.

PHYTOPATHOLOGY.—*The growth of the potato-scab organism at various hydrogen-ion concentrations as related to the comparative freedom of acid soils from the potato scab.* L. J. Gillespie. Phytopathology **8**: 257–269. 1918.

A study was made of the viability of a number of strains of the common potato-scab organism in culture media adjusted to various hydrogen-ion exponents. Two synthetic media and a medium prepared from potato extract were used, and especial attention was paid to the buffer action of the culture media. In media at the initial exponent 5.2 the growth was slower and generally less vigorous than at less acid exponents. Under some conditions individual strains were somewhat more sensitive to acidity, but the differences did not lead to any consistent distinctions among the strains. Sometimes the organisms succeeded in growing well in a medium which had initially an exponent of 5.2 or even 4.8, but the growth was accompanied by a marked decrease of acidity, and the manner of growth gave reason to doubt whether even in these cases more than a poor growth can occur at such exponents

It would appear that the acidity of the Caribou loam, which is known to be generally immune from the common (corky) potato scab, is often of sufficient intensity to exert in the soil an injurious action on the causal organism. The acidity of the Washburn loam, on the other hand, is generally not of sufficient intensity to be injurious to the causal organism, and potatoes grown on the Washburn loam are very often infected with the common scab. L. J. G.

PHYTOPATHOLOGY.—*Irrigation experiments on apple-spot diseases.* Charles Brooks and D. F. Fisher. Journ. Agr. Res. **12:** 109–138, pls. 2–5, figs. 1–10, tables 1–11. January 21, 1918.

The writers point out the distinguishing characteristics of a number of different spot diseases of the apple, including bitter pit, Jonathan spot, and drouth spots of various kinds, but the paper is devoted mainly to experimental data on the relation of the soil-water supply to the occurrence of these various troubles. In the experimental work the amount of soil water was controlled by the duration and frequency of irrigation and was determined from soil samples taken at various depths. Bitter pit was found to be greatly increased by heavy irrigation, particularly when applied late in the season. It was decreased by heavy irrigation followed by light. It was in general worse on large apples than on small ones, but heavy irrigation caused practically as great increase of the disease on small and medium sized fruit as on the large. Drouth spot were found to be produced by sudden shortage of water. Certain kinds of drouth and cork were apparently correlated with particular soil types. C. B.

PHYTOPATHOLOGY.—*A leafblight of* Kalmia latifolia. Ella M. A. Enlows. Journ. Agr. Res. **13:** 3. April 15, 1918.

The disease was found on mountain laurel in the vicinity of Washington. It is characterized by a blight or dry rot involving large areas of the leaf blade or the entire leaf. Later it extends through the petioles into the stems and may eventually kill the entire plant. The causal fungus is a new species: *Phomopsis kalmiae*, its parasitism having been demonstrated by successful inoculations into healthy plants.

Pycnidia are readily produced on diseased leaves placed in damp chambers. Sclerotia-like bodies and pycnidia are produced in large numbers in most of the ordinary culture media. The sterile bodies are undoubtedly potential pycnidia as shown by the production of pycnospores after transplanting portions to fresh culture media.

E. M. A. E.

PHYTOPATHOLOGY.—*Host relationships of the North American rusts, other than Gymnosporangiums, which attack conifers.* ARTHUR S. RHOADS, GEORGE G. HEDGCOCK, ELLSWORTH BETHEL, and CARL HARTLEY. Phytopathology **8**: 309–352. July, 1918.

This paper, which is of special interest to forest pathologists and mycologists, treats of fifty-two species of rusts attacking species of Abies, Ephedra, Larix, Picea, Pinus, Pseudotsuga, and Tsuga. With each species of rust is an abbreviated synonomy; citations of publications containing treatment of the species; a list of the coniferous host species; the names of genera bearing alternating stages, when present, of each rust; the distribution; remarks relative to important characters; and data of inoculating proof of the connection between the aecial and telial stages.

At the close of the paper is a host index in two parts, one of aecial hosts, the other of uredinial and telial hosts; and 148 citations of literature bearing upon the subject. G. G. H.

PHYTOPATHOLOGY.—*Some bacterial diseases of lettuce.* NELLIE A. BROWN. Journ. Agr. Res. **13**: 367–388, pls. 29–41. May 13, 1918.

The paper describes two new bacterial diseases of lettuce, one occurring in South Carolina and Virginia on lettuce grown out of doors, the other on greenhouse plants in Kansas. The organism producing the disease in South Carolina and Virginia has been named *Bacterium vitians*. In South Carolina, *Bacterium vitians* causes the lettuce stems to turn blue, then brown when seen in cross or longitudinal sections. Leaves are spotted occasionally but the stem affection is the prevalent condition. The organism isolated from diseased stems of South Carolina plants produces spots on leaves as well as brown stems when inoculated into healthy lettuce plants.

In Virginia the leaf spotting only was noted, but the isolated organism from these leaf spots will produce stem-rot readily when inoculated into the stem of healthy lettuce plants, as well as spots on leaves when it is sprayed on the leaves of healthy lettuce. The diseased Virginia lettuce had a second organism present producing spots on it, and this organism was isolated along with *Bacterium vitians*. It is one already known and described (*Bacterium viridilividum*) and the colonies isolated proved to be infectious.

It appears that *Bacterium vitians* and *Bacterium viridilividum* may be present and active in soil which is heavily fertilized with green manure or stable manure not thoroughly decomposed, and in which the organisms of decomposition are still active. If conditions are such that the plants are kept growing vigorously, these organisms will have no effect upon them, but if bad weather conditions obtain and the lettuce plants get weakened or growth is retarded, these organisms make their way into the roots or leaves and cause disease. The treatment recommended is the use of thoroughly decomposed green manure and well-seasoned stable manure in which tissue-disintegrating bacteria are inactive.

The Kansas disease is caused by a soil organism, to which the name *Bacterium marginale* has been given. It produces either a marginal wilting, or a spotting and speckling of the leaves. Care in watering plants so that soil does not get washed on the leaves and proper ventilation of greenhouses will prevent the disease.

Isolations, inoculations, cultural characteristics, and descriptions of the two organisms are discussed. N. A. B.

PHYTOPATHOLOGY.—*Influence of temperature and precipitation on the blackleg of the potato.* J. Rosenbaum and G. B. Ramsey. Journ. Agr. Res. **13**: 507–513, fig. 1, tab. 3. June 3, 1918.

Experiments were performed which showed that the organism (*Bacillus phytophthorus* Appel) producing the blackleg disease of the potato, under the winter conditions that existed during 1915–1916 and 1916–1917 in Aroostook County, Me., cannot live over in the soil or in diseased tubers that may remain there.

Comparison of weather records show that the winter of 1915–1916 was not an unusual one for Aroostook County.

The severity of the disease during the growing season is closely correlated with temperature and precipitation. A high temperature and low precipitation tend to diminish the disease, while a low temperature and high precipitation produce conditions favorable for it. J. R.

PHYTOPATHOLOGY.—*A hitherto unreported disease of okra.* L. L. Harter. Journ. Agr. Res. **14**: 207–211, pl. 23, figs. 3. July 29, 1918.

The author investigated a disease of the pods and stems of okra which occurred in Maryland in 1916. Infection experiments showed that several different varieties of okra were susceptible. The causal fungus was described as a new species of Ascochyta, *A. abelmoschi*.

L. L. H.

TECHNOLOGY.—*Combined table of sizes in the principal wire gages.* Bur. Stand. Cir. No. 67. Pp. 5. Jan. 17, 1918.

This table combines in one series the sizes in the American (B. & S.) Steel, Birmingham (Stubs'), British Standard, and Metric Wire Gages, arranged in order of sizes (diameters) of wires. It gives the diameter of all the gage numbers in these five systems in mils, millimeters, and inches, also the cross-sections in square mils, circular mils, square millimeters, and square inches. The table is especially useful to manufacturers who wish to determine the nearest equivalent in American or British gage sizes of wires specified in millimeters or square millimeters, or vice versa. R. Y. F.

TECHNOLOGY.—*Determination of permeability of balloon fabrics.* JUNIUS DAVID EDWARDS. Bur. Stand. Tech. Paper No. 113. Pp. 31. 1918.

This paper describes the various methods which may be employed for determining the permeability of balloon fabrics to hydrogen. The precise and rapid method used at the Bureau of Standards measures the hydrogen penetrating a given area of fabric by means of a gas interferometer. Data are given to show the effect upon the apparent permeability of different experimental conditions such as temperature, pressure, humidity of the gas, etc. A knowledge of the effect of these factors enables one to compare results of tests made under different conditions. The test adopted as standard by the Bureau is described. J. D. E.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on September 2, 1918. Mr. William Bowie resigned as treasurer, on account of having been commissioned a major in the Engineering Corps, U. S. A., and Mr. R. L. Faris, of the Coast and Geodetic Survey, was elected treasurer for the remainder of the year. A committee consisting of C. N. Fenner, C. N. Collins, and J. A. Fleming was appointed to audit the accounts of the retiring treasurer. Mr. E. W. Shaw was appointed chairman of the Committee on Meetings, succeeding Dr. Swann, who has left the city, and Dr. C. W. Kanolt was made an additional member of the Committee.

The following persons have become members of the Academy since the last issue of the Journal: Dr. William Clinton Alden, U. S. Geological Survey, Washington, D. C.; Mr. Samuel Sanford, Bureau of Mines, Washington, D. C.

Robert B. Sosman,
Corresponding Secretary.

SCIENTIFIC NOTES AND NEWS

A party of scientists has been sent by the Bureau of Plant Industry, at the request of the French High Commission, to Algeria, Tunis, and Morocco to study and advise upon agricultural conditions there. The party includes E. C. Chilcott, C. S. Scofield, and T. H. Kearney.

Dr. Arthur L. Day has presented his resignation as director of the Geophysical Laboratory, Carnegie Institution of Washington, to be in effect October 1, 1918, and will take up research on glass and allied materials for the Corning Glass Works in Corning, New York. Dr. Day has been director of the Laboratory since its establishment in 1906, having been previously engaged in silicate researches at the U. S. Geological Survey in 1904 and 1905.

Mr. F. A. McDermott, formerly research chemist with the Corby Company, is at the experiment station of E. I. du Pont de Nemours and Company, at Henry Clay, Delaware.

Dr. H. C. McNeil, of the chemical department of the Bureau of Standards, has been appointed professor of chemistry at George Washington University, as successor to Prof. C. E. Munroe, who is giving all his time to the work of the Committee on Explosives Investigations of the National Research Council.

Prof. F. A. Saunders, professor of physics at Vassar College, Poughkeepsie, N. Y., is in Washington on leave of absence, engaged in war work at the National Research Council.

Dr. E. C. Shorey, in charge of the division of chemical investigations of the Bureau of Soils, Department of Agriculture, has resigned to accept a position with the National Aniline and Chemical Company, at Marcus Hook, Pennsylvania.

Prof. W. J. Spillman, chief of the Office of Farm Management of the Department of Agriculture, resigned on August 31, 1918, to become editor of the *Farm Journal*. He will continue to reside in Washington for the present.

JOURNAL

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Vol. VIII OCTOBER 19, 1918 No. 17

RADIOTELEGRAPHY.—*New method of using contact detectors in radio measurements.* L. W. Austin, U. S. Naval Radio Laboratory.

For many measurements in radiotelegraphy it is necessary to use a radio frequency-current indicator of known resistance. If the current to be measured is small it is generally customary to use a thermoelement and galvanometer. The most sensitive thermoelements are either of the vacuum type or the welded tellurium type. The vacuum thermoelements can be obtained of any desired resistance and are very sensitive but are slow in action and frequently show a bad zero drift. In addition, the deflection usually shows considerable divergence from the current-square law. The tellurium platinum elements are quick acting and follow the current-square deflection law with sufficient accuracy for all practical purposes. They are however so fragile and difficult to manufacture and transport that no manufacturer has yet undertaken to supply them commercially. It is also impossible to make the contact resistance much less than 10 ohms. It is to be noted that the resistance in both the vacuum and tellurium types changes considerably with the amount of current flowing.

On account of the difficulties mentioned, the sensitive thermoelements in our laboratory have been replaced, for the most part, by a shunted contact detector circuit arranged as shown in figure 1. Here LC is any oscillating circuit having inductance and capacity, D is a contact detector, G a high resistance galvanometer, K a paper condenser of one microfarad capacity, and R a resistance which may have any value from 0.1 to 100 ohms. The greater part of the radio-frequency current passes through R, while a small portion is shunted through the condenser K and the detector. The direct current from the detector after passing through the galvanometer returns through R. On account of the high re-

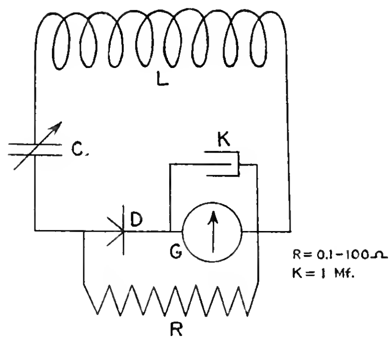

Fig. 1. Shunted contact detector

sistance of the detector, the total resistance of the detecting system is practically identical with R, as has been experimentally tested between 0.1 and 100 ohms.

The sensibility of this arrangement is much greater than that of the best vacuum thermoelements of equivalent resistance.

In the case of most of the well-known detectors the proportionality between deflection and current-square is excellent. Galena, while the most sensitive of any of the detectors tried, shows a slight deviation from the square law. For absolute current measurements the system must of course be calibrated by comparison with a known thermoelement at the time of experiment.

ORNITHOLOGY.—*Diagnosis of a new genus of Anatidae from South America.* HARRY C. OBERHOLSER, Bureau of Biological Survey.

The genus *Alopochen* Stejneger, as at present constituted, contains two recent and three fossil species. The former are *Alopochen aegyptiaca*, from Africa, and *Alopochen jubata*, from South America. Such widely separated ranges naturally raise a question regarding the generic identity of these two living species, which doubt has already found expression in the statement of the most recent authority on the family Anatidae.[1] Examination now shows that these two species are really generically different; and since *Anas aegyptiaca* Linnaeus is the type of *Alopochen*, a new generic name is necessary for *Anser jubatus* Spix.

Neochen,[2] gen. nov.

Chars. gen.—Similar and nearest to *Alopochen* Stejneger, but bill smaller, relatively shorter, and more conical, little more than one-half the length of head (instead of nearly as long), its height at base more than one-half the length of the exposed culmen (instead of much less); exposed culmen about one-half the length of the tarsus (instead of much more); vertical outline of culmen more concave; angle of feathers on the base of the culmen sharper and more prominent (less rounded), the reentrant angle of the bare area on each side of the culmen deeper and more pronounced; tertials and scapulars very much narrower and more pointed; nostrils apparently more elongated.

Type.—*Anser jubatus* Spix.

Remarks.—Concerning the proper applicability of the name *Alopochen* Stejneger, a few remarks may not be out of place in this connection. This generic term was originally proposed by Dr. L. Stejneger[3] in the text of a popular account. The name there appears simply in the combinations *Alopochen aegyptiaca* and *Alopochen jubata*, without mention of a type species or of any reason for the change. The type of *Alopochen* must, therefore, be determined by subsequent designation. Count Salvadori, in the work to which reference has already been made,[4] quotes *Alopochen* as equivalent to *Chenalopex* Stephens,[5] but gives no

[1] Salvadori, Cat. Birds Brit. Mus. **27:** 166. 1895.

[2] Νέος, novus; Χήν, anser.

[3] Stand. Nat. Hist. **4:** 140–141. 1885.

[4] Cat. Birds Brit. Mus. **27:** 166. 1895.

[5] Gen. Zool. **12**[2]**:** 41. 1824. (Type by monotypy, *Anas aegyptiaca* Linnae).

other indication of type. Lest a question should arise regarding this as a fixation of type we here definitely designate *Anas aegyptiaca* Linnaeus as the type of *Alopochen* Stejneger. Salvadori uses the name *Chenalopex* Stephens[5] for the group, evidently overlooking the fact that it is preoccupied by *Chenalopex* Dumont,[6] and by *Chenalopex* Vieillot;[7] which preoccupation is doubtless the occasion for the original introduction of the generic name *Alopochen* by Dr. Stejneger.

The type and only species of *Neochen* will now stand as *Neochen jubata* (Spix).

The taxonomy of the genus *Alopochen* has apparently given authors more or less trouble. Dr. Stejneger[8] associates it with the spur-winged geese (subfamily Plectropterinae), while Count Salvadori[9] includes it among the Anatinae. It seems to be, however, excepting, of course, the above separated *Neochen*, most closely allied to *Rhodonessa* Reichenbach and *Asarcornis* Salvadori. In fact, these four genera, together with *Sarkidiornis* Eyton, and probably also the fossil *Centrornis* Andrews, form a rather homogeneous group, which differs externally from the Plectropterinae in lacking the spur on the wing, as well as in having the head fully feathered, and which may be distinguished by the subfamily name of *Sarkidiornithinae*.

[6] Dict. Sci. Nat. **8:** 393. 1817. (Type by original designation, *Alca impennis* Linnaeus).

[7] Nouv. Dict. Hist. Nat. **24:** 132. 1818. (Type by implication, *Alca impennis* Linnaeus).

[8] *Loc. cit.*

[9] *Loc. cit.*

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*Thermal expansion of alpha and of beta brass between 0–600°C.* P. D. Merica and L. W. Schad. Bur. Stands. Sci. Paper No. 321. Pp. 20. 1918.

In connection with the investigation of the failure of brass by cracking, a comparison has been made of the thermal expansions between ordinary temperature and 600°C. of the two constituents, alpha and beta, of which 60:40 brass is composed. The results show that whereas at ordinary temperature the unit expansions of beta brass (55 per cent copper) and of alpha brass (65 per cent copper) are very nearly equal,—about 18×10^{-6} per degree C.—that of the beta brass becomes about 50 per cent greater than that of the alpha between 400° and 450°C., just below the beta transformation temperature.

This difference in expansion must result in the existence of differential local or "grain" stresses in a heterogeneous brass containing both alpha and beta when quenched from temperatures higher than from 400 to 500°C. at such a rate of cooling that geometrical adjustment cannot take place between these elements of the mass. The stress distribution in such a quenched brass is very complex; an approximate calculation on certain very arbitrary assumptions would indicate the possibility of the development by quenching of average tensional stresses of 15,000 pounds per square inch and more in the beta constituent.

The possible effect of such stresses on the mechanical properties and service behavior of brass and other materials is discussed. Experiments showed that these stresses caused in all probability a decrease of the proportional limit over that in the quenched and annealed state. They have failed to show, however, that such quenched brass will "corrosion-crack" in the mercurous nitrate test.

Attention is called to the desirability of studying this feature of heterogeneous alloy structure more fully. P. D. M.

PHYSICS.—*Spectro-radiometric investigation of the transmission of various substances.* W. W. COBLENTZ, W. B. EMERSON, and M. B. LONG. Bur. Stands. Sci. Paper No. 325. Pp. 24. 1918.

This paper gives the spectral transmission of various substances, especially colored fluorite and colored glasses. Some of the substances described in this paper provide a simple means of obtaining narrow spectral bands of energy of high intensity and large area without employing a spectroscope. By properly combining these substances one can obtain a screen having a narrow band of high transmission at 0.38μ, 0.5μ, 0.55μ, 0.7μ, 0.8μ, 1μ, and 2.2μ. The data on glasses are also useful in connection with the question of protecting the eyes from injurious radiations. W. W. C.

PHYSICS.—*The photoelectric sensitivity of bismuthinite and various other substances.* W. W. COBLENTZ. Bur. Stands. Sci. Paper No. 322. Pp. 14. 1918

This paper summarizes the results of an investigation of various substances (1) for an increase in electrical conductivity caused by the action of light upon them, and (2) for photoelectric activity when they were charged to a negative potential, in an evacuated chamber, and exposed to light. Pure gallium and silver sulphide were found to have but small photoelectric activity when charged to a negative potential and exposed to light. No change was observed in the electrical conductivity of tellurium, boleite, pyrite, silicon, and mixtures of the sulphides of lead and antimony, when exposed to light. An increase in conductivity was observed in crystals of bismuthinite, cylindrite, molybdenite, selenium, stibnite, boulangerite, jamesonite, and silver sulphide when exposed to light.

Experiments are described in which some of these substances were joined through a battery to the grid circuit of an audion amplifier and a telephone. The light stimulus was interrupted by means of a rotating sectored disk, as used in Bell's selenium photophone. When using a cell or crystal of selenium the fluctuations in light intensity produced a sufficient change on conductivity to cause a musical note in the telephone. Similarly, in some samples of bismuthinite and of molybdenite, a change in conductivity was produced, which caused an audible sound in the telephone receiver. Further experiments are in progress to determine to what extent and for what wave-lengths this is a true photoelectric change (increase) in conductivity, and to what extent it is caused by fluctuations in temperature with a resultant change in resistance within the crystal. W. W. C.

MAGNETISM.—*Terrestrial magnetism, United States magnetic tables and charts for 1915.* DANIEL L. HAZARD. U. S. Coast and Geodetic Survey. Spec. Publ. No. 44. 1918.

This publication contains the results of observations made in the prosecution of the magnetic survey of the United States to the end of 1915, with corresponding values for January 1, 1915; the collected results of observations at repeat stations used in determining the change of the magnetic elements with lapse of time; the secular change tables used in reducing the observed values to the common epoch January 1, 1915; and five magnetic charts showing graphically the distribution of the magnetic declination, dip, horizontal intensity, vertical intensity and total intensity in the United States on January 1, 1915. On the declination, dip, and horizontal intensity charts there are also lines showing the annual change of those elements in 1915. In addition to the results obtained by the Coast and Geodetic Survey the collection includes all available results of high grade from observations made by others in the United States and adjacent land and water areas, including those at stations in Mexico, Central and South America used in the construction of the isogonic chart of the West Indies published in 1914.

D. L. H.

SPECTROSCOPY.—*Wave lengths in the red and infra-red spectra of iron, cobalt, and nickel arcs.* W. F. MEGGERS and C. C. KIESS. Bur. Stands. Sci. Paper No. 324. Pp. 15. 1918.

It has long been known that the sensitiveness of photographic plates to yellow, red, and infra-red light may be increased by staining the plates with certain dyes, but the use of such stained plates in spectrum photography has not been very common. The long wave regions of the arc spectra of ferrous metals were recorded on plates stained with pinacyanol and with dicyanin. The photographs were made in the first order spectrum of a concave grating with 645 cm. radius of curvature. Exposures of ten minutes duration sufficed to register the spectrum up to 7000 Å; between 7000 Å and 9000 Å, twenty to thirty minutes' exposure was sufficient; while five to ten hours of exposure recorded many lines whose wave-lengths exceed 10,000 Å, or one micron. In the arc spectrum of iron, 298 lines were measured between the wave-length limits 6750 Å and 10,689 Å; 606 lines were measured between 5503 Å and 11,623 Å in the arc spectrum of cobalt; and 290 lines between 5504 Å and 10,843 Å in the arc spectrum of nickel.

W. F. M.

MYCOLOGY.—*Aspergillus fumigatus, A. nidulans, A. terreus n. sp. and their allies.* CHARLES THOM and MARGARET B. CHURCH. Amer. Journ. Bot. **5**: 84–104, figs. 3. February, 1918.

After comparison of a large number of strains in culture, the authors have grouped three series of them under two old and one new specific name. Cultural reactions for *A. fumigatus* and *A. nidulans* are given. An ascosporic form with the conidial morphology of *A. fumigatus* is described together with three ascosporic strains with the conidial morphology of *A. nidulans* and slight differences in size and markings of ascospores. *Aspergillus terreus,* a cinnamon or avellaneous form widely occurring in soil, is described. The constant occurrence of these three groups of strains in soil cultures led to experiments which showed these forms, together with five strains of *A. flavus, A. clavatus, A. oryzae, Penicillium luteum, P. pinophilum,* and three strains of the Citromyces section of Penicillium, to grow and fruit readily upon and in three types of soil used in laboratory culture. Full citation of the original literature of these species and types either confused with them or presumptively related to them are given.

C. T.

ENGINEERING.—*Ground connections for electrical systems.* O. S. PETERS. Bur. Stands. Tech. Paper No. 108. Pp. 224. 1918.

This paper contains the results of an investigation of methods of grounding electrical systems for protective purposes, made with special reference to the National Electrical Safety Code. The subject is taken up under the following main topics: (1) Resistance of ground connection; (2) their uses and service conditions; (3) different forms of ground connections and the electrical characteristics of each; (4) mechanical construction; (5) inspection and testing; (6) fire hazard and interference with service; (7) costs; (8) bases for specifications; and (9) field measurements of the resistance of ground connections. The section on field measurements is perhaps of greatest interest to practicing engineers, and contains results of resistance measurements on types of ground connections now in use in thirty-seven cities in different parts of the United States. In comparatively few places is it possible to obtain adequate protection from electrical dangers by means of grounds made with electrodes of small extent, such as driven pipes, plates, and other devices. To obtain protection which is continuous and reliable, it is necessary to make use of water pipes or common ground wires which connect plate grounds in parallel. O. S. P.

CHEMISTRY.—*The possibilities and limitations of the Duclaux method for the estimation of volatile acids.* L. J. GILLESPIE and E. H. WALTERS. Journ. Amer. Chem. Soc. **39**: 2027–2055. 1917.

Direct methods were found for the calculation of the results of analyses by the Duclaux method, and a study was made of the method by means of these methods of calculation. If a mixture can first be shown to contain not more than three volatile acids (of the fatty series) in significant quantities, then a single distillation will serve for the quantitative analysis (and to a certain extent the qualitative analysis) without too great error. The errors for four acids are too great. If four or more acids are present in significant quantities the mixture must be fractionated before applying the calculations into mixtures containing only three acids in significant quantity. The methods of calculations are applicable to distillations made in other ways, for instance to steam distillations at constant volume. In the addendum, an especially simple and rapid graphic method is given for the calculation for the case of three acids. This method has the advantage over the least square method, as any desired weight can be given readily to any observation. L. J. G.

SOIL PHYSICS.—*The action of neutral salts on humus, and other experiments on soil acidity.* LOUIS J. GILLESPIE and LOUIS E. WISE. Journ. Amer. Chem. Soc. **40**: 796–813. 1918.

The action of humus on solutions of sodium, potassium, and barium chlorides of different strengths was studied by means of the hydrogen electrode. The measurements showed a large increase of hydrogen-ion concentration as a result of the action. The effect was greatest in the case of barium chloride. Similar effects of smaller magnitude were seen in the action of potassium chloride on true solutions in the absence of humus or undissolved substances; these effects made it unsafe to draw conclusions as to the detailed mechanism of the process in the case of humus.

Some experiments with litmus paper served to make clear the difficulties and limitations of the litmus-paper test as applied to soils and soil extracts. These experiments make it plain that there is no ground for a recent classification of soils which respond in the moist state to blue litmus paper into two types: "truly acid" and otherwise, according to the behavior of the litmus paper toward the aqueous soil extract. Litmus paper cannot be used, without suitable precautions, to arrange soils in the order of their intensities of acidity. There seems to be no reason to assume a mysterious element in soil acidity. L. J. G.

SOIL PHYSICS.—*Hydrogen-ion concentration measurements of soils of two types: Caribou loam and Washburn loam.* LOUIS J. GILLESPIE and LEWIS A. HURST. Soil Sci. **4**: 313–319. 1917.

The Caribou loam and the Washburn loam from Aroostook County, Maine, possess before cultivation broadly different biological characteristics. Both types are largely devoted to potato culture, the Caribou loam being better adapted to this than the Washburn loam.

Cultivated soils of the Caribou-loam type exhibit, when examined by the colorimetric method, considerably greater hydrogen-ion concentrations than do soils of the Washburn-loam type. The average hydrogen-ion exponent for the Caribou soils was found to be 5.2; that of the Washburn loam, 5.9.

The possibility is indicated that the relative freedom of the Caribou loam from potato scab may be due to its greater hydrogen-ion concentration. L. J. G.

TECHNOLOGY.—*Comparative tests of chemical glassware.* PERCY H WALKER and F. W. SMITHER. Bur. Stands. Tech. Paper No. 107 Pp. 23. 1918.

Beakers of Kavalier glass, and beakers and flasks of Macbeth Evans, Pyrex, Jena, Nonsol, Fry, and Libbey glasses were tested for chemical composition, coefficient of expansion, refractive index, strain, behavior on repeated evaporation, resistance to heat and mechanical shock, and to solution in a variety of chemical reagents.

No conclusions as to the relative values of the different wares can be drawn from the chemical analyses, though these analyses may be useful by enabling the chemist to choose a glass which will yield no objectional ingredient to the solutions used in any particular piece of work. The coefficient of expansion of all the glasses is low and is unusually so in the Pyrex ware. All the ware shows more or less strain, but it was disappointing to find that no information as to liability to break under sudden changes in temperature or mechanical shock could be obtained by an examination for strain. All the ware tested showed good resistance to repeated evaporation of a salt solution. The Kavalier ware is unsatisfactory as regards solubility in water; all the other wares appear satisfactory in this respect. All the ware is resistant to acids. Kavalier is least resistant to carbonated alkalies, Pyrex more resistant than Kavalier but less resistant than the others. All the glasses are much attacked by evaporating caustic alkalies. The authors are of the opinion that considering all the tests each of the American wares is superior to the Kavalier and equal or superior to the Jena ware. F. W. S.

SCIENTIFIC NEWS AND NOTES

Dr. Frank Baker, former superintendent of the Zoological Park and a charter member of the Academy, died at his home, 1901 Biltmore Street, on September 30, 1918, in his seventy-eighth year. Dr. Baker was born at Pulaski, New York, August 22, 1841. He became professor of anatomy at Georgetown University in 1883, and superintendent of the National Zoological Park in 1890, retiring from the superintendency in 1916. He took an active part in the work of the scientific societies, having been secretary of the Academy for thirteen years (1899–1911), and a member of the Anthropological, Biological, and Medical Societies of Washington. He was president of the Association of American Anatomists in 1897, and editor of the *American Anthropologist* from 1891 to 1898.

Prof. John T. Bates, formerly professor of Chemical Engineering at Iowa State College, has come to the Bureau of Standards to work on the capacity rating of track scales.

Dr. Heber D. Curtis, of Lick Observatory, is engaged in military work relating to optical instruments at the Bureau of Standards.

Col. Bradley Dewey, of the Chemical Warfare Service, has been transferred to the New York headquarters of the Service and is in charge of its gas defense division.

Prof. E. C. Franklin, of Stanford University, California, is on leave of absence and is engaged in research work for the Nitrate Division, Ordnance Department of the Army.

Prof. W. S. Franklin, who has been engaged in investigation work on aeronautical instruments at the Bureau of Standards during the summer, has returned to continue his teaching work at the Massachusetts Institute of Technology.

Prof. R. S. Johnston, formerly in charge of the Structural Materials Laboratory at Lafayette College, has recently joined the staff of the Bureau of Standards.

Miss McDowell, Professor of Physics at Wellesley College, has returned to continue her academic work. She has been engaged in the investigation of crystal detectors for use in radiotelegraphy at the Bureau of Standards during the summer.

