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MINERALOGY.—*Hausmannite in the Batesville district, Arkansas.*[1] H. D. MISER and J. G. FAIRCHILD, U. S. Geological Survey.

During the investigation of the manganese deposits of the Batesville district by the senior author, beginning in 1918, particular attention was given to a manganese mineral that has been previously classed as braunite. The mineral forms a large part of the marketed manganese ore and, being entirely free or almost free of chemically combined silica, differs in this respect from the typical braunite that is found in this district, as well as at practically all, if not all, other known localities. The two accompanying analyses by the junior author, taken in connection with the physical and optical properties of the mineral under discussion, indicate that it is hausmannite. Since only one other authentic occurrence[2] of hausmannite in the United States has been reported and since it is, as stated above, one of the important ore-forming minerals of the Batesville district, this paper regarding it has been prepared.

The manganese ores of the Batesville district consist of oxides, of which psilomelane, hausmannite, braunite, manganite, pyrolu-

[1] Published by permission of the Director of the United States Geological Survey.

[2] E. S. LARSEN reports an occurrence from Plumas County, Cal. The optical properties of the hausmannite from that locality are given on page 6. Dana, in listing the occurrences of hausmannite in the *System of mineralogy*, 6th Edition, says, "Also reported from Lebanon, Pa. (but very doubtful, Genth)."

site, and wad have been identified. They generally occur in rough irregular-shaped masses from less than one pound to 22 tons in weight. Most of the masses are in clay; the others are in limestone, shale, chert, and sandstone, and there is much evidence that the manganese oxides of which the masses are composed have replaced all of these inclosing materials. The oxides have been derived from manganese-bearing carbonates near the surface and have been deposited by cold waters of meteoric origin. They do not extend below the permanent water level of the district. The workable deposits occur in the nearly horizontal Fernvale limestone and Cason shale of Ordovician age and in residual clays which were mainly derived from these two formations. Most of the masses in the clays are residual, having been freed from the above-named formations by their decomposition; the others have been formed by the replacement of the clays by manganese oxides.

The hausmannite is present at a large percentage of the nearly 200 mines and prospects in the district. It occurs partly in the Fernvale limestone as a replacement material but mostly in clay as residual masses that have been set free by the decomposition of the limestone. It has not been found in deposits that have been formed by the replacement of the Cason shale and residual clays. This apparently means that there was a smaller supply of available oxygen for the formation of manganese oxides in the limestone than in the shale and clays, because hausmannite contains a smaller percentage of oxygen than the other manganese oxides that are present in the district.

Hausmannite, if chemically pure, would contain 72 per cent of manganese which is greater than that found in the other important ore-forming minerals which are psilomelane and braunite; but on account of the presence of psilomelane and other impurities perhaps no sample containing the theoretical percentage can be obtained, though the percentage of manganese in a sample from the W. T. Gray mine of which an analysis is given on page 4 is 70.76. The presence of hausmannite in the high-grade ores accounts for the fact that many carload shipments of such ore have contained between 55 and 60 per cent of manganese. These are unusually high percentages for such shipments.

Although several oxides of manganese are present in the Batesville district, psilomelane is apparently the only one with which the hausmannite is intimately mixed. Much of the hausmannite is disseminated as large and small grains through compact psilomelane and specimens are common that show a gradation from psilomelane with a few grains of hausmannite scattered through it to a coarsely granular hausmannite with only a small quantity of psilomelane in it. Of all the specimens of hausmannite studied by the senior author both in the field and in the laboratory not one was seen that is entirely free from psilomelane.

The hausmannite is a brittle, steel-gray mineral with a chestnut-brown or reddish brown streak and submetallic luster. It is finely to coarsely granular but partly crystalline, is translucent on thin edges, has an uneven fracture, a perfect basal cleavage, and a hardness of about 5.5, and is weakly magnetic, some of the finely powdered mineral being picked up by a magnet. The magnetic property might be thought to be due to the presence of iron but this can not be so because one of the samples of which analyses are given in table 1 contained no iron, and the other contained only a trace of iron. The specific gravity of the two samples that have just been mentioned was determined by the junior author to be 4.836 for one and 4.778 for the other, respectively. The crystals are small and line cavities in the massive mineral. They resemble octahedra; none have been found that could be measured. The physical properties of the mineral as given above agree with those given by Dana[3] and Fermor,[4] though these writers do not mention hausmannite as being magnetic.

The analyses in table 1 represent the composition of two samples of hausmannite from two localities, 8 miles apart. Sample No. 1 was from the W. T. Gray mine, $4^1/_2$ miles north-northwest of the village of Pfeiffer on a spur of the Missouri Pacific Rail-

[3] *System of mineralogy*, 6th Edition, 1892.

[4] L. L. FERMOR. *The manganese-ore deposits of India*. Memoirs Geol. Survey India, 37: pt. 1, 229. 1909.

road, and Sample No. 2 was from the Club House mine, one-half mile north of the town of Cushman on another spur of the same railroad. The specimens from which the samples were prepared

TABLE I

ANALYSES OF HAUSMANNITE FROM THE BATESVILLE DISTRICT

	No. 1	No. 2
Manganese protoxide (MnO)	91.38	90.40
Oxygen (O)	7.78	8.87
Iron oxide (Fe_2O_3)	None	0.48[a]
Alumina (Al_2O_3)	None	
Silica (SiO_2)	None	0.10
Lime (CaO)	Trace	Trace
Magnesia (MgO)	Trace	Trace
Baryta (BaO)	0.26	None
Total water (H_2O)	0.62	1.03
Summation	100.04	100.88
Manganese (Mn)	70.76	70.00
Specific gravity at 15.5° C.	4.836	4.778

No. 1. Sample from W. T. Gray mine.
No. 2. Sample from Club House mine.

[a] Includes a trace of iron.

for the analyses contain a small quantity of psilomelane and for this reason the samples were carefully selected, using a pocket lens, so as to free the hausmannite as far as possible from the psilomelane. Polished surfaces of these specimens, however, show the presence of psilomelane as fine, disseminated particles and as crack-filling material too minute to be observed by a pocket lens on a rough fractured surface. Some psilomelane was therefore present in the samples and the polished surfaces indicate that there was more of it in Sample No. 2 than in Sample No. 1.

There are several varieties of psilomelane, which may be considered to be a manganese manganate, Mn_2MnO_5, otherwise expressed as $2MnO_2.MnO$. In the fundamental formula, the "Mn_2" may be replaced by such equivalent groups as Ba_2, Ca_2, K_4, H_4, etc. The ratio of MnO to available oxygen, which is here called the "oxygen ratio," is, according to the above formula, 3 to 2, or expressed more simply, 1.5. The composition shows 13.1 per cent available oxygen. The oxygen ratio for hausmannite (Mn_3O_4) is 3, its composition showing 7.0 per cent available oxygen. By referring to a few published analyses of psilomelane, the average ratio for the analyses cited in table 2 is seen to approach fairly close to the above ratio (1.5).

TABLE 2

OXYGEN RATIOS OF PSILOMELANE AS SHOWN BY PUBLISHED ANALYSES

No.	Locality	Analyst	Oxygen ratio
1	Ilmenau, Germany	Clausbruch	1.18
2	Silver Cliff, Colorado	W. F. Hillebrand	1.28
3	Romanèche, France	A. Gorgeu	1.34
4	Schneeberg, Germany	Clausbruch	1.36
5	Bálághát, India	....	1.37
6	Kájlidongri, India	....	1.54
7	Batesville, Arkansas	Wm. Elderhorst	1.83
	Average		1.41

1. R. A. F. PENROSE, JR. *Manganese—its uses, ores and deposits.* Arkansas Geol. Survey, Ann. Rept. 1890, 1: 146. 1891.

2. F. W. CLARKE. *Data of geochemistry.* U. S. Geol. Survey Bull. 616: 534. 1916.

3. Idem, 534.

4. R. A. F. PENROSE, JR., op. cit., p. 146.

5. DANA, *System of mineralogy*, third appendix, p. 39, 1915. Sample of Hollandite.

6. Idem. Sample of Hollandite.

7. R. A. F. PENROSE, JR., op. cit., p. 147.

The analyses of the samples of the mineral in question from the Batesville district show the following calculated compositions:

	Psilomelane (Mn_2MnO_5)	Hausmannite (Mn_3O_4)	Oxygen ratio
Sample No. 1	13 per cent	87 per cent	2.65
Sample No. 2	31 per cent	69 per cent	2.30

The analyses show that silica was absent in No. 1 and that there was only 0.1 per cent of it in No. 2. These analyses have been confirmed by testing for gelatinous silica 12 other samples from 9 different localities. No silica was found in most of them and hardly more than a trace was found in the others. On the other hand, similar tests were made on 5 samples of braunite from as many different localities in the Batesville district, and they all yielded fairly large quantities of gelatinous silica. The test for gelatinous silica is, in fact, the easiest method for distinguishing hausmannite from braunite, though their streaks can be used to advantage, hausmannite having a chestnut-brown streak and braunite a dark brownish black streak.

The optical properties of a specimen of the mineral under discussion were studied by E. S. Larsen and he concluded that it is hausmannite. In fact, he expressed this opinion before the present writers arrived at their conclusion regarding the identification of the mineral and also before the two accompanying analyses (Nos. 1 and 2) were made. He has kindly furnished the following statement giving the optical properties of the specimen from the Batesville district and for comparison has given unpublished data for a specimen from Plumas County, California:

"Hausmannite from Batesville district, Arkansas; reddish brown in section and non-pleochroic. Uniaxial—; $\omega_{Li} = 2.45 \pm 0.02$; $\epsilon_{Li} = 2.15 \pm 0.02$.

"Hausmannite from Plumas County, California; reddish brown in section and non-pleochroic. Uniaxial—; tend to lie on a cleavage normal to the optic axis; $\omega_{Li} = 2.46$; $\epsilon_{Li} = 2.15$."

Penrose[5] gives an analysis of a sample of a mineral from the Batesville district whose description accords rather closely with that of hausmannite, but the composition of the sample whose analysis he gives corresponds to the formula Mn_2O_3. He therefore considered the mineral to be a silica-free braunite and this opinion has been followed by other geologists who have worked in the district, though no further analyses were made until the present investigation was undertaken. For reasons given below the writers believe that the sample for Penrose's analysis consisted mainly of hausmannite but contained admixed psilomelane. His description of the mineral and the analysis follow:

"*Braunite.*—Specimen from the Sullivan Creek fork of Polk Bayou, 10 miles north of Batesville, Independence County. This is a dark iron-gray or black mineral, forming a coarsely crystalline aggregate with a marked cleavage, the crystallographic position of the cleavage being uncertain; lustre submetallic; streak dark chocolate-brown; hardness 5 to 5.5. Its specific gravity, as determined by the chemist of the Survey, is 4.50.

[5] R. A. F. PENROSE, JR., op. cit., pp. 148–149.

"With fluxes it gives manganese reactions; it dissolves in hydrochloric acid with the evolution of chlorine.

"The following analysis was made mostly by Dr. R. N. Brackett and partly by Prof. W. A. Noyes. It shows the composition of the mineral dried at 110°–115° Centigrade.

"ANALYSIS OF BRAUNITE FROM THE BATESVILLE REGION

	Per cent	Ratio	
Manganese protoxide (MnO)	87.47	1.232	2.05
Oxygen (O)	9.62	0.601	1.00
Ferric oxide (Fe_2O_3)	0.44		
Alumina (Al_2O_3)	0.11		
Lime (CaO)	0.34		
Baryta (BaO)	0.48		
Magnesia (MgO)	Trace		
Potash (K_2O)	0.10		
Soda (Na_2O)	0.05		
Phosphoric acid (P_2O_5)	0.25		
Silica (SiO_2)	0.18		
	99.04		

"It will be observed that the ratio of MnO to O is almost exactly as 2 : 1, which is the theoretical ratio of manganese sesquioxide (Mn_2O_3). It will also be noticed that the analysis shows less than 2 per cent of ingredients other than MnO and O, and the mineral is therefore a very pure Mn_2O_3. Though the mineral occurs as a compact crystalline aggregate and not as isolated crystals, it seems, judging from its general appearance and its physical characteristics, to be homogeneous. In some other specimens of a similar material there were found some very small crystals, apparently tetragonal pyramids, suggesting, from their general form, that they might be braunite. Hausmannite crystallizes in the same system, but the above analysis does not show any close relation to the composition of that mineral. The analysis shows a mineral resembling in all respects a braunite without silica, and the physical features of the specimen, as far as they can be distinguished, are also those of braunite."

Fermor,[6] in his report on the manganese-ore deposits of India, says that only two published analyses, that have not been checked by further analyses, show braunite to correspond to the formula Mn_2O_3. One of these is the above analysis given by Penrose and the other is an analysis by Bechi of a specimen from the island of Elba.[7] Fermor continues, "But it is to be noticed that another analysis of Arkansas braunite [from the Batesville district] shows 9.97 per cent of SiO_2, the analysis being by W.

[6] L. L. FERMOR. *The manganese-ore deposits of India.* Memoirs Geol. Survey India. 37: pt. 1, 64. 1909.

[7] MENEGHINI, *Mineralogical notices.* Amer. Journ. Sci. [2] 14: 62. 1852.

Elderhorst.[8] Nevertheless, it seems necessary to recognize the possible existence in nature of a mineral with a composition corresponding to the formula Mn_2O_3; it must be extremely rare."

Although a mineral with a composition corresponding to the formula Mn_2O_3 may, as pointed out by Fermor, be present in the Batesville district, its occurrence there is not believed by the writers to be probable, in view of the facts and conclusions brought out during the present investigation. Penrose, in a footnote[9] regarding the sample for his analysis, says, "The original specimen contained inclusions of a massive or semi-crystalline oxide of manganese, but the sample analyzed was carefully separated from this and was composed only of the coarsely crystalline parts." As he describes[10] psilomelane as being a massive mineral, and as psilomelane appears to be the only mineral that is intimately associated with hausmannite, the "massive or semi-crystalline oxide of manganese" in the sample for his analysis may have been psilomelane. The samples for our two accompanying analyses (Nos. 1 and 2) consisted entirely of the coarsely granular parts of the specimens so far as could be determined by means of a pocket lens, but as previously stated polished surfaces of the specimens show that it is not possible to discard all of the psilomelane by this method. A mixture containing about 60 per cent of hausmannite and 40 per cent of psilomelane (corresponding to the formula $2MnO_2.MnO$) would on analysis be found to contain manganese protoxide (MnO) and oxygen (O) in the ratio of 2 to 1, which is the ratio calculated from the analysis given by Penrose. As specimens are common showing a gradation from psilomelane with only a small amount of hausmannite in it to coarsely granular hausmannite with a very small percentage of psilomelane, a sample containing the above-mentioned percentages of these minerals could be obtained, but such a sample, it must be admitted, could be obtained only by accident.

[8] D. D. OWEN. *First report of a geological reconnaissance of the northern counties of Arkansas*, 164–165. 1858; R. A. F. PENROSE, JR., op. cit., pp. 149–150.

[9] R. A. F. PENROSE, JR., op. cit., p. 148.

[10] Idem, 145.

BOTANY.—*A preliminary revision of the North American and West Indian avocados* (Persea *spp.*). S. F. BLAKE, Bureau of Plant Industry.

For several years Wilson Popenoe, of the Office of Seed and Plant Introduction, has been engaged in the collection of the various forms of the avocado, or "alligator pear," which are found in Mexico and Central America. Many new and valuable forms have been introduced into the gardens maintained by the Office, whence they are being distributed among horticulturists, and a considerable amount of herbarium material has been accumulated. This material, which has recently been put into my hands for study, is sufficient, in connection with that already in the U. S. National Herbarium, to permit a fairly satisfactory preliminary treatment of the forms of the avocado which occur in Mexico, Central America, and the West Indies. Mr. Popenoe is about to extend the field of his investigations by a two years' trip in Central and South America, in which it is hoped material will be secured to settle the status of one or two South American forms, at present too poorly represented in our herbaria to be disposed of definitely. In the meantime it is desirable to put on record the information already obtained as to the relationship of the forms north of the Isthmus.

The latest systematic treatment of *Persea americana* and its relatives is that of Mez (1889),[1] in his monograph of the American Lauraceae. Mez recognizes, in the small group made up of the avocados, two species, *Persea gratissima* Gaertn. f. (*Laurus persea* L.) and *P. floccosa* Mez. Of *P. gratissima* two varieties are recognized in addition to the type, *P. gratissima schiedeana* (Nees) Meissn. and *P. g. drymifolia* (Schlecht. & Cham.) Mez. In a later publication Mez[2] has recognized the priority of the name *Persea americana* Mill. (1768) over *P. gratissima* Gaertn. f. (1807), the name by which the common avocado has generally been known in literature.

Mr. Popenoe,[3] as a result of his extensive field acquaintance

[1] Jahrb. Bot. Gart. Berlin 5: 145–148. 1889.

[2] Arb. Bot. Gard. Breslau 1: 113. 1892.

[3] In BAILEY, *Stand. Cycl. Hort.* 5: 2556. 1916.

with the avocado, has recognized three chief forms on the basis of leaf and fruit differences. These he separates by the following key:

A. Leaves anise-scented: skin of fruit thin and soft. 1. *Mexican type.*

AA. Leaves not anise-scented: skin of fruit thick.

B. Surface of fr. usually smooth: skin leathery, usually not more than $^1/_{16}$ in. thick; seed coats frequently distinct, the outer one adhering to wall of seed cavity; cotyledons often rough............................2. *West Indian type.*

BB. Surface of fr. usually rough or warty: skin brittle, granular, $^1/_{16}$–$^3/_{16}$ in. thick; seed coats adhering closely to the nearly smooth cotyledons..................3. *Guatemalan type.*

Mr. Popenoe, moreover, has become convinced that his "Mexican type" represents a distinct species, *Persea drymifolia*, Schlecht. & Cham., and that *Persea schiedeana* Nees is a distinct species. Both of these forms were treated by Mez as varieties of *P. americana.*

In the study of the extensive material which has now been brought together it became clear at once that Mez had erred in reducing *P. schiedeana* to varietal rank, since it possesses definite specific characters, not only in the pubescence of its leaves and its long pedicels, but also in the technical features of its floral parts, which were entirely passed over by Mez. *P. drymifolia* is a more doubtful form, not always distinguishable with certainty in herbarium material, and I prefer, at least for the present, to treat it as a variety of *P. americana.* The novel fact appears, moreover, that the most commonly cultivated avocado of Florida, known as the Trapp, represents a technically very distinct and undescribed species, characterized by its sparsely pubescent perianth and absolutely glabrous pistil and staminodes. Another new species of the avocado group, characterized by its glabrous ovary, narrow panicle, and sessile staminal glands, has been collected by Purpus in Oaxaca and is here described as *P. cinerascens.*

While the relationships of the North American forms can be considered as now established with a fair degree of definiteness, this cannot be said of the South American types. In addition to typical *P. americana* and its variety *drymifolia,* at least two other forms occur in South America which, through lack of sufficient material, cannot be definitely placed. One is the plant described as *P. gratissima* var. *melanocarpa* by Philippi,[4] a single specimen of which is in the National Herbarium. It is peculiar in its comparatively large bracts and subsimple panicles shorter than the peduncles. The other, collected by Mr. Pittier near Caracas (no. 5913), has a glabrous ovary, pubescent style, and unusually long stipes to the glands of the third series of stamens. Both these forms are best left in abeyance until further material becomes available.

The avocados[5] occurring in North America and the West Indies may be distinguished by the following key:

Perianth densely griseous-puberulous on both sides; staminodes pubescent.
- Ovary pubescent; staminal glands stipitate.
  - Pedicels 1 to 6 mm. long; staminode with triangular head, much broader than its stipe.
    - Branchlets glabrous to pilosulous, leaves glabrous to pilosulous beneath; filaments 2 to 3 times as long as the anthers; head of staminode much shorter than the stipe.
      - Leaves not anise-scented; perianth deciduous. . 1. *P. americana.*
      - Leaves anise-(or sassafras-)scented; perianth usually persistent. . . . . 1*a*. *P. americana drymifolia.*
    - Branchlets fulvous-villous; leaves floccose-tomentose beneath; filaments only one-third longer than the anthers; head of staminode about equaling or exceeding the stipe. . . . . 2. *P. floccosa.*
  - Pedicels 8 to 15 mm. long; stipe of staminode twice to thrice as long and essentially as broad as the elliptic head; branchlets densely ferruginous-tomentose. . . . . .3. *P. schiedeana.*
- Ovary glabrous; staminal glands sessile. . . . . .4. *P. cinerascens.*

Perianth sparsely pilosulous outside, essentially glabrous within; pistil and staminodes glabrous. . . . . .5. *P. leiogyna.*

[4] Anal. Univ. Chil. 91: 501. 1895.

[5] The avocados form a small group of the subgenus *Eupersea* Mez, characterized by their comparatively large flowers (usually 6 to 8 mm. long) with equal or only slightly unequal perianth segments. Of the species here considered, the most important commercially are *P. americana*, *P. americana drymifolia*, and *P. leiogyna*. *P. schiedeana* also has a large and well-flavored fruit, but is of little importance at present outside of its native habitat. *P. cinerascens*, and presumably *P. floccosa*, bear fruits too small to be of any value.

1. **Persea americana** Mill. Gard. Dict. ed. VIII. 1768. COMMON AVOCADO.
Laurus persea L. Sp. Pl. **1**: 370. 1753.
Persea gratissima Gaertn. f. Fruct. **3**: 222. pl. 221. 1807.
Persea gratissima vulgaris Meissn.; DC. Prodr. **15**^{1}: 53. 1864.
Persea gratissima oblonga Meissn.; DC. Prodr. **15**^{1}: 53. 1864.
Persea gratissima macrophylla Meissn.; DC. Prodr. **15**^{1}: 53. 1864.
Persea persea Cockerell, Bull. Torrey Club **19**: 95. 1892.

Tree, up to 20 meters high; branchlets glabrous to finely puberulous or pilosulous, more or less glaucous; leaf blades 9 to 30 cm. long, 3.5 to 20 cm. wide, oval varying to elliptic or obovate-oval, rarely ovate or suborbicular, short-pointed, acute, or acuminate, sometimes obtuse, at base unequal, broadly rounded to cuneate, papyraceous to pergamentaceous, feather-veined (lateral veins 5 to 7 pairs) and finely prominulous-reticulate beneath, above deep green, glabrous or sparsely pubescent along costa, beneath glaucescent, glabrous or pilosulous with more or less spreading hairs along costa and primary veins, rarely over whole surface; petioles glabrous or puberulous, 2 to 6.5 cm. long; panicles densely griseous-puberulous, several or many toward ends of branches, 6 to 22 cm. long (including the 2.5 to 9 cm. long peduncle); pedicels 3 to 6 mm. long; perianth (5) 5.5 to 7 mm. long, densely griseous-tomentulose both sides; segments elliptic or lance-elliptic to oval-ovate, obtuse, the outer 1 to 1.5 mm. shorter than the inner; stamens of series I 4.5 to 5.5 mm. long, the slender filaments densely pilose, 3 to 3.8 mm. long; of series II similar, 4 mm. long; of series III similar, 4.5 to 5.4 mm. long, the filaments (3.2 to 4 mm. long) bearing 0.5 to 0.8 mm. above base two rotund obtuse or rounded glands on pilose stipes of about the same length; staminodes 1.8 to 2.8 mm. long, the densely pilose stipe 1 to 1.8 mm. long, the head triangular, acute, usually apiculate, truncate or sagittate-cordate at base, 0.3 to 1.2 mm. long; ovary densely pilose, style pilose, about twice as long as ovary.

TYPE LOCALITY: West Indies.

SPECIMENS EXAMINED:

VERA CRUZ: San Pablo near Rio Nautla, June, 1841, *Liebmann* 13. Colipa, March, 1841, *Liebmann* 86. Orizaba, June, 1918, *Popenoe* 826 (S. P. I.).

PUEBLA: Atlixco, Dec., 1918, *Popenoe* 864 (S. P. I.).

OAXACA: Cafetal Concordia, near Pochutla, May, 1919, *Popenoe* 825 (S. P. I.).

CHIAPAS: Tapachula, Nov., 1918, *Popenoe* 819, 821 (S. P. I.). Zacualpa, July, 1918, *Popenoe* 828 (S. P. I.).

YUCATAN: Izamal, 1895, *Gaumer*, 402.

GUATEMALA: Near Finca Sepacuité, Alta Verapaz, 1902, *Cook & Griggs* 20, 322, 564. Guatemala City, Feb., 1917, *Popenoe* 758 (S. P. I.). Antigua or vicinity, Feb., 1917, *Popenoe* 765, 766, 767, 769, 771 (S. P. I.). Los Verdes, Dept. Amatitlan, Nov., 1893, *Heyde & Lux* 6229. Pacaya, March, 1890, *J. D. Smith* 1941.

EL SALVADOR: Without definite locality, 1905, *Renson* 219.