Prof. H. F. Moore, the Director of the University of Illinois Experiment Station, has been in Washington for the past few weeks to assist in the calibration of the large testing machine at the Bureau of Standards.

Mr. W. H. Sligh, of the Bureau of Standards, has been commissioned a captain in the Engineer Corps, U. S. A., and is stationed at Camp Humphreys.

Prof. James R. Withrow, of the department of chemistry, Ohio State University, is on leave of absence and engaged in war research at the American University Experiment Station of the Chemical Warfare Service.

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BOTANY.—*A phytogeographical sketch of southern Maryland.* Roland M. Harper, Office of Farm Management. (Communicated by A. S. Hitchcock.)

Southern Maryland, according to local usage, is that part of the state between Chesapeake Bay and the fall line, including the counties of Anne Arundel, Prince Georges, Calvert, Charles, and St. Marys, and small parts of a few others. The few botanists who have written about this area[1] have generally treated it as a geographical unit; but its vegetation is really very diversified. Geologists have subdivided this part of the coastal plain in two different ways: first according to the outcroppings of the various Cretaceous and Tertiary strata, and second according to the superficial formations, which are supposed to represent four Pleistocene terraces.[2]

For phytogeographical purposes southern Maryland can be divided into five more or less distinct regions, the soil, topography, and vegetation of each of which vary only within certain limits. Two of them correspond pretty closely with the areas in which certain Cretaceous and Eocene formations are exposed, and another with the oldest and highest Pleistocene (or perhaps Pliocene) terrace. One cannot be correlated very well with any

[1] The most comprehensive account is that by Chrysler in the Plant Life of Maryland, pp. 149–197 (Baltimore, 1910).

[2] These terraces have been discussed at length, with numerous maps, by G. B. Shattuck in his report on the Pliocene and Pleistocene, a separate volume of 291 pages and 75 plates published by the Maryland Geological Survey in 1906.

existing maps of geology or soil, and the last includes the remainder not otherwise disposed of, which may possibly be subdivided hereafter.

Within the last two years the writer has utilized many Sundays and holidays and a few other days in making pedestrian excursions through all the counties named for the purpose of studying the vegetation and other geographical features. Copious notes have been taken en route, which are now sufficiently complete to form the basis of a fairly accurate quantitative analysis of the existing plant covering, at least as far as the more common and conspicuous native species, especially trees, are concerned.[3] These quantitative studies bring out many differences that the ordinary floristic or qualitative lists fail to show; for it happens that the vast majority of the native plants of Maryland belong to common and widely distributed species[4] (especially is this true of the trees), so that the number confined to any one region would be exceedingly small.

In this preliminary paper each region will be described very briefly, and then its commonest trees listed as nearly as possible in order of abundance. The wooded area of each region, and the percentage of evergreens in the forests, have been estimated with the aid of Besley's recent report on the forests of the state.[5] No attempt is made to assign percentages to the different species at this time, but it happens that the first one in each list constitutes not far from 20 per cent of the total, and the numbers for the others would form something like a descending geometrical progression (like the population figures for cities arranged in order of size, and numerous other kinds of statistics). Where it is reasonably certain that a given species is more abundant in one of the regions than in any of the others its name in that list is starred, which will enable the reader to pick out the characteristic species of each region at a glance.[6] Evergreens are

[3] For an outline of the methods used see 6th Ann. Rep. Fla. Geol. Surv. 177–180. 1914; Torreya **17:** 1–2, 5–7. 1917.

[4] See Torreya **11:** 36. Feb. 1911.,

[5] Baltimore, 1917. Reviewed in Torreya **18:** 120–122. 1918.

[6] For an application of a method similar to this to the trees of Illinois see Torreya **18:** 168–170. 1918. This plan should be useful also to any one desiring a supply of a particular kind of timber, e.g., black walnut.

indicated by the letter E, and the percentage of them for each region has been estimated, for that seems to be a good index of soil fertility. Common names are added for the benefi of nonbotanical readers who may have occasion to explore some of the same territory.

The plant lists include only native forest trees large enough to be sawn for lumber, those being the most conspicuous and important components of the vegetation. If smaller trees, such as the dogwood, were included it would be difficult to compare them with the larger ones with respect to abundance, and very little additional contrast would be gained thereby, for it happens that the dogwood is the commonest small tree in all five regions (as well as in many other parts of the eastern United States). A few notes on shrubs and herbs are added, but to attemptto list those would require entirely too much space for the limits of this paper. The names of trees seen only a few times in a given region are omitted, because of the possibility of their having been wrongly identified, or not properly belonging to the region.

1. THE FALL-LINE CLAY HILLS

This corresponds approximately with the region of the non-marine Lower Cretaceous formations (Potomac group), which form a belt averaging seven or eight miles wide adjacent to the fall line all the way across Maryland and the District of Columbia and a little way into adjoining states. It is analogous in many ways to the fall-line sand hills of the Carolinas and Georgia, and some of its features, particularly the mottled clays and ferruginous sandstones, are matched very closely in a belt just below the fall line in Alabama. It is most typically developed between Washington and Baltimore, where it occupies all the country between the Baltimore & Ohio Railroad and the Washington, Baltimore & Annapolis electric line, and a little more on either side.

The underlying strata, exposed in innumerable cuts, consist of pinkish or mottled stiff clay, more or less mixed with sand and gravel, and the soils are mainly sandy and gravelly loams, all distinctly acid or noncalcareous. The surface is strewn in many places with fragments of ferruginous sandstone. The topography varies from flat terraces near sea level to steep hills rising some 350 feet higher. Streams are numerous, but the smaller ones on the more clayey soils are intermittent. The gravelly bogs recently described by McAtee in his Natural History of the District of Columbia[7] are almost confined to this region.

About 40 per cent of the area is still wooded, in spite of its proximity to two large cities, and there was a movement about five years ago looking toward the establishment of a national forest between Baltimore and Washington.

The commonest trees seem to be:

E **Pinus virginiana.* Scrub pine.	*Quercus falcata.* Red oak (southern).
Quercus alba. White oak.	*Nyssa sylvatica.* Sour gum.
Acer rubrum. Red maple.	*Quercus marylandica.* Black-jack oak.
E **Pinus rigida.* Pitch pine.	*Quercus palustris.* Pin oak.
**Quercus velutina.* Black oak.	*Platanus occidentalis.* Sycamore.
Castanea dentata. Chestnut.	*Quercus coccinea.* Scarlet oak.
Liriodendron tulipifera. Poplar.	*Quercus stellata.* Post oak.
**Quercus montana.* Chestnut oak.	E *Pinus echinata.* Short-leaf pine.
Betula nigra. Birch.	*Hicoria alba.* Hickory.
Liquidambar styraciflua. Sweet gum.	*Quercus phellos.* Willow oak.
Fagus grandifolia. Beech.	*Hicoria glabra?* Hickory.

Evergreens make up about 35 per cent of the forest, and oaks a little less. The undergrowth consists very largely of shrubs belonging to the Ericales, of which *Gaylussacia baccata* (huckleberry) is probably the commonest. *Epigaea* (arbutus) is very common, and apparently in no immediate danger of extermination.

2. THE GREENSAND BELT

This is determined by the outcrop of several Upper Cretaceous and Eocene formations which consist largely of greensand marl. It lies immediately southeast of the belt just described and is of about the same width. The boundary between them is pretty sharply defined in some places, e.g., near Brightseat. It is mostly north of the Chesapeake Beach Railway, and is best

[7] Bull. Biol. Soc. Wash. **1**: 74–90. May, 1918.

developed between that and the Patuxent River. The same or similar geological formations extend northeastward nearly to New York, making fairly fertile soils all the way, but east of Chesapeake Bay the topography and vegetation are somewhat different.

The soils are largely, if not mostly, derived from Pleistocene material, and are loamy sands, fine sandy loams, etc. In some places, particularly near Upper Marlboro, the greensand comes to the surface and gives the soil a decided greenish yellow tinge, which is a very rare color for soils. On the whole the soils are rather above the average in fertility.

The topography is a little less hilly than that of the fall-line hills, and there are more flat areas, but small rounded knolls or knobs averaging perhaps 500 feet in diameter and 15 or 20 feet high are very characteristic, even in some of the valleys separated from the main body of the greensand.

The region has been extensively farmed for over 200 years, and the forests reduced to a little less than a third of the area. Nearly all are second growth, but a few magnificent original stands of yellow poplar, white oak, etc., have been preserved.[8] Evergreens constitute not more than 10 per cent of the total, and as the prevailing evergreen is the scrub pine, which is partial to worn-out fields, etc., we may infer that the original forests were almost wholly deciduous.

The commonest trees at present seem to be as follows:

Liriodendron tulipifera. Poplar.
E *Pinus virginiana*. Scrub pine.
Quercus alba. White oak.
Acer rubrum. Red maple.
**Fagus grandifolia*. Beech.
**Betula nigra*. Birch.
Castanea dentata. Chestnut.
Liquidambar styraciflua. Sweet gum.
**Ulmus americana*. Elm.
**Platanus occidentalis*. Sycamore.
Quercus velutina. Black oak.
Nyssa sylvatica. Sour gum.
**Fraxinus americana*. Ash.
**Quercus borealis maxima*.[9] Red oak (northern).
Quercus palustris. Pine oak.
Hicoria alba. Hickory.
Quercus falcata. Red oak (southern).
Morus rubra. Mulberry.

Any one familiar with the habitats of these trees will notice a great contrast between the starred ones in this list and the pre-

[8] For the location of some of these see map of Prince Georges County in Besley's forest report previously mentioned.

[9] Formerly referred to *Q. rubra*. See Torreya **17**: 135. 1917.

ceding in the matter of soil preferences. The huckleberries and other low shrubs are rather scarce in this region. The commonest herb in undisturbed forests is probably *Meibomia nudiflora*. Oaks seem to make up less than one-fifth of the standing timber.

3. THE BAY SHORE HILLS

This name may be applied to a north-south strip about five miles wide and 25 miles long, bordering Chesapeake Bay in Anne Arundel and Calvert counties. Chesapeake Beach is near the middle of this strip, and its western edge is about on the divide between the bay and the Patuxent River. The underlying strata are Miocene of the Chesapeake group (well exposed in the high cliffs just south of Chesapeake Beach), but they are by no means peculiar to the region under consideration.

The soils are rather loamy, approaching clay loam or silt loam in some places, generally of a light brown color, and evidently quite fertile. The topography is probably the most broken of any region in the Atlantic coastal plain. Some of the bluffs facing the bay are over 100 feet high, and two or three miles farther back elevations of 150 feet or so are reached. And yet hillsides with a slope of 30° or more have been cultivated for years with very little trouble from soil erosion.

About 40 per cent of the area is wooded now, and evergreens make up about 16 per cent of the forest. The commonest trees seem to be:

Castanea dentata. Chestnut.
Liriodendron tulipifera. Poplar.
E *Pinus virginiana*. Scrub pine.
Liquidambar styraciflua. Sweet gum.
E *Pinus taeda*. Loblolly pine.
Quercus alba. White oak.
Fagus grandifolia. Beech.
Juglans nigra. Black walnut.
Morus rubra. Mulberry.
Ulmus americana. Elm.
Quercus falcata. Red oak (southern).
Quercus velutina. Black oak.
Hicoria alba. Hickory.
Hicoria sp.[10] Hickory.
Platanus occidentalis. Sycamore.
Nyssa sylvatica. Sour gum.
Quercus borealis maxima. Red oak (northern).
Prunus serotina. Wild cherry.

[10] Not yet identified. Perhaps more than one species.

A comparison of the starred species in this and the preceding list, in connection with chemical analyses of representative soils of the two regions, should throw valuable light on the soil preferences of the trees involved. In the abundance of chestnut and poplar, and in a few other particulars, this region differs from all other parts of the coastal plain and resembles the Piedmont region, particularly that part immediately north of the District of Columbia. The chestnut is now badly blighted, and this is said to have happened only in the last three or four years. The undergrowth comprises a remarkable number of herbs with compound leaves (such as *Cimicifuga*, *Phegopteris hexagonoptera*, and *Botrychium virginianum*) or barbed fruits (*Cynoglossum*, *Circaea*, *Washingtonia*, *Meibomia*), and others that are more characteristic of hilly or even mountainous regions (e.g., *Oxalis violacea*, *Obolaria*, *Arabis canadensis*, *Hepatica*). *Asimina triloba* (pawpaw) is one of the commonest shrubs or small trees. The Ericales are almost wanting. The various oaks constitute only about 11 per cent of the forest: a very small figure for this part of the world.

4. THE BRANDYWINE PLATEAU

This corresponds pretty closely with the area mapped by Maryland geologists as occupied by the Lafayette or Brandywine terrace (the latter name taken from the village of Brandywine in Prince Georges County). Its northern extremity is near the eastern corner of the District of Columbia, nearly 300 feet above sea-level, and it extends southward with gradually decreasing altitude to the vicinity of LaPlata and Charlotte Hall. It is perhaps the best example of a plateau in the whole coastal plain.

The general surface of the uplands is rather flat, but is deeply dissected by several creeks, some of which cut down into the greensand and make fertile valleys a mile or more wide. These valleys have proved a well-nigh insuperable obstacle to building railroads from Washington in the direction of Leonardtown, and St. Marys County is now without railroad connections. The plateau is something like a miniature of the Highlands of New Jersey or the Cumberland Plateau of Tennessee and Alabama, which have broad well-wooded uplands with poor soil, interrupted by occasional cultivated limestone valleys. The soil is mostly loam of a pale buff color ("Leonardtown loam"), varying toward sand in some places. One of the gravelly bogs mentioned above is known in this region, and possibly others may be hidden away among the forests.

About 55 per cent of the area is still wooded, and perhaps half of that is virgin forest, or at least occupies land that has never been cultivated. Evergreens constitute about 25 per cent of the timber. The commonest trees are about as follows:

E *Pinus virginiana.* Scrub pine.
**Quercus alba.* White oak.
Liquidambar styraciflua. Sweet gum.
**Quercus marylandica.* Black-jack oak.
Quercus stellata. Post oak.
Quercus falcata. Red oak (southern).
**Nyssa sylvatica.* Sour gum.
**Quercus phellos.* Willow oak.
**Quercus coccinea.* Scarlet oak.
Acer rubrum. Red maple.
Castanea dentata. Chestnut.
Liriodendron tulipifera. Poplar.
E **Juniperus virginiana.* Cedar.
Quercus velutina. Black oak.
Fagus grandifolia. Beech.
Quercus montana. Chestnut oak.
Hicoria alba. Hickory.
**Hicoria glabra.* Hickory.
Quercus palustria. Pin oak.
E *Pinus rigida.* Pitch pine.

The various oaks here make up nearly half the forest, or more than in any of the other four regions. The shrubby and herbaceous undergrowth is very similar to that of the fall-line clay hills.

5. THE ST. MARYS REGION

Under this head is lumped for the present the remainder of southern Maryland, namely, all south of latitude 38° 30′, together with the Patuxent Valley as far up as a line connecting Annapolis and Upper Marlboro. It is all underlain by Miocene strata, except the southwest corner, in the great bend of the Potomac River, where there is an Eocene greensand area around Nanjemoy that is comparatively inaccessible and little known.

The soil is mainly loam and sandy loam of medium fertility, and the topography is pretty thoroughly dissected into low hills which flatten out toward tidewater. But on some of the divides in St. Marys County there are a few small shallow ponds, hardly large enough to show on topographic maps. The highest altitude is about 180 feet.

About half the area is in forest, but probably not more than one-fourth is original forest. About 40 per cent of the trees are evergreen. The prevailing species seem to be as follows:

E *Pinus virginiana*. Scrub pine.
**Quercus falcata*. Red oak (southern).
Quercus alba. White oak.
Liquidambar styraciflua. Sweet gum.
Castanea dentata. Chestnut.
Quercus stellata. Post oak.
E **Pinus taeda*. Loblolly pine.
Liriodendron tulipifera. Poplar.
Quercus velutina. Black oak.
Acer rubrum. Red maple.
Nyssa sylvatica. Sour gum.
**Hicoria alba*. Hickory.
Fagus grandifolia. Beech.
Quercus marylandica. Black-jack oak.
E *Juniperus virginiana*. Cedar.
Quercus phellos. Willow oak.
Quercus montana. Chestnut oak.
Pinus echinata. Short-leaf pine.
Quercus coccinea. Scarlet oak.
Platanus occidentalis. Sycamore.
Betula nigra. Birch.
Hicoria glabra. Hickory.
Ulmus americana. Elm.

Oaks here make up a little more than one-third of the forest. The few species starred may prefer this region to the other four simply because it is the southernmost and warmest, for they all range much farther southward than northward. Among the small trees or large shrubs *Ilex opaca*, *Aralia spinosa*, and *Myrica cerifera* are much commoner here than in the other regions, probably for the same reason. The smaller shrubbery does not differ much from that in regions 1 and 4.

PLANT PHYSIOLOGY.—*The reactions of the soils supporting the growth of certain native orchids.* EDGAR T. WHERRY, Washington, D. C.

That soil reaction is an important factor in connection with the growth of certain plants is now thoroughly established—most legumes require an alkaline soil, most heaths an acid one, and so on. It has seemed to the writer a matter of interest to ascertain the relations in the case of some of the less widespread native plants, and during vacation trips for several years past tests have been made with this end in view. The results obtained with the Orchidaceae are here presented.

The majority of the native orchids grow either in bog-peat or in upland peat, both of which are usually acid in reaction. Several species of the genera Cypripedium, Habenaria,[1] Spiranthes, etc., are, however, known to grow in limestone regions, where the soil may possess a distinctly alkaline (basic)[2] reaction. It seemed desirable to confirm these inferences as to the reactions of the soils in all cases, for, as the following examples will show, incorrect deductions may readily be drawn from superficial examinations.

In some limestone valleys in northern Pennsylvania and New Jersey choked by glacial drift, swamps and bogs have developed in which the standing water and underlying soil are alkaline, owing to the presence of calcium bicarbonate in solution. The orchids growing there, which include several Cypripediums, *Spiranthes lucida*, *Arethusa bulbosa*, etc., might all be presumed to be calciphilous and to require an alkaline soil. Actual tests have shown, however, that while the tall Cypripediums do indeed grow in the calcareous water, *C. acaule* and the other two plants noted grow upon hummocks of sphagnum or other mosses, where the soil proves to be decidedly acid in reaction.

In other instances *Cypripedium acaule*, usually an acid soil species, has been found in dry woods in limestone valleys, and might have been classed as tolerant of alkaline conditions. But in every case chemical tests have shown normal acidity, and its roots have proved to be imbedded in sandstone drift so thick as to exclude any possible effect of the underlying rock.

[1] The nomenclature of Gray's Manual, 7th edition, 1908, is used here; for the benefit of those who prefer other names, important synonyms are added in the table containing the summary of results. In a study like the present it would appear to make no difference what code of nomenclature is followed, so long as the plants are correctly identified, and in this direction the utmost care has been taken.

[2] The term alkaline is here used in the physical-chemical sense, and has nothing to do with the so-called "alkali" soils, in which there may be a neutral salt of an alkali metal, so that the reaction is not necessary alkaline at all. According to the usage adopted, alkaline is essentially synonymous with basic, and refers to the presence of free hydroxyl ions, and ability to neutralize acids, irrespective of the actual base present.

It seems evident that conclusions as to the requirement of alkaline or acid conditions by a given species can be depended upon only when based on actual investigation of the soils in which they grow.

There are two methods in use for determining the reactions of soils: titration, which shows the quantity of acid or alkali present, and measurement of hydrogen-ion concentration, which furnishes information as to the strength of the acid or alkali. The latter feature being the more significant from the biochemical point of view,[3] attention has been confined to it.

The following procedure has been adopted for making the observations: A sample of soil a gram or two in weight is shaken up thoroughly in a thick-walled test-tube 1.5 cm. in diameter with about 5 cc. of the purest water available and allowed to stand at an angle of 45 degrees until the bulk of the suspended matter has settled. One cc. of this liquid is pipetted off and placed in a 1 cm. wide test-tube, and to it a like volume of an indicator solution is added. In another 1 cm. tube 1 cc. of the same indicator is diluted with 1 cc. of water. In order to overcome the effect of the remaining turbidity, an additional portion of the soil extract is diluted somewhat in a 1.5 cm. tube of the same length as the narrower one containing the indicator, and the latter tube is plunged into the cloudy liquid. The effect of the turbidity on the color of the indicator is thereby rendered the same in both tubes, but in the one case the indicator and soil extract are mixed, in the other they are separate, and the slightest change of color produced by any acid or alkali in the soil extract may be readily seen on comparison of the two tubes.

The indicators covering the extreme range likely to be met with in ordinary soils, their color changes, and the intensities of acidity or alkalinity corresponding to each color, are listed in table 1. Instead of describing the reactions by the rather difficultly comprehensible exponential method, as is ordinarily done by physical chemists, direct numerical intensities are here employed. According to this plan the more intense the acidity,

[3] See Gillespie, *Journ. Wash. Acad. Sci.* **6**: 7. 1916; Sharp and Hoagland, *Journ. Agr. Res.* **7**: 123. 1916; Clark and Lubs, *Journ. Bact.* **2**: 109. 1917, etc.

the larger the number used to describe it; thus, a liquid with an intensity of 1000 is 10 times as acid as one with an intensity of 100, and so on.[4]

TABLE 1

Indicators* for Soil Acidity and Alkalinity Determination

	Intensity of acidity							
	3000	1000	300	100	30	10	3	1
Bromphenol blue......	yellow	green	vio.-blue					
Methyl red.			vio.-red	br.-red	orange	yellow		
Bromcresol purple....					yellow	br.-red	red-vio.	
Phenol red..							yellow	orange

	Intensity of alkalinity				
	1	3	10	30	100
Phenol red....................	orange	br.-red	vio.-red		
Phenolphthalein...............			white	pink	red

* Samples of several of these were kindly supplied to the writer by Dr. H. A. Lubs.

The indicators are used in extremely dilute solutions, mostly about 0.0001 per cent, although it is most convenient to transport them into the field in more concentrated form, and to dilute them as needed. For the first examination of each soil phenol red is employed, as its color changes occur around the true neutral point, at which, according to the plan here adopted, acidity = alkalinity = 1. When the effect produced is that of either its most acid or most alkaline color, the procedure is repeated with indicators showing changes over adjoining ranges

[4] This plan was used by the writer in a previous paper on a similar subject, *Journ. Wash. Acad. Sci.* **6**: 675–676. 1916. Its simplicity has led to its employment throughout the present one, but for the benefit of those accustomed to the P_H values, they are added to the table containing the summary of results. To transform numerical intensities into P_H exponents: if acid, subtract the power of 10 represented by the number from 7; if alkaline, add 7 to it. The "two points of interest on the scale of hydrogen-ion exponents for soils" recently discussed by Gillespie (*Science* **48**: 393–394. 1918), namely 6.0, the acid limit for *Azotobacter*, and 5.2, that for the potato-scab organism, would be represented in the scale here used by acid 10 and acid 63 respectively.

of acidity or alkalinity, and this is continued until either an intermediate color of one indicator, or opposing extremes of two overlapping ones, are obtained.

The soils supporting the growth of all of the commoner species of orchids native to the east-central states have been studied by this method, about 200 soil samples, collected as close to the roots of the plants as possible, having been examined. The results can best be expressed by describing first the relations found to exist in the different types of habitat, taken up in the order of increasing acidity.

In swamps in limestone regions the reaction of the standing water and of the underlying soil may be distinctly alkaline, because of accumulation of calcium bicarbonate. This substance in saturated solution may show an alkalinity of 100 or more, but in bogs supporting the growth of orchids it appears never to be sufficiently concentrated to exceed the alkaline intensity of 10. The only orchids which have been noted as growing in a soil with such a reaction are the tall Cypripediums, *C. candidum, C. hirsutum, C. parviflorum,* and the variety *pubescens.* The writer has not had opportunity to carry his studies north of Pennsylvania, but several more northern species are reported to grow frequently or exclusively in calcareous, (or "marly") bogs in which the reaction is no doubt similar to that here noted; these include *Calypso bulbosa, Habenaria dilatata, H. hyperborea, Microstylis monophyllos,* and *Spiranthes romanzoffiana.*[5]

Calcareous (alkaline) soils may also develop in woods above limestone rocks, so it seemed interesting to inquire if the same or related species of orchids might grow in such situations. Two instances have been brought to the writer's attention, *Cypripedium parviflorum* and *Orchis spectabilis,* growing in black soil full of limestone chips a mile southwest of Allentown, Pennsylvania.[6] Tests of these soils showed them to be in fact slightly

[5] This list has been compiled from articles by Prof. M. L. Fernald and others scattered through the journal *Rhodora* for several years past, supplemented by a private communication concerning occurrences in New York kindly sent by Prof. K. M. Wiegand.

[6] These were located by Mr. Harold W. Pretz of Allentown.

alkaline, so that this habitat is comparable with the preceding one. On the other hand, the same two species have been found elsewhere growing in brown woods soil over noncalcareous rocks, exhibiting a distinctly acid reaction, although in no case where the plants appeared to be in a flourishing condition was the intensity greater than 100. In so far as the data admit of generalization, then, it may be stated that the showy orchid and the yellow lady's slipper prefer habitats in which the reactions do not extend far to either side of the neutral point.

Acid intensities ranging from 1 (neutrality) to 100 are shown by the brown soil of open woods, in which thrive so many orchids, such as *Aplectrum*, *Corallorrhiza*, *Epipactis*, some Habenarias, *Liparis*, some Pogonias, *Tipularia*, etc., and by the clayey soil in damp to dry meadows, supporting other Habenarias and many species of *Spiranthes*.

Bogs and swamps in noncalcareous regions show as a rule an acid reaction throughout. The spring water supplying them may be neutral or weakly acid, carbon dioxide producing for instance an intensity of 3; in other cases the water may have an intensity of as much as 300 just as it emerges from the earth, perhaps owing to the presence of traces of sulfuric acid formed by the oxidation of pyrite contained in the strata. But whatever the intensity of the water originally, the organic acids formed by the decomposition of the accumulated vegetable matter frequently attain an intensity of about 300, which, it may be noted by way of comparison, approximates that of acetic acid, when half neutralized by a strong alkali. *Calopogon pulchellus*, *Habenaria flava*, *Pogonia ophioglossoides*, *Spiranthes cernua*, *S. odorata*, and rarely other species, have been observed growing directly in the water of such swamps.

The case of *Cypripedium acaule* is rather peculiar, in that it shows a different soil preference from the other species of this genus. It has been found in sandy open woods, where the intensity of acidity proves to be 100 to 300. An associate in these surroundings is *Spiranthes beckii*. In pure rotted pine needles, in which the reaction covers the same range, it grows alongside of *Microstylis unifolia* and *Spiranthes cernua.* It occurs also on sphagnum hummocks, the relations of which will next be described.

The hummocks of sphagnum and other mosses which develop in many swamps or bogs support a number of characteristic orchids especially *Arethusa, Calopogon, Pogonia ophioglossoides,* and the above mentioned *Cypripedium acaule.* Tests of the partially rotted vegetable matter which surrounds their roots have shown that the acidity is often greater than that of the water in the hollows between the mounds. Even in calcareous swamps, where the water is alkaline, a definite and rapid increase in acidity is found on ascending through the moss, and an intensity of 300 is often present at the top. The more acid the water in the first place, the less rapid is this increase, but the same upper limit is almost always reached. The orchids rooted in this moss may therefore be living in highly acid conditions, even though others growing between the hummocks may have their roots bathed in alkaline waters.

The habitat in which the most acid conditions of all may develop appears to be the peat overlying clay which usually occurs around the margins of bogs. In it grow *Habenaria blephariglottis, H. ciliaris, H. clavellata, H. cristata,* and *Liparis loeselii.* The intensity of acidity of such material has been found to vary in general from 100 to 1000. In one case, however, a soil supporting *Habenaria blephariglottis,* near Hyattsville, Maryland, the extreme value of 3000 has been observed. It may be noted here that the peat used for growing tropical orchids also shows an intensity of acidity of 100 to 1000.

The results obtained with all the species studied are collected in table 2.[7]

[7]It is not claimed that some of these plants may not occasionally grow in soils with reactions outside of the ranges here given, but these ranges are based on measurements in sufficient number to justify regarding them at least as normal. Points of special significance in the tabulated series of reactions appear to be: alkaline 10 (P_H 8.0), the greatest alkalinity observed; acid 100 (P_H 5.0), the upper acid limit for many species, and the lower limit for a few; acid 300 (P_H 4.5), the acid limit for a further large number; and acid 3000 (P_H 3.5) the greatest acidity observed.

TABLE 2

Soil Reactions of Native Orchids

SPECIES	REACTION AND RANGE OF INTENSITY	P_H
Cypripedium candidum	alkaline 10 to neutral	8.0–7.0
parviflorum	alkaline 10 to acid 100	8.0–5.0
var. pubescens (hirsutum)	alkaline 10 to acid 100	8.0–5.0
hirsutum (spectabile, reginae)	alkaline 10 to neutral	8.0–7.0
Cypripedium (Fissipes) acaule	acid 100 to 300	5.0–4.5
Orchis (Galearis, Galeorchis) spectabilis	alkaline 10 to acid 10	8.0–6.0
Habenaria (Blephariglottis) blephariglottis	acid 100 to 3000	5.0–3.5
ciliaris	acid 100 to 1000	5.0–4.0
cristata	acid 100 to 1000	5.0–4.0
fimbriata (grandiflora)	acid 10 to 100	6.0–5.0
lacera	acid 10 to 100	6.0–5.0
peramoena	acid 10 to 100	6.0–5.0
psycodes	acid 10 to 100	6.0–5.0
Habenaria (Coeloglossum) bracteata	acid 10 to 100	6.0–5.0
Habenaria (Gymnadeniopsis) clavellata (tridentata)	acid 100 to 300	5.0–4.5
nivea	acid 10 to 100	6.0–5.0
Habenaria (Lysias) orbiculata	acid 30 to 100	6.5–5.0
Habenaria (Perularia) flava (virescens)	acid 100 to 300	5.0–4.5
Calopogon pulchellus (Limodorum tuberosum)	acid 30 to 300	5.5–4.5
Arethusa bulbosa	acid 100 to 300	5.0–4.5
Pogonia ophioglossoides	acid 30 to 300	5.5–4.5
Pogonia (Triphora) trianthophora (pendula)	neutral to acid 30	7.0–5.5
Pogonia (Isotria) verticillata	acid 10 to 100	6.0–5.0
Spiranthes (Gyrostachys, Ibidium) beckii (simplex)	acid 100 to 300	5.0–4.5
cernua	acid 3 to 300	6.5–4.5
gracilis	acid 10 to 100	6.0–5.0
lucida (latifolia)	acid 10 to 100	6.0–5.0
odorata	acid 10 to 100	6.0–5.0
praecox	acid 10 to 100	6.0–5.0
vernalis	acid 10 to 100	6.0–5.0
Epipactis (Goodyera, Peramium) pubescens	acid 10 to 100	6.0–5.0
repens	acid 30 to 100	5.5–5.0
Serapias (Epipactis) helleborine (viridiflora)	acid 10 to 30	6.0–5.5
Microstylis (Acroanthes, Malaxis) unifolia	acid 30 to 300	5.5–4.5
Liparis (Leptorchis) liliifolia	neutral to acid 100	7.0–5.0
loeselii	acid 3 to 300	6.5–4.5
Aplectrum hyemale (shortii, spicatum)	acid 3 to 100	6.5–5.0
Tipularia discolor (unifolia)	acid 10 to 100	6.0–5.0
Corallorrhiza maculata (multiflora)	acid 10 to 100	6.0–5.0
odontorhiza	acid 3 to 100	6.5–5.0
wisteriana (maculata)	acid 3 to 30	6.5–5.5

In conclusion, a brief discussion of some of the relations brought out by the above table may be added. The separation of *Cypripedium acaule* from the other species, and its assignment to a separate genus, *Fissipes*, first proposed on purely botanical grounds, may perhaps be regarded as having a chemical basis, in that its soil reaction is markedly different from that of the others. A similar case, although hardly sufficiently marked to deserve taxonomic recognition, is that the Habenarias with a simple fringed lip grow in distinctly more acid soils than do those with a three-parted lip.

In some instances the reaction of the soil appears to be more important than its moisture content in determining where a given species will grow; for a single species may be found in habitats varying widely in wetness. Thus *Cypripedium acaule* grows in wet sphagnum in various swamps, and in dry sandy woods on the Coastal Plain; *Spiranthes cernua* in running water in brooks, and in dry pine needles on some District of Columbia and Pennsylvania hills; *Liparis loeselii* in oozy muck in the swamps of northern New Jersey and Pennsylvania, and in barren soapstone gravel on a steep slope along the Potomac near Washington. Yet in every case the acidity of the soils supporting each of these species varies within comparatively narrow limits. This undoubtedly signifies that the fungus living symbiotically on the roots of each species is less tolerant of changes in acidity than in moisture.

Finally, it may be worth while to consider the bearing of the above data on the cultivation of the native orchids. It seems obvious that the growth of the tall Cypripediums would be favored by the addition of a little powdered limestone to the soil; and the writer has been able to grow the northern *C. hirsutum* successfully in the District of Columbia in this way. On the other hand most species require the soil to be made distinctly or even strongly acid. This may be accomplished by adding partly decomposed peat, by mixing in pure quartz sand, and even by watering with highly dilute phosphoric acid or acid phosphate solutions. It seems probable that if more attention should be given to the reactions of the soils into which it is proposed to transplant wild flowers in general, their cultivation would be attended with a greater degree of success.

ETHNOLOGY—*A unique form of prehistoric pottery.*[1] J. WALTER FEWKES, Bureau of American Ethnology.

The specimen of pottery here described was found by a farmer in cultivating his field near Dolores, in the southwestern corner of Colorado. The antiquities of this region show that it was inhabited in prehistoric times by a people who had made great advancement in architecture, on which account some of the best known examples of their buildings have been set aside by the Government for the permanent preservation of these remains. Some of the best known of these buildings are the cliff dwellings of the Mesa Verde National Park, but there are many others in form of castles and towers equally instructive situated in canyons and valleys west of this plateau as far as Utah. These skillful builders have left evidence of their superior craft far into New Mexico, at Aztec, and the large buildings along the Chaco Canyon. They characterize what is called the San Juan culture area. the horizon of which has not yet been determined.

This so-called San Juan culture area can be distinguished by ceramic as well as architectural features. Similar varieties of pottery are found over this whole area. In other words pottery and its decoration support architectural evidences of the extent of this culture area. We find the same technique, color, and design throughout. Foremost among the distinctive forms of pottery found in this area are the corrugated and black and white ware, types no longer manufactured and most abundant in early prehistoric times. We rarely find in this area imitations of human and animal figures in relief, a style of ceramic art quite common in northern Mexico and southern Arizona.

Several effigy vases have been collected from this area in the last few years, and it is probable that their numbers will increase year by year. The specimen here considered cannot be called

[1] Published by permission of the Secretary of the Smithsonian Institution.

an effigy base, but rather a rare double vase with handle decorated with rude representations of animals. It was plowed up by a farmer, Mr. Littrell, while working on his land near the Yellow Jacket Canyon about 5 miles south of Sandstone post office, 20 miles west of Dolores, Colorado. The exceptional features of this object are shown in the accompanying illustrations (figs. 1, 2). The vessel consists of two vases of equal size united by a handle, modeled in the form of a bird and another animal. The end of this handle to the left of the observer is

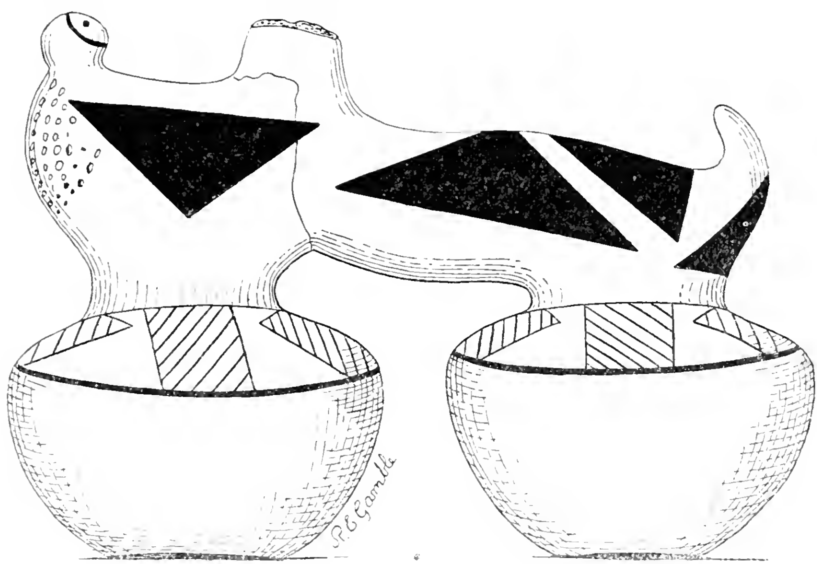

Fig. 1. Double vase from side

a rude representation of the head and body of a bird. The orifice of the vase is on the back of this bird. The representation of the bird is very crude, but triangles similar to those generally painted on the sides of the body of birds are sometimes used in pueblo pictures to designate wings. Similar black figures of triangular shape also occur over the whole handle. The head is almost globular with dots representing eyes enclosed in a circle. The breast is spotted with black dots characteristic of bird and butterfly designs among the pueblos. An effigy vase with these symbols, undoubtedly representing a bird, was excavated last summer in a cemetery eight miles west of Sandstone Canyon.

The posterior extremity of the animal represented on the handle of the two bowls could hardly represent the tail feathers of a bird, but might be intended for the tail of another group of animals, as quadrupeds. The handle can be interpreted as portions of the animals united; one of which is a bird and the other nondescript, both with one common body, a condition

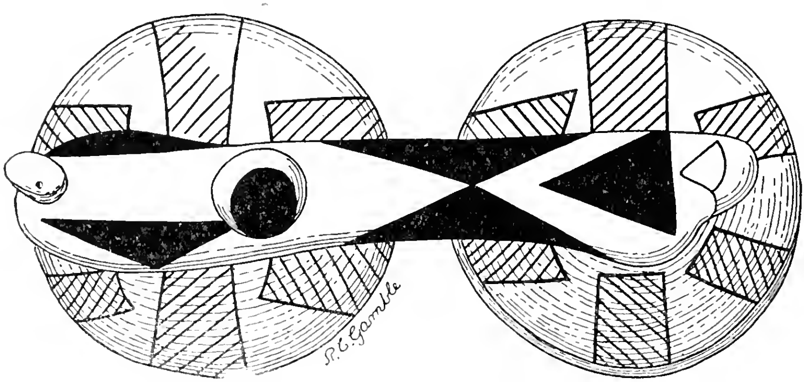

Fig. 2. Double vase from above

like that which characterizes some of the figures painted on the interior of mortuary bowls from prehistoric graves in the Mimbres Valley, New Mexico. In these are found figures of well-drawn fishes combined with an antelope or some nondescript animal combinations. Collections of pottery from Colorado and New Mexico show no designs where double animals are painted or molded.

The orifice of this double vase is situated in almost the middle of the handle, nearer that of the supposed head. It communicates with the cavities of both vases through the hollow handle and suggests that the object was used as a receptacle for sacred water. It is not unusual for the Hopi priests to-day to make long pilgrimages to distant springs to procure water to use in their rites. The medicine vessels of Hopi priests are, however, smaller and simpler than that here considered, although some of these sacred vessels are furnished with handles. The size of the two members of the prehistoric vessels are about the same; both are almost spherical, slightly flattened on their upper side where they are decorated with parallel lines distributed in four blocks. Both have an unusual feature in prehistoric pottery—a concave basal depression. This unique form of pottery belongs to the black-and-white ware which is regarded as archaic and characteristic of the most ancient pueblo ruins.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

ORNITHOLOGY.—*Autumn water-bird records at Washington, D. C.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **30**: 122. 1917.

The autumn of 1916 at Washington, D. C., was ornithologically interesting on account of the large number of shore-bird visitors. During this period, two species, *Pisobia fuscicollis* and *Squatarola squatarola cynosurae,* were first recorded from the District of Columbia. A second record for *Micropalama himantopus,* and the fourth, fifth, and sixth records for *Spatula clypeata* were also obtained. Attracted by unusual conditions, several species stayed far beyond their previous latest dates, notable among these being *Totanus melanoleucus,* which was noted on October 26; *Totanus flavipes,* November 1 (erroneously given as November 2); *Pisobia minutilla,* November 1 (erroneously given as November 2); and *Pisobia maculata,* November 1 (erroneously given as November 2). H. C. O.

ORNITHOLOGY.—*Costa's hummingbird—its type locality, early history, and name.* T. S. PALMER. The Condor **20**: 114–116. 1918.

Costa's hummingbird (*Calypte costae*) has an interesting but somewhat obscure history. It was originally described as from California, but its type locality proves to be Magdalena Bay, Lower California, the type specimen having been collected in 1837 by Dr. Adolphe Simon Neboux during the course of a voyage of the French frigate Venus. It was named for Louis Marie Pantaléon de Costa, Marquis de Beau-Regard. Not until twenty years later was the species found in California, and not until 1876 were its eggs discovered.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*A list of the birds observed in Clay and O'Brien counties, Iowa.* IRA N. GABRIELSON. Proc. Iowa Acad. Sci. **24:** 259–272. 1918.

Clay and O'Brien counties lie in northwestern Iowa in the prairie region near the Great Plains. The country is nearly all rolling prairie now largely under cultivation, and the only timber consists of the fringes along the streams and about some of the lakes, together with the trees planted about buildings. The artificial groves have exerted an important influence in attracting numbers of birds that favor the vicinity of human habitations, and have decidedly increased their numbers. Another important result of the settling up of this part of Iowa is the draining of innumerable ponds and marshes that formerly existed in the prairie regions. This has brought about a great change in the breeding water-fowl population, for these birds have practically disappeared from the area. The present list comprises 136 species, of which forty-seven are water birds and shore birds. The latter are particularly interesting as showing what species of water-fowl lived in this region before the elimination of their favorite breeding places.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*A second bird survey at Washington, D. C.* HARRY C. OBERHOLSER. Wilson Bulletin **30:** 34–48. 1918.

The scientific results of our first comprehensive bird census near Washington, D. C., were so important that we decided to repeat it in the spring of 1917. On this second occasion twenty-two naturalists took part, and the seventeen parties covered the various kinds of country within twenty miles of the city. The date chosen was May 11, 1917, one day earlier in the month than in 1913. An extraordinary combination of circumstances made this time exceptionally favorable for birds; and the results were as remarkable as they were interesting. The total number of species observed by all the parties collectively was 166, which is, so far as we are aware, the largest number ever reported in a single day at any locality in the United States. The total number of individual birds noted was 17,074. The reasons for this rather astonishing result are not far to seek. The very cool weather of April and early May induced the winter residents to remain late, and at the same time retarded the movements of the later migrants; so that while a large number of species was present, there were only a few individuals of many of the more tardy migrants on this May 11, on which date the spring migration about Washington is ordinarily at its height. In 1917, however, the high tide of the migration was not reached until May 17 to 23, nearly ten days later than usual. On the other hand, in 1917 some of the early migrants were very numerous for so late in the season, as, for instance, *Sitta canadensis canadensis*, *Lanivireo solitarius solitarius*, and *Carpodacus purpureus purpureus*. The occurrence of an exceptional number of rare and of occasional visitors at the time our census was taken aided materially in swelling the total number of species observed. This peculiar combination of circumstances which made possible such a great record is not likely to recur for many years. The most noteworthy of these rarities are probably *Phalacrocorax auritus auritus*, *Bonasa umbellus umbellus*, *Bartramia longicauda*, *Pelidna alpina pacifica*, *Pisobia fuscicollis*, *Larus atricilla megalopterus*, *Chlidonias nigra surinamensis*, *Hydroprogne caspia imperator*, and *Sterna hirundo*.

The following fourteen species were present on this date (May 11, 1917), later in spring than ever previously observed in the vicinity of Washington: *Anas platyrhyncha*, *Anas rubripes tristis*, *Lophodytes cucullatus*, *Tringa solitaria solitaria*, *Bartramia longicauda*, *Pelidna alpina pacifica*, *Pisobia fuscicollis*, *Larus argentatus*, *Larus delawarensis*, *Larus atricilla megalopterus*, *Hydroprogne caspia imperator*, *Sterna hirundo*, *Euphagus carolinus*, *Spizella monticola monticola*.

H. C. O.

ORNITHOLOGY.—*Notes on the subspecies of* Numenius americanus *Bechstein*. Harry C. Oberholser. The Auk **35**: 188–195. 1918.

There are two geographic races of *Numenius americanus*. The typical form, *Numenius americanus americanus* Bechstein, breeds in the western United States, excepting the northernmost part, and migrates east to the eastern United States and Newfoundland, and south to Mexico and Guatemala. The smaller northern race described as *Numenius americanus parvus* Bishop, but which has an earlier name in *Numenius americanus occidentalis* Woodhouse, breeds in southwestern Canada and the northern part of the western United States, and migrates south to Mexico, east to Iowa, casually to Rhode Island, South Carolina, and even to Jamaica. H. C. O.

ORNITHOLOGY.—*Mutanda ornithologica. III*. Harry C. Oberholser. Proc. Biol. Soc. Wash. **31**: 47–50. May 16, 1918.

Messrs. Brabourne and Chubb have recently renamed *Haematopus ater* Sharpe from the Falkland Islands *Haematopus quoyi*, but there already is an earlier name in *Haematopus townsendi* Audubon. The spotted redshank of Europe is now called *Totanus fuscus* (Linnaeus), but this is preoccupied, and (by inadvertence) the use of *Totanus maculatus* (Tunstall) for this species is here advocated. [The correct, because earliest, designation is *Totanus erythropus* (Pallas).] The lory commonly called *Eos riciniata* (Bechstein) should properly be called *Eos guenbyensis* (Scopoli), a name of many years' priority. The specific name of the fruit pigeon now known as *Leucotreron gularis* (Quoy and Gaimard) is preoccupied, and it is here rechristened *Leucotreron epia*. The current specific name of the South American dove known as *Gymnopelia erythrothorax* (Meyen) is preoccupied, and the bird must, therefore, be known as *Gymnopelia cecilioe* (Lesson).

H. C. O.

ORNITHOLOGY.—*The great plains waterfowl breeding grounds and their protection.* HARRY C. OBERHOLSER. Yearbook, U. S. Dept. Agr. 1917: 191–204, pls. 30–31. 1918.

For obvious reasons the breeding grounds of our waterfowl are of prime importance. Although there are valuable isolated breeding places in the west at many of the large lakes of the arid interior, the Great Plains contain the most extensive breeding grounds for waterfowl in the United States, and the best of these lie in the states of Nebraska, South Dakota and North Dakota. In the latter areas large numbers of ducks and other waterfowl breed about the lakes and sloughs, and the maintenance of their breeding ground is essential to the continuation of the game supply. In addition to hunting restrictions, an exceedingly desirable additional measure of protection is the establishment of further game preserves, both public and private.

H. C. O.

ORNITHOLOGY.—*Birds collected by Dr. W. L. Abbott on various islands in the Java Sea.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. **54**: 177–200. November 2, 1917.

This paper contains the ornithological results of Dr. W. L. Abbott's visits to four islands in the Java Sea. These islands, which apparently had never been previously visited by an ornithologist, are Solombo Besar, Arends, Mata Siri, and Kalambau.

On Solombo Besar Island, from December 3 to 6, 1907, Dr. Abbott collected 33 specimens representing 10 species, 8 of which proved to be undescribed forms. The most interesting of these new birds are *Kakatoe parvulus abbotti,* which marks a new western limit for the genus; *Perissolalage chalepa,* a new genus and species of Campephagidae, related to *Lalage* Boie; a drongo, *Dicruropsis pectoralis solombensis;* and an apparently distinct species of white-eye, *Zosterops solombensis,* allied to *Zosterops flava* of Java.

Only three species were obtained on Arends Island, November 23 to 24, 1908, but one of these, *Megapodius duperryii gouldii,* is worthy of particular note as extending the western limit of the known range of this species.

On the island of Mata Siri Dr. Abbott collected from November 7 to 12, 1907, and from November 25 to December 1, 1908, gathering on these occasions altogether 13 specimens of birds of eight species, five of these representing new subspecies. The most important of the new birds are a bulbul, *Pycnonotus brunneus zaphaeus,* apparently most closely allied to *Pycnonotus brunneus brunneus* from the Malay Peninsula; *Malacocincla abbotti sirensis,* allied to *Malacocincla abbotti olivacea* from the Malay Peninsula; and a drongo, *Dicruropsis pectoralis sirensis,* apparently nearest *Dicruropsis pectoralis solombensis* Oberholser from Solombo Besar Island.

On Pulo Kalambau, which is one of the three largest islands of the Laurot group, Dr. Abbott landed for a day on December 7, 1907. Here he collected two birds, one of them a new subspecies of white-eye (*Zosterops solombensis zachlora*).

From these incomplete collections the faunal relations of Solombo Besar Island seem to be with Java and Timor; and of Mata Siri with Borneo. H. C. O.

ORNITHOLOGY.—*The shedding of the stomach lining by birds, particularly as exemplified by the Anatidae.* W. L. McAtee. The Auk **34:** 415–421, pls. 16–17. 1917.

The shedding of the stomach lining and its disposal by regurgitation, in hornbills and a number of other birds, is well known. It is now shown that this operation takes place commonly in many species of birds, but that the process is usually one of gradual disintegration and mixing with the food contents of the stomach. In this way the discarded lining is ground up with the other food by the rotary movement of the gizzard contents, and passed out of the body through the intestines. This process has been observed in 24 species of ducks and geese and in the following other birds: *Thalasseus maximus*, *Himantopus mexicanus*, *Limnodromus griseus scolopaceus*, *Colinus virginianus texanus*, *Cerchneis sparveria sparveria*, *Coccyzus americanus americanus*, *Coccyzus erythropthalmus*, *Pica pica hudsonia*, *Corvus ossifragus*, *Sturnella magna argutula*, *Toxostoma redivivum sonomae*, *Mimus polyglottos polyglottos*, and *Hylocichla guttata* subsp.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on North American birds. IV.* HARRY C. OBERHOLSER. The Auk **35:** 62–65. 1918.

Recent investigations show that *Pelacanus californicus* Ridgway is a subspecies of *Pelecanus occidentalis* Linnaeus, and should, therefore, stand as *Pelecanus occidentalis californicus* Ridgway. Similarly, *Creciscus coturniculus* (Ridgway) is undoubtedly a subspecies of *Creciscus jamaicensis* and should be called *Creciscus jamaicensis coturniculus* (Ridgway). *Tringa maculata* (Vieillot), has been said to be preoccupied by *Tringa maculata* Linnaeus, and for the species called *Pisobia maculata* the name *Tringa pectoralis* Say has been resurrected. There is, however, no *Tringa maculata* Linnaeus, as this is a misquotation for *Tringa macularia*. Our pectoral sandpiper must, therefore, retain its present designation of *Pisobia maculata* (Vieillot). The form of *Agelaius phoeniceus* breeding in the central northern United States and middle Canada was some time ago described as *Agelaius phoeniceus arctolegus* Oberholser, but has not been considered separable from *Agelaius phoeniceus fortis*. Additional material shows it, however, to be a recognizable race. H. C. O.

ORNITHOLOGY.—*The birds of Desecheo Island, Porto Rico.* ALEXANDER WETMORE. The Auk **35:** 333–340. 1918.

Desecheo Island lies in Mona Passage west of Porto Rico, and is about one and one-fourth miles long by three-quarters broad. It is a rocky island rising to a peak six hundred feet high, and is covered by jungle or brush. The avifauna is limited to eleven species, only three of which are land birds. Only one passerine bird, *Margarops fuscatus fuscatus*, has been found on the island.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Third annual list of proposed changes in the A. O. U. Check-List of North American birds.* HARRY C. OBERHOLSER. The Auk **35**: 200–217. 1918.

This is the third annual résumé of recent ornithological work in so far as it affects North American birds. Like the first and second lists it comprises only ornithological cases,—*i.e.*, such as require specimens or the identification of descriptions for their determination, and consists of additions, eliminations, rejections, and changes of names due to various causes. However, only changes known to be based on revisionary work are included; therefore no mention is made of changes involved in names used without sufficient explanation in local lists or elsewhere. It is intended to include here everything pertinent up to December 31, 1917, not previously chronicled. Some of these changes date back as far as 1910, but were previously overlooked. The present list summarizes the addition of twenty-three genera either new or raised from subgenera; four subgenera; six species detected for the first time in North America, three of these from Greenland; and forty-nine subspecies either newly described or for the first time found in North America. Besides these there are six new subfamilies. H. C. O.

ORNITHOLOGY.—*New light on the status of* Empidonax traillii *(Audubon).* HARRY C. OBERHOLSER. Ohio Journ. Sci. **18**: 85–98. February, 1918.

Few birds are as puzzling as the flycatchers of the American genus *Empidonax*. None of these are more difficult to understand than *Empidonax traillii* and its closely related forms, the status of which has long been in dispute. At present the name *Empidonax traillii traillii* is applied to the subspecies from the western United States, and that from Manitoba and the eastern United States is called *Empidonax traillii alnorum*. A reexamination of the type of *Empidonax traillii* now shows that it belongs to the eastern race; and this should, therefore, henceforth stand as *Empidonax traillii traillii*. This race breeds in most of the wooded parts of Canada and Alaska, in the northeastern United States, west to Montana, and south to Maryland, while it winters southward to Ecuador. The subspecies inhabiting the western United States south to Mexico is renamed *Empidonax traillii brewsteri*. An interesting development of the present study is the discovery of the existence of six more or less well-marked color phases in both of the subspecies. H. C. O.

ENGINEERING.—*Tests of large bridge columns.* J. H. GRIFFITH and J. G. BRAGG. Bur. Stand. Tech. Paper No. 101. Pp. 139. 1918.

Tests were made upon eighteen large bridge columns which were half-size models of chord sections of railroad bridges recently erected at St. Louis, Mo., Metropolis, Ill., and Memphis, Tenn. The specimens were constructed of nickel, Mayari, chrome, silicon, and high carbon steels. They varied in length from $15\frac{1}{2}$ feet to $24\frac{1}{2}$ feet, and in cross-sectional areas from 42 to 119 square inches. The slenderness ratios varied from 15 to 44. The columns were of modern design and were constructed in accordance with approved methods of shop practice and were tested in the 10,000,000 Olsen compression machine of the Bureau at Pittsburgh.

The strengths of the columns varied from a minimum of 31,200 pounds per square inch for the carbon steel to a maximum of 657,000 pounds per square inch for the Mayari steel members, the intermediate values corresponding to the grades of steel used in the construction of the columns. The strengths for twelve columns failing as units were approximately defined by the yield points of the individual steels used in the construction, being confined within a zone determined by the upper and lower limits obtained by independent tests of the component steels. The mean deviation was found to be 0.5 per cent from the mean-yield points determined for the columns at failure, the range of variation being from four to twelve per cent. Of the remaining six columns four failed by local bending at the ends and two by body failures due apparently to the unsymmetrical action of lattice bars.

A full discussion is given of the effects of initial eccentricity, the laws of stress distribution from bending of columns, and the laws of distributions in pin plates and lattice. The analyses were conducted from the point of view of the column formula used in design and the more rational formula based on initial eccentricity in a column.

J. H. G.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 315th meeting of the Society was held on Wednesday, October 2, 1918, in the hall of the Perpetual Building Association at 1101 E Street N. W. There were present 18 members and 4 visitors.

The editor announced the appearance of the long delayed volume 19, of the Society's Proceedings.

Dr. G. F. White and Mr. R. A. St. George, both of the U. S. Bureau of Entomology, were elected to membership in the Society.

The program was as follows:

W. M. Mann: *Collecting in Fiji.* Owing to the illness of Dr. Mann this paper was read by title.

R. A. Cushman: *Cocoon spinning habit of two species of Braconids.* This paper, which dealt with the author's observations of the cocoon spinning of two common species, was discussed by Messrs. Schwarz, Rohwer, and Abbott,

A. B. Gahan: *A synopsis of the species belonging to the chalcidoid genus Rileya Ashmead.* In the absence of the author this paper was presented by the secretary. It dealt almost entirely with a systematic treatment of the genus Rileya, including all of the known species of the world. The paper was discussed by Messrs. Schwarz and Rohwer.

C. N. Ainslie: *Notes on the economic importance of* Samia Cecropia. This paper was read by Mr. Rohwer and discussed by Messrs. Abbott and Cushman.

A. B. Gahan, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

In accordance with the suggestions of the health authorities, several meetings of the scientific societies, regularly scheduled to be held in October, were postponed, on account of the rapid spread of influenza in the city. Among the meetings for which programs had been arranged were those of the Philosophical Society on October 12 and of the Chemical Society on October 10.

Members of the British Educational Mission visited Washington on October 14–18, 1918. The visiting members were: Sir ARTHUR EVERETT SHIPLEY, of Christ's College, University of Cambridge; Sir HENRY MIERS, of the University of Manchester; Rev. EDW. MEWBURN WALKER; Sir HENRY JONES, of the University of Glasgow; Dr. JOHN JOLY, of Trinity College, Dublin; Miss CAROLINE SPURGEON, of the University of London; and Miss ROSE SIDGWICK, of the University of Birmingham.

During the past summer a number of professors of physics have been cooperating with the Bureau of Standards in writing a text book on radio communication. This book is to be used at the various training schools established by the Signal Corps for training radio electricians. Among those who were engaged in this work, and who have recently returned to their respective colleges to resume teaching, are: Prof. F. W. GROVER, of Colby College; Prof. H. M. ROYAL, of Clarkson College of Technology; Prof. G. M. SMITH, of Purdue; and Prof. L. B. WHEELER, of Yale.

Prof. E. C. BINGHAM, of Lafayette College, has returned to take up his work as Professor of Chemistry there. During the past summer he has been in Washington engaged in an investigation of the lubricating oils used in aviation engines.

Prof. A. D. COLE has returned to Ohio State University after spending the summer at the Bureau of Standards, where he has been engaged in research on vacuum tubes.

Prof. G. F. WITTIG, formerly of the University of Pennsylvania, and Mr. G. C. SOUTHWORTH, of the Bureau of Standards, have resigned to take up the teaching of intensive courses in radio now being given by the Signal Corps at Yale University.

Mr. Roy O. Fitch, of the Bureau of Standards, died on October 13, 1918, of complications resulting from an attack of influenza. Mr. Fitch was born in Oregon in 1891, graduated from the University of Oregon in 1912, and entered the government service in 1913 as junior chemist. His work was chiefly on bituminous materials of construction, and he had been engaged recently on war problems connected with the manufacture of prepared roofings for the cantonments and the treatment of the hulls of concrete ships. He was a member of the Chemical Society.

Mr. Thomas Bartlett Ford, associate physicist at the Bureau of Standards, died on October 1, 1918, of pneumonia resulting from influenza. Mr. Ford was born October 4, 1882, graduated from the University of Kansas in 1904, and entered the government service in 1907. He had been for several years in charge of the low-temperature laboratory of the Bureau, including the liquid air and liquid hydrogen apparatus, and had devoted considerable attention to the separation of the rare gases. He was a member of the Chemical and Philosophical Societies of Washington.

Prof. David Ernest Lantz, assistant biologist in the Biological Survey, U. S. Department of Agriculture, died on October 7, 1918, of pneumonia following influenza, at the age of 63. Prof. Lantz was born in Pennsylvania, March 1, 1855. He was associated with the secondary schools of Kansas and with the Kansas State Agricultural College until 1904, when he became a member of the Biological Survey. He was a member and former secretary of the Biological Society of Washington. His publications were concerned chiefly with ornithology and economic mammalogy.

Dr. Harrison E. Patten, of the Bureau of Chemistry, Department of Agriculture, has been commissioned a captain in the Quartermaster Corps.

Mr. George A. Rankin, of the American University Experiment Station, has been commissioned a captain in the Chemical Warfare Service.

Prof. J. E. Rowe has returned to Pennsylvania State College after having spent the summer at the Bureau of Standards working on problems connected with airplane radiator design.

Mr. E. W. Shaw, of the Geological Survey, has been appointed an internal revenue agent under the Treasury Department, and is chairman of the committee on natural gas taxation.

Mr. H. C. Raven, of the Smithsonian Institution, who for three years has been collecting mammals and birds in Celebes, arrived in Washington September 28.

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BOTANY.—Cosmos sulphureus, *the xochipalli or flower paint of the Aztecs.* William Edwin Safford, Bureau of Plant Industry.