COSTA RICA: San Francisco, March, 1897, *Tonduz* 10999. Port

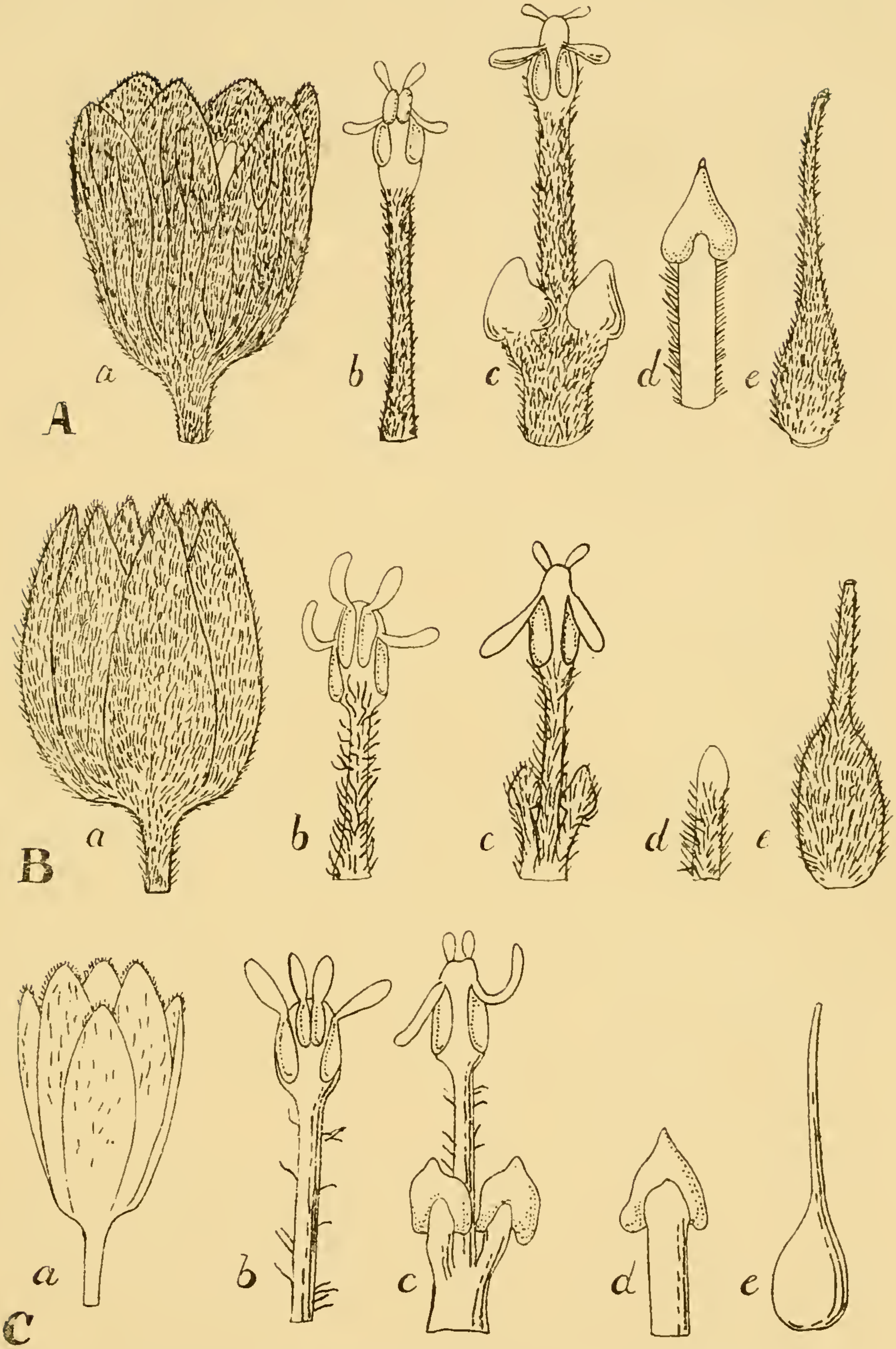

Fig. 1.—A, *Persea americana* Mill. B, *P. schiedeana* Nees (drawn from Purpus 7074). C, *P. leiogyna* Blake (drawn from Popenoe 219). *a*, perianth, × 5; *b*, stamen of series I, × 10; *c*, stamen of series III, viewed from dorsal side, × 10; *d*, staminode, × 10; *e*, ovary, × 10

Limon, May, 1903, *Cook & Doyle* 476. San José, April, 1903, *Cook & Doyle* 2.

PANAMA: Around Culebra, Jan., 1911, *Pittier* 2144.

BAHAMA ISLANDS: Nassau, New Providence, 1903, *Curtiss* 116.

CUBA: Santiago de las Vegas, 1905, *Abasco* 4556.

SANTO DOMINGO: Without definite locality, 1871, *Wright, Parry*, and *Brummel*.

PORTO RICO: Cabo-Rojo, 1885, *Sintenis* 759, 759*b*. Ponce, 1903, *Prey* 69. Caguas, 1899, *Heller* 931.

ST. THOMAS: 1881, *Eggers*.

ST. CROIX: Big Princess, 1896, *Ricksecker* 305.

MARTINIQUE: 1871, *Hahn* 350. Without date, *Duss* 1948.

GRENADA: Belmont, St. Georges, 1905, *Broadway*.

COLOMBIA: Vicinity of Santa Marta, 1898–1901, *Herbert H. Smith* 1760.

BOLIVIA: Cochabamba, 1891, *Bang* 1162.

BRAZIL: Botanic Garden, Pará, 1908, *Baker* 59.

PHILIPPINE ISLANDS: Cultivated, Manila, Luzon, 1919, *Merrill* 6347.

This is the first known of the avocados, and is by far the commonest and most widely cultivated in the American tropics and in the tropics of the Old World. It is undoubtedly a native of tropical America, but specimens which were certainly indigenous where found are nearly or quite unknown.

Of the three races distinguished by Mr. Popenoe, whose key has already been cited, the first or "Mexican type" is here separated as *P. americana drymifolia*. The other two races, called by Mr. Popenoe the West Indian and the Guatemalan, respectively, do not appear to show distinctive characters of botanical importance, however significant their differences in fruit and fruiting season may be from the horticultural point of view. At any rate, I have failed to find any differences whatever in the abundant herbarium material examined, and am consequently compelled to treat the West Indian and Central American forms as a single species.

Specimens collected by Merrill in Manila, where the plant has recently been introduced, show an interesting abnormality in the floral structure, one or two of the staminodes being antheriferous in addition to the normal fertile stamens. They are about 4 mm. long, with the hairy filaments about 3 mm. long, bearing laterally near the middle one or two sessile adnate glands; the anthers are 4-celled, with the two lower cells laterally dehiscent, the upper cells introrse. This occasional conversion of the staminodes into stamens was long ago noted by Meissner.[6]

[6] DC. Prodr. 15^1: 53. 1864.

1a. **Persea americana drymifolia** (Schlecht. & Cham.) Blake. MEXICAN AVOCADO.

Persea drymifolia Schlecht. & Cham. Linnaea **6**: 365. 1831.

Persea gratissima drymifolia Mez, Jahrb. Bot. Gart. Berlin **5**: 147. 1889.

Leaves anise- or sassafras-scented when crushed, usually smaller than in *P. americana*, elliptic, and acute or acuminate at each end, but sometimes as broadly oval as in *P. americana*, and showing the same variation in pubescence; perianth equaling that of the larger-flowered examples of *P. americana*, its segments usually persistent in young fruit or even to maturity; fruit thin-skinned.

TYPE LOCALITY: Papantla, Vera Cruz, Mexico.

SPECIMENS EXAMINED:

NUEVO LEON: Monterey, March, 1891, *Dodge* 150.

SINALOA: Above Colomas, July, 1897, *Rose* 1813.

SAN LUIS POTOSI: Without definite locality, 1879, *Schaffner* (Vigener No. 572).

TEPIC: Between Aguacate and Dolores, 1897, *Rose* 2013.

VERA CRUZ: Fortin, 1883, *Kerber* 306. Patio of Hotel Colon, Puerto Mexico, July, 1918, *Popenoe* 827 (S. P. I.). San Andres Tuxtla, 1918, *Popenoe* 824 (S. P. I.).

STATE OF MEXICO: Coyoacan, Federal District, Jan., 1919, *Popenoe* 854, 855, 856 (S. P. I.).

PUEBLA: Cultivated, Orizaba, 1857, *Mohr*. Atlixco, Dec., 1918, *Popenoe* 857, 859, 860, 861, 862, 863 (S. P. I.).

GUATEMALA: Roadside below Santa Maria de Jesus, Zacatepequez, Oct., 1916, *Popenoe* 675 (S. P. I.), Feb., 1917, *Popenoe* 770 (S. P. I.).

ECUADOR: Quito, 1918, *Rose & Rose* 23556. Cultivated, Ambato, 1918, *Rose & Rose* 22338.

This, the common Mexican race of avocado, is a form of doubtful rank. In its commonly persistent or subpersistent perianth it departs not only from its close relative *P. americana* but from the character ordinarily given for the genus. This feature is not universal, however, and the form in the absence of fruit can be distinguished only by its anise-scented leaves. I can find no differences whatever in floral structure, and therefore rank it for the present as a variety of *P. americana*. Mr. Popenoe, however, who is familiar with the plant in the field, is of the opinion that it represents a distinct species. Its Mexican name is given in the original description as "aguacate oloroso."

2. **Persea floccosa** Mez, Jahrb. Bot. Gart. Berlin **5**: 148. 1889.

Tree with fulvous-villous, glabrate branchlets; leaf blades 11 to 17 cm. long, 4.8 to 7.5 cm. wide, ovate, acuminate, at base obtuse or somewhat acutish, densely ferruginous-lanate on both sides when young, in age above subglabrate, densely foveolate-punctate, beneath glaucescent, floccose-tomentose, loosely prominent-reticulate; petioles up

to 4.5 cm. long; panicles pyramidate, shorter than the leaves, ochraceo-villous; pedicels 1 to 3 mm. long; perianth villous, 5 mm. long, the segments equal, narrowly ovate, acute; filaments $^1/_3$ longer than the anthers, densely long-pilose, those of series III bearing at base two large sub-globose acute glands; staminodes foliaceous-triangular, not barbellate at apex, the head slightly longer than the densely long-pilose stipe; ovary densely pilose, ellipsoid, about equal to style; fruit unknown.
TYPE LOCALITY: Chinantla, Puebla, Mexico.

This species, based on *Liebmann* 85, does not seem to have been collected again. It is said to bear the name "aguacate cimaron." No material has been seen by the writer, and the above description is translated from Mez's original.

3. **Persea schiedeana** Nees, Syst. Laur. 130. 1836. COYÓ.
Persea gratissima schiedeana Meissn.; DC. Prodr. **15**[1]: 53. 1864.
Persea pittieri Mez, Bot. Jahrb. **30**: Beibl. 67: 15. 1901.

Tree 15 to 20 meters high, rarely to 50 meters; branchlets stout, densely ferruginous-tomentose, glabrescent; leaf blades 12.5 to 30 cm. long, 7 to 15 cm. wide, obovate or elliptic-obovate to oval-obovate or sometimes oval, at apex abruptly short-pointed, obtuse, broadly rounded, or even subtruncate, at base broadly rounded, cuneate-rounded, or subcordate, feather-veined (lateral veins 11 to 13 pairs) and rather loosely prominulous-reticulate beneath, above deep green, in youth densely ferruginous-tomentose, in age glabrate or merely tomentose along costa and sometimes along chief veins, beneath glaucous, along veins and veinlets or over whole surface densely pilosulous with loose spreading sordid-griseous hairs; petioles stout, densely sordid or ferruginous-tomentose, at length glabrescent, 1.5 to 4.5 cm. long; panicles densely griseous-tomentulose, nearly equaling the unfolding leaves, 10 to 12 cm. long (including the 4.5 to 6.5 cm. long peduncle); pedicels 8 to 15 mm. long; perianth 6 to 8 mm. long, densely griseous-tomentulose both sides; tube obsolete; segments subequal, lance-elliptic, gradually narrowed to an acutish tip, 2.5 to 2.8 mm. wide; stamens of series I 3.2 to 3.5 mm. long, the rather slender densely pilose filaments 2 to 2.2 mm. long, the anther 1.3 mm. long; of series II similar, 4 mm. long, those of series III similar, 3.6 mm. long, the densely pilose filaments bearing essentially at the base two ovate obtuse pilose glands on pilose stipes of about the same length to twice as long; staminodes 1.3 to 1.9 mm. long, pilose, the stipes subulate, twice to thrice as long and essentially as broad as the elliptic obtuse head; ovary densely pilose, twice as large as in *P. americana;* style pilose, two-thirds as long as the ovary.
TYPE LOCALITY: Misantla, Vera Cruz, Mexico.
SPECIMENS EXAMINED:
MEXICO: Zacuapan, Vera Cruz, March, 1914, *Purpus* 7074. Tree in forest, probably indigenous, Dos Ríos, near Santa Lucrecia, Vera

Cruz, April, 1918, *Popenoe* 830 (S. P. I.). Cultivated, San Anrdes Tuxtla, Vera Cruz, April, 1918, *Popenoe* 829 (S. P. I.).

GUATEMALA: San Augustín, Nov., 1916, *Popenoe* 741 (S. P. I.). Near Finca Sepacuité, Alta Verapaz, March, 1902, *Cook & Griggs* 21. Sepacuité, May, 1914, *Cook & Doyle* 43. Near Finca Sepacuité, Nov., 1916, *Popenoe* 745 (S. P. I.). Common wild and cultivated, Tactic, Alta Verapaz, March, 1917, *Popenoe* 772, 775 (S. P. I.). Rare, north bank of Motagua, above El Rancho, Nov., 1916, *Popenoe* 739 (S. P. I.).

COSTA RICA: Without definite locality, 1905, *Wercklé*.

PANAMA: Foot of El Salto Ravine, El Boquete, Chiriqui, altitude 1000 to 1300 meters, March, 1911, *Pittier* 3132.

This species, incorrectly treated as a variety of *P. americana* (*P. gratissima*) by Mez, is readily distinguished by its densely ferruginous-tomentose branchlets, long pedicels, equal perianth-segments, narrow staminode tips, and short style.