Vegetable dyes were used by the aborigines of all parts of America for ornamenting their utensils, staining their bodies, or coloring their baskets and fabrics. Many of the textiles found in the prehistoric graves of Peru are remarkable for their beautiful and permanent colors. Few of these, unfortunately, can be traced to the plants from which they were derived. The introduction of foreign dyes has been disastrous. Their cheapness and the facility with which they can be transported has caused them to be widely adopted in place of native dyes, the preparation of which is fast becoming obsolete. The ancient Mexicans made use of a number of beautiful pigments, mostly vegetable, for the picture-writing of their celebrated codices. Nearly all of their colors can be identified. A crimson was obtained from the cochineal insect, reared upon a cactus (*Nopalea coccinellifera*). This they called nocheztli, or "prickly-pear-blood." With it they sometimes combined other ingredients, especially the leaves of a Melastomataceous plant called tezoatl, or texhuatl. From the reddish-yellow aril of the seeds of *Bixa orellana* they derived a pigment called achiotl. This is now widely used throughout the world, and is known commercially as annatto, or arnotto. A bright yellow was obtained from a leafless parasitic plant, *Cuscuta tinctoria*, called zacatlaxcalli. From logwood *Haematoxylon campechianum*, and the closely allied *Hae-*

matoxylon brasiletto, called uitzquauitl, or huitzcuahuitl, they obtained a purple, and other shades, resulting from various additional ingredients. The use of this wood is now world wide. From the twisted pods of *Caesalpinia coriaria,* called nacascolotl, they obtained a fine black. These pods, known commercially as cascalote or dividivi, are now an important source of tannin. Another dye-plant, interesting on account of its old-world affinities, was their xiuhquilitl, *Indigofera suffruticosa,* more commonly known as *Indigofera anil,* and very closely allied to *Indigofera tinctoria,* from which most of the commercial indigo is derived; and another beautiful blue, called mohuitli, was obtained from *Jacobinia mohintli* and *J. umbrosa.*

One of their colors, however, which all writers on Mexico mention, has hitherto remained unidentified. This was called xochipalli, or "flower-paint," a name also applied to the plant itself. It is the object of the present paper to announce its rediscovery and to give a description, by means of which the plant can be identified with certainty. The most remarkable fact in connection with this plant is that, although it was described and figured more than three centuries ago, it has remained hitherto unidentified. It is widely spread in Mexico. In the present State of Guerrero there is a town, Xochipalla, the name of which signifies "the place where the xochipalli abounds."[1] The celebrated traveller, Gemelli-Careri, who visited this town in 1697, while en route from Acapulco to Cuernavaca, passed through a neighboring district where the girls gathered xochipalli flowers and made of them a cosmetic paste. The Proto-Medico, Dr. Francisco Hernandez, who was sent by his sovereign Philip II in 1570 to New Spain to study its resources, gave the following description of this plant, illustrated with a rude drawing, a fac-simile of which is here shown (fig. 1).

"Xochipalli is an herb six cubits in length, with sinuous (pinnatifid) leaves somewhat like those of Artemisia, stems a finger thick, flowers resembling those of the cempoalxochitl [*Tagetes erecta* L.], but smaller and of a reddish yellow color, and roots slender and long. It is widely spread in the *tierras calientes,*

[1] See Robelo, Diccionario de Aztequismos, pp. 444, 447, 449. 1904.

and is an herb well known to everybody. Only the flower is used, the which is moderately hot and of an agreeable odor and taste, comforting the heart, curing maladies of the womb and ulcers, especially those of the mouth. But the chief use of the flowers is for dyeing wool and painting images and objects of a yellow color which in a certain manner verges to red, for which object they are boiled in water together with an alkali, after which the juice is expressed and strained, yielding a color which is used by painters and dyers, for the purposes we have indicated."[2]

A search for the name xochipalli, or its modern variant, suchipal, in Ramirez and Alcocer's *Sinonomia vulgar y cientifica de las plantas Mexicanas* was without result, nor could it be found in the *Nueva farmacopea Mexicana.* In Siméon's monumental *Diccionnaire de la langue Nahuatl,* however (p. 701) the importance of this plant is attested by the following definitions: "*Xochipalli* ou *Xuchipalli,* Herbe dont la feuille ressemble a celle de l'artémise et sert à teindre les étoffes en jaune rouge; couleur rouge, rose. RR. *xochitl, palli.*" Robelo, also, in his *Diccionario de Aztequismos* (p. 444) refers to it as follows: "Suchipal (Xochipalli: *xochitl,* flor; *palli,* color: 'flor-color,' ó 'color de flor'). Yerba cuya hoja se parece á la artemisa, y sirve para teñir las telas de amarillo, rojo ó naranjado." On page 447, note 23, he says: "Esta planta no está clasificada;" and on page 449, under geographical names, he includes "Xochipala (xochi-pal-la: *xochi-palli, ó xuchi-palli, suchipal; la,* variante de *tla,* particula abundancial):" "Donde abunda el suchipal."

In response to letters of inquiry the writer received replies from several Mexican botanists, all of whom, following Hernandez's description, were disposed to refer the plant in question to the genus Tagetes, which includes the so-called "French" and "African" marigolds of our gardens, both of which are flowers of Mexican origin, held in high esteem by the Aztecs and used by them in certain religious rituals. Dr. B. P. Reko of Oaxaca referred it to *Tagetes patula* and Dr. C. Conzatti thought that it might possibly be *Tagetes multiseta.* In a letter dated July 5,

[2] See Ximenes' translation of Hernandez, Cuatro Libros, Libr. 3, cap. 36. 1615.

1918, Dr. Conzatti says that, although Hernandez declares the xochipalli to be an herb well known to everybody, no one could be found who knew it: even the oldest natives in the vicinity of

Fig. 1 Xochipalli (*Cosmos sulphureus* Cavanilles), the "flower-paint" of the Aztecs, as figured by Hernandez in 1576 and published in 1651.

Oaxaca were ignorant of such a plant. Since Hernandez described it as having "flowers resembling the cempoalxochitl (*Tagetes erecta*) but smaller," Dr. Conzatti was inclined to refer it to the smaller cempoalxochitl, *Tagetes multiseta*, a dried specimen of which he enclosed in his letter. That the plant in question could not possibly belong to the genus Tagetes was shown at once by the form of the involucre subtending the flower-head, which according to Hernandez's drawing, was not at all cup-shaped, or tubular like that of Tagetes but composed of several distinct linear bracts. A comparison of Hernandez's rude illustration (fig. 1) with herbarium specimens of Tagetes showed that the plant in question could not possibly be included in the same genus with them. His figure represents a composite with flower-heads not unlike those of a Coreopsis, but the accompanying leaves are artemisia-like as stated in the original description. The widely spread ray-flowers, few in number, are three-toothed at the apex. On one of the heads they have fallen off, indicating that they are not persistent like those of Tagetes. The disk flowers form an erect cylindrical bundle, while the entire head is subtended by an involucre not at all like that of the genus Tagetes, but composed of a few linear sepal-like bracts as stated above.

Failing to find the plant in the genus Coreopsis, the writer carefully examined the plants belonging to allied genera. At last, in the genus Cosmos, he came upon a species corresponding in all respects with Hernandez's figure. The long sought Xochipalli proved to be *Cosmos sulphureus*, a species which, though figured the latter part of the eighteenth century by two eminent botanists, had never been associated with the dye-plant described and figured by the great protomedico a century previously. To verify the discovery, a decoction of the flowers was made for the writer by Dr. L. A. Hawkins, Plant Physiologist, of the Department of Agriculture. Almost immediately the water became suffused with an orange tinge, and on the addition of a very small quantity of alkali it changed to a rich orange-red, the color of the xochipalli described by Hernandez.

Though never hitherto connected with the classic "flower-color" used by the Aztecs in painting their codices, *Cosmos sulphureus* is not a rare plant. Specimens of it were lacking in the United States National Herbarium until 1886, when it was encountered by the veteran explorer Dr. Edward Palmer in the

Fig. 2. *Cosmos sulphureus* Cavanilles, *a*, disk flower; *b*, achene.

vicinity of Guadalajara, Jalisco; and five years later he collected it at Culiacan, Sinaloa, bringing back with him from this locality seeds from which plants were propagated at Washington. The account of its introduction into cultivation in the United States is told by Dr. J. N. Rose in *Garden and Forest* for December, 1895, where an excellent figure of it was published. It is now represented in the United States National Herbarium by specimens from many other parts of Mexico: from Durango, Sonora, Tepic, Colima, Oaxaca, Chiapas, Guerrero, and Morelos. It is interesting to note that this species, observed by Gemelli-Careri centuries ago while traveling between Acapulco and Cuernavaca, has been collected at both of these terminals, at Acapulco by Dr. Palmer, in 1894, and at Cuernavaca by Dr. J. N. Rose, in 1902. Seeds of this classic dye-plant of the Aztecs were recently obtained by the writer, and he now has a number of vigorous young plants of the true xochipalli growing in one of the greenhouses of the United States Department of Agriculture.

DESCRIPTION

Cosmos sulphureus is a tall, rank, pubescent annual composite, growing usually about four to seven feet high, with stems as thick as the thumb and bipinnatifid or tripinnatifid leaves, not unlike those of the common *Artemisia vulgaris* in form. The flower heads, borne on long slender peduncles, are subtended by a calyx-like involucre composed of two series of eight bracts each, the outer bracts linear and green, the inner broader and scarious. The flowers vary in color from bright orange to deep reddish orange. The heads are composed of eight broadly ovate ray-flowers, three-toothed at the apex, spreading at right angles to the axis and soon falling off, and fertile tubular disk flowers forming a compact erect cylindrical bundle. The exserted anthers are black with orange tips, and the style is branched, terminating in two slender tips. The fruit is a linear akene nearly an inch long, including the slender barbed beaks, and the pappus consists of two slightly hispid awns.

REFERENCES

Cosmos sulphureus Cavanilles, Icon. Pl. **1**: 56, pl. 79. 1791. Rose, Gard. & For. **8**: 484, *fig. 66*. 1895.

Coreopsis artemisiaefolia Jacquin, Icon. Pl. Rar. 595; Col. Suppl. 155. 1791.

Xochipalli . . . folia ferens sinuosa, magna, et Artemisiae quadantenus similia. Hernandez, in Nard. Anton. Recchi, Rerum Medic. Nov. Hisp. Lib. 7, Cap. 36. 1651.

In the accompanying illustration (fig. 2) the plant is shown, slightly reduced, accompanied by drawings of a disk flower (a) and an achene (b), the two latter enlarged about two diameters.

BOTANY.—*A new Polystichum from California.*[1] WILLIAM R. MAXON, National Museum.

In reviewing recently the Polystichums of the Pacific coast region of the United States as represented in the National Herbarium and in the very ample collections of the Dudley Herbarium of Leland Stanford Junior University, the latter lent for study through the courtesy of Professor LeRoy Abrams of that institution, it has been found that the plant of the Santa Cruz peninsula and of two or three localities not far northward which has commonly been referred to *Polystichum aculeatum* (or formerly to its "var. *angulare*") represents a new species. This is described below, being named in memory of the late William R. Dudley, for many years professor of botany in Leland Stanford Junior University.

Polystichum Dudleyi Maxon, sp. nov.

Rhizome stout, decumbent, together with the numerous stipe-bases densely paleaceous, the inner basal scales mostly linear-lanceolate, attenuate, dark brown, dull, semiopaque, imbricate, those above spreading, larger and broader, narrowly oblong to ovate, long-acuminate, up to 2 cm. long, brown to fulvous, concolorous, translucent, membranous, distantly denticulate-ciliolate, extending well up the stipe but mostly deciduous above the basal third, underlaid by a dense series

[1] Published with the permission of the Secretary of the Smithsonian Institution.

of small, narrow, attenuate, paler scales, these freely denticulate-ciliate. Fronds several, erect-spreading, 40–120 cm. long; stipes stramineous above the dark arcuate base, usually more than half as long as the blade, sulcate; blades narrowly ovate to narrowly oblong-lanceolate, very long-acuminate to long-attenuate, 25–75 cm. long, 8–25 cm. broad, bipinnate; rachises densely and subpersistently paleaceeous, the scales pale, mostly linear-attenuate, or acicular from a small, roundish-cordate, fimbriate base; pinnae numerous, the lower ones slightly apart, spreading, a little shorter than those above, these mostly contiguous, oblique, often strongly arcuate, linear to narrowly oblong-lanceolate from a broader, invariably inequilateral base, attenuate from the middle, the apex rather abruptly acute to long-acuminate; pinnules numerous, oblique, straight or usually falcate, petiolulate, obliquely ovate or ovate-oblong from a distinctly cuneate, inequilateral base, the superior basal pinnule much the largest, this obliquely cleft or with several pairs of nearly free segments, the other pinnules auriculate, serrate to obliquely incised, the acuminate apex and the curved serratures rather abruptly short-awned; pinnules with a copious covering of pale, lax, sinuous, tortuous, filiform scales beneath, a few similar scales borne on the upper surface; leaf tissue bright light green, papyraceous, the course of the veins evident above; sori numerous, terminal or subterminal upon the first anterior branch of the oblique veins, or several pairs borne upon the simple pinnately arranged veinlets of the auricles and of the segments of the superior basal pinnules; indusia orbicular, membranous, copiously long-ciliate, the cilia flaccid, septate, frequently equaling in length the diameter of the body of the indusium.

Type in the U. S. National Herbarium, no. 887829, collected "near bridge, Peter's Creek," Santa Cruz Mountains, San Mateo County, California, May 2, 1903, by W. R. Dudley. Three sheets with identical data are preserved in the Dudley Herbarium, which contains also numerous other collections by Professor Dudley of the same plant from the Santa Cruz peninsula, as follows: Near bridge below La Honda, San Mateo County, March 24, 1894; King's Mountain, San Mateo County, March 5, 1898; sandstone rocks, Upper Gazos Creek, San Mateo County, January 1, 1902; cliffs near Camp on Pescadero Creek, Santa Cruz Mountains, San Mateo County, June 19, 1905; rocky canyon of east fork of Waddell Creek, Santa Cruz County, September 23, 1901; south fork of Big Creek, Santa Cruz County, August, 1903; Los Gatos Canyon, Santa Clara County, April 21, 1895, July 22, 1895. Other specimens from the same or near-by regions are as follows: Foothills west of Los Gatos, Santa Clara County, *Heller* 7226; Hume Canyon, Saratoga, Santa Clara County, alt. 270 meters, *Pendleton* 1468; Santa Cruz Mountains, *Anderson, Miss E. B. Norton, Mrs. A. E. Bush, Miss Bowles;* San Gregorio, San Mateo County, May 31, 1870, *Brannan & Kellogg;* Ukiah, Mendocino County, May 11, 1869, *Kellogg;* above "Grimes," Santa Lucia Mountains, Monterey County, August, 1903, *Dudley;* without special locality, *Kellogg & Harford* 1183.

Polystichum Dudleyi was figured by D. C. Eaton as *Aspidium aculeatum* var. *angulare* in the second volume of the Ferns of North America,[2] but the illustration is defective in failing to show the pinnules as distinctly stalked and copiously clothed with filiform scales, and as sufficiently oblique. In papyraceous texture, fully bipinnate blades (which are only slightly narrowed at the base), stalked pinnules, and terminal or subterminal sori the relationship of *P. Dudleyi* is clearly with the European plant called *Polystichum angulare* by most English botanists, *Aspidium aculeatum* B. *aculeatum* by Milde, *Aspidium lobatum β angulare* by Luerssen, and *Polystichum aculeatum* by Christensen, the last author maintaining *P. lobatum* (Huds.) Presl as specifically distinct; but, inordinately variable as the European plant is, *P. Dudleyi* is at once distinguished from that by its invariably oblique, less strongly awned, and more copiously filiform-paleaceous pinnules, and by its strikingly fimbriate-ciliate indusia. The enlarged superior basal pinnules are a constant feature not seen in most forms of *P. aculeatum* (*P. angulare*); in this particular alone *P. Dudleyi* suggests *P. lobatum* (the *P. aculeatum* or *P. aculeatum* var. *lobatum* of British botanists, *Aspidium lobatum genuinum* of Luerssen, *Aspidium aculeatum* A. *aculeatum* of Milde), a plant otherwise very different in its barely bipinnate blades (these strongly narrowed downward), its sessile to adnate, less incised segments, its dorsal sori, and its harsh, rigid texture. It is worth noting also that, so far as specimens at hand and descriptions indicate, the European plants have the indusia entire or, at most, minutely erose, a marked departure from the conspicuously long-ciliate indusia of *P. Dudleyi*. Although the proper classification of the very numerous European forms of this alliance is admittedly a difficult matter, it appears that related American plants are almost without exception specifically distinct from them. In the present instance *P. Dudleyi* may be regarded as an analogue of the European *P. aculeatum*, just as *P. californicum* (D. C. Eaton) Diels, is to a certain extent, a Californian counterpart of *P. lobatum*.

[2] *Pl. 62, f. 7.* 1879.

ANTHROPOLOGY.—*Catawba notes.*[1] JOHN R. SWANTON, Bureau of American Ethnology.

The writer spent the greater part of the month of May, 1918, on the Catawba reservation, South Carolina, collecting linguistic material from some of the few Indians still able to use the old Catawba language. These Indians have been surrounded by whites and negroes for such a long period and their economic condition has altered so completely that one feels uncertain whether the scraps of information regarding the old life and beliefs now to be obtained had a purely Indian origin, and how far they may have been colored by external influences. Nevertheless these scraps may have some value for future investigators who may be in a better position to separate the various elements entering into them. At any rate such scraps are all that we now have, outside of the very limited material from earlier writers such as Lawson, and I give them for what they may be worth. They were collected merely incidentally in the course of the linguistic investigation, and are principally from an old woman named Margaret Brown and her son John Brown. An account of the only important native industry which has come down to modern times, pottery making, has been omitted, since this has been treated very fully by Mr. M. R. Harrington[2] in a special paper containing also a few notes on other features of Catawba ethnology.

Margaret Brown says that when she was a girl the Catawba lived, not in frame houses as they do today, but in brush dwellings. According to her description these had a single ridgepole supported at either end by a forked stick, a roof of pine bark, and walls of brush. The house was round or oblong, the door in the latter case being midway of one of the longer sides, and along the wall opposite to the door was a bed of the usual southern Indian style, a bench of wattle or matting supported by short poles. The fire was in the middle of the house, and there was no vent for the smoke except the door.

[1] Published with the permission of the Secretary of the Smithsonian Institution.

[2] HARRINGTON, M. R., Amer. Anthrop. n. ser. **10**: 399–407.

Spoons, long trays, and other dishes were made of wood from the dogwood and cedar trees. Pipes were of pottery or stone, stone working having been a native industry as well as working in clay. John Brown can make bone and flint arrow points with one or more barbs, but I do not think he has acquired his knowledge from the Indians, or at least from those of his own tribe.

In making baskets they used the following dyes: (1) a red dye from a plant called in Catawba wayûk, popularly "coon roots;" (2) another red dye from the "red root," Catawba taktuwia; (3) a yellow dye from a plant called ītī wiye^{n}, "yellow root;" and (4) black from the black walnut. There were probably others which have been forgotten.

The ancient dress seems to have been practically identical with that of other southeastern Indians. Margaret Brown said she had seen aprons in use made of large hickory leaves pinned together with broomstraw. Small knit caps or hoods for children were fabricated out of the inside bark of the slippery elm, but nothing seems to be remembered about the old mulberry-bark textiles. It is, however, recalled that little bags of sand were placed on the foreheads of infants to give them "a heap of sense," an evident reminiscence of the ancient custom of head-flattening. Adult Indians made a hair-wash out of the red sap from broken stems of young grapes.

The Catawba had white, yellow, and blue corn, strawberry corn—corn striped red all over—and popcorn. Which of these were truly aboriginal it would be impossible to say. The old native beans (ī^{n}ye nuntce) are said to have been of the size of lima beans, colored black with white spots. The native tobacco is reputed to have been about 4 feet high but with broad leaves. It is thought that the "sow weed" (*Oxalis violacea*), called by the Catawba nūpai^{n}tare, was sometimes smoked. Like all of the other southeastern Indians the Catawba pounded their corn into meal in a wooden mortar, usually of hickory. The inside was lined with tacks to keep the wood from fraying out and leaving splinters in the meal. To take off the outer skin of the corn they put it into a pot over the fire along with wood ashes.

They also employed a fanner (wûski'), and two sifters, the coarser known as noⁿso' kāttcigne, and the finer as kûs ompa, and the dishes made from it appear to have been identical with those known to the other southern Indians. Among them were hominy (kuspi seratere), cold meal (kûs umpasa'), and the famous dish known to the Creeks as sofki but called by Catawba Indians kusimeyū. The hominy was also mixed with cooked beans and squeezed up into cakes called kustaⁿ notcepetcö'. When they ate these they commonly sat in a circle around a big dish of gravy into which each dipped his cake. Like the other southern tribes the Catawba also put cornmeal dough mixed with beans into cornhusks, and cooked a number of them together in a pot over the fire. Cornmeal dough was sometimes laid upon oak leaves which had been placed upon sand, other oak leaves being raked over the top, and the whole covered with sand, after which a big fire was lighted over all and the dough roasted. Again cornmeal dough was sometimes placed on a short smooth board and cooked in front of the house fire. This dish was called kustaⁿ iⁿpitēⁿ kīsa iktaⁿ. It was occasionally enriched by adding persimmons, the seeds of which had been removed. Parenthetically I was assured that persimmon seeds make excellent coffee. I learned nothing about the use of hickory and acorn oil, though it was certainly resorted to but a good flavor was given to hominy by stirring in walnut meats thoroughly, while the pot was boiling.

Beef, and at an earlier period venison, was cut into strips and hung aroung the fire to dry. When any of this was desired a piece was taken off and broken up fine in a stone mortar with an iron pestle. The resulting fragments were put into a big pan, gravy was poured over them, and all sat around and ate out of the one dish. Meat was boiled in pots hung over the fire or roasted on wooden spits. Cooking was sometimes performed at the fire inside of the house, sometimes at a fire out of doors.

Fish were stupefied and then caught in the usual southeastern style, by pounding up buckeye, devil's shoestring, and some other plants and throwing them into a pool of water.

Medicines were of the same miscellaneous character observable elsewhere among Indians, but were mostly from plants. The following list contains all that I learned of during my short stay, but there were of course many more. For the botanical identifications I am indebted to Mr. Paul Standley, of the Smithsonian Institution.

Ya' suâ^n wītīwạ', "rattle snake medicine," *Agave virginica*, used, as the name implies, in curing snake bites, but sometimes in cases of dropsy. In cases of snakebite the roots were mashed up and put into water, some of which was then taken internally and some applied externally. For dropsy they selected the smaller roots, pounded them up, and added them to a glass of clear water, along with a tablespoonful or two of whisky. Some was then applied externally to the affected parts, but the rest taken internally, one tablespoonful three times a day.

Depô^{n}wâ^n yisi nō^{n}ne'-i, or po^{n}wo^n yạsină', popularly known to whites as "Sampson's snake root," was used to stop pains in the stomach, an infusion, hot or cold, being drunk or the roots chewed. It was also applied to cure backache.

Wâ^{n}sa haone' (or wâ^{n}sa hawinon), popularly called "star grass," *Aletris farinosa*. An infusion was drunk to cure stomach trouble and dysentery.

Yīre^{n}tce wītīwạ', *Cracca virginiana*, popular name "devil's shoestring." In olden times it is said that a tea was made from the roots of this plant along with those of the low sumac, but it is not known for what ailment.

Hāstūk, *Erigeron ramosus*. A drink was made of the roots and taken in cases of heart trouble.

Dōpa sīgrīhere, *Salvia lyrata*. A salve to put on sores was made of the roots.

Itēwạrap wētere, *Senecio (smallii?)*, was considered good for consumption.

Isdawạrạphere wētikrī^{n}are, "it is good medicine for backache," *Arnica acaulis*, was used, as the name implies, for backache; the green leaves were crumpled up and laid on sores.

Serak wạrûwē', *Oenothera fruticosa*. The roots were used to wash sores.

I^{n}yāb wạp (or wạrop) krī^{n}here, "good for toothache," *Hypoxis hirsuta.* The roots were pulled up and chewed and some of the chewed root inserted into the cavity in the affected tooth.

Witsạgua^{n}-i skạmpatcī'ạ, *Parthenium integrifolium.* When a horse had a sore back the leaves were burned and the ashes applied to it. People sometimes placed the fresh leaves over burns.

Wēte wôropkere, *Psoralea pedunculata,* popularly called "bald roots." The roots of this plant were scraped fine, beaten, and stirred up in water and the decoction applied internally and externally to sores or cancers. The cure was said to be infallible.

Wīti si^{n}wạre, "blossoming medicine." This has a flower like that of self-heal but larger. The roots were used in cases of backache and by women.

Surēạre, *Marshallia obovata,* a wild clover, used in certain diseases.

Wāswâ^{n} wētīwạre, *Prunella vulgaris,* used in certain diseases.

The bark of the slippery elm was used in cases of consumption.

The ītī wiye^{n}, "yellow root," from which the yellow basketry dye was obtained, was chewed to heal a sore mouth.

The wayûk, or "coon roots," mentioned as used in dyeing baskets, were also fed to animals to make them lively and improve their appetites.

From broomweed roots they made a drink to ạdminister to malarial patients, and from its stalks, cut up and mixed with water, an eyewash.

A few medicines non-vegetal in character, were also spoken of. It was thought that chills might be cured by swallowing a grandaddy-long-legs rolled up in dough. Rattlesnake rattles were hung about the head to cure headache. In order that newborn babies might have long lives the heart of a "couter" turtle was dried, beaten fine, and stirred up in water which the child was made to drink. To improve the speech of a child unable to talk plainly the green burrs of the sweet gum were taken at the time when they first come out and burnt to an ash which the child was made to blow upon.

When a marriage took place among the older Catawba the couple was seated back to back and a white cloth thrown over them. It is not believed that the speech of men and women differed, but the present condition of the Catawba language is such that this statement has little value.

Bodies of the dead were anciently put under the beds inside of the houses themselves, some person making a speech on the occasion. If one died in the morning he was buried the same evening; if in the evening he was buried next morning. As soon as a death occurred three live coals were placed upon each piece of cold bread in the house so that the ghost of the deceased would not eat it, and no food of any kind was taken by the people of the household until after the body had been laid away. In the intervening period they frequently warmed their hands at the fire and then rubbed their faces with them; otherwise they feared that the skin of the face would become drawn up and wrinkled something like the skin of a chicken.

When a partridge (ipạkä) went through the yard it was a sign that someone in the house would soon die. When the calf of the leg twitched it was a sign that someone was coming. When the arm twitched it was a sign that someone was coming on horseback. When the mouth or eye twitched it was a sign that the person to whom this happened was going to mourn over a death in the family or some other severe affliction.

A relic of the belief in witchcraft is preserved in the story of a woman who once turned into an owl, went out of the house through her chimney, and stole chickens which she brought back in the same way.

At one place in Catawba River is a row of rocks where noises are sometimes heard, said to be caused by old Indians crossing there. At a place near the reserve known as "the old Indian town" people are sometimes heard dancing and singing. Close to the river there, a man once saw a woman dressed in the ancient manner, with a bundle on her back and bow and arrows (!). She disappeared suddenly.

Aside from these tales I learned of only one story that has the appearance of an aboriginal Indian tale, and of this only in outline. It relates that a child was once stolen away from its mother, and the latter began hunting for it. She asked the various animals and other living creatures which she encountered, one after the other, if they could tell her anything of her child, but in vain. At last, however, she came to the giant red-headed woodpecker (wạtcāk) who said that he knew and would inform her if she would give him a pair of earrings. She agreed and the bird said that the child had been stolen by an old woman, the owl, who had carried it far north to the other side of the Cherokee mountains. Upon hearing this the woman gave the bird her earrings and continued on to the place indicated. After she had recovered her child, the old woman who had stolen it began to rise from the ground, and as she ascended her bird tail grew longer and longer, and finally she became the comet.

Two principal dances, possibly vestigial ceremonies, are remēmbered, the Bear dance and the Wild Goose dance. Originally they took place out of doors, near the full of the moon, the former about roasting-ear time, the latter in the fall. In the later period of decline they were held indoors in winter. A drum was used, and the men carried gourd rattles, while the women had turtle-shell rattles fastened to their ankles in the familiar southeastern manner. The participants imitated bear and wild geese as well as they were able, the leaders being chosen in particular for their skill in representing the parts. Besides these there is said to have been a black snake dance.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

BACTERIOLOGY.—*A study of the Streptococci concerned in cheese ripening.* Alice C. Evans. Journ. Agr. Res. **13**: 235–252. 1918.

Two species of streptococci are distinguished from the well-known *Streptococcus lacticus*, and all three species are described culturally and biochemically.

The most pronounced characteristic which distinguishes *S. lacticus* from the other two species is the small quantity of acetic acid which it produces in milk cultures. Vigorous strains curdle litmus milk in less than two days, with complete reduction of the litmus beneath the pink surface layer. Crystals of tyrosin are formed in milk cultures after several weeks incubation. Peptone yeast broth of a hydrogen-ion concentration of $P_H = 6.0$ is rendered alkaline with a final hydrogen-ion concentration of $P_H = 6.8$.

Streptococcus X requires from two to twelve days to curdle milk. The litmus is not reduced, or is only partially reduced. No crystals are formed in milk cultures. The hydrogen-ion concentration of peptone yeast broth is reduced to the same point as in the case of *S. lacticus*. Streptococcus X produces a comparatively large quantity of acetic acid in milk cultures (0.7 to 0.8 gram per liter).

Streptococcus kefir is notable among dairy streptococci because of its vigorous production of carbon dioxide when grown in milk containing peptone, or in trypsin digested milk. It does not produce sufficient acid in milk cultures to bring the milk to curdling. There is no reduction of the litmus. No growth takes place in peptone yeast broth.

Experimental cheese inoculated with the three species of streptococci alone or in various combinations showed that the flavor of cheese of the cheddar type and of soft cream cheese could be varied according to the species of streptococci used for a starter. A. C. E.

BACTERIOLOGY.—*The bacterial flora of Roquefort cheese.* ALICE C. EVANS. Journ. Agr. Res. **13**: 225–233. 1918.

This paper reports the study of the bacterial flora of imported Roquefort cheese as compared with the bacterial flora of experimental cheese of that type made in the Dairy Division of the Department of Agriculture. The experimental cheese differed from the imported in being made of cow's milk and ripened in rooms artificially cooled and moistened, whereas the imported cheese was made of sheep's milk and ripened in natural caves. The two varieties of cheese are very similar. The results of the study may be summarized as follows:

The microorganisms essential for the manufacture and ripening of Roquefort cheese are *Streptococcus lacticus* and *Penicillium roqueforti*. *Streptococcus lacticus* decomposes the lactose during the manufacture of the cheese and thus produces the lactic acid necessary for the cheese making. These organisms disappear from the cheese after about two or three weeks, being killed by the high concentration of sodium chlorid. The remaining flora of Roquefort cheese consists of cheese streptococci and *Bacterium bulgaricum*, organisms which are found in all kinds of ripening cheese. These organisms do not have any significant part to play in the ripening of Roquefort cheese.

The cheese slime consists of characteristic types of micrococci, rod forms, and yeast cells. The enzymes from the slime do not appear to be essential to the ripening of the cheese. The flora of both the interior and the slime of the experimental cheese was identical with the flora of the interior and the slime of the imported cheese.

If the maker of Roquefort cheese will inoculate properly with *Streptococcus lacticus* and *Penicillium roqueforti*, and provide the proper condition of manufacture and ripening, he need have no other concern about biological ripening agents. A. C. E.

BOTANY.—Eupatorium urticaefolium *as a poisonous plant.* C. DWIGHT MARSH and A. B. CLAWSON, Journ. Agr. Res. **14**: 699–715, pls. 52–55. 1918. *White snakeroot or richweed* (Eupatorium urticaefolium) *as a stock-poisoning plant.* C. DWIGHT MARSH and A. B. CLAWSON. U. S. Dept. Agr. Bur. An. Ind. Circ. **26**: 1–7. 1918.