Mr. Popenoe, in the manuscript notes which he has courteously placed at my disposal, has noted the following names for this species: coyó and coyocté (at Senahu, Sepacuité, Guatemala), kiyó (San Cristóbal, Cobán), kiyaù (Cobán), chucte (El Rancho), chaucte (San Augustín), shucte (Zacapa), kotyó (Chamá, Alta Verapaz). In Mexico it is known as chinini. Mr. Pittier describes the tree from which he collected specimens (no. 3132) as about 50 meters high, 1.2 m. in diameter at base, with brownish yellow flowers. The fruits were said to be about 10 cm. in diameter, with a thick mesocarp, and of exquisite flavor. The vernacular name is given as aguacatón.

According to Mr. Popenoe, the flowers are produced from November to March in Guatemala, and the fruit ripens from July to October. The flowers are pale greenish yellow, turning crimson at base in age, or sometimes light rose, the stamens likewise turning crimson with age. The staminal glands are bright orange. The flowers of *P. americana* are described by Mr. Popenoe as pale green, not changing color in age.

The fruit of the coyó (*P. schiedeana*) is said by Mr. Popenoe to be much like that of the common avocado, and equally variable in appearance and quality. The skin is thick but leathery and pliable, and the flesh of a brownish white color and a fine oily texture, almost always penetrated by fibres. The flavor is much like that of the common avocado, but distinguishable, suggesting that of a ripe coconut. The cotyledons when cut are rose-pink in color, while they are whitish in the avocado.

Although the type number of *Persea pittieri* Mez (*Pittier* 1156, from Valle de Rancho Redondo, near Volcán Irazù, altitude 1500 meters, Costa Rica) has not been available for examination, it is clear from Mez's full description that his plant is only *P. schiedeana*. His error is undoubtedly due to the fact that he had previously treated *P. schiedeana* as only a variety of *P. gratissima*, and consequently did not consider it in this connection.

4. **Persea cinerascens** Blake, sp. nov.

Tree; branchlets of the year densely pilose-tomentose with sordid-rufescent hairs; older branchlets fuscous, more sparingly pilose-tomentose; leaves alternate, crowded on the young branchlets, the blades 10 to 20 cm. long, 5 to 8 cm. wide, elliptic to oval-oblong or obovate, acute

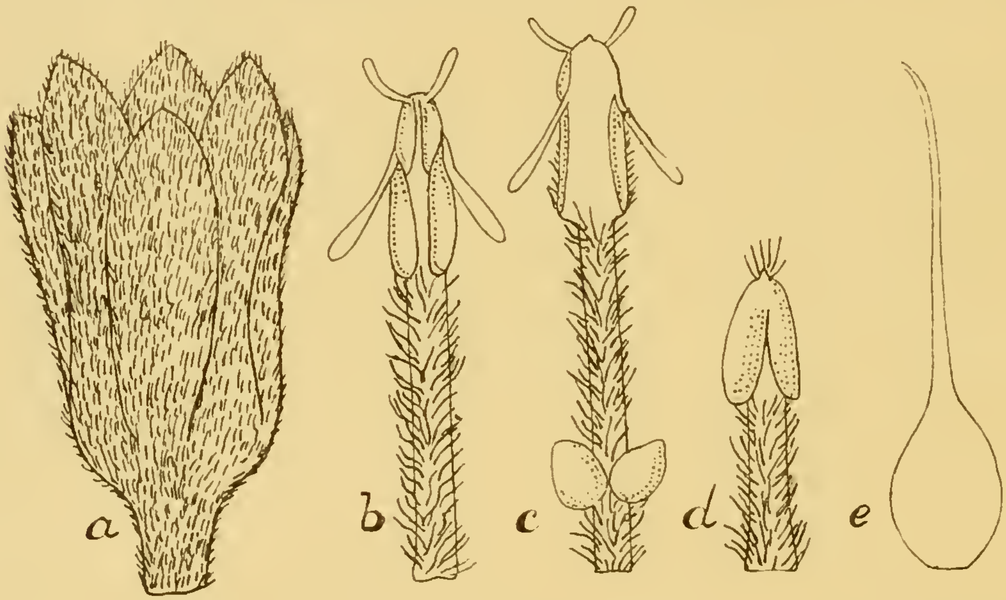

Fig. 2.—*Persea cinerascens* Blake (drawn from Purpus 7671). *a*, perianth, × 5; *b*, stamen of series I, × 10; *c*, stamen of series III, viewed from dorsal side, × 10; *d*, staminode, viewed from ventral side, × 10; *e*, ovary, × 10.

or short-pointed but blunt at apex, cuneate at base, chartaceous, entire, above dull green, rather obscurely foveolate, with impressed veins, sordidly pilose-tomentose chiefly on costa and lateral veins, beneath cinerascent, sordidly pilosulous on whole surface but more densely so on the veins with crisped spreading hairs, prominent-reticulate, the 14 to 16 pairs of lateral veins diverging at an angle of 45° to 60°, the secondaries connecting them nearly at right angles; petioles pilose-tomentose with sordid-rufescent hairs, 2 to 3 cm. long; peduncles axillary, 3.5 to 7 cm. long, like the whole inflorescence sordidly pilose-tomentose; panicles 5 to 7 cm. long, 3 to 4 cm. wide, narrowly subpyramidate, the short branches 3- to 6-flowered toward apex; bractlets deciduous; pedicels stout, 1 mm. long; perianth 7 to 8.5 mm. long, densely pilosulous-tomentose both sides with sordid-cinereous hairs, the tube about 1 mm. long, the segments elliptic-oblong, 1.8 to 2 mm.

wide, obtusish, the outer 1 to 1.5 mm. shorter than the inner; stamens of series I 4.8 mm. long, the densely pilose filaments 3 mm. long, the slightly broader anthers 1.8 mm. long; stamens of series II similar, 4.5 mm. long; stamens of series III 5.2 mm. long, the densely pilose filament 3.4 mm. long, bearing 0.7 mm. above base two sessile ovoid pilosulous glands 0.7 mm. long, the anther 1.8 mm. long, the lower cells subextrorsely dehiscent, the upper lateral-introrse; staminodes 3 mm. long, the densely pilose filament 1.7 mm. long, the cordate-sagittate apiculate gland 1.3 mm. long, glabrous on inner face, dorsally pilose and barbate at apex; ovary ellipsoid, glabrous, 1.5 mm. long; style slender, glabrous, 3.5 mm. long; extreme base of calyx segments thickened and persistent in fruit, forming a saucer 1 mm. high, 4.5 mm. wide; berry subglobose, glaucous-blue, about 12 mm. long and thick; seed globular, 8 mm. thick.

Type in the U. S. National Herbarium, No. 884613, collected at Zacuapan, Vera Cruz, Mexico, June, 1916, by C. A. Purpus (No. 7671). Duplicates in the Gray Herbarium. Also collected in fruit at the same locality at a later date by Purpus (No. 8144).

This species is readily distinguished by its glabrous ovary, sessile staminal glands, narrow panicle, and by the pubescence of its leaves. In Mez's treatment of *Persea* it seems to come nearest to *P. liebmanni* Mez, from the description of which it differs in its larger flowers, longer anthers, staminodal glands glabrous inside, and larger berry. It is evidently of no importance as a food plant.

The sheet in the National Herbarium is in bud only, and the complete description of the species has been made possible through the kindness of the Gray Herbarium in loaning two sheets of the same number bearing a few opened flowers, and of Mr. T. S. Brandegee in sending fruiting material of a later collection by Purpus from the same locality.

5. **Persea leiogyna** Blake, sp. nov. Trapp Avocado.

Tree about 10 meters high, with broad low head; branchlets stout, glabrous, glaucous; leaves alternate, the blades 7.5 to 16 cm. long, 4.5 to 8 cm. wide, ovate or elliptic-ovate to oval, acute or short-pointed, the apex usually blunt, at base unequal, rounded to cuneate-rounded, pergamentaceous, pinnate-veined (veins 4 to 9 pairs, prominulous-reticulate beneath), above deep green, glabrous, beneath somewhat glaucous, glabrous or with very sparse short incurved hairs along costa and toward base of primary veins; petioles glabrous, 2 to 3.5 cm. long; panicles axillary, 5.5 to 10 cm. long (including peduncle, this 2 to 4 cm. long), crowded toward tips of branchlets, about twice as long as the petioles, rather sparsely puberulous with loose curved hairs, not at all canescent; pedicels 2 to 4 mm. long; perianth yellowish green, 5.3 to 6 mm. long, short-ciliate above middle and sparsely pilosulous outside with loosely spreading curved hairs, essentially glabrous inside, punctate, the segments elliptic-oblong, obtuse to rounded, the outer

4 to 5 mm. long, 2 mm. wide, the inner slightly longer, 5.3 to 6 mm. long, 2 mm. wide; stamens of series I 3 to 4 mm. long, with slender sparsely ciliate filaments 1.5 to 2.7 mm. long; of series II similar but longer, the filaments 2.2 to 2.9 mm. long, the anther 1.3 mm. long; of series III similar, the filaments 2.5 to 3.2 mm. long, the anthers 1.2 to 1.4 mm. long, the glands borne about one-sixth to one-fifth the length of the filament above its base, ovate or rotund-ovate, obtuse or obliquely emarginate at apex, cordate-sagittate at base, glabrous, borne on distinct but shorter glabrous stipes; staminodes glabrous, 1.8 to 2.5 mm. long, the head triangular, narrowed from the base, apiculate, equaling or shorter than the filament; ovary glabrous, ovoid; style glabrous, slightly longer than ovary; fruit oblate to globose, 7 to 12 cm long, light yellowish green outside, with smooth thickish skin; seed often loose in the cavity.

Type in the U. S. National Herbarium, No. 1012124, collected in Charles Deering's grove at Buena Vista, Florida, April 7, 1916, by Wilson Popenoe (No. 219). Other specimens examined (cultivated): FLORIDA: Plant Introduction Garden, Miami, April 5, 1916, *Popenoe* 196, 198 (S. P. I.).

In foliage characters *Persea leiogyna* is so close to many specimens of *P. americana* that the two species can not be distinguished by leaves alone. In its shorter greenish yellow (when dried) sparsely pilosulous perianth, its smaller sparsely ciliate stamens, its glabrous staminodia, and its glabrous ovary, however, *P. leiogyna* is unique in the group of species known under the name of avocado.

Persea leiogyna is the commonly cultivated "Trapp avocado" of Florida, from Fort Pierce to Winter Haven, Bradentown, and southward. The "Family avocado," represented by *Popenoe* 196, is identical in botanical characters. The latter is said to be a variety of local origin, rather extensively propagated.

The material of this species which I have examined consists of that above cited, and in addition eight branches from different trees of the "Trapp avocado" collected in the vicinity of Miami in the early spring of 1919 by Mr. Popenoe. All of these agree precisely with the type in the diagnostic characters above mentioned. The species flowers from March to April, and fruits from October to December.

The many thousand trees of the Trapp avocado now in cultivation in Florida and Cuba have all been produced by budding and grafting from the single original tree, grown in Florida from seed believed to have been brought from Cuba, by the late C. L. Trapp, of Cocoanut

Grove, Florida.[7] As might be expected from the method of propagation, they have remained very constant in their characteristics, and specimens from different trees throw no light on the possible origin of the species. It is of the so-called West Indian race, with smooth, leathery, thick-skinned fruit and seed commonly loose in the cavity. Whether it really is a long-distinct wild species, a native of Cuba or more probably brought there from other regions, whose wild original is extinct or awaits rediscovery, or whether it is a comparatively recent mutant under cultivation, or perhaps even a hybrid, are questions which at present can receive no answer. It is possible that the seedlings now being grown in South Florida may throw light on the question when they flower. On the basis of our present information, however, and in view of its striking and constant technical characters, the species must be considered one of the most distinct in the genus.

[7] The name "Trapp avocado" was given by Prof. R. H. Rolfs (Bur. Pl. Indus. Bull. 97: 119. 1907) in honor of "Mrs. Trapp, Cocoanut Grove, Fla., who owns the original tree."

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.—*Reflecting power of stellite and lacquered silver.* W. W. COBLENTZ and H. KAHLER. Bur. Standards Sci. Paper **342**. Pp. 3. 1919.

It is shown that the reflectivity of stellite varies somewhat in the visible spectrum, depending upon the homogeneity and no doubt upon the exact composition of the alloy.

Data are given on the reflecting power of lacquered silver mirrors, before and after exposure to ultra-violet light. It is shown that owing to photochemical action in the lacquer, the silver is turned brown in color, thus reducing its reflecting power. W. W. C.

CHEMISTRY.—*Bibliography of scientific literature regarding helium.* Bur. Standards Circular **81**. Pp. 21. 1919.

The year 1918 marks the beginning of a new era in the history and use of helium. Before that time only a few liters of the gas had been collected and the cost per liter was enormous. During the war the development of great fractionating plants capable of separating from natural gas a sufficient quantity of helium to supply a fleet of airships has aroused the keen interest not only of engineers and scientists, but also of the general public, in the unique properties of this gas. This circular contains a bibliography of the scientific literature relating to helium prepared for use during the war and now published. Related papers are grouped together in their chronological order, making the bibliography, in effect, a brief outline history of the subject.

E. R. W.

ENTOMOLOGY.—*The ants of Cocos Island.* WILLIAM MORTON WHEELER. Proc. Calif. Acad. Sci. [4] **2**: Pt. 2, 299–308. June, 1919.