Eupatorium urticaefolium is one of the plants that has been thought to be the cause of milk sickness, but published accounts of experimental work have been very contradictory. In this paper are detailed experiments on cattle and sheep which show not only that the plant is poisonous, but that it produces many of the symptoms of milk-sickness, and undoubtedly is the cause of many if not most of the cases of so-called milk-sickness in cattle and sheep. The symptoms of the poisoning and the pathological results are worked out. The dosage is determined, and it is noted that Eupatorium poisoning is cumulative. It is not considered by the authors that Eupatorium poisoning explains all cases of milk-sickness, but it is thought probable that under this term is included also a bacterial disease.

The second paper is a résumé of the work on Eupatorium, of a more popular character than the above, and designed for distribution among the farmers. C. D. M.

BOTANY.—*The peanut a great American food.* H. S. Bailey and J. A. LeClerc. Yearbook, U. S. Dept. Agr. 1917: 746. 1918.

The composition and yield of the peanut and the methods of making peanut oil and peanut flour are discussed. It is shown that the shelled nuts are a splendid food, cheap and nutritious, and that peanut butter is highly useful in many ways, being rich in fat and protein. The methods of using peanut butter, peanut oil, and peanut flour are given.

PLANT PHYSIOLOGY.—*Wheat flour substitutes.* J. A. LeClerc. Iowa Coll. Agr. Bull. **16:** no. 33. 1918.

This is an address given at the Bakers' Short Course at Ames, Iowa. History of the use of substitutes was touched upon and likewise a digest of the food situation prevailing at the time. A discussion of the wheat kernel and of the composition of the various parts of the wheat kernel and likewise the losses due to milling were given. The speaker compared the amount of food value to be derived from 100 pounds of wheat when milled into white flour and when milled into graham flour. J. A. L.

PLANT PHYSIOLOGY.—*Respiration and catalase activity in sweet corn.* C. O. Appleman. Amer. Journ. Bot. **4:** 207–209. 1918.

Respiration in sweet corn in the milk stage is very high when the corn is first pulled. This high rate of respiratory activity falls off rapidly with storage. Catalase activity in a collateral set of ears showed a decline with storage which is almost directly proportional to the decline in respiratory intensity after a like period of storage.

The catalase activity of the expressed juice from both sweet corn and potato tubers is a fair index of the comparative intensity of respiration in the tissues.

The data seems to justify the general induction that catalase action in these tissues, at least, is correlated with the oxidative processes involved in respiration. C. O. A.

PLANT PHYSIOLOGY.—*The effect of sodium nitrate applied at different stages of growth on yield, composition and quality of wheat.* J. Davidson and J. A. LeClerc. Journ. Amer. Soc. Agron. **10**: no. 5. 1918.

This is the second of a series of papers on the same subject. The first, also published in the above named journal (**9**: 145. 1917), gave data regarding the influence of sodium nitrate applied at different stages of growth on the yield and protein content of the grain. In this paper a study of the straw is made instead of the grain. The protein content of the straw shows the same tendency as the protein content of the grain, viz, an increase of protein content as a result of the application of nitrates at the second stage (heading of the wheat). An increase in yield results when the nitrates are applied at the first stage.

ANTHROPOLOGY.—*An early account of the Choctaw Indians.* John R. Swanton. Mem. Amer. Anthrop. Assoc. **5**: 1–20. 1918.

The translation of part of an unpublished French memoir of uncertain authorship preserved in the Edward E. Ayer collection of Americana in the Newberry Library, Chicago. It appears to have been written shortly after the middle of the eighteenth century. Its peculiar value consists in the fact that, although the Choctaw were the largest tribe with which the French had intimate relations and although their customs must have been well known to many Frenchmen, this is the only lengthy account of them, so far as known, that has been preserved. In addition to numerous matters of general ethnological interest it contains unique information regarding the social organization of the Choctaw nation, something which has hitherto been shrouded in great obscurity. Both archeologists and ethnologists will be interested in the mention of pipes which were apparently made of stone obtained from the famous catlinite quarries in Minnesota. J. R. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on October 28, 1918. The Board adopted the recommendation of the Executive Committee that "those honorary members of the ACADEMY who are enemy subjects be suspended until the end of the war, and that their cases be again considered at that time." The publication in January, 1919, of a new edition of the "Red Book," or directory of the ACADEMY and its affiliated societies, was approved.

ROBERT B. SOSMAN, *Corresponding Secretary.*

SCIENTIFIC NOTES AND NEWS

The Katmai National Monument has been established in Alaska by executive order of President Wilson, dated September 24, 1918. It consists of the volcano of Katmai and considerable outlying territory, including the Valley of Ten Thousand Smokes, which has been visited by several National Geographic Society expeditions under the direction of Prof. R. F. GRIGGS, of Ohio State University. It is expected by those interested in the establishment of the park that its reservation as a national monument will have been the first step toward making this remarkable region accessible to the public as a national park, similar to the Yellowstone and the Yosemite.

Dr. CHARLES W. RICHMOND, of the Division of Birds, United States National Museum, has been appointed Associate Curator of Birds in that Institution.

Mr. BRADSHAW H. SWALES has been appointed Honorary Curator of Birds' Eggs in the United States National Museum. This position has been vacant since the death of Dr. W. L. Ralph in 1907.

Lieut. HENRI CRETIEN, of the French Ministere d'Armament, has recently come to the Bureau of Standards to carry on research work in various military problems related to optics. He is the designer of the Cretien gun sight now universally used on air planes.

Prof. JOHN F. HAYFORD, dean of the College of Engineering of Northwestern University, is engaged in research at the Wind Tunnel Laboratory of the Bureau of Standards. This work is carried on in connection with the National Advisory Committee for Aeronautics, of which Prof. Hayford is a member.

Mr. DOUGLAS C. MABBOTT, biologist of the Biological Survey, U. S. Department of Agriculture, was reported in an October casualty list to have been killed in action in France. He was in the seventy-ninth company of the Sixth Regiment of the Marine Corps, and took part in the fighting near Chateau Thierry in July. Mr. Mabbott was born at Arena, Wisconsin, March 12, 1893, and entered the service of the Biological Survey in December, 1915. He enlisted in February, 1918. He was a member of the Biological Society of Washington, and had contributed for publication three papers on American wild ducks and their food habits.

Mr. William deC. Ravenel has been placed in immediate charge of the administration of the National Museum with the title Administrative Assistant to the Secretary. The position of Assistant Secretary of the Smithsonian Institution, in charge of the National Museum, made vacant by the recent death of Dr. Richard Rathbun, has been discontinued, effective November 1. Mr. Ravenel has been connected with the Museum in an administrative capacity since 1902.

Miss McDowell, Professor of Physics at Wellesley College, has returned to the Bureau of Standards on leave of absence.

Dr. F. W. McNair, President of the Michigan School of Mines, is now at the Bureau of Standards working on airplane engine problems.

Mr. George W. Morey, of the Geophysical Laboratory, Carnegie Institution, has been given a year's leave of absence and is in charge of the optical glass plant of the Spencer Lens Company at Hamburg, New York.

Dr. C. Nussbaum, formerly instructor in physics at Harvard University, has been engaged in the study of aeronautic instruments at the Bureau of Standards during the past summer.

Mr. E. P. Peck, formerly Superintendent of Operation of the Georgia Railway and Power Company, has recently come to the Bureau of Standards to assist in work connected with the standardization of electrical apparatus for the War Department.

Mr. B. H. Rawl, chief of the Dairy Division of the Bureau of Animal Industry since 1909, has been appointed assistant chief of the Bureau.

Dr. William H. Ross, of the Bureau of Soils, U. S. Department of Agriculture, has been commissioned a captain in the Chemical Warfare Service, and has been assigned to the Edgewood Arsenal, Edgewood, Maryland.

JOURNAL

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CHEMISTRY.—*A note on the precipitation of zirconium phosphate.* GEORGE STEIGER, Geological Survey.

The recent interest in the determination of zirconium seems to justify the publication of the results of some laboratory work done several years ago to determine the allowable acidity of a solution in which zirconium phosphate may be quantitatively precipitated. The work was done to determine more exactly the conditions necessary when applying this method to the analysis of rocks, which contain only small percentages of zirconium, and although the quantities involved were small the work showed that the composition of the phosphate ranges between limits so wide that unless conditions of precipitation are fully determined and rigorously maintained the results of such work can not be used in a gravimetric determination.

As the main object of this precipitation was the separation of zirconium from titanium, iron, and other metals in a rock, no effort was made to determine the conditions under which zirconium phosphate of constant composition may be precipitated.

In determining quantities of zirconium so small as those found in the average rock the analyst can obtain results that are sufficiently accurate by assuming that the composition of the ignited phosphate is ZrP_2O_7, and that it contains 46.32 per cent of ZrO_2. The results are given in the hope that they may be of service to those who are required to determine larger quantities of zirconium.

The standard zirconium solution used was made by preparing from native zircon the double fluoride of zirconium and potassium. After this salt had been purified by repeated crystallization it was decomposed with sulphuric acid and the fluorine was driven off by heat. Its strength was determined by precipitating the

TABLE I

Precipitation of ZrP_2O_7 in Presence of Sulphuric Acid

								ZrP_2O_7 fused with Na_2CO_3 leached with water		
								Residue	Filtrate divided into two parts	
ZrO_2 taken	Bulk of solution	H_2SO_4 by weight	Amount of H_2O_2	When precipitate first showed	When precipitation seemed complete	ZrP_2O_7	Zirconium in filtrate from phosphate	Ignited, fused $NaHSO_4$, dissolved in water and precipitated with NH_4OH	Acidified with HNO_3 determined P_2O_5	Acidified with HCl and tested for SO_3
1	2	3	4	5	6	7	8	9	10	11
grams	*cc.*	*per cent*	*cc.*			*grams*				
0.0182	100	1.0				0.0278	None		0.0144	None
0.0182	100	2.0				0.0293	None	0.0182	0.0122	None
0.0182	100	3.0				0.0337	None	0.0180	0.0184	None
0.0182	100	5.0				0.0353	Slight trace	0.0187	0.0170	None
0.0182	100	9.0				0.0357	0.0011	Lost	Lost	Lost
0.0101	100	0.1	5	Immediately	$\frac{1}{2}$ min.	0.0142	None	0.0095	Lost	
0.0101	100	0.1	5	Immediately	$\frac{1}{2}$ min.	0.0138	None	0.0101	0.0030	
0.0101	100	1.0	5	$\frac{1}{2}$ min.	5 min.	0.0157	None	0.0103	0.0053	
0.0101	100	5.0	5	2 min.	$\frac{1}{2}$ hr.	0.0156	0.0008	0.0105	0.0060	
0.0101	100	10.0	5	Had not appeared in $\frac{1}{2}$ hr.	Over night	0.0185	0.0024	0.0099	0.0095	

zirconium with ammonia, filtering and igniting the precipitate, and weighing the residue as oxide. The volume of the solution finally used in each experiment was 100 cc., and to conform with conditions met in practice, it was made up in part of hydrogen peroxide. The sulphuric acid was added to the solution in varying quantities, and the zirconium precipitated by the addition of microcosmic salt. The solutions were constantly stirred while the salt was added and allowed to stand over night before filtering. The precipitates obtained were weighed, fused with sodium carbonate, leached with water, and filtered. To determine zirconium the insoluble residue was fused with sodium bisulphate, and the melt was dissolved in water, precipitated with ammonia, filtered, and the zirconium weighed as oxide. The phosphorus in the leach water was determined as $Mg_2P_2O_7$ after preliminary precipitation as phospho-ammonium molybdate. Repeated tests of the leach water for sulphates showed that the precipitation of the phosphate did not carry down sulphate.

As both iron and titanium may be thrown down with zirconium phosphate it is desirable to use a solution containing the greatest possible quantity of free acid, and the titanium must be kept well oxidized with hydrogen peroxide in order to prevent it from being precipitated.

Other phosphates than zirconium phosphate, except those of the rare earth metals, are readily soluble and may be easily separated in dilute acid solutions.

It is not safe to base definite conclusion on the results of work involving quantities so small as those used in these experiments, but those results indicate the formation of a basic salt that approaches normal zirconium phosphate as the acidity of the solution is increased. The table given indicates that the solution employed may safely contain at least 3 per cent and perhaps as much as 5 per cent of free sulphuric acid.

BOTANY.—*The North American species of Genipa.*[1] Paul C. Standley, National Museum.

The genus *Genipa* is a member of the family Rubiaceae, tribe Gardenieae, being closely related to the genera *Gardenia* and *Randia*. About 15 species are known, most of them American (chiefly South American), although several have been described from the tropics of the Old World. From North America 3 species of the genus have been reported heretofore, *Genipa americana* L., *G. caruto* H. B. K., and *G. codonocalyx* Standl. *Genipa*

[1] Published with the permission of the Secretary of the Smithsonian Institution.

americana L.[2] was based upon Plumier's description and illustration of a West Indian plant. It has several synonyms, but only one of importance. In 1818 Kunth described[3] *G. caruto*, from material obtained by Humboldt and Bonpland in Colombia and Venezuela. *Genipa caruto* has been recognized rather generally as a valid species, but it differs from the earlier *G. americana* only in having copious pubescence, the latter plant being nearly or quite glabrous. In the absence of any concomitant characters the presence or absence of pubescence is scarcely a sufficient basis for specific segregation; consequently it seems preferable to consider *Genipa caruto* a synonym or at most a subspecies of *G. americana*.[4]

This is one of the best known and most interesting plants of the American tropics. It ranges from southwestern Mexico (Guerrero to Chiapas) through Central America to Peru and Brazil, and occurs also in Cuba, Hispaniola, Porto Rico, and the Lesser Antilles. It is a tree sometimes 20 meters high, with a trunk up to 50 cm. in diameter, with stout, spreading branches. The large, entire leaves are usually obovate, and 14 to 35 cm. long, with a breadth of 6 to 19 cm. The sweet-scented flowers are borne in small dense cymes, the corollas being salverform, white or yellowish white, and 2 to 4.5 cm. long. The fruit is subglobose, 6 to 7 cm. in diameter, or often larger, 2-celled, covered with a thick, smooth or rough, russet or brownish green rind. The large, flat, brown seeds are imbedded in a scant, whitish, acidulous pulp with violet juice.

Through its wide area of distribution many different names are applied to the plant, some of which are the following: "Caruto" (Venezuela, Colombia), "jagua" (Venezuela, Colombia, Porto Rico, Panama, Nicaragua, Mexico), "jagua azul" (Tabasco), "jagua blanca" (Tabasco), "guaitil" (Costa Rica), "tapaculo" (Nicaragua,) "yigualtí" (Nicaragua), "gigualtí" (Nicaragua).

[2] Syst. Veg. ed. 10. 931. 1759.

[3] H. B. K. Nov. Gen. & Sp. **3**: 407. 1818.

[4] Schumann (in Mart. Fl. Bras. **6**[6]: 352. 1889) has treated *G. caruto* as a subspecies of *G. americana*, under the name *G. americana caruto*. The form is of sufficient importance, probably, to receive nomenclatural recognition. The pubescent plant occurs in continental North America, while the glabrous form is found in the West Indies.

The wood of this tree is soft and fibrous but strong, elastic, and resistant, with a specific gravity reported to range from 0.670 to 0.873. In color it is whitish tinged with reddish gray, or sometimes gray, and is said to take a good polish and to resist the attacks of insects. It has been used in making gunstocks, axe handles, wagons, and other articles. The bark is astringent and is sometimes used for tanning. A decoction of the roots is said to be used for venereal diseases in the West Indies. In Brazil the leaves are reported to be valuable as forage for cattle, and the fruits are said to fatten pigs.

The fruit of *Genipa americana* is doubtless the most important and widely used part of the plant. It is used in Porto Rico and elsewhere to prepare a refreshing beverage, and it is also often fermented to produce an intoxicating drink. When green or ripe it contains copious juice which imparts to everything with which it comes in contact a blue, violet, or nearly black stain. Among the native tribes of tropical America the juice has been highly esteemed for dyeing cloth and other articles. More important, however, is its wide employment among the aborigines for painting and tattooing the skin. For this purpose it is still much used by the uncivilized tribes of certain parts of South America. It is said that the Indians paint their skins with it not only for adornment, but to protect themselves partially against the attacks of the insects so annoying to human life in humid tropical regions.

Because of the economic importance of the commonest species of the genus, it is of interest to find in the U. S. National Herbarium specimens of two rubiaceous plants of Panama, evidently undescribed, which apparently are congeneric. Diagnoses of these are given below. Although both are known only from fruiting material, and it may be that the flowers, when collected, will show that they are not properly referable to *Genipa*, they are certainly closely allied, and agree better with *Genipa* than with any other genus of American Gardenieae.

Besides *Genipa americana*, the other published North American species of the genus is *G. codonocalyx*, described[5] recently by the writer from the Pacific coastal belt of Cost Rica. This is known

[5] Contr. U. S. Nat. Herb. **17:** 446. 1914.

only from a single collection, and may be merely a variant of the common species.

Genipa maxonii Standl., sp. nov.

Large spreading tree, the wood pinkish, the branchlets glabrous, with short internodes; stipules lance-oblong, about 3.5 cm. long, filiform-attenuate, glabrous; petioles about 2 mm. long; leaf blades obovate or rhombic-obovate, 34–44 cm. long, 13.5–25 cm. wide, narrowed from below the middle to a rounded or subtruncate base, narrowed to the apex and subabruptly obtuse-acuminate, chartaceous, bright green above, reddish along the veins, sublustrous, glabrous, the costa and lateral veins impressed, paler and reddish beneath, obscurely puberulent when young, the venation prominent, the lateral veins slender, about 20 on each side, nearly straight, the secondary veins numerous, parallel, distinct, the ultimate veinlets prominulous, reticulate, the margin plane; fruit (probably immature) globose, 5.5 cm. in diameter, glabrous, the pericarp about 4 mm. thick; seeds irregularly rhombic, 1.5–2.5 cm. long, very thin, black, lustrous, the corklike flesh breaking up into large flat irregular sections, each containing a single seed.

Type in the U. S. National Herbarium, no. 675223, collected in forest along the Río Indio de Gatún, Canal Zone, Panama, near sea-level, February 17, 1911, by William R. Maxon (no. 4848).

The venation of the leaves is very different from that of *G. americana*, and the leaves are narrowed to an obtuse base, rather than to a very acute base, as in that species. The corklike flesh which envelops the seeds appears quite unlike the flesh of young fruits of *G. americana*.

The wood of *Genipa maxonii* has a beautiful pinkish tint. Mr. H. Pittier forwarded from Panama a small box made of wood which appears to belong to this tree, although it may have come from some allied rubiaceous species. This wood is rather fine-grained, and probably would take a handsome polish. It agrees in its pink coloration with the branches of the type specimen of *Genipa maxonii*. When exposed for some time to sunlight the wood loses its original color and assumes a dirty-white appearance, but after being kept in a dark place the former coloration is finally restored.

Genipa williamsii Standl., sp. nov.

Tree, 10 meters high, the trunk 12.5 cm. in diameter, the branchlets reddish brown, glabrous, the internodes short; stipules broadly obovate, 1.8 cm. long, 1.2 cm. wide, cuneate at the base, rounded at the apex, brownish, sparsely strigose outside; petioles stout, 1–2.5 cm. long, glabrate; leaf blades obovate or oblong-obovate, 12.5–19 cm. long, 6–9.5 cm. wide, acute or cuneate at the base, rounded at the apex, chartaceous, green above, sublustrous, glabrous, the venation plane or prominulous, brownish beneath, strigose along the veins, the costa stout, prominent, the lateral veins slender, 8 or 9 on each side, ascending at a wide angle, nearly straight, laxly anastomosed near the margin; fruit subglobose, 4.5 cm. in diameter, terminal, solitary, subsessile, the pericarp very thick; seeds (very immature) numerous.

Type in the U. S. National Herbarium, no. 678301, collected in the vicinity of Cana, Panama, altitude 1350 meters, in 1908, by R. S. Williams (no. 814).

A relative of *Genipa americana*, apparently, but very different in the rounded apex of the leaves and rounded, obovate stipules.

ZOOLOGY.—*Classification of the Philippine operculate land shells of the family Helicinidae, with a synopsis of the species and subspecies of the genus Geophorus.*[1] PAUL BARTSCH, National Museum.

The constant demand for determinations of Philippine land shells frequently makes it necessary to lay aside monographic work on the mollusks of these islands, in order to straighten out the nomenclature of a group wholly different from the one upon which the writer may be engaged. This is true in the present instance. Several sendings of *Helicina*, in the old sense of that term, have made it necessary to subject the whole group, which is a rather large one, to critical examination. It is believed that the synopsis of the superspecific groups and the keys and brief comments on the species and subspecies of the largest genus of the family in the islands, *Geophorus*, will prove helpful in classifying material.

The genus *Geophorus* is not a difficult one. The greatest trouble in the past appears to have been the assigning of too many forms to one name, for frequently in the past authors have assigned to one species specimens which we now know belong to different genera. A very careful inventory of all the characters should enable anyone readily to place any of the known forms under its proper name by the use of the appended keys and critical remarks.

In the preparation of this paper, I have been particularly fortunate in having in the National Museum collections a set of Sowerby's cotypes collected in the Philippine Islands by Hugh Cuming, and also a set of von Möllendorff's Philippine Island shells,

[1] Published by permission of the Secretary of the Smithsonian Institution.

which helped materially in the fixing of the majority of the old names.

The members of the family *Helicinidae* found in the Philippine Islands belong to the subfamily *Helicininae,* which in turn breaks up into five genera; namely, *Ceratopoma, Pleuropoma, Sulfurina, Geophorus,* and *Kosmetopoma.*

All of these genera are based upon opercular characters which appear wonderfully constant.

Of these genera, *Ceratopoma* Möllendorff has the least specialized operculum, for here we find a simple thin transparent horny shield without calcareous deposit. The type of this genus is *Helicina caroli* Kobelt.

In *Pleuropoma* Möllendorff the operculum is still simple, i.e., a horny shield, but there is in addition a slight deposition of calcareous material. A flexuose ridge extends close to the margin in a sigmoid curve from the columellar border along the parietal edge. This gives the edge of this portion and in some species the entire operculum the appearance of being double. The type of this genus is *Helicina dichroa* Möllendorff.

In *Sulfurina* Möllendorff we find the operculum similar to that of Pleuropoma but the calcification is stronger and the flexuose line is replaced by a strong raised keel which is usually a little farther removed from the edge. The type of this genus is *Helicina citrina* Sowerby.

In typical *Geophorus* the operculum is much thickened by calcareous deposits. The columellar border bears a deep groove, giving this portion the appearance of being double.

This groove frequently extends for a considerable distance along the two long sides. The outer portion at the columellar border is frequently a little shorter than the inner, and at times considerably thickened, particularly at the posterior columellar angle, where even a knob develops in some forms. The above characters apply to *Geophorus* in the restricted sense as typified by *Helicina agglutinans* Sowerby, the genotype. There are, however, two modifications of this form of operculum, one in which the columellar border is thickened into a strong knob at the parietal edge on the outside, which is limited anteriorly by a slit or deeply impressed groove. Upon this group I will bestow the subgeneric name *Schistopinax* with *Geophorus* (*Schistopinax*) *siquijorensis* Bartsch as genotype.

The other group has the main portion of the operculum, as in typical *Geophorus*, but a strong lamella extends across the operculum on the outside a little distance from the columellar border dividing this into a large shallow spoon shaped area, and a deep pit between the columellar border and the lamella. The group of mollusks having these opercular characters are now assigned to a new subgenus, *Diplopinax*, with *Geophorus* (*Diplopinax*) *peracutissimus* Wagner as genotype.

Geophorus therefore breaks up into the three subgenera, *Geophorus*, *Schistopinax*, and *Diplopinax*.

The most highly specialized operculum is possessed by the genus *Kosmetopoma* Wagner, which has the inside not unlike *Sulfurina*, with the internal ridge quite low, while the exterior is marked on the edge adjoining the outer and basal lip by several dentate ridges. The type of this genus is *Helicina amaliae* Kobelt.

The mollusks of this genus are earth dwellers; i.e., they live on the ground among the dead leaves about the base of trees and rocks, but their favored place of abode is found in the pockets, nooks, and crannies of honey-combed limestone in shady moist situations. I have, on several occasions, picked thousands from an area of a few square yards under such circumstances. During the rainy season they become quite active and one may then find them crawling up the lower portions of the bowl of trees and on fallen logs or rocks, while during the dry period they are neatly wedged away in the crevices of the rock and between chinks of bark and the leaf or moss-covered base of trees.

Key to the sections of the subgenus Geophorus

Spiral sculpture present.
  Angle at junction of columella and basal lip present I
  Angle at junction of columella and basal lip absent II
Spiral sculpture absent.
  Angle at junction of columella and basal lip present III
  Angle at junction of columella and basal lip absent IV

In the use of this key care must be taken not to confuse the fine cross-hatch or crinkly short lines, which are found in varying strength in all the members of the genus, with true incised spiral lines. The junction of the columella and the basal lip in one big series always forms a conspicuous angle. Members of this group practically always have the columella decidedly excavated. In the other series, the columella passes directly into the basal lip with scarcely an indication of the junction.

Section I

In this section, fine incised spiral lines are present. The columella is strongly excavated and forms a conspicuous angle at its junction with the basal lip. The following key will help in the identification of the known forms:

Greater diameter more than 14 mm.
  Periphery with an obsolete keel . . . . *boholensis* Bartsch
  Periphery with a strongly compressed keel
    Base decidedly inflated . . . . *pachychilus* Möllendorff
    Base not inflated
      Greater diameter more than 16 mm. . . . . . . *romblonensis* Bartsch
      Greater diameter less than 15 mm. . . . . *mindoroensis* Wagner
Greater diameter less than 12 mm.
  Spire rather elevated . . . . *negrosensis* Bartsch
  Spire rather depressed
    Shell yellow . . . . *nitidulus* Möllendorff
    Shell japan rose . . . . *versicolor* Möllendorff

The specimens of this section fall readily into two groups, one embracing large shells, in which the diameter is always more than 14 mm., and one in which the diameter is always less than 12 mm. There are four species of the larger forms. Of these, the specimens from Bohol, *Geophorus boholensis* n. sp., have the peripheral keel obsolete and the base decidedly inflated. No depression is present at the junction of the base and the peripheral keel. This is the largest of the four species. The type, Cat. No. 104419, U. S. National Museum, has 5.1 whorls and measures: altitude, 10 mm.; greater diameter, 16.5 mm.

The other three species have the peripheral keel very strongly developed. One of these, *Geophorus pachychilus* Möllendorff has the base strongly inflated and but slightly concaved at its junction with the peripheral keel. This species comes from the island of Guimaras. A typical specimen of this species, Cat. No. 258761, has 5.3 whorls and measures: altitude, 16.3 mm.; greater diameter, 14.7 mm.

The other two species have the base only moderately convex. The one *Geophorus romblonensis* n. sp., coming from the island of Romblon, is a rather compressed form, having a very broad peripheral keel, with a decided depression at the junction of the base and keel. The type of this, Cat. No. 334254, has 5.5 whorls, and measures: altitude, 8 mm.; greater diameter, 16.5 mm.

The fourth species, *Geophorus mindoroensis* Wagner which is also rather depressed, is much smaller than the last and comes from the island of Mindoro. A typical specimen, Cat. No. 184940, having 5.1 whorls, measures: altitude, 7.1 mm.; greater diameter, 14.3 mm.

Of the smaller species belonging to this section, three are known. One of these from the island of Negros, which may be known as *Geophorus negrosensis* n. sp., has the spire rather elevated. The type of this, Cat. No. 302751, has 5.5 whorls and measures: altitude, 7.3 mm.; greater diameter, 10.9 mm.

The other two species have the spire rather depressed. On one of these, *Geophorus nitidulus* (Möllendorff) Wagner, the shell varies from yellow to horn colored. This comes from central Luzon, and is particularly abundant in the region of Montalban. A typical specimen, Cat. No. 256989, having 5.3 whorls, measures: altitude, 6 mm.; greater diameter, 10.6 mm.

The last species, *Geophorus versicolor* Möllendorff, which comes from the island of Sibuyan, has the whorls japan-rose colored. A specimen of this species, Cat. No. 195495A, having 5.6 whorls, measures: altitude, 6.8 mm.; greater diameter, 11.9 mm.

Section II

The second section has fine incised spiral lines, but the columella is not strongly excavated, nor does its junction with the basal lip form a decided angle, but the columella passes almost without demarcation into the basal lip. Of this section there are five species.

Shell with a brown band on the base near the periphery.
  Greater diameter more than 15 mm. . . . . *worcesteri* Bartsch
  Greater diameter less than 10 mm. . . . . *benguetanus* Bartsch
Shell without a brown band on the base near the periphery.
  Greater diameter more than 14 mm . . . . *cataínganus* Bartsch
  Greater diameter less than 8 mm.
    Shell decidedly elevated. *trochulus* Möllendorff
    Shell depressed . . . . *monticolus* Möllendorff

Two of the five forms of this section have a brown band near the periphery on the base. One of these, *Geophorus worcesteri* n. sp., which comes from the island of Leyte, is a large form. The type, Cat. No. 184931, has 5.1 whorls and measures: altitude, 8.4 mm.; greater diameter, 15.2 mm.

The other banded form, *Geophorus benguetanus*, n. sp., is globose and decidedly smaller. It comes from the mountains of the Benguet region, Luzon. The type, Cat. No. 239871, has 4.5 whorls and measures: altitude, 6.1 mm.; greater diameter, 9.4 mm.

Of the five unbanded forms, the largest, *Geophorus catainganus* n. sp., comes from Cataingan Bay on the island of Masbate. This is well elevated and has the base quite convex and a strong depression at the junction of the base and the peripheral keel. The type, Cat. No. 258768, has 5.1 whorls and measures: altitude, 9.5 mm.; greater diameter, 14.2 mm.

The two remaining forms are small species. Of these, one, *Geophorus trochulus* Möllendorff, which comes from the island of Tablas, is decidedly elevated. A specimen of this, Cat. No. 195507, has 5.1 whorls and measures: altitude, 6.2 mm.; greater diameter, 7.4 mm.

The other species, *Geophorus monticolus* Möllendorff, is rather depressed. A specimen, Cat. No. 184927, from Morong, Luzon, has 4.8 whorls and measures: altitude, 4.5 mm.; greater diameter, 6.4 mm

Section III

This group of *Geophorus* has no spirally incised lines. The columella is excavated and forms a decided angle at its junction with the basal lip. The shells thus characterized fall readily into three groups.

Shell large, broadly conic.
  Shell with color bands. . . . . .Group A
  Shell without color bands. . . . . .Group B
Shell small, narrowly conic. . . . . .Group C

Group A

Shell large, broadly conic, marked by color bands

Shell decidedly elevated.
  The summit of the last whorl falling below the strong peripheral keel and permitting this to show as a frill at the suture. . . . . *peracutus* Wagner
  The summit of the last whorl not falling below the strong peripheral keel but appressed to it.
    Greater diameter of shell more than 12 mm. . . . . . *leytensis* Bartsch
    Greater diameter of shell less than 12 mm. . . . . *leytensis basiaoensis* Bartsch
Shell rather depressed.
  Greater diameter more than 13 mm. . . . . *siargaoensis* Bartsch
  Greater diameter less than 11 mm. . .*siargaoensis surigaoanus* Bartsch

There are three species and two subspecies of red and yellow-banded *Geophorus* which have a granular upper surface, no incised spiral lines, and an excavated columella that forms a decided angle at its function with the basal lip. One of these, *Geophorus paracutus* Wagner, from the island of Tablas, is a stout conic form, having the whorls but slightly convex and possessing a strong peripheral keel below which the summit of the last two turns falls in such a manner as to leave this in the suture as a frill. The early whorls of this species are yellow while the last has a zone of yellow at the summit and another at the periphery, the rest of the surface being red. The lower surface beyond the peripheral keel, which is of the same color as above, is brown, turning paler at the umbilical callus, which is pale yellow. The inside is brown while the peristome is white, washed on the inner border with brown. A specimen of six whorls measures: altitude, 8.8 mm.; greater diameter, 14.1 mm.