In this, the second publication dealing with the ants of Cocos Island, the author records seven forms of ants from the island. Two of these are considered really endemic and characteristic. "It is evident that the Cocos ants are decidedly tropical whereas those of the Galapagos are mainly such as belong to subtropical or temperate regions or at any rate to the cooler or subalpine regions in the New World tropics. * * * * The data derived from a study of the ants are too meager to enable me either to accept or to reject Stewart's view that Cocos is a true oceanic island of more recent origin than the Galapagos and that it has received its biota as 'Flotsam and jetsam' from the Central American mainland."

S. A. Rohwer.

ENTOMOLOGY.—*The ants of the Galapagos Islands.* William Morton Wheeler. Proc. Calif. Acad. Sci. [4] 2: Pt. 2, 259–297. June, 1919.

In the introduction the author gives a history of the development of our knowledge of the ants of the Galapagos Islands and briefly reviews the literature of the two opposing theories of the development of the islands. In reference to these theories he states that "The unbiased worker can only conclude from what has been written on the subject, and notwithstanding the many excellent monographs that have been produced on various portions of the fauna and flora, that we need a still more intensive and exhaustive exploration of the islands and above all a much better acquaintance with their geology than we now possess, before he can definitely accept either of the hypotheses."

The number of ants recorded from the islands comprise 36 different forms representing 18 species, 10 genera and four of the five subfamilies of the Formicidae. Only nine species are considered as clearly indigenous to the islands and all of these are distinctly Neotropical in their affinities but all but three or four are either well-known species widely distributed in tropical and subtropical portions of America or are merely subspecies or varieties of such forms. The author considers that no fewer than 26, or 72.2 per cent, of the 36 forms (subspecies and varieties) are endemic.

S. A. Rohwer.

VOLCANOLOGY.—*The composition of the gases of Kilauea.* E. S. Shepherd. Bull. Hawaiian Volcano Obs. 7: 94–97. July, 1919.

Since 1912, when Day and Shepherd collected the first gas samples ever taken from the Kilauea crater, work has continued on the composition of these gases. Further collection was made in 1917 and a shipment of gases collected by Dr. T. A. Jaggar, Jr., director of the observatory at Kilauea, has just been received. This work presents rather unusual difficulties in the matter of collection and also in the analysis.

This preliminary report is concerned primarily with the 1917 collection, but includes a new analysis of one of the 1912 tubes and one tube from Jaggar's 1918–19 collection, for comparison. From an examination of the tables of analyses it appears that the gases from this volcano vary greatly in composition. About the only constituent which appears in more or less constant quantity is water vapor, which averages about 50 per cent of the gases given off by the lava. This refers, of course, to the gases obtained from the inside of flames, *i. e.*, before the gas has come in direct contact with air. The remaining constituents are CO_2, CO, H_2, N_2, Ar (trace), SO_2, and S_2, with traces of Cl_2 and F_2. The chief ingredients are CO_2, SO_2, S_2, and H_2O. It seems significant that the combustible gases are (at the surface) relatively small in amount, and this doubtless explains the quiet nature of Kilauea eruptions—there is little left to furnish an explosion. It is also probable that with the additional evidence which the gases recently collected by Jaggar and the systematic collection which he purposes for the future will furnish, we shall be able to establish the relative importance of the several hypotheses thus far proposed to account for the energy supply of this crater. The analyses of the 1917 gases are as follows:

GASES COLLECTED FROM KILAUEA, 1917

[Volume per cents at 1200°C.]

Tube	CO_2	CO	H_2	N_2	Ar	SO_2	S_2	Cl_2	H_2O
1[1]....	2.65	1.04	4.22	23.22	udt.	0.16	0.70	udt.	67.99
2[1]....	17.95	0.36	1.35	37.84	udt.	3.51	0.49	udt.	38.48
3.....	33.48	1.42	1.56	12.88	0.45	29.83	1.79	0.17	17.97
4.....	11.12	3.92	1.42	.....	0.51	.....	8.61	0.02	77.50
5.....	9.54	1.12	1.53	10.47	.....	9.90	2.72	.....	64.71
6.....	1.97	0.82	0.21	3.50	0.07	0.95	2.70	.....	89.77
7.....	17.25	0.62	0.76	5.88	0.18	9.75	1.07	0.25	64.18
8.....	15.27	0.45	0.70	0.87	0.14	6.98	0.49	.....	75.08
9.....	8.32	0.82	1.82	8.92	0.29	16.80	2.49	1.01	59.97
10.....	1.54	0.43	0.37	2.44	0.39	.....	3.56	1.34	89.93

[1] Tubes 1 and 2 were analyzed before the calcium tube was added to the apparatus, so that the rare gases were not determined. Chlorine was not determined in these tubes (udt.). Other blanks in the table mean that the gas was not present in determinable amounts.

E. S. S.

CHEMICAL TECHNOLOGY.—*The technique of optical glass melting.* CLARENCE N. FENNER. Journ. Amer. Ceram. Soc. 2: 102–145. February, 1919. (Geophysical Lab. Papers on Optical Glass, No. 7.)

The course of melting operations is followed from beginning to end and the essential features of procedure are described. Details of practice which are common to all forms of glass-making and are familiar to glass-makers in general are either omitted or passed over with brief descriptions, and attention is concentrated on those matters which in the making of optical glass differs from that of other kinds. Because of the fact that the purposes for which optical glass is to be used are in many respects radically different from those of other glasses, and require that exact optical and other physical properties be maintained and that certain defects be eliminated, it is essential that manufacturing operations be controlled throughout by methods of precision. The article describes the general course which must be followed to accomplish these results and the effects caused by departures from the standard of procedure, and takes up in more detail the principal defects which are likely to occur, and considers their causes and the methods of avoiding them. Some of the subjects discussed are: The effects of different available batch-materials upon melting operations and the range of choice in this matter; the necessity of close temperature regulation and the results of inattention to this; fining operations, especially with reference to the elimination of bubbles, and the causes and prevention of bubbles in general; variations of optical properties from requirements and to what they are due; differences of procedure required for the different types of glass; stirring operations, and the manner in which they should be conducted to obtain glasses relatively free from striæ.

C. N. F.

CHEMICAL TECHNOLOGY.—*An improved method of optical glass manufacture.* GEORGE W. MOREY. Journ. Amer. Ceram. Soc. 2: 146–150. February, 1919. (Geophysical Lab. Papers on Optical Glass, No. 8.)

Stirring is begun during the fill and is continued during the fining period. Details are given of changes in procedure following this departure from the usual schedule. The results show that with proper furnace control, the customary time of manufacture of a pot of glass can be reduced to 24 hours, with improvement in color due to diminished pot corrosion.

G. W. M.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES.

BIOLOGICAL SOCIETY

601ST MEETING

The 601st regular meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club on November 15, 1919; called to order at 8.10 p.m. by Vice-President Vernon Bailey. Twenty-six persons present.

Under heading of brief notes Dr. L. O. Howard reported a letter read before the council from B. W. Evermann in which Dr. Evermann regretted that he was unable to attend the anniversary meeting on November 1.

Dr. R. W. Shufeldt exhibited living young of the southern soft-shelled turtle [*Amyda ferox* (Schneider)] and gave an account of the distribution and habits of this group of turtles.

W. H. Osgood gave a brief synopsis of the meetings of the American Ornithologists' Union held during the past week in New York City.

A. Wetmore remarked upon the attitude of the male sage grouse [*Centrocercus urophasianus* (Bonaparte)] in strutting, as shown in motion pictures taken by W. L. Finley.

The regular program consisted of three communications:

N. Hollister: *Relative abundance of waterfowl in Wisconsin* (illustrated by diagrams). This paper, based on observations made at Delavan Lake in southeastern Wisconsin, will be published in the *Auk*. The paper was discussed by W. H. Osgood, A. Wetmore and V. Bailey.

A. Wetmore: *A peculiar habit of grebes* (with exhibition of specimens). This communication will appear in full in the *Condor*. The paper was discussed by R. W. Shufeldt and V. Bailey.

E. O. Wooton: *Notes on a short visit to Tamaulipas.* Prof. Wooton gave an interesting account of a trip made during midsummer 1919 to examine the possibilities of Northern Tamaulipas in regard to agriculture and range. Although the time of year was unfavorable for botanical collecting, 207 species of plants were preserved and of these several proved to be new to science. A general account of the region and of its vegetation was given. The paper was discussed by E. A. Goldman, V. Bailey and A. Wetmore.

Alexander Wetmore, *Recording Secretary pro tem.*

SCIENTIFIC NOTES AND NEWS

At a meeting held on November 25 in the main auditorium of the New National Museum, Professor Irving Fisher, of Yale University, addressed the Scientific-Technical Section of the Federal Employees Union on the subject of "The purchasing power of salaries." The speaker elaborated his theory of a stabilized dollar, pointing out that an invariable unit of value is of even greater importance than invariable units of other quantities, such as length and mass. The Section voted to appoint a Committee for a study of the proposal for a more stable unit than the gold dollar, with instructions to report back a resolution granting or withholding endorsement according to the findings of the Committee.

Dr. P. G. Agnew, physicist in the Electrical Division of the Bureau of Standards, has resigned to become secretary of the American Engineering Standards Committee, with headquarters at the Engineering Building, 29 West 39th Street, New York City.

Dr. Louis A. Bauer, director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, gave an illustrated lecture on "The solar eclipse of May 29, 1919, and the Einstein effect" before the Royal Astronomical Society of Canada at the University of Toronto on December 2, and at the College of the City of New York on December 4. On December 3 Dr. Bauer, assisted by Dr. S. J. Mauchly, gave a lecture on the magnetic and electric work of the Department before a special meeting of the Mathematical and Physical Society of the University of Toronto.

Mr. N. H. Darton, geologist of the U. S. Geological Survey, will spend two months in the Dominican Republic early in 1920 to investigate oil conditions for a New York company.

Dr. W. S. Gorton has resigned from the Bureau of Standards, where he has been engaged in work on potential-transformer testing and automotive engine ignition, to accept a research position with the Western Electric Company in New York City.

Dr. Carl P. Hartley, pathologist in the office of Forest Pathology, Bureau of Plant Industry, resigned in October to accept a position as pathologist with the Instituut voor Plantenziekten en Cultures, Buitenzorg, Java.

Mr. W. B. Heroy, formerly of the U. S. Geological Survey, and recently on the staff of the McGraw-Hill Company, publishers of technical periodicals, has resigned to accept a position as geologist with the Sinclair Consolidated Oil Corporation, with offices at 120 Broadway, New York City.

Messrs. F. L. Hess and R. M. Overbeck, of the U. S. Geological Survey, are on a six months' leave of absence and are engaged in exploration of deposits of ores of the rare metals in Bolivia, for private interests.

Miss Martineau Knight, geologic aid of the U. S. Geological Survey, has been employed by the Roxana Oil Company of California as office geologist.

Dr. S. Koniski of the Department of Commerce and Agriculture of Japan, and Technical Adviser to the Japanese delegates at the Peace Conference, visited Washington in December.

Prof. T. H. Laby of the University of Melbourne visited the scientific laboratories of Washington in December, while on his way back to Australia from England, where he has been doing research work on war problems.

Mr. A. G. Maddren resigned from the U. S. Geological Survey in December, to enter the employ of the Vulcan Oil Company. He will make a detailed study of part of the Ranger oil field, Texas, under the direction of Ralph Arnold.

Senator Medill McCormick of Illinois has been appointed a regent of the Smithsonian Institution.

Mr. John D. McChesney, disbursing clerk of the U. S. Geological Survey since its organization, died on December 5, 1919.

Mr. C. C. Osbon, statistical clerk in charge of peat and asphalt in the mineral resources branch of the Geological Survey, has resigned to do statistical work for the Marland Refining Company.

Prof. Louis Valentine Pirsson, professor of geology at Yale University, and a non-resident member of the Academy, died on December 8, 1919, in his sixtieth year. Professor Pirsson was born in New York City, November 3, 1860. His entire academic career of thirty-seven years was spent at Yale. His work was principally in petrology, particularly of the igneous rocks of Montana and New England. He had been a member of the Academy since 1900, and was also a member of the Geological Society of Washington.

Mr. Henry S. Rawdon, physicist in the metallurgical division of the Bureau of Standards, went to Europe in November, to spend about three months in collecting information on permissible limits for sulfur and phosphorus in steels.

A wireless message from South America states that Dr. Gaillard Sherburne Rogers, geologist of the U. S. Geological Survey, was drowned on November 18, 1919. He was engaged at the time in the examination of oil and gas concessions in Colombia. Dr. Rogers was born on March 21, 1889, in New York City. He joined the Geological Survey in 1911 and had devoted his attention particularly to the geology of oil and gas deposits. He was a member of the Academy and of the Geological Society.

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MATHEMATICS.—*A trigonometric computer.* F. E. WRIGHT, Geophysical Laboratory, Carnegie Institution of Washington.