The banded shells from Jaro, Leyte, *Geophorus leytensis* n. sp. have the whorls more rounded than those on Tablas and the summit of the last whorl does not fall below the peripheral keel, but is appressed to its edge. The main color of the upper surface is dark red on the later whorls, edged with a narrow zone of bright yellow at the summit and the periphery. The lower surface has a yellow peripneral zone followed by a broad band of red, while the median half is pale yellow. The interior corresponds with the external color pattern. The type, Cat. No. 219023, has 5.5 whorls and measures: altitude, 8.3 mm.; greater diameter, 13 mm.

Specimens from Basiao Island, off Samar, closely resemble *Geophorus leytensis* in outline and coloring but the yellow bands are a ltttle broader and the shell is much smaller. These may be known as *Geophorus leytensis basiaoensis* n. subsp. The type of this subspecies has 5.5 whorls and measures: altitude, 7.5 mm.; greater diameter, 11 mm.

The third species is the most brilliantly colored and beautiful of all the known Philippine Island Helicinids. The shell is very broadly conic and but moderately elevated, the extreme apex extending scarcely more above the periphery than the anterior tip of the columella extends below it. The early whorls are bright yellow. The last has a broad yellow band on the summit, which is about two-thirds as wide as the dark brown band that follows, which in turn equals the bright yellow zone that bounds the very strongly angulated periphery. The brown band pales as it passes backward from the aperture which, by the way, it does not quite reach, for it terminates abruptly a little behind it and is quite lost on the second turn back. The base is bright pale yellow excepting a sharply limited brown zone which is about as broad as the yellow zone that intervenes between this and the periphery. The interior corresponds with the exterior in coloration, the peristome being bright pale yellow. This species, which comes from the island of Siargao, may be known as *Geophorus siargaoensis* n. sp. The type, Cat. No. 184,929 has 5 whorls and measures; altitude, 7 mm.; greater diameter, 13.2 mm.

In the northeast portion of Mindanao, at Surigao, a small race of this species occurs, which differs from *Geophorus siargaoensis* chiefly in its lesser size, but also in having the basal brown band a little nearer the periphery and not so sharply limited. This smaller race may be known as *Geophorus siargaoensis surigaoanus* n. subsp. The type, Cat. No. 302772, has 5.1 whorls and measures: altitude, 6.3 mm.; greater diameter, 10.8 mm.

Group B

Shell large, broadly conic, without color bands

Peripheral keel compressed.
- Operculum broadly oval . . . . *ticaoensis* Bartsch
- Operculum rhomboidal.
  - Peripheral keel limited on the under side by a strongly incised line.
    - Middle whorls mustard yellow.
      - All whorls mustard yellow . . . . *tantalus tantalus* Bartsch
      - All whorls not mustard yellow, the last turns with a paler zone at the summit . . . . *tantalus masbatensis* Bartsch
    - Middle whorls capucine orange.
      - Last whorl pale capucine orange . *tantalus palawanensis* Bartsch
      - Last whorl flesh colored . . . . *tantalus mansalayanus* Bartsch
  - Peripheral keel not limited by an incised line on the under side . . . . *romblonensis* Bartsch

Peripheral keel rounded . . . . *agglutinans* Sowerby

Sowerby, in describing *Helicina agglutinans,* listed three varieties. Of these, variety *a* comes from the island of Guimaras, variety *b* from Bohol, and variety *c* from Panay. The name *agglutinans* Sowerby has since been fixed upon variety *c* by Wagner. This is a large shell which has a rounded peripheral keel, with the base somewhat inflated. There is no depressed area between the periphery and the rest of the base. The upper surface of the shell is uniformly bright yellow while the lower has a narrow zone of yellow near the periphery, below which it is suffused with reddish brown, this color shading gradually to yellow on the middle of the base. A cotype collected by Cuming, Cat. No. 302753, has 5 whorls and measures: altitude, 9.2 mm., greater diameter, 17.3 mm.

The shells from the island of Ticao belonging to this section have the base decidedly inflated and the aperture very high, which gives the operculum an oval, rather than a trapezoidal appearance. The shells are large, barium yellow, paling toward the aperture. The upper surface is marked by coarse irregular lines of growth, the suture being rendered irregular and wavy by the coarse sculpture. The peripheral keel is reduced to a cord, which is limited by a shallow depression on the under side only. These shells may be known as *Geophorus ticaoensis* n. sp. The type, Cat. No. 256999, comes from San Miguel, Ticao. It has 5 whorls and measures: altitude, 8.9 mm.; greater diameter, 14.8 mm.

The most difficult group of this section is represented in our collection by a series of specimens from the islands of Mindoro, Palawan, Samar, and Masbate. This group embraces medium-sized shells having a moderately elevated spire and a narrow peripheral keel, which is bounded on the lower side by a well incised spiral line. They represent a distinct group to which the name *Geophorus tantalus* n. sp. may be applied. I have seen good series of specimens from the four above mentioned islands which demand a further subdivision of this species, as indicated in the key. The specimens from Samar have the shell mustard yellow and this race may carry the subspecific name *Geophorus tantalus tantalus* Bartsch. The type, Cat. No. 288773, comes from near Catbalogan, has 5 whorls, and measures: altitude, 7.1 mm.; greater diameter, 10.7 mm.

The specimens from Masbate are of similar coloration as the last excepting that on the last two turns a lighter yellow zone bounds the summit. This race may be known as *Geophorus tantalus masbatensis* n. subsp. The type of this, Cat. No. 258769, comes from Cataingan Bay and has 5.5 whorls, and measures: altitude, 6 mm.; greater diameter, 10.2 mm.

The western specimens, i.e., those from the islands of Mindoro and Palawan, have the extreme tip mustard yellow and the turns immediately succeeding capucine orange. In the specimens from Palawan the last turn is pale capucine orange. This species may bear the name *Geophorus tantalus palawanensis* n. sp. The type of this, Cat. No. 334256, comes from Bacuit, has 5.1 whorls and measures: altitude, 6.3 mm.; greater diameter, 10.6 mm.

The shells from Mindoro agree with the last excepting that the last turn is flesh colored. These may bear the trinomial designation *Geo-*

phorus tantalus mansalayanus n. subsp. The type, Cat. No. 258762, comes from Mansalay Bay, has 5.6 whorls, and measures: altitude, 6.4 mm.; greater diameter, 10.8 mm.

From the island of Romblon we have seen several lots of shells which agree with *Geophorus tantalus* Bartsch in size and general sculpture, but the peripheral keel is wider and not limited on the basal side by an incised line. A shallow depressed concave area separates the convex portion of the base from the peripheral keel. This form also has the whorls considerably more convex on the upper side than the shells of *Geophorus tantalus* and the sculpture is very coarse, while in Geophorus *tantalus* it is rather fine. I therefore feel that it is specifically distinct from *Geophorus tantalus* and it may be known as *Geophorus romblonensis* n. sp. The type, Cat. No. 208246, has 5.3 whorls and measures: altitude, 7 mm.; greater diameter, 11.5 mm.

Group C

Shell small, narrowly conic

Shell with a deep umbilical pit. . . . . *pseudomphalus* Möllendorff
Shell without a deep umbilical pit.
  Shell with a strongly compressed peripheral keel
    cyrtopomus Möllendorff
  Shell with a rounded peripheral cord.
    Peripheral cord strong, coarse and wavy
      trochaceus calayanensis Bartsch
    Peripheral cord well rounded, smooth.
      Upper surface coarsely granular.
        Greater diameter 8.9 mm. . . . . . . *trochaceus palauiensis* Bartsch
        Greater diameter 7.9 mm. . . . . *trochaceus marivelesanus* Bartsch
      Upper surface finely granular.
        Shell elongate conic. . . . . *trochaceus trochaceus* Möllendorff
        Shell broadly conic. . . . *trochaceus nanus* (Möllendorff) Wagner

The small conic granulose *Geophorus* having an excavated columella that forms a strong angle at its junction with the basal lip and lacking spirally incised lines, fall readily into three divisions, which may be considered species. One of these, *Geophorus pseudomphalus* Möllendorff, has a strongly impressed umbilical pit. This is so far known only from the environs of Sibul, Bulacan Province, Luzon. The second species, *Geophorus cyrtopomus* Möllendorff, ranges through the mountains of central Luzon at least from Montalban to Morong. It is characterized by a decidedly compressed peripheral keel and decidedly less elevated spire than the next species. The third species, *Geophorus trochaceus* Möllendorff, has a much wider range in distribution and breaks up into a number of geographic races. *Geophorus trochaceus trochaceus* Möllendorff comes from the island of Leyte. It is a very small shell of elongate conic form, having the peripheral keel rather rounded and the upper surface finely granulate. A specimen of *Geophorus trochaceus trochaceus* Möllendorff from Leyte, Cat. No. 302767, has 5.3 whorls and measures: altitude, 5.3 mm.; greater diameter, 6.8 mm. The most northern race, *Geophorus trochaceus calayanensis* n. subsp., comes from Calayan Island, of the Babuyanes group. This is considerably larger than the typical form with coarser incremental lines and granulations. The peripheral keel, too, is stronger, irregular and wavy. The type of this, Cat. No. 334254, has 5.3 whorls and measures: altitude, 6.2 mm.; greater diameter, 8.1 mm.

Another, *Geophorus trochaceus palauiensis* n. subsp., recalls strongly the shell from Calayan. It is almost of the same size but has the peripheral keel well rounded and is in every way less coarsely sculptured than the northern representative. It comes from Palaui Island. The type, Cat. No. 258789 has 5.3 whorls and measures: altitude, 6.2 mm.; greater diameter, 8.9 mm.

Two additional subspecies occur upon the island of Luzon. One, a medium sized form, *Geophorus trochaceus marivelesanus* n. subsp., which is known from the southern end of the Zambales range at Mariveles. This, like the Palaui race, has the upper surface coarsely granular, but it is much smaller. The type, Cat. No. 302774, has 5.3 whorls and measures: altitude, 5.3 mm.; greater diameter, 7.8 mm.

The smallest race, *Geophorus trochaceus nanus* (Möllendorff) Wagner, comes from Sibul, Bulacan Province. This race has a lesser number of whorls and is a little more finely granular than the other Luzon forms. A typical specimen, Cat. No. 195491, having 4.5 whorls measures: altitude, 4 mm.; greater diameter, 5.8 mm.

Section IV

Shell banded.................................*acutissimus* Sowerby
Shell not banded.
  Shell broadly conic.............................*palananus* Bartsch
  Shell narrowly conic.
    Operculum with a knob at the posterior columellar border
        perezi Bartsch
    Operculum without a knob at the posterior columellar border
        caramoanus Bartsch

The section in which the spiral sculpture is absent and in which the columella is not excavated and in which there is no decided angle at the junction of the columella and basal lip is rather small. It is represented at present by four forms only, coming from the islands of Luzon, Pagbilao, and Bohol. One of these three forms has color bands. The largest, *Geophorus acutissimus* Sowerby, comes from the island of Bohol. In this, all but the last turn are pale yellow, the last is flesh-colored. There is a zone of rose pink at the summit and an equal one near the peripheral keel. A third cone about twice as wide as these is on the base separated from the peripheral keel by a narrow light zone. On the inside of the aperture these red bands are almost scarlet. A cotype, of this species, Cat. No. 104415, collected by Cuming, has 5 whorls and measures: altitude, 9 mm., greater diameter, 16.7 mm.

Of the three unbanded forms of this section one, *Geophorus palananus* n. subsp., is of medium size, broadly conic, and of quite uniform honey, yellow. The sculpture of the upper surface is much coarser than in the preceding. This race comes from Palanan, Isabela Province, Luzon. The type, Cat. No. 302787, has 5 whorls and measures: altitude, 6.3 mm.; greater diameter, 9.9 mm.

Two of the races have a decidedly elevated narrow conic shell. One of these, *Geophorus perezi*, n. sp., comes from the greater Pabgilao Island, off southwestern Luzon. This is a small form in which the operculum is very broad and bears a decided knob at the posterior columellar border. The type, Cat. No. 310058, has 5 whorls and measures: altitude, 5.2 mm.; diameter, 7.6 mm. The other, *Geophorus caramoanus* n. sp., comes from Caramoan on the south end of the Caramoan peninsula in Ambos Camarines, Luzon. This has the shell a little more elevated than *G. perezi* Bartsch, with the operculum much narrower and with a tooth on the posterior columellar end of it. The type, Cat. No. 195504, has 5 whorls and measures: altitude 5 mm.; greater diameter, 6.8 mm.

Schistopinax, new subgenus

In this subgenus, the columellar border is thickened into a strong knob at the parietal edge on the outside, which is limited anteriorly by a deeply incised groove.

Greater diameter more than 12 mm. . . . . *siquijorensis* Bartsch
Greater diameter less than 8 mm.
  Last whorl moderately rounded. . . . . *trochiformis* Sowerby
  Last whorl very strongly rounded
    trochiformis subtrochiformis (Möllendorff) Wagner

Of this subgenus I know only three forms and of these only one from personal examination; namely, the type of the subgenus, *Geophorus*

(*Schistopinax*) *siquijorensis* n. sp. This species, which comes from the island of Siquijor, is broadly conic and has a brown band on the base near the periphery. The type, Cat. No. 195499, has 5.5 whorls and measures: altitude, 7.5 mm.; greater diameter, 12.8 mm.

The other two forms are much smaller and narrowly conic. *Geophorus* (*Schistopinax*) *trochiformis* Sowerby comes from the island of Negros. Wagner cites 4.5 whorls with an altitude of 5.5 mm. and a major diameter of 6.5 mm. for the specimen he figures. He states and shows that this is a little less elevated and has the last whorl a little less rounded than *Geophorus* (*Schistopinax*) *trochiformis subtrochiformis* (Möllendorff) Wagner, which he describes from the island of Marinduque, and for which he gives the measurements: altitude, 5.5 mm.; greater diameter, 7 mm.

Diplopinax, new subgenus

This subgenus is characterized by having the outer surface of the operculum crossed by a lamella which divides the operculum into a shallow, large labial portion and a strong pit at the columellar end. Type: *Geophorus* (*Diplopinax*) *tagbilleranus* Bartsch.

Incised spiral lines present.
 Color band present on the base.
  Greater diameter more than 13 mm. . . . . *acutus* Pfeiffer
  Greater diameter less than 11 mm.
   albocarinatus (Möllendorff) Wagner
 Color bands absent on the base.
  Greater diameter more than 17 mm. . . . . . . *bothropomus* Möllendorff
  Greater diameter less than 12 mm.
   Spire decidedly elevated . . . . *conoidalis* Möllendorff
   Spire decidedly depressed . . . . *möllendorffi* Bartsch
Incised spiral lines absent.
 Color bands present.
  Greater diameter more than 14 mm. . . . . *peracutissimus* Wagner
  Greater diameter less than 13 mm.
   Interior suffused with red . . . . *tagbilleranus* Bartsch
   Interior not suffused with red . . . . *cumingi* Bartsch
 Color bands absent.
  Shell broadly conic . . . . *lazarus* Sowerby
  Shell narrowly conic . . . . *duponanus* Bartsch

It is interesting to note that in none of the species so far known do we find the junction of the columella and basal lip forming a decided angle. The subgenus can be divided into two sections on the presence or absence of fine incised spiral lines.

The section in which incised spiral lines are present embraces five species coming from the islands of Luzon, Marinduque, Siquijor, and Cebu, while the six belonging to the section that has no incised spiral lines come from the islands of Luzon, Negros, Bohol, and Leyte.

Of those having incised spiral lines, two are provided with collar bands. One of these, *Geophorus* (*Diplopinax*) *acutus* Pfeiffer, is much larger than the other. A cotype, Cat. No. 104393, collected by Cuming at Argao, eastern Cebu, has 5.5 whorls and measures: altitude, 8.3 mm.; greater diameter, 13.8 mm. The smaller banded form, *Geophorus* (*Diplopinax*) *albocarinatus* (Möllendorff) Wagner, comes from the island of Siquijor. A specimen, Cat. No. 195505, having 5.1 whorls measures: altitude, 6.6 mm.; greater diameter, 10 mm.

Of the three unbanded species one, *Geophorus* (*Diplopinax*) *bothropomus* Möllendorff, is quite large. Of this I have not seen specimens. Wagner figures the operculum and gives the following measurements: altitude, 9.5 mm.; greater diameter, 18 mm. It comes from Caramoan, Luzon. The other two species are decidedly smaller. One of these *Geophorus* (*Diplopinax*) *conoidalis* Möllendorff, has the spire decidedly elevated and the base but very slightly rounded. A specimen of this species, Cat. No. 258786, has 5.3 whorls and measures: altitude, 7.4 mm.; greater diameter, 10.8 mm. The last species, *Geophorus* (*Diplopinax*) *möllendorff* in. sp., has the spire rather depressed and the base strongly rounded. The type, Cat. No. 195503, comes from the island of Siquijor. It has 5.1 whorls and measures: altitude, 4.9 mm.; greater diameter, 9.8 mm.

The section lacking incised spiral lines can be divided into a banded and plain group. The banded group embraces three forms, of which *Geophorus* (*Diplopinax*) *peracutissimus* Wagner is quite large. This species comes from the island of Negros. A specimen, Cat. No. 302777, having 5.1 whorls measures: altitude, 8 mm.; greater diameter, 14.6 mm. This has a faint brown band at the summit and another above and below the periphery, a little within the edge. The other two forms are of medium size. One, *Geophorus* (*Diplopinax*) *cumingi* n. sp., collected by Cuming on Negros, has the color bands as in *Geophorus* (*Diplopinax*) *peracutissimus* Wagner, but the shell much more elevated. The type, Cat. No. 302739, has 5.2 whorls and measures: altitude, 7.5 mm.; greater diameter, 11.2 mm. The third banded species, *Geophorus* (*Diplopinax*) *tagbilleranus* n. sp., has the last whorls suffused with red and the interior of the same color. The type of this, Cat. No. 258760, comes from Tagbileran, Bohol. It has 5.2 whorls and measures: altitude, 7 mm.; greater diameter, 11.9 mm.

Two species and a subspecies are known of the unbanded forms. Of these one, *Geophorus* (*Diplopinax*) *lazarus* Sowerby, is a broadly conic, medium-sized shell that comes from the region of Bongabong, Nueva Ecija, Luzon. A cotype of this, collected by Cuming, Cat. No. 302740, has 4.9 whorls and measures: altitude, 5.9 mm.; greater diameter, 11.6 mm. The subspecies, *Geophorus* (*Diplopinax*) *lazarus transitans* Wagner, which comes from Libmanan, Ambos Camarines, Luzon, is said to have measured: altitude, 7 mm.; greater diameter, 12 mm. The remaining species, *Geophorus* (*Diplopinax*) *duponanus* n. sp., has the shell narrowly conic. The type, Cat. No. 258787, comes from the west shore of Port Dupon, Leyte. It has 5 whorls and measures: altitude, 6.5 mm.; greater diameter, 9.4 mm.

In the preceding synopsis of the Philippine members of the genus *Geophorus*, all but the following three known forms, of which no specimens were at hand, have been heated. I suspect that all three of these belong to *Geophorus* in the restricted sense, but shall refrain from assigning them to a definite position until representative material will make it possible to do so positively. These forms are: *Geophorus trochiformis gibbosulus* (Möllendorff) Wagner cited from Tayabas, Luzon; *Geophorus agglutinans solidulus* (Möllendorff) Wagner, from the island of Lubang; and *Geophorus acutus intermedius* (Möllendorff) Wagner from the island of Cebu.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

CRYSTALLOGRAPHY.—*The application of optical methods of identification to alkaloids and other organic compounds.* Edgar T. Wherry. U. S. Dept. Agr. Bull. 679. Pp. 9. 1918.

The value of optical methods for identifying crystalline substances is pointed out, and methods for the study of substances such as alkaloids are outlined. The observations recommended are: I. In ordinary light: Color, habit, angles, cleavage, and refractive indices; detailed directions with respect to the last are given, including the preparation of special immersion liquids of solutions of potassium-mercuric iodide, which are required for certain alkaloids. II. In parallel polarized light: extinction, double refraction, and sign of elongation. III. In convergent polarized light: class, sign, and dispersion. The details of manipulation are illustrated by describing the procedure in the case of cinchonine. E. T. W.

CRYSTALLOGRAPHY.—*The identification of the cinchona alkaloids by optical-crystallographic measurements.* Edgar T. Wherry and Elias Yanovsky. Journ. Amer. Chem. Soc. **40**: 1063–1074. 1918.

The methods described in the paper previously abstracted were applied to carefully purified cinchonine, cinchonidine, quinine, and quinidine, crystallized from alcohol and from benzene. The optical properties of these are presented in a standard formal description and then tabulated in columns to show the differences. Determinative tables based on the properties measured are given. The results of crystallization of mixtures are also described, and a method for the examination of a medicinal preparation containing these alkaloids outlined. E. T. W.

CRYSTALLOGRAPHY.—*Modern extensions of Hauy's laws of crystallography.* EDGAR T. WHERRY. Amer. Mineral. **3**: 134–136. 1918.

It is pointed out that many of the modern developments in crystallography represent logical extensions of the laws formulated by Hauy over 125 years ago. E. T. W.

MAMMALOGY.—*The rice rats of North America (Genus Oryzomys).* EDWARD A. GOLDMAN. N. Amer. Fauna **43**: 1–100, pls. 1–6, figs. 1–11. September 23, 1918.

The genus Oryzomys, of wide distribution in North and South America, has, for the systematist, long been one of the most difficult groups of small mammals; and there has been a considerable difference of opinion as to the status and distribution of the comparatively few forms found in the United States, while the intricate maze of species and subspecies in the Tropics has proved a stumbling block for almost every worker. In every extensive collection many specimens were wrongly determined, or simply stored without an attempt at specific identification.

In the present revision Major Goldman has recognized 51 forms from Panama northward, 44 of which he places in the typical subgenus Oryzomys, 5 in the subgenus Oligoryzomys, and 2 in the subgenus Melanomys. Two Mexican subspecies are described as new: *Oryzomys melanotis colimensis* from Armeria, Colima; and *Oryzomys fulvescens mayensis* from Apazote, Campeche. The author predicts that when many regions now unexplored are carefully worked by collectors, the forms assignable to Oryzomys will probably far outnumber those of any other genus of American rodents. More than 150 species and subspecies have already been described in the genus, many of these from South America and therefore extralimitary to the present paper. Some forms have in late years been separated from Oryzomys by the erection of closely allied genera, and a careful revision of the South American genera, subgenera, species, and geographical races of Oryzomys and its allies, somewhat comparable to Goldman's work, would be a boon to mammalogists. The relationships between the genera and subgenera of Oryzomys-like rodents are especially complex and there will doubtless always be a considerable difference of opinion regarding the relative values of the named groups, the various sections blending one into another in an intricate manner. The author calls attention to the intimate relationships between Oryzomys and Nectomys, and other American cricetines, and incidentally expresses the opinion that Nesoryzomys, based by Heller on rice rats inhabiting the Galapagos Islands, is a synonym of Oryzomys.

Keys to the forms; lists of specimens examined, with footnote reference to the museums where the material from various localities may be found; average and extreme dimensions of specimens; detailed distribution of each form; and, in the plates, nearly 100 well-selected figures of skulls and teeth; all add to the values of the revision, which is based on the examination of 1613 specimens assembled from the various larger American museums. N. Hollister.

PHYTOPATHOLOGY.—*Seed treatment control and overwintering of cucumber angular leaf spot.* W. W. Gilbert and M. W. Gardner. Phytopathology **8**: 229–233. May, 1918.

The authors give the results secured from small and large scale tests of disinfecting cucumber seed to control angular leaf spot. The treatments tried consisted in soaking the seed for 5 to 10 minutes in solutions of mercuric chlorid (1 to 1000), copper sulfate (0.5 and 1 per cent), and formalin (2 and 4 per cent) and then washing in running water. Hot water treatment (52°C. for 10 minutes) was also tried. Half-acre field tests carried on at Madison, Wisconsin, showed conclusively that all the treatments tried almost entirely eliminated the disease from the seed. The mercuric chlorid treatment (1 to 1000 for 5 minutes) is considered the safest, most practical, and most effective method tested. Both formalin and copper sulfate caused some injury to germination. The effectiveness of the treatment with mercuric chlorid was further tested on about 150 cucumber fields in Wisconsin and Indiana, in one half of which the seed used was treated and in the remainder untreated. The original seed was from the same source. Observations made near the end of the season showed a very considerable reduction in the amount of disease on fields not previously in cucumbers planted with treated seed. The data secured on overwintering indicate that the disease does live over in the soil to a considerable extent, making it inadvisable to plant cucumbers on the same land two years in succession.

Seed disinfection and crop rotation are advised as methods of controlling angular leaf spot. W. W. G.

PLANT PHYSIOLOGY.—*Boron: its effect on crops and its distribution in plants and soil in different parts of the United States.* F. C. COOK and J. B. WILSON. Journ. Agr. Res. **13**: 451–470. May 27, 1918.

This is the final paper of a series of three dealing with this subject. The influence of borax (sodium borate) and of calcined colemanite (calcium borate) was studied on various cultivated plants. The experiments in some cases extended over three years and the maximum amount of borax used was in excess of that which truck growers, in applying manure treated with borax to kill larvae of the house fly, might possibly add to their cultivated fields. Soils showed a decided difference in rendering the added borax nontoxic to plants. There was a complete disappearance of detectable amounts of soluble borax and of colemanite, although small amounts of total borax were found. It is evident that insoluble borax compounds are formed in the soil. The calcium of the colemanite did not prevent the absorption of borax by the plants.

The amounts of borax absorbed seemed to vary with the variety of plant, the solubility of the borax compound used, the amount added to the soil, the time elapsing after the compound was added to the soil before planting, the amount of rainfall, etc., and finally with the character of the soil to which the borax compound was added.

The distribution of the borax in different parts of the various plants was investigated and results showing the influence on the yield of some of the crops are included. F. C. C.

AGRONOMY.—*Effect of temperature and other meteorological factors on the growth of sorghums.* H. N. VINALL and H. R. REED. Journ. Agr. Res. **13**: 133–148, pls. 11, 12. April, 1918.

The purpose of this study was to determine the reactions of the sorghum plant to climatic conditions. Several varieties were grown under field conditions at Chillicothe, Texas; Bard and Chula Vista, California; and Puyallup, Washington. The average of the monthly means of temperatures for the growing seasons at the above points was 75.6°, 81.8°, 62.4°, and 60.4° F., respectively. The percentage of actual to possible sunshine was 75, 93, 68, and 46. The total degrees of positive temperature received by the sorghums at Chillicothe was 3028°, at Bard 4236°, at Chula Vista 1895°, and at Puyallup 1615° F.

None of the sorghums matured at Puyallup, but all matured at Chula Vista with only 280° difference in the total of positive temperatures.

This would seem to indicate that the amount of sunshine is an important factor in bringing sorghums to maturity.

The conformance of the sorghums at Chillicothe, Bard, and Chula Vista to Linsser's Law of Growth was remarkable. The "physiological constant" according to this law, for the period from planting to maturity was for Chillicothe 0.539, Bard 0.530, and Chula Vista 0.526.

Vegetative characters which are ordinarily considered stable, such as the number of leaves per plant, varied with the climatic conditions. Blackhull kafir had 3 and Sumac sorgo 6 more leaves at Bard than at Chula Vista. The varieties also showed decided differences in height and diameter of the stem and in the size of the leaf at these two places.

Studies on the effects of different dates of planting at Bard, indicate that "more favorable conditions are obtained if the date of planting is regulated so that the early stages of the plant's development coincide with a period of high temperatures and the later stages, when the plant is nearing maturity, come when moderate temperatures prevail."

H. N. V.

TECHNOLOGY.—*The milling and baking tests of einkorn, emmer, spelt, and polish wheat.* J. A. LeClerc, L. H. Bailey, and H. L. Wessling. Journ. Amer. Soc. Agron. **10**: no. 5. 1918.

A description of these various rare wheats is given, and likewise the composition of the flours and characteristics of the bread made from the flours of these rare wheats. It is shown that the rare wheats, emmer and spelt (both free of hulls) and polish wheat can be milled into a satisfactory flour and the flour used in baking a good loaf of bread. The results obtained from einkorn (free of hulls) are not so encouraging.

J. A. L.

TECHNOLOGY.—*The chemical analysis of wheat-flour substitutes and of the breads made therefrom.* J. A. LeClerc and H. L. Wessling. U. S. Dept. Agr. Bull. 701. 1918.

The work embodied in this bulletin was started in 1912. Included are found the chemical analysis of some 30 substitutes which may be used in combination with wheat flour in the making of bread. There is also found the analysis of the various breads made from a combination of three parts of wheat flour and one part of substitute. Photographs of the different breads as well as certain descriptive physical characteristics of these breads are given.

J. A. L.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The 124th meeting of the ACADEMY was held in the Assembly Room of the Cosmos Club the evening of Thursday, April 18, 1918, with President BRIGGS presiding, the occasion being the fifth lecture of the series on Science in Relation to the War, by Lieut. Col. X. REILLE, Chief of Artillery in the French Advisory Mission. The address, entitled *The problem of anti-aircraft firing*, has since been published in the JOURNAL (**8**: 465–480. August 19, 1918).

The 125th meeting of the ACADEMY was held in the Assembly Room of the George Washington University Medical School the evening of Thursday, May 9, 1918, with Vice-president ROSE presiding. The occasion was the sixth lecture of the series on Science in Relation to the War, by Dr. RAYMOND PEARL, of the United States Food Administration, entitled *Biology and war*. This lecture has been published in the JOURNAL (**8**: 341–360. June 4, 1918).

The 126th meeting of the ACADEMY was held jointly with the Chemical Society in the Assembly Room of the Interior Department the evening of Wednesday, May 15, 1918, with Vice-president POWER presiding. The address, by Dr. ARTHUR A. NOYES, Professor of Theoretical Chemistry at the Massachusetts Institute of Technology, and Chairman of the Nitrate Committee, entitled *The nitrogen problem in relation to the war*, has been published in the JOURNAL (**8**: 381–394. June 19, 1918). It is the seventh of the series on Science in Relation to the War.

WILLIAM R. MAXON, *Recording Secretary.*

THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 316th regular meeting of the Society was held at the hall in the Perpetual Building Association's building, 1101 E Street, N.W., November 6, 1918. There were present 24 members and one visitor.

The following new members were elected: Messrs. O. K. COURTNEY and P. W. MASON, of the Bureau of Entomology and Dr. NORMAN PERRINE, of the Federal Horticultural Board.

The PRESIDENT announced the death of two of our fellow members, viz., Mr. FREDERICK KNAB and Mr. A. B. DUCKETT, and the meeting was, for a short time, turned into a memorial meeting in honor of the deceased. Resolutions on the death of Mr. Duckett were read and a copy of same ordered sent to the bereaved family. Short remarks laudatory of Mr. Duckett were made by Messrs. GAHAN, POPENOE, CUSHMAN, SCHWARZ, and SNYDER.

The PRESIDENT read a short statement by Dr. L. O. HOWARD on the life and work of Mr. Knab, after which short but eloquent tributes were paid to his memory by Messrs. ROHWER, WALTON, ELY, and PIERCE. The PRESIDENT announced that he would name a committee to prepare a short biographical sketch and a bibliography of Mr. Knab's work.

The regular program was as follows:

MANN, Dr. W. M.: *Notes on collecting in Fiji.* Mr. Mann told of a collecting trip through the Fiji islands in 1915–1916. The trip was made as a Sheldon Traveling Fellow of Harvard University, the object being to study the insect and, as far as possible, other faunae from the standpoint of zoogeography.

The Lau Archipelago, first visited, was little productive. The visit was during the dry season but it is probable that at other seasons the fauna is also poor. These islands are almost entirely coralline limestone and isolated. In the forests, generally at high altitudes on the larger islands of Fiji proper, life was abundant and the proportion of endemic forms large. Considerable material was collected and a report on the ants is in preparation.

Several points of local distribution were discussed. One moth, the larva of which bores into coconut leaves on the island of Viti Levu, the largest island in the group, has weakened the trees so that practically no nuts are produced. It is remarkable that this species has never spread to the other islands, especially those near by, considering the strong winds and hurricanes that are so prevalent in Fiji.

One of the serious insect pests of the coconut is a large phasmid. This occurs so abundantly that on one plantation where Hindu labor was employed, phasmid collecting was given to some of the laborers as a task, and seven pounds weight of the insects required as a day's work. They collected this amount apparently with little trouble.

SANFORD, H. L.: *The chrysanthemum gall fly.* Mr. Sanford's paper dealt with the life-history, distribution, and control of this imported pest of chrysanthemums, and was illustrated by several interesting specimens of its work and also by some photographs.

ROHWER, S. A.: *Notes on and descriptions of sawflies.* (Read by title.)

GREEN, C. T.: *A note on the habit of* Pegomyia affinis *Stein.* (Read by title.)

FISHER, W. S.: Chrysobothris transquebariea *versus* impressa. (Read by title.)

COCKERELL, T. D. A.: *Descriptions of new bees.* (Read by title.)

MOSIER, C. A. and SNYDER, T. E.: *Further notes on Tabanidae from Florida Everglades.* (Read by title.)

A. B. GAHAN, *Secretary.*

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. VIII DECEMBER 19, 1918 No. 21

GEOLOGY.—*Titanium-bearing corundum spinellite (rock emery): a preliminary statement of its occurrence and composition in Virginia.* Thomas L. Watson, University of Virginia, and George Steiger, United States Geological Survey.

It is proposed in this paper to summarize briefly the geologic occurrence and composition of a type of mineral deposit (rock emery) in Virginia that possesses considerable scientific interest as well as commercial importance. The rock name spinellite applied in 1893 to certain ore deposits at Routivare, Sweden, is suggested for the ilmenite-magnetite-corundum-spinel aggregate from Virginia. The geology of the Virginia area, including the bodies of rock emery, will be treated at some length in a report of the State Geological Survey, which is in an advanced stage of preparation.

RÉSUMÉ OF THE AREAL GEOLOGY

The area is in the north-central part of Pittsylvania County near to and along the west side of the Southern Railway, about 40 miles south of Lynchburg, and 20 miles north of Danville. Whittles, a station on the Southern Railway, 5 miles north of Chatham, the county seat, is the present shipping point.

As mapped by the Virginia Geological Survey, the area comprises approximately 20 square miles. It forms a part of the crystalline rock complex of the Piedmont Plateau province. Its surface is maturely dissected, averaging in elevation about

850 feet above sea level, and is characterized by the absence of marked relief.

The rocks are all crystalline and include a variety of metamorphic and igneous types that are prevailingly deeply weathered, so that outcrops, especially of the metamorphic types, are few. Schists and gneisses, chiefly the former, compose the rock complex into which the igneous masses are intruded. They probably form as much as five-eighths of the area mapped. Muscovite schist with or without biotite and common red garnet is the prevailing type, although other varieties of schists occur. The gneiss is biotite-bearing, in places garnetiferous, and is of granitic composition. It was derived probably from an original granite, while the schists were almost as certainly derived from sediments.

The strike of the foliation of the schist-gneiss complex is to the northeast, ranging from N. 10°–85° E., with a probable average of N. 50° E.; the dip varies from 40° S.E. to vertical, with a probable average of 65°.

The igneous rocks, including granite of several kinds, olivine norite, and olivine and olivine-free diabase, are intrusive into the schist-gneiss complex. Olivine norite intrudes the granite and is therefore younger, while the diabase is limited chiefly to the schist-gneiss complex. With the exception of gneissoid structure developed in the granite in places, the igneous rocks are massive. Quartz veins and pegmatites of granitic composition are abundant. Black tourmaline and red garnet occur in the pegmatites in several localities.

Of the igneous rocks in the district granite, which probably forms three-eighths of the area mapped, is the only one that needs be considered, since the ore bodies are always closely associated with it and the two are undoubtedly genetically related. Two varieties of granite which are strongly contrasted occur: (a) granitite, or biotite-granite, with or without muscovite, and (b) muscovite granite aplite-pegmatite. Both are commonly massive although gneissoid structure may occur locally. The two varieties appear to be intimately associated in places and the muscovite aplite-pegmatite may carry minute scales of biotite sparsely scattered through it. The ore bodies are associated with the aplite-pegmatite and not with the granitite.

The granite aplite-pegmatite is a white muscovite-bearing rock which exhibits the usual irregularities of texture of such rocks. Chemical analyses, as would be expected, show it to be distinctly more silicic than the granitite. Microscopic study of thin sections shows the principal minerals to be quartz and feldspar (orthoclase and albite in varying proportions) with some muscovite.

The chemical composition of the granite aplite-pegmatite is shown in table 1 below in the average of three analyses of samples collected from different parts of the area.

TABLE 1

AVERAGE OF THREE ANALYSES OF GRANITE APLITE-PEGMATITE, PITTSYLVANIA COUNTY, VIRGINIA. (S. D. GOOCH, ANALYST)

	Per cent
SiO_2	76.19
Al_2O_3	15.14
Fe_2O_3	.66
FeO	.19
MgO	trace
CaO	.47
Na_2O	4.16
K_2O	2.29
H_2O-	.05
H_2O+	1.06
TiO_2	.02
P_2O_5	.11
MnO	.02
CO_2	none
	100.36
Sp.Gr.	2.671[a]

[a] Average of three determinations on separate rock fragments, ranging from 2.659 to 2.693.

Calculated in the usual way, the principal normative composition of the rock corresponding to the above analysis is:

Quartz	41.9
Orthoclase	13.3
Albite	35.6
Anorthite	2.5

THE ORE BODIES

From developments thus far made, the emery ore bodies are quite similar in mode of occurrence to many titaniferous magnetites in gabbroic rocks and to the Virginia nelsonites. They form sharply defined vein-like masses or lenses which range up to 6 feet across, with the greatest length thus far exposed in prospecting of more than 120 feet. They may occur either in the granite aplite-pegmatite or in the schist near the granite aplite-pegmatite contact. In either case the much greater resistance of the ore to weathering than that of the inclosing rocks has resulted in the surface being heavily littered with large and small masses of the emery.

Contacts of the ore with fresh granite have nowhere been observed, since the openings are shallow and are confined to the residual decayed product of the granite. Along the margins of the ore bodies there is usually abundant chlorite up to several inches in thickness. The chlorite may exhibit a rude vertical banding, the bands of which sometimes alternate with similar ones of ore, limited in all cases to marginal positions in the ore bodies thus far developed. Chlorite occurs also in bunchy form in the ore usually distributed through the marginal portions of the ore body; and, as a rule, is absent from the other parts of the rich massive ore bodies but may be an important constituent of the lean ones. Indeed a characteristic feature of the rich massive emery bodies is their freedom from micaceous (chloritic) minerals so common to emery of many localities. Chlorite is similarly associated with the ore bodies occurring in schist. On weathering the chlorite is removed and characteristic pitted surfaces are developed in the ore.

The ore bodies in the schists are genetically related to the granite aplite-pegmatite and are formed very near to the schist-granite contact. They range from mere stringers a small fraction of an inch thick to veinlike bodies or lenses 5 or 6 feet across. They conform closely with the foliation of the schists, although exceptionally they cut across the schist structure. In the openings thus far made the schists are in an advanced stage of decay, yielding varicolored residual clays, chiefly pink to deep red and brown, in which the structure of the original schists is usually completely preserved. The ore bodies have a general northeasterly strike, with steep dips to the southeast which frequently approach the vertical. In the thin stringer-like bodies, closely spaced and alternating with thin bands of schist, many specimens exhibit beautiful folds. Chlorite is similarly associated with the ore bodies formed in the schist as with those formed in the granite described above. Marked contact effects on the schist are shown in places, involving the development of an entirely new set of minerals, including sillimanite and some andalusite with the ore minerals, spinel and magnetite, and in places a little corundum.

PETROGRAPHY OF THE EMERY.

The rock emery is a heavy black fine-grained crystalline aggregate that resembles somewhat closely a homogeneous fine-grained magnetite ore. It is an exceedingly tough rock and is magnetic from the presence of magnetite as one of its constituents. A small horseshoe magnet will pick up very small fragments of the ore but will usually not lift pieces a half inch or more in size. The texture of the ore may or may not be entirely uniform. More often it is uniform but frequently difference in granularity (size of grain) even in a small hand specimen is emphasized by sharp usually parallel boundaries which impart a distinct banded appearance to the ore. This difference in granularity seems to be more frequent in the ore in schist than in the ore in granite, but it occurs in both. In the coarsest textured emery the mineral grains do not exceed 2 mm. in diameter, while in the finer textured rock, which includes most of the ore, they are under 0.1 mm.

In the most of the ore none of the component minerals can be distinguished by the naked eye. In the schist occurrences, however, the ore contains corundum sufficiently coarse to be readily identified on sight, formed usually in small segregation-like areas or bunches or as thin light-colored bands or streaks.

less often as scattered single crystals. The corundum crystals measure up to 2.5 cm. long and 1 cm. wide, but probably most of them range from 1 to 3 mm. and under 1 mm. in size. They are usually clear and nearly white or colorless to light grayish, but many are light to deep blue. Megascopic corundum, however, has been identified only in the ore in the schist, none having yet been observed in the ore in the granite. Otherwise the ore in its two rock associates is identical in appearance and cannot be distinguished in either hand specimens or large masses.

As a rule the ore is entirely massive, and is cut by one or more sets of joints irregularly spaced, which break it into blocks of different sizes. Exceptions, however, are noted in some of the schist occurrences where thin bands of ore alternate with similar ones of schist, and in those places where tiny bands of light-colored corundum are developed, or under conditions mentioned above where difference in granularity is shown. In each case a rather distinct banded structure is apparent.

Microscopic study of more than fifty thin sections of the ore[1] shows it to consist of a fine-grained interlocking aggregate of spinel (pleonaste), magnetite, and corundum, with some ilmenite, and in some sections a brown mineral whose identity has not yet been established. From the optical data it is possible that the brown mineral may prove to be a new species. In addition to the minerals mentioned some sections show sillimanite, andalusite (chiastolite), and a pale-green chlorite, possibly corundophyllite. The dominant mineral is spinel (pleonaste), which makes up 50 per cent or more of the rock. All the principal minerals vary considerably in amount. Corundum, for example, may be abundant in some sections and almost or entirely wanting in others.

The spinel occurs in rich green, sometimes brown, grains, which may show partial crystal outline, and is, of course, isotropic. In the coarser grained rock the spinel grains do not exceed 2 mm. in diameter, while in the finer grained rock they will average less

[1] The microscopic description that follows relates entirely to the schist occurrences of the ore; study of thin sections of the granite occurrences of ore has not been completed.

than 0.05 mm. Inclusions of magnetite and corundum, especially magnetite, are rather common. Thin plate-like interpositions of magnetite or ilmenite oriented with the octahedral cleavage are observed in many spinel individuals of some sections. Also the substance of the spinel is frequently crowded with minute black dots in such abundance at times as almost to obscure the host. These are often confined to the central portion of the spinel individual like the inclusions in some leucite. Alteration from weathering into a nonpleochroic isotropic reddish brown substance, the composition of which has not been investigated, is common in some sections. Usually the alteration product forms distinct rims which strongly contrast with the unaltered rich green cores of spinel.

The composition of the spinel is shown in column I of table 2. It is compared with analyses of spinel of the Peekskill emery, Westchester County, New York (columns III and IV), and with an analysis of spinel from the titanomagnetite spinellite of Solnör, Norway (column V).

TABLE 2

ANALYSES OF SPINEL FROM VIRGINIA, NEW YORK, AND NORWAY

	I[a]	II	III	IV	V
Al_2O_3	53.52	54.39	65.19	64.86	61.8
Fe_2O_3	10.35	10.52			4.6
FeO	24.53	24.91	20.78	21.78	18.1
MnO					1.05
MgO	10.02	10.18	14.03	13.36	14.75
SiO_2	0.92				
TiO_2	0.67				
	100.00	100.00	100.00	100.00	100.30

I. Spinel from Pittsylvania County, Virginia, rock emery area. George Steiger, analyst.

II. No. 1 calculated to a silica and titania free basis.

III and IV. Spinel from Westchester County, New York, Peekskill rock emery area. G. Sherburne Rogers, Ann. N. Y. Acad. Sci., **21**; 69. 1911.

V. Spinel from titanomagnetite spinellite, Solnör, Norway. J. H. L. Vogt, Zeitschr. Prakt. Geol., 1900, p. 237.

[a] Spinel and corundum were obtained as a residue after repeated treatment with strong hydrochloric acid. Corundum was determined separately and deducted.

The results given in the table above indicate the differences in composition of the spinel from the three widely separated localities. By way of comparison attention need only be directed to the closer similarity in composition of the spinel from Virginia and Norway than that from New York. Upon further comparison with analyses of spinel from other localities, the Virginia mineral is remarkable for its comparatively low MgO and high Fe_2O_3.

According to the analysis given in table 2, the Virginia spinel corresponds to the formula (Fe, Mg)O.(Al, Fe)$_2$O$_3$, in which FeO is molecularly greater than MgO and Fe_2O_3 is slightly more than one-eighth of the Al_2O_3. In the comparatively high Fe_2O_3 the mineral shows similarity to chlorospinel, while in the protoxide ratio (FeO molecularly greater than MgO) approach toward hercynite is indicated. It is, however, apparently more closely allied to pleonaste to which it is referred and in which Fe_2O_3 on chemical grounds is shown in this case to be isomorphous with Al_2O_3.

The spinel in the New York and Norway rocks is also referred to the variety pleonaste by Rogers[2] and by Vogt.[3] Williams[4] previously concluded that from low MgO (about 9 per cent) shown on analysis of the New York spinel, the results of which were unfortunately lost, the mineral closely approached hercynite, although on a later page (197) he remarks, in commenting on other analyses, that in "a very large proportion, if not all, of the New York spinel, the samples consisted of pleonaste."

Magnetite, the second most important mineral quantitatively, is usually much less abundant than spinel. It is developed in grains that often show a strong tendency toward crystal outline, although good crystals are rare. The grains will average slightly less in size than those of spinel and are scattered among the latter with which they are intergrown or interlocked with sharp angular boundaries, and are also formed as inclusions in both pleonaste and corundum.

[2] Rogers, G. S., Ann. N. Y. Acad. Sci. **21**: 69. 1911.
[3] Vogt, J. H. L., Zeitschr. Prakt. Geol., p. 237, 1900.
[4] Williams, G. H., Amer. Journ. Sci. **33**: 195. 1887.

Corundum is subject to wide variation in amount and, with the exceptions noted above, it is usually not visible megascopically. It may fail entirely in some thin sections and may be present in considerable quantity in others. In the bulk sample of the rock yielding the results on analysis given in table 2, the corundum was estimated at about 18 per cent. It is developed both in grains and in distinct crystals of prismatic habit, which measure up to 0.12 mm. in length. The corundum generally cuts sharply against the spinel and magnetite, but in places the boundaries are irregular and rather indefinite, suggesting, in such cases, a form of intergrowth with the ore minerals indicating approximately simultaneous crystallization. However, it seems reasonably clear that a part of the corundum crystallized ahead of the spinel and magnetite.

Inclusions of both spinel and magnetite occur, especially the latter, which may be grouped at times in areas of minute rounded black particles in such abundance as almost entirely to obscure the substance of the corundum. Regular rhombohedral parting is frequently well developed and, as a rule, the individuals are marked by irregular fractures or cracks.

CHEMICAL COMPOSITION

Composition of the Virginia rock emery is shown in the detailed chemical analysis in column I of table 3. For purposes of comparison two analyses (II and III) by Rogers of the Peekskill emery, New York, and two of the Naxos emery (IV and V) by Papavasiliou are tabulated.

The differences in chemical composition of the emery from the three localities, strikingly shown in a comparison of the analyses, are differences that express variation in the proportion and composition of the minerals that enter into the make-up of the emery from the different localities. Higher combined iron oxides and lower alumina characterize the Virginia emery. Magnesia in the emery from Virginia and New York, widely variable in the latter, may be considered low for rocks in which spinel is a principal mineral, but in each case it can be accounted for on the basis of composition of the spinel, the analyses of which show FeO in excess molecularly of MgO. It is essentially negligible

TABLE 3

ANALYSES OF EMERY FROM VIRGINIA, NEW YORK, AND NAXOS

	I	II	III	IV	V
SiO_2	2.53	1.93	0.84	3.23	4.90
Al_2O_3	45.38	68.14	59.22	66.16	63.64
Fe_2O_3	23.33	1.43	16.66	24.27	29.61
FeO	17.90	16.25	14.02	3.48	1.80
MgO	5.71	10.02	3.54	0.38	0.06
CaO	0.06	trace	trace	1.62	0.45
Na_2O	0.20	trace	trace		
K_2O	none	trace	trace		
H_2O-	0.33	0.12	0.05	0.37	1.04
H_2O+	0.99	1.15	2.65		
TiO_2	3.72	1.41	3.28		
ZrO_2	none				
CO_2	0.07				
P_2O_5	none	trace	trace		
SO_3	none				
S	none	0.05	0.06		
Cr_2O_3	0.05	0.04	trace	trace	
NiO	0.04				
MnO	0.15	trace	0.06	0.25	0.03
BaO	none				
SrO	none				
	100.46	100.54	100.38	99.76	100.53
Sp. Gr.	4.152[a]			4.064	4.008

I. Rock emery 1½ miles west of Whittles, Pittsylvania County, Virginia. George Steiger, analyst.

II. Spinel emery, high grade, Buckbee mine, Westchester County, New York. G. S. Rogers, analyst. Ann. N. Y. Acad. Sci. **21**; 64. 1911.

III. Pure emery, Dalton mine, Westchester County, New York. G. S. Rogers, analyst. Ann. N. Y. Acad. Sci. **21**; 64. 1911.

IV and V. Naxischen handelssmirgels nach Oser. S. A. Papavasiliou. Zeitschr. Deutsch. Geol. Ges., **65**: 87.

[a] Average of five determinations made by S. D. Gooch on separate fragments at 24°C.

in the Naxos emery because of the practical, though not entire, absence of spinel. Ilmenite, present up to 5 or 6 per cent in the emery from Virginia and New York, accounts for the appreciable percentages of TiO_2 in the analyses—a constituent not reported in the analyses of the Naxos emery.

Pleonaste, corundum, and magnetite with some ilmenite are the principal minerals in the emery from Virginia and New York, while magnetite and corundum are the components of the Naxos emery, with little or no spinel and ilmenite. The wide variation in the principal constituents shown in the two analyses of the Peekskill emery is due directly to difference in the proportion of the same minerals as expressed in the modes determined by Rogers.[5] Omitting the less than 2 per cent of quartz, the mode in each case as given by Rogers is shown in table 4.

TABLE 4

MODES OF PEEKSKILL, NEW YORK, EMERY (ROGERS)

	II[a]	III[a]
Spinel	75.0	21.1
Corundum	19.5	45.2
Magnetite	2.1	24.1
Ilmenite	2.6	6.2

[a] Corresponds to same number in table 3.

The same minerals are shown above to be the chief components of the Virginia emery, but the spinel in excess of the other minerals, is shown to differ from that of the Peekskill emery in that Fe_2O_3 isomorphous with Al_2O_3 enters largely into its composition. Variation in the mineral proportions is likewise an important factor in explanation of the differences shown in the analyses of the emery from New York and Virginia.

The norm of the Virginia rock calculated by Washington from analysis I in table 3 is:

Norm of Virginia emery

Corundum	45.09
Nephelite	0.85
Olivine	6.38
Magnetite	33.87
Ilmenite	6.99
(Mg, Fe)O	5.71
Rest	1.48

[5] ROGERS, G. S., op. cit., p. 64.

Since the spinels are regarded as alferric minerals, the rock falls in Class III, Subclass V, and in Section I of the C. I. W. P. system.

THE NAME SPINELLITE

The name spinellite, applied by Peterssen and Sjögren[6] in 1893 to the titaniferous iron ore at Routivare in northern Sweden composed of the ore minerals magnetite, ilmenite, and spinel with the silicate minerals olivine and pyroxene, seems applicable to the Virginia rock. Indeed the name seems more applicable, since the chief mineral in the Virginia rock is spinel. Based on the group name spinel, spinellite would have equal application to the two rocks, since magnetite and spinel comprehended under it are important constituents but their ratio in the two rocks is reversed.

Since 1893 occurrences of titanomagnetite-spinellite in Norway and Sweden have been found to be rather frequent. They are grouped as magmatic segregation deposits in chiefly gabbroic rocks and generally contain 7 to 12 per cent of spinel,[7] but as a rule, carry no corundum, which latter is an important mineral in the Virginia rock. Based, then, on mineral composition, the Virginia rock in which spinel is the principal component is referred to spinellite, which would also include the Peekskill, New York, occurrence.

OCEANOGRAPHY.—*An instrument for recording sea-water salinity.*[1] A. L. THURAS, Bureau of Standards. (Communicated by S. W. Stratton.)

In a paper published in this JOURNAL, **8**: 145. 1918, a description was given of an instrument for continuously recording sea-water salinity. This instrument has been constructed and tested and experimental data have been obtained giving the magnitude of the various sources of error. The present paper

[6] Zeitschr. prakt. Geol., p. 269, 1893; Geol. Fören. Förh. 1893.

[7] BEYSCHLAG, VOGT, and KRUSCH., Ore Deposits, **1**: 250 et seq. (Trans. by Truscott.) 1914.

[1] Done under the auspices of the Interdepartmental Committee on Oceanography, subcommittee on instruments, apparatus, and measurements.

is a continuation of the work on this instrument and concludes with the measurement of the specific conductivity (conductivity per cm. cubed) of sea water, in reciprocal ohms, throughout the range of concentration found in the open ocean.

The author wishes to express his profound sorrow at the death of his associate, Captain Weibel, who was recently killed at the Front in France, while engaged in special scientific work. The loss of his advice and inspiration has been keenly felt in this development of his suggestions. His perseverance and encouragement in the preliminary work showing the feasibility of the method has been of great value to me in carrying out this work.

DESCRIPTION OF THE METHOD

The method consists in measuring the ratio of the resistances of sea water in two similar electrolytic cells; one cell is sealed and contains sea water of average salinity and the other cell has flowing through it the sea water to be measured. This ratio is obtained with a Wheatstone bridge, using an alternating current galvanometer and recorder. A calibration of the apparatus can be made at any time by using sea water of a known salinity in the open cell. A compensation for the temperature coefficient of sea water is made by placing both cells close together in a temperature bath through which sea water continuously flows.

SOURCES OF ERROR

The preliminary experiments indicated several effects which might produce errors in measurement. The extent of these errors has been determined by use of the new multi-tubular cells in a Wheatstone bridge circuit. A sensitive alternating current galvanometer, designed by Weibel, greatly facilitated the balancing of the bridge. An enumeration of the disturbing effects is given below and is followed by a discussion of the experimental data obtained.

1. Change in frequency and wave form of the current.

2. Change in the electrical capacity of the cells with change in current and concentration of the sea water.

3. Heating produced by the current in the cells.
4. Temperature lag of the sealed cell when the temperature of the bath suddenly changes.
5. Flow of sea water through the open cell.
6. Time necessary for the resistance ratio to reach its true value when the sea water passing through the open cell changes in salinity.
7. Air bubbles in the cells.

Different frequencies and wave forms, of alternating current, were obtained from a machine giving a good sine wave form at 1000 and 500 cycles and a power circuit giving about 60 cycles. Successive conductivity measurements on the same solutions with these three frequencies gave readings none of which differed by as much as 5 parts in 100,000. The open cell and sealed cell in the two arms of the bridge contained sea water of a salinity of 35 and 32 grams per 1000 grams of sea water.

The electrical capacities of the cells were measured in a Wheatstone bridge circuit by use of a vibration galvanometer and a variable inductance. Each cell was placed in one arm of the bridge in series with a variable inductance which was used to balance the capacity effect in the cell. Before making the measurements the cells were carefully platinized with a 1 per cent solution of pure platinic chloride for three hours, reversing the current every ten minutes. This covered the electrodes with a firm gray coating of platinum black. The apparent series capacity of the sealed cell was found to be 11,000 microfarads and the capacity of the open cell 14,000 microfarads. These large series capacities are equivalent to small reactances and since these reactances are in quadrature with the ohmic resistances they only affect the balance of the dynamometer by reason of second order terms and are therefore negligible. No variation in capacity was obtained with sea water of different concentrations. Increasing the current in the cell from 0.05 to 0.25 ampere increased the apparent capacity by 30 per cent. However, since the capacities of the cells are large any change in capacity may be neglected as may also the reactances of the capacities themselves, for the accuracy required in this work. The Wheatstone bridge may, therefore, be considered as made up of ohmic resistance, and only a single balance for resistance, as in a direct current bridge, is necessary.

The heating coefficient, i.e., temperature rise per watt dissipated in the cell, for a stirred bath was found to be only 0.1°C. and did not change appreciably with the rate of stirring. In an unstirred bath the coefficient was about 0.3°C. For operating the recorder about 0.05 ampere in the cell is needed. This will raise the temperature of the sealed cell about one-fortieth of a degree above the temperature of the bath and open cell.

The differential temperature coefficient which is here expressed as the per cent change in the ratio of the resistances of the two cells, containing different solutions, per degree change in the temperature of the bath in which the two cells are immersed was found at various temperatures.

The following values of this coefficient were obtained for salinities of 29 and 32 grams per 1000 in the two cells respectively.

from 0 to 10°—0.00013
10 to 20°—0.00009
20 to 30°—0.00007

From these values a small correction can be applied if the temperature of the sea water is different from the temperature at which the calibration of the instrument is made.

The thermal time constant of the cells, which is the time necessary for the temperature of the cell to approach the temperature of the bath to 67 per cent of its initial difference in temperature, was found to be small. For a stirred bath the time constant of the sealed cell is 37 seconds and the open cell 34 seconds, and as in the case of the heating coefficient these values did not change much with the rate of stirring. For an unstirred bath the time constant was 62 seconds. As stated in the previous paper this small time constant is sufficient to bring the cells quickly to the temperature of the bath for the maximum change occurring in the temperature of the sea water.

The effect of flow in the open cell was determined by passing a thoroughly mixed solution through the cell from a large supply. No change in conductivity was obtained up to a flow of as high as 1 liter per minute.

The efficiency of washing out the cell was obtained by use of two solutions, one having a salinity of 35 and the other a salinity of 32. These solutions were passed through the cell simultaneously and the resistance of the cell was measured at definite intervals. For a slow flow (100 cc. per minute) the cell washed out to within 0.01 of the salinity of the second solution, after 400 cc. of this solution had been used. For a rapid flow this degree of washing-out was attained with only 300 cc. of the solution. This is much better than was obtained in the preliminary experiments on other cells; and is sufficiently rapid for the maximum change in salinity which occurs in the ocean.

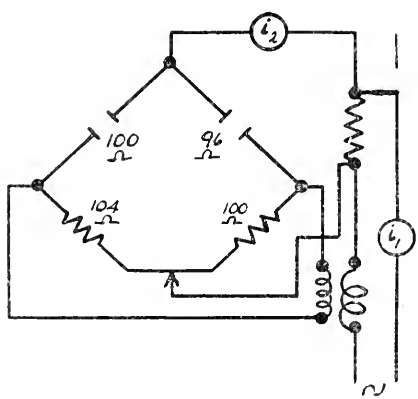

Fig. 1. Bridge resistances

A few experiments to find the effect of air bubbles showed that bubbles on the back of the electrodes caused no change in conductivity and bubbles up to 3 mm. in diameter just in front of the electrodes gave no change in conductivity. A bubble 2 mm. in diameter in one of the tubes gave a change in conductivity corresponding to 0.01 in salinity. By tilting the cells 15 degrees any bubbles which might form in the cells will come to the surface above the electrodes.