The solution of spherical triangles by the logarithmic computation of trigonometric formulas is at best a time-consuming process, especially if there be many such triangles to solve. In case high precision is required no other method is available; but if only approximate results are desired, graphical methods may be used, such as an exact projection net; of these the stereographic net published by G. W. Littlehales[1] is the most accurate and furnishes results correct to about $2'$ of arc under favorable conditions. If the results are to be correct within one-half minute of arc graphical methods are not adequate and recourse must be had either to computation or to some mechanical device of high precision.

In crystallographic work the degree of precision is of the order of magnitude of $^1/_2{}'$. In the measurement of the changes in

[1] *Altitude, azimuth, and geographical position.* J. B. Lippincott Company. Philadelphia, 1906.

crystal angles with temperature the position of each crystal face is determined on the two-circle goniometer by means of two angles (polar distance and azimuth). Having given the position-angles of any two faces, the angle between them can be found by the solution of a spherical triangle.

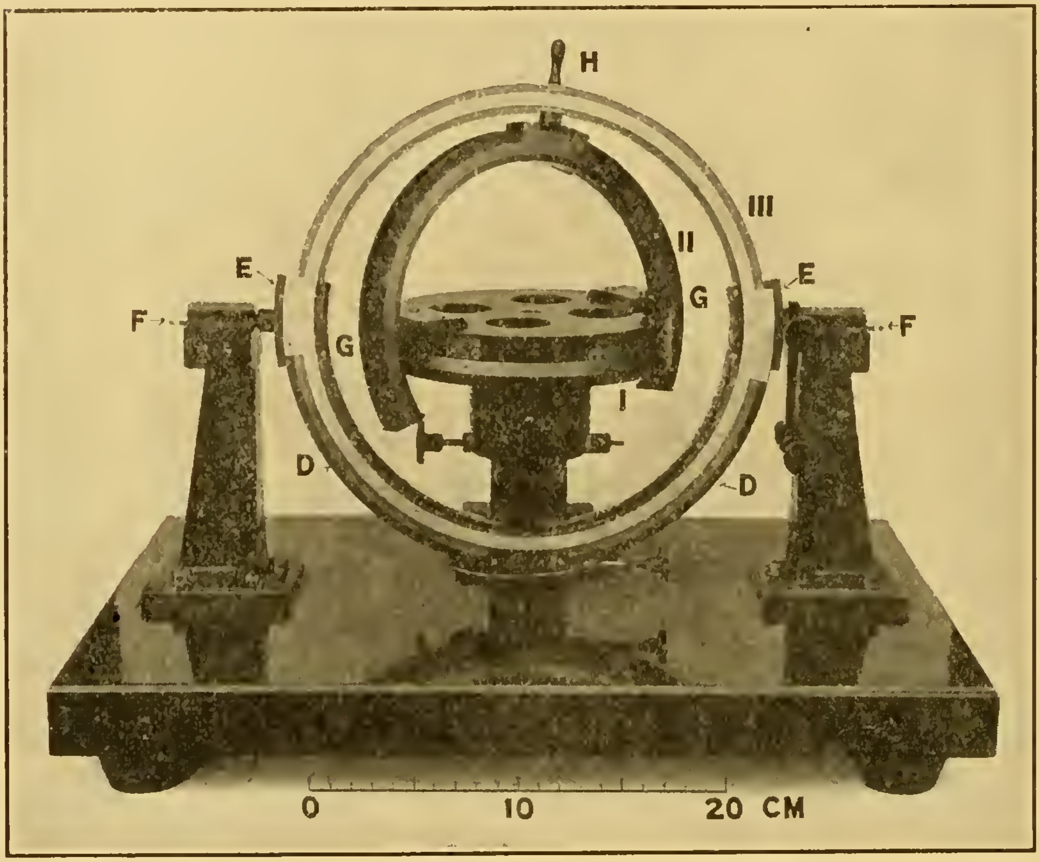

Fig. 1. Photograph of trigonometric computer.

In 1913 the writer had occasion to solve many triangles of this type, and to save time had a mechanical computer constructed in the instrument shop of the Geophysical Laboratory. This instrument has proved to be satisfactory in practice for the solution of oblique spherical triangles in which three of the angles are given and the value of any one of the three remaining angles is sought with a precision of about half a minute. The computer was designed for, and functions best in, the solution of the problem: given two sides and the included angle of a spherical triangle; find the third side.

Description of instrument.—A photograph of the instrument is reproduced in fig. 1. It consists essentially of three concentric graduated circles which can be inclined at different angles one to the other. The inner circle I is horizontal and can be rotated about a vertical axis. The outer circle III fits in the semicircular groove *D* and is free to turn in this bearing, the angle of turning being read off on the vernier at *E, E;* the circle in its bearing can also be rotated about the horizontal axis *F, F.* The intermediate circle II is not a complete circle and is attached to the circle I by the horizontal axis *G, G,* and to the circle III by the axis *H.* The angles of rotation and revolution of these circles can be read off on appropriate verniers. The circles are equipped with clamp screws and slow-motion devices for the accurate setting of angles.

The following steps are taken to solve the problem: given two sides *a, b,* and the included angle *C* of a spherical triangle; desired the third side *c.*

Set the three circles at right angles to each other—all verniers reading 90°. Turn circle III about the horizontal axis to the position where it includes the angle *C* with the horizontal circle I (angle read off on the vernier of circle II). Turn circle II in its bearing until axis *H* includes an angle *a* with the axis *F, F;* turn horizontal circle I about its axis until axis *G, G* includes the angle *b* with the axis *H.* The angle *H-G* is then the desired angle *c.* The entire operation requires about one minute and is simple and readily checked.

The instrument is necessarily one of high precision, and first class workmanship is required to produce a satisfactory computer. In its construction care was taken to include adequate adjustment facilities such that the instrument can be readily adjusted in case of wear. The instrument is mounted on a heavy cast-iron base. Credit is due to Mr. J. Jost of the mechanical staff of the Laboratory for the excellent mechanical workmanship on this computer.

BOTANY.—*The Venezuelan mahogany, a hitherto undescribed species of the genus* Swietenia. H. PITTIER, Bureau of Plant Industry.

It is interesting to note how many groups of trees well known for their industrial or other economic uses have thus far escaped the attention of botanists. This is especially true in the case of tropical woods, and the principal reason seems to be that collectors, taking it for granted that plants universally used by man are too well known to deserve critical study, seldom secure the herbarium material which is indispensable for their proper botanical identification.

Among many examples of this kind may be mentioned the Venezuelan mahogany, a stately tree which is rather abundant in the basal region of Venezuela, from sea-level up to about 1,000 meters. Besides being extensively used locally, it has for some time been exported to Europe and the United States. The only attempt at its scientific classification was that of Dr. A. Ernst, who in 1883, inh is report on the Venezuelan National Exposition, considered it identical with the Santo Domingo mahogany (*Swietenia Mahagoni* L.). From this species, however, it differs widely in the size and dehiscence of the fruit, the size, shape, and texture of the leaflets, and the details of the flower structure.

Since 1913, when for the first time I had an opportunity to observe this tree *in situ*, I have been able to study it over an extensive territory. From the first it seemed to me specifically distinct from the real mahogany, of which several individuals, grown from seeds brought directly from Santo Domingo, are to be seen in the vicinity of Caracas. I was struck principally by the dimension of the capsules and by their mode of dehiscence. Heretofore the basal dehiscence noted in the true mahogany has been considered one of the diagnostic characters of the genus. In the Venezuelan species, however, the capsules open as often from the apex as from the base, and I have noticed that such is the case also with *S. macrophylla*, which I have had occasion to observe in Panama.

After my first trip to Venezuela the above observations were reported to the then best recognized authority on the family Meliaceae, Casimir de Candolle, whose death science has lately had to lament. Mr. de Candolle's views confirmed mine. In a letter he referred to the necessity of revising the generic definition of *Swietenia* as to the mode of dehiscence of the capsule, and expressed his intention of describing the Venezuelan species as new. This he seems not to have been able to do, for which reason I now proceed to give my own description, dedicating the species to the memory of that illustrious botanist, whose friendship I am proud to have enjoyed for nearly forty years.

Swietenia Candollei Pittier, sp. nov.

A tree up to 40 meters high, the trunk erect, 120 cm. in diameter at the base, covered with rimose bark, the crown more or less elongate-ovoid. Leaves abruptly pinnate, glabrous, the rachis 15 to 22 cm. long, terete, slender, the petiolar part 7 to 8.5 cm. long; leaflets 3- or 4-jugate, opposite, subcoriaceous, inequilateral, the petiolules slender, canaliculate, 6 to 12 mm. long, the blades ovate to elliptic-lanceolate, acute or subacute at the base, long and narrowly cuspidate at the apex, 4 to 11 cm. long, 2 to 4 cm. broad, shining above, dull and paler beneath.

Inflorescence axillary, entirely glabrous, 10 to 15 cm. long, the peduncles 5 to 6 cm. long, the flowers pediceled, yellowish white, the bractlets minute, caducous; pedicels 3 to 6 mm. long, slender, erect; calyx short, cupular, the 5 lobes ovate-rounded, obtuse; petals (imbricate in bud) inequilateral, obovate, obtuse, 5 to 6.5 mm. long, about 3 mm. broad, reflexed in anthesis; stamen tube tubular-urceolate, 4 mm. long, the teeth narrow and acuminate, the anthers subsessile, ovoid-oblong; disk crenulate, 0.8 mm. high; pistil about 4.5 mm. high, glabrous, the ovary ovoid, the style rather slender, the stigma discoid, 1.5 mm. in diameter, entirely exserted from the stamen tube at full anthesis.

Fruiting peduncles 10 to 24 cm. long; capsule distinctly obpyriform, 13 to 14 cm. long, 8 to 9 cm. in diameter, pale brown outside, with a rugose surface; valves 5, opening mostly from top to base, ligneous, 7 to 8 mm. thick, with a white inner coating adhering loosely to the seeds; central column about 11 cm. long, club-shaped and 5-winged, light and spongy; cells 5, provided at the top with a double series of spongy, dark brown scales, the 9 to 12 perfect seeds inserted on these by a hilum at the apex of the wing, 2 to 4 of the upper seeds being generally undeveloped and imperfect; wing basal, about 7 cm. long and 2.5 cm. broad, papyraceous, thicker on the outer margin, two fibro-vascular bundles here connecting with the hilum; body of the seed more or less flattened, rounded at the tip, about 2.4 cm. long, 1.5 cm. broad, 5 to 8 mm. thick, entirely smooth and of a rich brown color, with an agreeable odor when fresh; embryo 2 cm. long, 1.2 cm. broad, flattened, yellowish white, with a dark umbilical area on the outer thicker margin.

Type in the U. S. National Herbarium, no. 601496, collected at La Trinidad de Maracay, State of Aragua, Venezuela, at an altitude of about 440 meters, in flower, January 31, 1913, by H. Pittier (no. 5789).

The purpose of the spongy suberose tissue surrounding the embryo is to store moisture for the promotion of germination.

To my knowledge, *Swietenia Candollei* is spread in the basal region all over the coastal range of Venezuela and in the interior valleys north of the llanos. A tree which is presumably this species is reported to exist in the Orinoco Valley also, and along the foot of the Andes in the region of Lake Maracaibo, but until we have specimens it is not possible to affirm that there is but a single species in these regions. Several other timber trees belonging to diverse genera are in the local market under the name *caoba*, which is the Spanish equivalent for mahogany.

The Venezuelan mahogany is often seen along streets and in parks, as for instance in Valencia, in the State of Carabobo. It is used also for shade or as a windbreak in cacao plantations and in former times was planted extensively in the live hedges bounding the sections of the larger estates. It strikes root readily from stakes and, as it has proven profitable in the past, ought to be propagated now, because of its economic value.

BIOLOGY.—*The Bioclimatic Law.*[1] ANDREW D. HOPKINS, Bureau of Entomology.

In 1718 Dr. Jacob Bigelow, who was then Rumford professor and lecturer on *materia medica* and botany in Harvard University, published a paper[2] based on evidence secured from the reported dates of the blooming of the peach tree at different places between Montreal, Canada, and Fort Clairborne in Alabama Territory. In this paper Dr. Bigelow suggested that the difference in the time of the event between the northern and southern extremes of the country was not less than two months and a half. This suggestion served to stimulate further studies along this line by botanists in Europe and especially in Germany, and finally led to the founding of the science of periodical phenomena under the designation of Phenology.

[1] Read before the Biological Society of Washington, November 29, 1919.

[2] Memoirs Amer. Acad. Arts and Sciences 4, Part I.

For a time the study related to plants alone and thus was associated with botany. Later, animals, and still later, the relation of periodical phenomena of plants and animals to climate, were included, and from the first, variation in the time of occurrence of periodical phenomena with geographical position was recognized. Thus the science is founded on and embraces certain features of biology, climatology, and geography, and involves, in the consideration of its problems, a number of other branches of science and practice.

Beginning about 1830, special attention was given by German writers to a study, first of the rate of variation with latitude, and later to the variation with altitude, and finally, in 1893, the discovery was announced of a rate of variation with longitude.

In 1894 the writer noted that the dates of emergence of the periodical cicada in West Virginia varied with the latitude and altitude. This, in connection with the announcement by Dr. Merriam of the relation of climate and temperature to the defining of equal or similar biological associations, designated as life zones, led to a consideration of the relation within the State of West Virginia of insect and plant distribution to periodical activities, temperature, latitude, and altitude. About this time the Hessian fly was very destructive to wheat throughout the State and, guided by the findings of Professor Webster that in Ohio there was a difference in safe dates to sow wheat to avoid damage by this insect, varying with latitude north and south of Wostor, an effort was made by the writer to apply the principle in West Virginia. It was soon found that altitude was equally as important as latitude, and a detailed study of this new phase of the problem, aided by phenological observations at different latitudes and altitudes, resulted in the publication in 1895 of Bulletin 67 of the West Virginia University, Agricultural Experiment Station, in which it was suggested that the rate of variation in the safe dates for seeding wheat was about one day for fifteen minutes of latitude and one hundred feet of altitude. It was further suggested that this rate of variation was in accordance with natural law, which could be applied in designating the time of periodical events or practice for any given place in the

State. As an example, and to serve as a guide to the selection of the time to sow wheat at different latitudes and altitudes to avoid damage by the fly, a calendar of dates and altitudes was prepared and issued with the bulletin, to be used in connection with a map of the State. By means of this map-calendar the average safe date for any place could be determined by the farmer. The practical value of this method was recognized, and demonstrated in the greatly lessened loss from Hessian fly damage the following year (1896) and even to the present time.

Up to the time the bulletin was published and some years later the determination by the writer as to the rates of variation in time with variations in latitude and altitude was entirely independent of the German literature on the subject, yet the conclusions were practically identical with those published many years before.

Recognizing the broad application of a knowledge of the suggested law to science and practice in entomology, general biology, climatology, and agriculture, the writer has given special attention to the subject during the past 24 years, as applied more specifically to forest entomology.

As a result of these studies new facts and evidence have accumulated which serve to establish a definite interrelation of organisms with climate and geographical position which we have designated as the *Bioclimatic Law.*

The basic principle in the operation of this law is found in the character of the responses of the organisms to the complex elements and factors of its local and immediate environment. In other words, the organism is utilized as the instrument by which the climate of a place and other influences on its activities are determined and the rate of variation in the dates of events and in latitude and altitude limits of distribution is measured. This method of studying the relations between life and climate has the advantage over that based on artificial instruments designed to record temperature, barometric pressure, humidity, sunshine, rain, wind, etc., because the organism not only records the influence of all of these, but that of all other elements, factors, and forces which affect life activity and which no instruments yet invented can record.

It appears that, in general, all organisms that are adapted to a given environmental influence respond to such influence in like manner. Therefore single species or groups of species of animals and plants can be utilized to interpret and measure the character and intensity of the controlling influences of a place or region. As sources of evidence and facts for the study of the broader phases of the problem of responses of organisms in general to the controlling influences of the local environment and regional climate, it has been found that plants, and especially trees and hardy shrub species, are the most convenient and reliable.

HOW THE PLANT RECORDS AND MEASURES THE INTENSITY OF THE CONTROLLING INFLUENCES

Trees and shrubs record the intensity of the influences which affect their life processes by means of more or less distinct events in their periods of activity and rest. In the humid climate of the north temperate zones the beginning of the period of activity is simultaneous with the advent of the spring season, in the South in February, and progressively later northward into June. This response is manifested by the swelling and opening of the winter leaf and flower buds, followed by successive events during the seasons of maximum and minimum activities such as the unfolding of the leaves, opening of the flowers, first leaves full grown, full foliage, winter buds forming, fruit forming, ripening or falling, autumnal coloring of the foliage, etc. Each event in each individual of a species marks both a stage in the development of the life processes and the advance of the season as related to the controlling influences of the locality or region.

Variations in the date of a periodical event from a given norm or constant are a measure, in terms of time, of the intensity of the controlling influences and forces as related (*a*) to geographical position, (*b*) to the season, (*c*) to the inherent tendency of species under the same external influences to vary towards early and late individual responses, and (*d*) to early and late responses of individuals of the same variety under varying local influences. The variation from a constant in the date of an event also measures the intensity of the controlling influences in terms of distance as related to feet of altitude or equivalents in degrees of latitude or longitude.

Studies in the application of these principles show quite conclusively that the responses to the controlling influences and forces are in accordance with natural law, in that (*a*) the time of occurrence of a given periodical event in the seasonal activity, or (*b*) the latitude limits of distribution of an organism, or (*c*) its altitude limits, are determined primarily by geographical position. Therefore, *other things being equal*, the variation between two or more geographical positions bears the same proportion to the distance between them, that 4 days of time bears to 1 degree of latitude, 400 feet of altitude, or 5 degrees of longitude. These coordinates of the law and their relations one to another are shown in table 1.

TABLE I. COORDINATES OF THE BIOCLIMATIC LAW

Geographical coordinates	Geographical unit coordinates	Time in day coordinate	Distance in feet coordinate
Latitude	1°	4	400
Altitude	400 ft.	4	400
Longitude	5°	4	400

APPLICATION OF THE LAW

The fundamental principle in the application of the law to research and practice is that which relates to variations from a constant.[3]

In the law as outlined the variation from the base should be at the rates mentioned. Therefore, on the basis of equal influence other than that related to geographical position, it is a simple mathematical problem to compute from the records at one place, the date, limit, or temperature *constant* for any other place. We know, however, that the *other* controlling influences are rarely, if ever, equal at two or more places and that, therefore, we must expect a greater or less variation from the constants.

[3] The constants of the law are the dates and the altitude and latitude limits that are computed from the records at a given base for any geographical position.

Thus the fundamental question to be answered is, what amount of variation from the constant in terms of days, feet, or degrees of distance, are we to expect for the varying local and regional influences which contribute to earlier or later dates, or higher or lower altitude.

During recent years special efforts have been made to find a reliable basis for answering this question. The first clue towards the answer was obtained from a study of over 40,000 reported dates of the beginning of wheat harvest, within the range of winter wheat culture in the United States. The results showed that the variations from the date constants, for all of the geographical units involved,[4] were in the same directions in certain regions of the country.

Throughout the Mississippi Basin from the Great Lakes southward, the reported dates were universally + or later than the computed constants; throughout the Great Plains, Rocky Mountain Plateau and part of the Great Basin, the reported dates were —, or earlier; throughout the Pacific Slope they were later; and so on. These results were strikingly significant of prevailing influences towards the acceleration in some regions and retardation in others of periodical phenomena as compared with the time-constant of the law.

Continued investigations along this line involved a detailed study of the altitude limits of species and of biological associations of plants and animals as mapped by the federal and state biological surveys and determined in a number of cases by personal investigations. The results of these later studies served not only to verify the evidence furnished by the wheat harvest records but to establish, as a general principle, the approximate amount of variation we may expect to find in all regions, from those in which there is no perceptible retarding or accelerating influence to those where the intensity of the influences reaches its maximum. As measured in time the variation from the constants is found to range from one to forty, with a maximum of fifty days at certain points along the Pacific Coast. As measured in altitude the variations are from 100 to 3000, with a

[4] Quadrangle $^1/_4 \times 1$ degree, and the average altitude.

maximum of 5000 feet. In these departures the earlier dates and higher altitudes are the result of accelerating influences, and later dates and lower altitudes are due to retarding influences.

In order to gather further facts and evidence on the variations from the constant and also the rate of advance of the spring season, as revealed by periodical phenomena, observations were begun at Brownsville in southeastern Texas and at Palm Beach and Miami, Florida, in February of the present year (1919). These were continued along routes from Brownsville in a general northeastward direction to the northern borders of the States of New York, Vermont, and Maine and to above the timberline on Mount Washington, from Miami north along the Atlantic Coast to Washington and from Palm Beach across the Florida Peninsula to Ft. Wayne, then north to Lake City and west to Pensacola, and return to Washington by the way of Birmingham, Alabama, Atlanta, Georgia, and Charlotte, North Carolina. These routes involved a travel, principally by rail, by Messrs. Griffith, Craighead, Snyder, and the writer, of over 20,000 miles and the recording of over 20,000 observations. The data accumulated by these investigations has served not only to verify the facts and evidence furnished by the wheat harvest and altitude limit data but has contributed information towards the solving of many other problems of scientific and economic interest, relating to the application of the law in research and practice, which I hope to discuss in future papers before this and other societies of Washington.

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.

APPARATUS.—*Potentiometers for thermoelement work.* WALTER P. WHITE. Bull. Amer. Inst. Min. Met. Eng. 1763–1772. Sept., 1919.

Thermocouple pyrometers are read in three ways. First, by direct readers where the current, and therefore the deflection, is proportional to the electromotive force of the couple; second, by potentiometers where the galvanometer merely helps to balance the electromotive force of the couple against that of a standard cell by means of known resistances and a constant battery-current; third, by intermediate instruments such as the pyrovolter, employing the potentiometer principle with a constant battery, but avoiding the standard cell, and measuring current with a calibrated galvanometer. Similar in result, but different in principle, is the new Harrison-Foote instrument, where the circuit resistance can be very quickly adjusted to the correct value. All these special instruments avoid the main difficulty of a direct reader, namely, the error from uncertain or variable resistance. It is necessary to use the regular potentiometer in order to avoid also the uncertainty (perhaps 1 per mille) of the calibration of the direct reader. With a slide-wire a simple and portable potentiometer is made, good to about 10 microvolts, or 0.25° with most thermocouples. The slide-wire also permits readings to 1 microvolt, though not altogether satisfactorily. Two special designs of potentiometer, the Diesselhorst-Wolff and the White, enable readings to be made to 0.1 microvolt or better, and the White potentiometer is very little affected by corrosive gases. Both these are deflection potentiometers, enabling part of the readings to be taken direct from the galvanometer with a gain in speed and without sensible error. If the potentiometer is arranged as a double potentiometer, speed can be still further gained in reading different instruments simultaneously. The precision of these potentiometers exceeds that needed in ordinary pyrometry, but is useful in fundamental standardization work, in calorimetry, and in numerous other applications of the thermoelement. W. P. W.

PHYSICS.—*A standardized method for the determination of solidification points, especially of naphthalene and paraffin.* R. M. WILHELM and J. L. FINKELSTEIN. Bur. Standard Sci. Paper **340.** Pp. 12, figs. 4. 1919.

This paper, after a brief treatment of the definitions of melting and freezing points both of pure substances and of mixtures, describes a method of making solidification-point determinations of naphthalene. This method was recommended at a conference of Bureau of Standards and U. S. Customs officials, and is based on the well-known cooling curve or constant temperature method. The method is shown to be applicable to the determination of the freezing points of paraffin and other substances. R. M. W.

PHYSICS.—*Standardization of the sulphur boiling point.* E. F. MUELLER and H. A. BURGESS. Bur. Standards Sci. Paper **339.** Pp. 21, pls. 2, figs. 2. 1919.

This paper describes experiments made to complete the data which are required for the standardization of the sulfur boiling point as a thermometric fixed point. The precision attainable in calibration of resistance thermometers at the sulfur boiling point is so much higher than the accuracy of the gas thermometer determinations of the temperature that it was considered desirable to standardize the temperature corresponding to normal atmospheric pressure by definition at 444.60°, and the data from which this figure was deduced are given. The relation between the vapor pressure of sulfur and the temperature, over the pressure range from 700 to 800 mm., was determined with a precision of 0.01° or better. The result of this work is the formula

$$t = 444.60° + 0.0910(p\text{-}760) - 0.000049(p\text{-}760)^2$$

where t is the temperature in Centigrade degrees, assumed by a properly shielded resistance thermometer in the standard form of sulfur boiling apparatus, and p is the pressure, expressed in equivalent millimeters of mercury at 0° and under standard gravity (g = 980.665). In an appendix are given the specifications for a proposed standardization of the sulfur boiling point. E. F. M.

PHYSICS.—*Tables and curves for use in measuring temperatures with thermocouples.* LEASON H. ADAMS. Bull. Amer. Inst. Min. Met. Eng. 2111–2124. Sept., 1919.

Previous publications have called attention to the advantages of standard calibration tables for translating the electromotive force of a thermocouple into temperature, and such standard tables have been given for copper-constantan and for platinum-platinrhodium couples. It has now been found advisable to extend the range of the copper-constantan table so that this couple may be available for measuring temperatures up to 400° and down to —200° C. A table for chromel-alumel (the Hoskins couple) has also been worked out and the previous platinum-platinrhodium table for temperatures between 0° and 1755° is reprinted without change. The question of fixed-junction corrections is discussed and the best methods for making such corrections are described in detail. L. H. A.

PHYSICS.—*Spectral photoelectric sensitivity of silver sulphide and several other substances.* W. W. COBLENTZ and H. KAHLER. Bur. Standards Sci. Paper **344.** Pp. 18, figs. 17. 1919.

This paper gives data on the change in the electrical resistance of the sulphides of silver and of bismuth, when exposed to radiations of wave-lengths extending from 0.6μ to 3μ. Measurements were made also upon galena, cylindrite, pyrite, and jamesonite, which, however, did not show photoelectrical sensitivity for the highest spectral radiation intensities available.

Both the natural mineral, acanthite, Ag_2S, and a laboratory preparation were examined. The latter material, which was hammered into a thin plate, was found insensitive photoelectrically, at room temperature. But at —157° C. a sharp maximum of photoelectrical sensitivity was observed for radiations of wave-length $\lambda = 1.05\mu$.