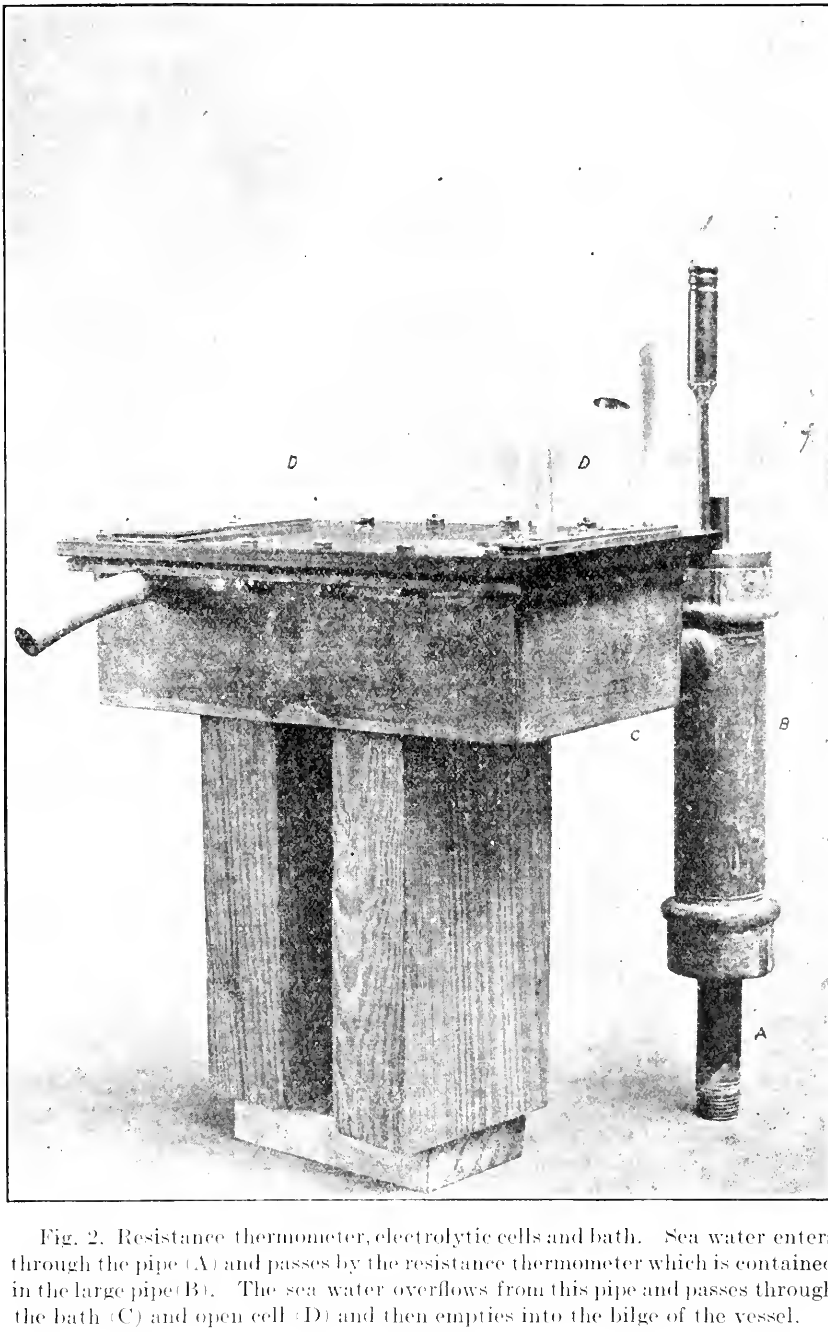

Fig. 2. Resistance thermometer, electrolytic cells and bath. Sea water enters through the pipe (A) and passes by the resistance thermometer which is contained in the large pipe (B). The sea water overflows from this pipe and passes through the bath (C) and open cell (D) and then empties into the bilge of the vessel.

ELECTRICAL CONDUCTIVITY OF SEA WATER

The electrical conductivity of sea water was measured in the sealed cell placed in a stirred bath. The temperature was maintained at 25°C. to within 0.01°C. The resistance capacity of the sealed cell was measured with 1/10 N solutions of potassium and sodium chloride.[2]

The electrical measurements were made by substituting an accurate resistance box in place of the cell in one arm of a Wheatstone bridge circuit. The 60 cycle power circuit was used and no auxiliary capacity or inductance was used to compensate for the capacity of the cell. The resistance capacity was determined with one sodium chloride solution and two potassium chloride solutions. One of the potassium chloride solutions was specially prepared by the chemical division of the Bureau of Standards and the resistance capacity given by this solution has been used to measure the conductivity of sea water. Following are the capacities obtained with the three solutions at 18°C. using a frequency of 60 cycles:

1/10N, KCl prepared by the Bureau of Standards	5.182
1/10N, KCl prepared from Kahlbaum's pure salt	5.181
1/10N, pure NaCl	5.178

Unfortunately the specific conductivity of standard solutions, at a frequency of 60 cycles, has not been measured. The resistance capacities given above are therefore only apparent and can be used to measure the specific conductivity of sea water provided the change in resistance with frequency is the same for a 1/10 normal solution of KCl as it is for sea water which has a strength of about 1/5 normal. The resistance capacities obtained with 1/10 normal KCl and 1/10 normal NaCl solutions indicate that the change in resistance with frequency is the same

[2] The specific conductivity of these solutions at 18°C. measured by F. Kohlrausch and M. E. Maltby in 1900 are 0.011203 and 0.009202 reciprocal ohms respectively. As prepared by Kohlrausch the 1/10 N solution of KCl used in these measurements contained 7.445 grams of KCl to one liter of solution at 18°C. and the 1/10 N solution of NaCl contained 5.848 grams of NaCl to one liter of solution at 18°C. All weighings were made in air and low conductivity distilled water was used.

for different solutions of the same concentration. Previous tests on the two cells in a bridge circuit also indicate that for small differences in concentration (salinity of 35 to salinity of 32) there was no appreciable change in resistance with frequency. The sea-water conductivity measurements have therefore been made with the assumption that the resistance change with frequency is the same for 1/10 N, KCl as it is for sea water.

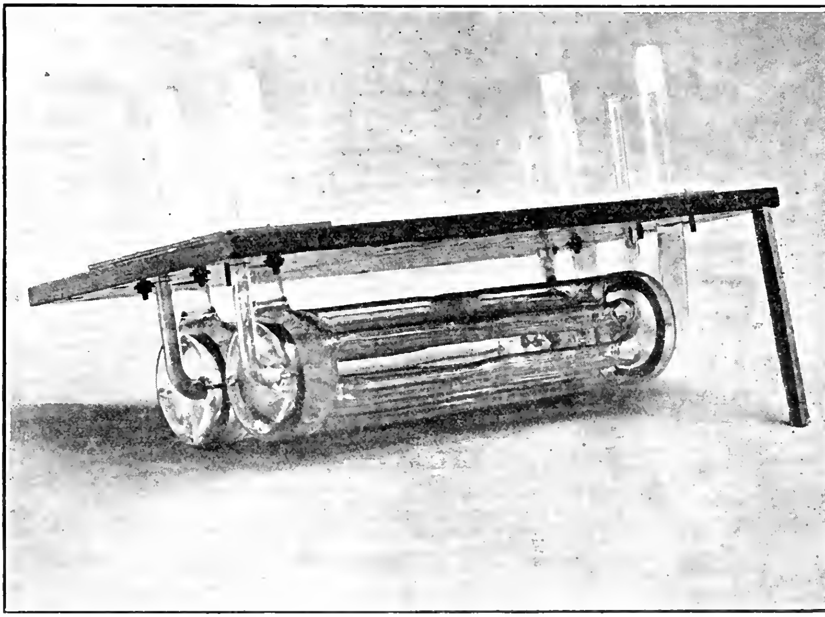

Fig. 3. Electrolytic cells. Mounted in the hard rubber cover of the bath.

The sea water for conductivity measurements was collected by the *U. S. S. Androscoggin* on April 9, 1918, in Latitude 30°–4′N and Longitude 67°–10′W. This water had a high salinity and the more dilute samples were prepared from it by adding distilled water. The one sample of a higher salinity was prepared by carefully distilling sea water. The distillate was measured for conductivity and the low conductivity obtained showed that no chemicals in the sea water were given off.

RECORDER

To modify the Leeds and Northrup recorder for using alternating current at low frequency the only change necessary is the substitution of an electro-magnet for the permanent magnet in the galvanometer. Experiments were performed using a laminated magnet of 2.5 sq. cm. cross section and containing 2000 turns of wire. All other parts of the galvanometer were unchanged except that the damping coil on the moving system was removed. The moving coil has 147 turns, a resistance of 45 ohms and an area of 3.65 sq. cm. The average flux density passing through the moving coil was found for different currents in the stationary coil. These are given in table 1.

With this galvanometer and the resistances shown in figure 1, critical damping of the galvanometer was obtained with 0.65 amperes in the fixed coil (i_1) and 0.15 amperes in the bridge circuit (i_2). With a change of 0.03 of an ohm (corresponding to 0.01 in salinity), in the resistance marked A, the end of the aluminum pointer of the galvanometer which is 4 cm. long, moved 1.3 mm. This sensitivity is sufficient to permit recording to 0.01 in salinity on shipboard. Reducing the current in the fixed coil to 0.4 amperes only slightly underdamped the galvanometer and gave almost the same sensitivity.

The resistances in the two arms of the bridge are a 100 ohm coil and a resistance determined by the ratio of the electrical resistance capacities of the two cells. This ratio was determined by repeated measurements of the resistances of the two cells containing the same solution at the same temperature. The ratio of sealed cell to open cell gives 104.18 ohms as the resistance of the coil in the second arm of the bridge. The slide wire of the recorder will have a resistance depending on the accuracy required in the measurements of salinity. If the salinity is to be recorded to 0.01 then resistances can be inserted, automatically, in one of the ratio arms so that the slide wire can be used twice throughout the range of salinities measured.

The densities of the six samples of sea water were measured at 25°C. by the Bureau of Standards. Table 2 gives the densities referred to distilled water at 4°C. and conductivities in reciprocal ohms. The salinities (grams of total salt per 1000 grams of sea water) given are calculated from the densities at 25°C. by means of Martin Knudsen's Hydrographical Tables.

TABLE 1

FLAX DENSITY IN COIL

CURRENT, AMPERES	H LINES/CM^2
0.23	670
0.40	1210
1.00	2400
1.28	2760
1.50	2990

Samples 2 and 3 are from the same sea water which was collected in two bottles. The accuracy of the conductivity measurements is limited by the accuracy of determining the densities, which is 2 in the fifth decimal place.

TABLE 2

SPECIFIC CONDUCTIVITIES AT 25° C.

SAMPLE	SALINITY	DENSITY AT 25° C.	SPECIFIC CONDUCTIVITY AT 25° C.
1	38.46	1.02598	0.05767
2	36.58	1.02456	0.05514
3	36.57	1.02455	0.05515
4	34.52	1.02300	0.05240
5	32.47	1.02146	0.04966
6	30.62	1.02006	0.04711
7	29.15	1.01896	0.04518

The mean temperature coefficient of sea water per degree C. between 18°C. and 25°C. expressed in terms of conductivity at 18°C. is 0.02237 for a salinity of 29, and 0.02212 for a salinity of 37.

CONCLUDING REMARKS

It is quite probable that this recording salinometer and the recording thermometer mentioned in the first paper can also be used, with some modifications, to measure the physical properties of sea water below the surface, at least to moderate depths. This method of observation at various oceanographic stations would seem to be far more advantageous than the present instruments used for this work. These advantages are, first, many more observations could be made in the same length of time; secondly, the observations would be immediately available for correlation and study; thirdly, a corroboration of any doubtful data could easily and quickly be made.

Recently some other important recording instruments have been designed and built for oceanographic research. A current meter, designed by Hans Pettersson,[3] has been successfully used to obtain the direction and velocity of the currents in the North Sea and along the coasts of Norway and Sweden. This meter can be suspended at various depths below the surface by means of a special anchor and buoy and will automatically register both direction and velocity for a period of two weeks.

R. A. Daly[4] and H. C. Clark have also designed and constructed a deep sea thermograph which will give a high degree of accuracy. This instrument is also automatic and will give a record of the temperature at any depth for a period of one week.

Systematic observations with a number of these automatic thermographs and current meters supplemented with a continuous record of surface salinity and temperature, and also salinities and temperatures below the surface at various stations, greatly increase our knowledge of ocean circulation. Such observations made simultaneously and at definite intervals throughout the cross-section of an ocean current, as for instance the Gulf Stream, would yield results of great scientific value.

[3] Quart. Journ. Met. Soc. London 1915. Monthly Weather Review, May, 1917.

[4] Dr. Daly recently informed me that a description of this thermograph will soon appear in an issue of the Bulletin of the Museum of Comparative Zoology, Harvard University.

SUMMARY

A new method of obtaining a continuous record of the surface salinity of the ocean water by the measurements of the electrical conductivity is described. The various sources of error have been investigated and were mostly found to be negligible. A small correction must be applied for the lack of temperature compensation if a high degree of accuracy is required in the salinity measurements.

The instrument will respond rapidly to the maximum rate of change of salinity or temperature which may occur in the ocean water in moving, at ordinary speeds, across the boundary of currents of the greatest difference in salinity. The accuracy of the method is limited by the accuracy with which the standard sea water in the sealed cell is known.

The conductivity of sea water is given throughout the range of concentration found in the open ocean.

The paper concludes with suggested applications of the salinity recorder in conjunction with other recent recorders for making physical oceanographic measurements.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

CHEMISTRY.—*Chemistry and histology of the glands of the cotton plant, with notes on the occurrence of similar glands in related plants.* E. E. Stanford and Arno Viehoever. Journ. Agr. Res. **13**: 419–436, pl. 42–50. May 20, 1918.

The compounds previously isolated were suspected to occur in glands which are found plentifully in various parts of the cotton plant. The origin, distribution, structure, and chemistry of these glands were therefore studied, and are discussed in detail. They are of lysigenous formation and more or less internally located in the primary and secondary cortices, foliage, flower, fruit, and seed of *Gossypium hirsutum* and *Gossypium barbadense.* In the parts of the plant exposed to light these glands contain quercetin, probably wholly or partly in the form of its glucosides, quercimeritrin and isoquercetin. Under these conditions the gland is surrounded by an anthocyan-bearing envelope of flattened cells. The chief content of glands not exposed to light is gossypol; no anthocyan is found in the flattened cells surrounding such glands. Gossypol is found in the glands of the developing corolla; on their exposure to light it is replaced by quercimeritrin. In the developing seedling, the gossypol of the seed is changed without the formation of quercimeritrin.

Internal glands of this type appear to be universally present within the genus *Gossypium*, and occur also in some members of the related genera, *Thespesia*, *Cienfuegosia*, *Erioxylon*, and *Ingenhouzia* (*Thurberia*). The only representative of the latter species, *I. triloba*, commonly known as "Arizona wild cotton," possesses very conspicuous glands which are arranged like those of *Gossypium.*

Gossypium hirsutum also possesses four sets of nectar glands which are of an entirely different type, both morphologically and physiologically. These glands are briefly described. E. E. S.

CHEMISTRY.—*Chemistry of the cotton plant, with special reference to Upland cotton.* ARNO VIEHOEVER, LEWIS H. CHERNOFF, and CARL O. JOHNS. Journ. Agr. Res. **13**: 345–352. May 13, 1918.

This paper represents the first part of a chemical and biological investigation of the cotton plant (species of *Gossypium*), undertaken with the purpose of isolating and determining the nature and location within the plant of the substance or substances which prove so attractive to the boll weevil. The isolation of an ethereal oil from different parts of the plant is described. Upon investigation the Bureau of Entomology found this oil to be decidedly attractive to boll weevils. This volatile oil showed characteristics different from those of an ethereal oil obtained from the rootbark of *Gossypium herbaceum*. It distills mainly between 200° and 300°C., the lower fractions having a yellow to greenish yellow, the higher fractions a light green to dark blue color. The plants contained an average of 0.0015 per cent of the ethereal oil, the squaring plants apparently yielding the largest amounts.

The isolation from Upland cotton of the glucosides quercimeritrin and its isomer isoquercitrin, formerly found in other types of cotton, is also discussed. In the leaves and flowers, with petals removed, quercimeritrin was found, while from the petals both quercimeritrin and isoquercitrin were obtained. The glucoside gossypitrin and its product of hydrolysis gossypetin, both found in other types of cotton, could not be isolated from Upland cotton. The chemical results throw an interesting light on the relationship of different species of cotton.

A. V. and C. O. J.

SCIENTIFIC NOTES AND NEWS

The Mission of French Scholars to the United States visited Washington on November 18, 1918. The visiting members were: Professors Emanuel de Martonne, Fernand Baldensperger, and Charles Cazamian, of the University of Paris; Dr. Etienne Burnet, of the Pasteur Institute; Dr. Theodore Reinach; Mr. Charles Koechlin; and Mr. Seymour de Ricci.

A new Hygienic Laboratory of the Public Health Service will be built on the grounds occupied by the present Laboratory at Twenty-fifth and E Streets. The new laboratory will cost approximately $250,000.

Mr. Robert Somers Brookings, of St. Louis, chairman of the price fixing committee of the War Industries Board, has been elected by the Senate to succeed the late Charles W. Fairbanks as a regent of the Smithsonian Institution.

Major Samuel Avery of the Chemical Warfare Service has been permitted by the War Department to resign his commission in order to resume his duties as chancelor of the University of Nebraska.

Mr. H. S. Bailey has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, and is with E. I. du Pont de Nemours & Co., of Wilmington, Delaware.

Dr. William N. Berg, of the Bureau of Animal Industry, has been commissioned a captain in the Sanitary Corps, and has been detailed to the Yale Army Laboratory School at New Haven, Connecticut.

Brig. Gen. William H. Bixby, U. S. A., Retired, formerly chief of engineers, has been relieved from emergency duty at St. Louis, and has been transferred to Chicago.

Mr. H. E. Howe, formerly manager of the commercial department of Arthur D. Little, Inc., of Cambridge, Massachusetts, has been appointed consulting chemist to the Nitrate Division, Ordnance Department of the Army.

Mr. Edwin Henry Ingersoll, chemist in the Bureau of Animal Industry, U. S. Department of Agriculture, died of influenza on November 5, 1918. Mr. Ingersoll was born in the District of Columbia in June, 1887. He was a graduate of George Washington University and had been in the government service for thirteen years, acting also as instructor at the University during a part of that time. He was a member of the Chemical Society.

Mr. Frederick Knab, of the Bureau of Entomology, U. S. Department of Agriculture, died on November 2, 1918, in his fifty-fourth year. Mr. Knab was born at Würzburg, Germany, September 22, 1865. He was engaged in entomological work in Massachusetts and Illinois for a number of years, and then entered the service of the Bureau of Entomology in 1906. His scientific studies and publications were concerned chiefly with the coleoptera and diptera. He was a member of the Biological and Entomological Societies of Washington. In his will, dated July 6, 1918, he bequeathed funds to the Entomological Society for its publication fund, and his library and collections to the National Museum.

Lt. Col. Gilbert N. Lewis has returned from France and has been in Washington for several weeks on business connected with the Chemical Warfare Service.

Dr. Artemas Martin, of the U. S. Coast and Geodetic Survey, died on November 7, 1918, in his eighty-fourth year. Dr. Martin was born in Steuben County, New York, August 3, 1835. He had been connected with the Coast Survey since 1885. For many years he had been a frequent contributor to mathematical journals, and he also edited and published the *Mathematical Visitor* and the *Mathematical Magazine*. His writings dealt chiefly with properties of triangles, logarithms, properties of numbers, diophantine analysis, probability, and elliptic integrals. He was a member of the Philosophical Society of Washington and of many American and foreign mathematical societies.

Colonel John Millis, of the Corps of Engineers, U. S. Army, has been transferred from the Engineer Office at Savannah, Georgia, to the Headquarters of the Central Department, at Chicago, Illinois.

Dr. Charles Reitell, formerly Professor of Economics and Cost Accounting at the Wharton School of Finance and Commerce, University of Pennsylvania, has recenty been appointed Economist at the Bureau of Standards.

Dr. Charles Richard Van Hise, President of the University of Wisconsin, and a nonresident member of the Academy, died on November 19, 1918. President Van Hise was born at Fulton, Wisconsin, May 29, 1857. His entire academic career was spent at the University of Wisconsin, where he became successively professor of metallurgy, professor of mineralogy and petrology, professor of geology, and finally president of the University (in 1903). He was associated also with the Wisconsin Geological Survey and the U. S. Geological Survey. His publications, which include several monographs of the U. S. Geological Survey, were concerned chiefly with metamorphism, ore deposits, structural and Pre-Cambrian geology, and, latterly, conservation and economics. He was a member of the Geological Society of Washington, the National Academy of Sciences, and many American and European scientific societies.

Dr. Edward Haslam Walters, formerly a biochemist in the Bureau of Plant Industry, U. S. Department of Agriculture, died in France of bronchial pneumonia on September 25, 1918. Dr. Walters was born December 12, 1891, graduated from the Utah Agricultural College and the University of California, and entered the Bureau of Chemistry in 1910. He was transferred to the Office of Soil Fertility Investigations, now a part of the Bureau of Plant Industry, in 1913. In December 1917 he was commissioned a first lieutenant in the Sanitary Corps, N. A., and was assigned to the Central Medical Department Laboratory of the American Expeditionary Forces in France. He was the author of several papers on the isolation of certain organic compounds in soils. He was a member of the Chemical Society.

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An * denotes an abstract of a published paper. A † denotes an abstract of a paper presented before the Academy or an affiliated Society. A § indicates an item published under the head Scientific Notes and News.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Tuesday, January 8: The Washington Academy of Sciences, at the Cosmos Club, at 8.15 p.m. Program:

Annual meeting for the reports of officers, announcement of elections, and other business.

Address of the retiring President of the Academy, DR. W. H. HOLMES: *"Man's place in the Cosmos, as shadowed forth by modern science."*

Wednesday, January 9: The Geological Society, at the Cosmos Club, at 8 p.m.

Thursday, January 17: The Washington Academy of Sciences, at the Cosmos Club, at 8.30 p.m. Program:

Major AULD, of the British Mission: *The use of gases in warfare.*

Saturday, January 19: The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

E. T. WHERRY: *Certain relations between optical properties and crystal form, and their bearing on the question of "crystal molecules" in organic compounds.* (By invitation.) 30 min.

W. F. MEGGERS and C. G. PETERS: *The refractive index and optical dispersion of air.* 20 min.

[1] The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the thirteenth and the twenty-seventh day of each month.

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Vol. VIII — No. 2

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Saturday, January 26: The Biological Society, at the Cosmos Club, at 8 p. m.

Tuesday, January 29: The Anthropological Society, at the Public Library, at 8 p. m. Program:

Dr. Leo Frachtenberg: *Poland and the Polish question.*

Saturday, February 2: The Philosophical Society, at the Cosmos Club, at 8.15 p. m. Program:

W. S. Gorton: *Investigations of X-ray protective materials.*

P. T. Weeks: *The efficiency of production of X-rays.*

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Tuesday, February 5: The Botanical Society, at the New Ebbit Hotel, at 8.15 p. m. Program:

The retiring President, T. H. Kearney, will deliver an address on *Plant life on saline soils.*

Saturday, February 9: The Biological Society, at the Cosmos Club, at 8 p. m.

Tuesday, February 12: The Anthropological Society, at the Public Library. Program:

Joseph Dunn: *Scotland.*

Wednesday, February 13: The Geological Society, at the Cosmos Club, at 8 p. m.

Thursday, February 14, at the Cosmos Club, at 8 p. m. Program:

Grinnell Jones, of the Tariff Commission: *Work of the Tariff Commission and its relation to the chemical industries.*

D. B. Jones, Bureau of Chemistry: *Hydrolysis of Kafarine.*

Saturday, February 16: The Philosophical Society, at the Cosmos Club, at 8.15 p. m. Program:

H. E. Merwin, of the Geophysical Laboratory: *Complementary colors and the properties of pigments.* 30 min.

I. G. Priest, of the Bureau of Standards: *The photometry of lights of different colors.* Illustrated. 20 min.

B. C. Kadel, of the Weather Bureau: *Some simplifications in recording instruments.* 15 min.

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BALTIMORE, U. S. A.

ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Thursday, February 21: The Washington Academy of Sciences, at the Cosmos Club, at 8.15 p. m. Program:

DR. GEORGE E. HALE: *Astronomy and the War.*

Saturday, February 23: The Biological Society, at the Cosmos Club, at 8 p. m.

Tuesday, February 26: The Anthropological Society.

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March 4, 1918

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Tuesday, March 5: The Anthropological Society.

Tuesday, March 5: The Botanical Society, at the Cosmos Club, at 8 p. m.

Thursday, March 7: The Washington Academy of Sciences, at the Cosmos Club, 8:15 p. m. Program:

Col. C. F. Lee, of the British Aviation Mission: *Aviation.*

Saturday, March 9: The Biological Society, at the Cosmos Club, at 8 p. m.

Wednesday, March 13: The Geological Society, at the Cosmos Club, at 8 p. m.

Thursday, March 14: The Society of Foresters. Program:

E. H. Clapp, H. S. Betts, and Rolf Thelen: *Forest products and the war.*

Saturday, March 16: The Philosophical Society, at the Cosmos Club, at 8 p. m. Program:

J. H. Dellinger, of the Bureau of Standards: *The principles of electrical measurements at radio frequencies.* (Illustrated)

P. D. Merica, of the Bureau of Standards: *Relative thermal expansivities of the constituents of brass.* (Illustrated)

G. W. Vinal, of the Bureau of Standards: *Some electrical properties of silver sulfide.*

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Tuesday, March 26: The Anthropological Society, at the West Study Room of the Public Library, at 8 p.m. Program:

Dr. V. Giuffrida-Ruggeri, Professor of Anthropology at the University of Naples. The paper will be read by Dr. Austin H. Clark, U. S. National Museum: *The origins of the Italian people.*

Thursday, March 28: Society of American Foresters. Program:

Raphael Zon: *The forest resources and timber trade of the world after the war.*

Thursday, March 28: The Washington Academy of Sciences, at the Cosmos Club. Program to be announced later.

Saturday, March 30: The Philosophical Society, at the Cosmos Club, at 8:15 p.m. Program:

D. L. Hazard, of the U. S. Coast and Geodetic Survey: *The magnetic survey of the United States.*

J. P. Ault, of the Department of Terrestrial Magnetism, Carnegie Institution: *Cruises III and IV of the Yacht* Carnegie *in the Arctic and Sub-Antarctic Regions, 1914-1917.*

(Illustrated with slides and moving pictures.)

Tuesday, April 2: The Botanical Society, at the Cosmos Club, at 8 p.m.

Thursday, April 4: The Entomological Society.

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Saturday, April 6: The Biological Society, at the Cosmos Club, at 8 p. m.

Tuesday, April 9: The Anthropological Society, at Public Library, at 8 p. m. Program:

PAUL HAUPT, Professor of the Semitic languages and Director of the Oriental Seminary in the Johns Hopkins University: *Mesopotamia and Palestine.*

Wednesday, April 10: The Geological Society, at the Cosmos Club, at 8 p. m. Program:

EDWIN KIRK: *Paleozoic glaciation in Southeastern Alaska.*

H. E. MERWIN and E. POSNJAK: *The iron-hydroxide minerals.*

J. B. MERTIE: *Repeated stream piracy and other physiographic anomalies in the Tolovana district, Alaska.*

Thursday, April 11: The Chemical Society, at the Cosmos Club, at 8 p. m.

Thursday, April 11: Society of American Foresters. Program:

BENTON MCKAYE and L. S. MURPHY: *Colonization and management of forest lands after the war.*

Saturday, April 13: The Philosophical Society, at the Cosmos Club, at 8 p. m.

Monday and Tuesday, April 22 and 23: The National Academy of Sciences, at the Smithsonian Institution. A cordial invitation is extended by the President of the National Academy of Sciences to the members of the Washington Academy of Sciences to attend the scientific sessions and the public lectures.

The William Ellery Hale Lectures will be given by Professor JOHN C. MERRIAM, Professor of Paleontology, University of California, on the subject: *The Beginnings of Human History from the Geologic Record.*
These lectures will be held at 8 p. m. on Monday and 4 p. m. on Tuesday.
Important reports on the work of the National Research Council will be presented at the scientific sessions.

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Saturday, April 20: The Biological Society, at the Cosmos Club, at 8 p. m.

Tuesday, April 23: The Anthropological Society, at the Public Library, at 8 p. m. The Annual Meeting.

The retiring President, WILLIAM H. BABCOCK, will deliver an address on *Some ethnological and national factors in the present war.*

Thursday, April 25: The Chemical Society, at the Cosmos Club, at 8 p. m.

Thursday, April 25: The Society of American Foresters. Program:

J. G. PETERS, AUSTIN CARY, and W. R. MATTOON: *Southern forestry problems.*

Saturday, April 27: The Philosophical Society, at the Cosmos Club, at 8 p. m.

Thursday, May 2: The Entomological Society.

Saturday, May 4: The Biological Survey, at 8 p. m., the place to be announced later.

Tuesday, May 7: The Botanical Society, at 8 p. m., the place to be announced later.

Monday and Tuesday, April 22 and 23: The National Academy of Sciences, at the Smithsonian Institution. A cordial invitation is extended by the President of the National Academy of Sciences to the members of the Washington Academy of Sciences to attend the scientific sessions and the public lectures.

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Tuesday, May 7: The Botanical Society, at 8 p. m.

Thursday, May 9: The Washington Academy of Sciences, at the George Washington Medical School, at 8.15 p. m. Program to be announced later.

Thursday, May 9: The Chemical Society. The regular meeting has been replaced by the joint meeting with the Washington Academy, May 15.

Saturday, May 11: The Philosophical Society, at the Cosmos Club, at 8.15 p. m. Program:

A. Q. Tool, Bureau of Standards: *The constitution of the gas ion.* (Illustrated).

L. A. Bauer, Department of Terrestrial Magnetism: *Corresponding changes in the earth's magnetic state and in solar activity, 1888–1916.* (Illustrated).

Wednesday, May 15: The Washington Academy of Sciences and the Chemical Society, joint meeting at the Interior Department, 18th and F Streets, at 8.15 p. m. Program:

Arthur A. Noyes, Massachusetts Institute of Technology: *The determination of crystal structure by x-rays.*

Saturday, May 18: The Biological Society, at the Meeting House, Friends' School, 1809 I Street, at 8 p. m. Program:

Dr. J. C. Merriam, Professor of Paleontology, University of California: *Cave hunting in California.*

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Saturday, May 25: The Philosophical Society.

Thursday, June 6: The Entomological Society.

[1] The programs of the meetings of the affiliated Societies will appear on this page if sent to the editors by the thirteenth and twenty-seventh of each month.

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No. 19

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Saturday, November 23: The Philosophical Society, at the Administration Building, Carnegie Institution of Washington, 16th and P Streets, at 8.15 p.m. Program:

W. F. Meggers: *Photography of the red and infra-red solar spectrum.* Illustrated. 30 minutes.

A. J. Henry. *The hot spell of August, 1918.* 20 minutes.

Saturday, December 7: The Philosophical Society, at the Administration Building, Carnegie Institution, at 8.15 p.m. Forty-eighth annual meeting, for the election of officers.

[1] The programs of the meetings of the affiliated societies will appear on this page if sent to the editors by the first and fifteenth days of each month.

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REPRINT OF LECTURES ON SCIENCE IN RELATION TO THE WAR

A series of public lectures dealing with the scientific and engineering aspects of the war was given under the auspices of the Washington Academy of Sciences during the winter and spring of 1918. The lectures as published in the JOURNAL are as follows:

Major S. J. M. AULD, of the British Military Mission: *Methods of gas warfare.*

Col. C. F. LEE, of the British Aviation Mission: *Aviation.*

Maj. Gen. JOHN HEADLAM, C.B., D.S.O., of the British Artillery Mission: *The development of artillery during the war.*

Lieut. Col. X. REILLE, Chief of Artillery in the French Advisory Mission: *The problem of anti-aircraft firing.*

Dr. RAYMOND PEARL, of the U. S. Food Administration: *Biology and war.*

Prof. ARTHUR A. NOYES, of the Massachusetts Institute of Technology: *The nitrogen problem in relation to the war.*

The ACADEMY has reprinted in collected form a limited edition of these lectures. Copies of the brochure, substantially bound in flexible cloth covers, may be purchased of the Treasurer, Mr. R. L. Faris, Coast and Geodetic Survey, Washington, D. C., at seventy-five cents each (postage included).

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