Increasing the intensity of the exciting radiations shifts the maximum of the photoelectrical sensitivity curve toward the long wave-lengths.

There is no simple law governing the variation in the photoelectric response in silver sulphide with variation in intensity of the radiation stimulus. Mechanical working (hammering into a thin plate) appears to lower the intrinsic photoelectrical sensitivity of acanthite and changes the position of the maximum of spectral sensitivity. A spectral photoelectric sensitivity curve of bismuthinite, Bi_2S_3, was obtained at —166° C. There are maxima of sensitivity at 0.64μ, and 1.08μ, respectively. W. W. C.

SPECTROSCOPY.—*Measurement of wave-lengths in the spectra of krypton and xenon.* PAUL W. MERRILL. Bur. Standards Sci. Paper **345.** Pp. 6, pl. 1. 1919.

This paper records photographic measurements of wave-lengths in the spectra of krypton and xenon, principally in the red and infra-red. In krypton 37 new lines were measured between 6576 A and 8928 A, and in xenon 52 new lines between 6318 A and 9162 A. In this region there are numerous strong lines which are probably among the most important in the spectra of these elements. Notable among these are xenon lines at 8231 and 8280. These and other lines may be of value as wave-length standards in the infra-red.

Attention is called to a probable analogy between the spectra of the rare gases neon, argon, krypton, and xenon which this investigation has brought to light. P. W. M.

INORGANIC CHEMISTRY.—*The relations between tridymite and cristobalite.* CLARENCE N. FENNER. Journ. Soc. Glass Technology **3,** Trans.: 116–125. Aug., 1919.

Several articles have appeared recently in French and British journals, in which some of the conclusions regarding the stability relations between the various forms of silica, published several years ago by the author, have been questioned. The principal basis for doubt seems to the present writer to be not that new evidence has been discovered, but that the observers have failed to take fully into consideration the rather remarkable properties of silica, which tend to obscure stability relations and whose effect was discussed in some detail in the article cited; moreover, that some of the evidence set forth there has been overlooked or disregarded, and explanations have been advanced which are inconsistent with this evidence. For this reason it has seemed well to take up the matter anew and present the evidence which bears upon the specific points involved. The points at issue are especially those which deal with the relations between tridymite and cristobalite. Certain evidence previously given is repeated in somewhat different form, and, to support it, further evidence is offered which either has not been given before in detail or is entirely new. In addition to the writer's work, other directly relevant information supplied by the work of Ferguson and Merwin on the system $CaO-MgO-SiO_2$ is cited in confirmation. All of the results are in accord with the conclusions previously announced, and it is believed that the explanations suggested by the foreign observers are directly at variance with the experimental evidence. The conclusion is reached, as before, that the field of stability of tridymite is limited by the temperature of 1470° ± 10°, and that at higher temperatures up to the fusing point cristobalite is the stable form. C. N. F.

ANALYTICAL CHEMISTRY.—*The rapid electrometric determination of iron in some optical glasses.* J. B. FERGUSON and J. C. HOSTETTER. Journ. Amer. Ceram. Soc. **2**: 608–621. Aug., 1919. (Geophysical Lab. Papers on Optical Glass, No. 16.)

The results of the application of the electrometric determination of iron with stannous chloride and potassium dichromate are discussed in this paper. The electrometric method enables one to make rapid and accurate analyses for both ferric and ferrous iron, provided interfering substances are absent. Under favorable conditions, such an analysis can be made in 10 minutes and may be carried out in glassware. Four different procedures are described for total iron and one for ferrous iron. A number of analytical results, including many ferrous-iron determinations, are given. The ferrous-iron content of the glasses proved to be dependent upon a number of factors and in some cases reached values in excess of 35 per cent of the total iron present. J. B. F.

ANALYTICAL CHEMISTRY.—*Determination of free carbon in rubber goods.* A. H. SMITH and S. W. EPSTEIN. Bur. Standards Techn. Paper **136**. Pp. 8. 1919.

After a brief review of the literature, a discussion is given of the difficulties encountered in the use of the nitric acid method. It is shown that nitric acid attacks the carbon and gives an insoluble compound, with the result that a factor of 1.05 must be used. An experiment is outlined which is taken to prove that bituminous matter is all removed by the treatment indicated. The effects of various mineral constituents are discussed and methods are outlined for their removal.

The authors conclude that, though the attack of nitric acid on carbon makes a very accurate determination impossible, the error caused thereby when the factor 1.05 is used is sufficiently small to justify the use of this method at the present time as a routine one in the rubber laboratory. S. W. E.

GEOLOGY AND PALEONTOLOGY.—*Contributions to the geology and paleontology of the West Indies.* Prepared under the direction of THOMAS WAYLAND VAUGHAN. Carnegie Institution of Washington, Publ. 291. Pp. 184, pls. 53, figs. 8. 1919.

Contents:

This series of memoirs, which has resulted from a minor grant made by the Carnegie Institution, presents data for the correlation of the different geologic events in the West Indies. The evidence furnished by all the classes of organisms studied is in accord. It is expected that this volume will be followed by others containing accounts of the fossil corals, the echini, the fossil and living land mollusks, and the stratigraphy and geologic history of the region.

1. Five species of coralline algae are described: 1 from the Eocene of St. Bartholomew, 3 from the Oligocene of Antigua, and 1 from the Oligocene of Anguilla.

2. The Foraminifera reported on are the Vaughan collection from the Leeward Islands, the Maury collection from Santo Domingo, the Johns Hopkins University collection from Bowden, Jamaica, and several lots from Cuba. The correlations indicated by the Foraminifera are discussed and 117 species are described or listed.

3. The Bryozoa described number 42 species; three of them are referred to new genera. The collections studied include representatives from the Oligocene of Antigua, Anguilla, and Panama and from the lower Miocene of Jamaica, Santo Domingo, and Costa Rica. The stratigraphic position and range of the species is tabulated.

4. In addition to 101 species of mollusks, including one new genus, from the Eocene, Oligocene, and Miocene of St. Bartholomew, Antigua, Anguilla, and Cuba, two new species of brachiopods from the Eocene of St. Bartholomew are described. The correlations of the formations are briefly discussed.

Since the completion of this paper, which was written early in 1917, the arbitrary boundary line between the Oligocene and the Miocene has been shifted a notch or two lower in the time scale, thus placing the La Cruz marl of Cuba, which had been regarded as Oligocene, on the Miocene side of the boundary. The fossils from the La Cruz marl are referred to the Oligocene instead of to the Miocene. This error is one of nomenclature, not of correlation.

The specimen from Anguilla figured on plate 2, fig. 3, and identified as *Orthaulax pugnax* (Heilprin) has proved, on further study, to be an undescribed species. Excellent specimens of the same species were recently obtained at several widely separated localities in Santo Domingo, and two fine casts come from the Island of St. Croix. As Miss C. J. Maury had described in manuscript an *Orthaulax* from Aguadilla, Porto Rico, which may be this species, I am refraining from giving my specimens a name until after her paper has been published.

5. The Crustacea studied are the Decapoda in the Vaughan collection from Anguilla and Antigua, the Gabb and Maury collections from Santo Domingo, and one specimen of doubtful origin. Thirty species are listed, but only 22 are specifically identified. Three new genera are described. C. WYTHE COOKE.

ANTHROPOLOGY.—*A structural and lexical comparison of the Tunica, Chitimacha, and Atakapa languages.* JOHN R. SWANTON. Bur. Amer. Ethnology, Bull. **68**. Pp. 56. 1919.

The Tunica, Chitimacha, and Atakapa languages were made the bases for the Tonikan, Chitimachan, and Attacapan linguistic families or "stocks" in the original classification of American languages north of Mexico by J. W. Powell. Even in Powell's time a reduction in the number of recognized stocks took place, and the process of reduction, or attempted reduction, had been markedly accentuated in recent years. The author believes he has adduced sufficient evidence in the present bulletin to prove the genetic relationship of the three languages considered. J. R. S.

ANTHROPOLOGY.—*Handbook of aboriginal American antiquities.* Part I: *Introductory, The lithic industries.* W. H. HOLMES. Bur. Amer. Ethnology, Bull. **60**. Pp. 380. 1919.

As explained by the author in his preface, "the present work forms one of the series of handbooks of the Bureau of American Ethnology, which was conceived as the natural and necessary outgrowth of the Handbook of American Indians (Bulletin 30), a comprehensive treatise completed and sent to press while the writer was Chief of the Bureau."

The purposes of the present volume and the nature of its contents are also best given in his own words. "This work," he says, "is not designed as a formal presentation of American archeology in which the antiquities are described and discussed country by country, or region by region, in geographical sequence, but rather as a reference work or manual, the principal purpose of which is to assemble and present the antiquities of the continent in such a manner and order as to make them readily available to the student who shall undertake to present a comprehensive view of the evolution of culture among men.

"The present volume is, in large measure, introductory to the systematic presentation of the antiquities; it deals with the scope of archeologic science, the character, extent, and classification of its subject matter, the progress of research; with the several important problems which present themselves for solution, including those of race origin, migrations, culture evolution, and chronology; with the ethnic characterization areas; with the acquirement of the substances employed in the arts; and finally with the manipulation of stone.

"The second volume is to be devoted exclusively to the implements, utensils, and other minor artifacts of stone. These are given precedence over other grand divisions of the subject matter for the reason that they lie at the foundation of Stone Age culture, and, for that matter, at the foundation of all progress toward the civilized state, and at the same time are the chief reliance of the historian and chronologist who seeks to write the early chapters of the story of humanity. Additional volumes are expected to treat of all the remaining materials —mineral, animal, and vegetable—and it is further planned to give separate consideration to the more important arts and industries practiced by the native peoples, as building, sculpture, the textile and fictile arts, and metallurgy." J. R. SWANTON.

CHEMICAL TECHNOLOGY.—*Constant-temperature still head for light-oil fractionation.* FREDERICK M. WASHBURN. Bur. Standards Techn. Paper 140. Pp. 12, figs. 4. 1919.

The three types of methods generally in use for the fractionation of light oil for the determination of benzene, toluene, and solvent naphtha are discussed. An apparatus which is an improvement on the dephlegmator of the Wilson and Roberts still is described, and the details of its operation are given. The apparatus is easily and inexpensively constructed, and requires no greater attention or time than others used.

Exceptionally large volumes of "pure" fractions are obtained which have a very small boiling-point range, showing that they contain only negligible amounts of impurities. Almost all of each of the components of the mixture distilled is obtained in practically the pure state, since the volumes of each of the intermediate fractions are only about 1.5 per cent of the volume taken for distillation. The composition of each of the intermediate fractions is actually determined, and the error introduced by this determination is small, since it is applied to only small volumes. The apparatus works well on mixtures containing widely varying percentages of benzene, toluene, and solvent naphtha.

F. M. W.

CERAMICS.—*Use of optical pyrometers for control of optical glass furnaces.* CLARENCE N. FENNER. Bull. Amer. Inst. Min. Met. Eng. 1001–1011. July, 1919. (Geophysical Lab. Papers on Optical Glass, No. 13.)

Among the features of careful control required in the manufacture of optical glass, that of the regulation of furnace temperatures is of high importance. It was found that the thermocouples generally in use did not come up to the requirements for rapid determination of temperatures, and it was thought that optical pyrometers should be a satisfactory substitute. Before adopting them for general use, tests were made to determine to what degree the requirements were satisfied. As a result, it was found that the manufacturer's calibration tables were considerably in error in some cases (which implies that they should always be checked), and that the luminosity of furnace-walls agrees satisfactorily with that of a "black body" under some conditions but departs very widely under others. The reason for these results and the factors upon which they depend are discussed. The manner in which the pyrometer is used under working conditions is described. The conclusion is reached that when the readings of the pyrometer are properly checked by such tests as these the instrument gives a very satisfactory and reliable means of controlling furnace temperatures.

C. N. F.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

339TH MEETING

The 339th meeting of the Geological Society of Washington was held in the Auditorium of the Cosmos Club on Wednesday evening, November 12, 1919. President E. O. ULRICH presided. The program was as follows:

REGINALD A. DALY: *Changes of land and ocean levels.*

Field study of the zones of post-Glacial emergence in the Gulf of St. Lawrence, along the New England coast, and in northwestern Europe has suggested two tentative conclusions bearing on general principles of geology. The first is that a world-wide (eustatic) sinking of ocean level to the extent of 20 to 25 feet seems to have occurred since the Wisconsin stage of the Glacial period. Secondly, certain field observations favor Jamieson's hypothesis that the sinking and rising of the earth's crust, due respectively to glacial loading and to unloading by deglaciation, have been accompanied, again respectively, by synchronous rising and sinking in the belt peripheral to the ice-caps; in other words, that these isostatic adjustments have been accomplished largely through viscous deformation of the earth, rather than by purely elastic deformation of the earth's radii.

The first suggestion has been strikingly enforced by facts recently ascertained in Florida and in the Samoan Islands, as well as by compilation of the published statements regarding "raised" beaches and allied forms along the shores of the United States, the Bahamas, Brazil, the British Isles, Australia, New Zealand, Pacific archipelagoes, and elsewhere.

Field evidence for the second suggestion has been secured chiefly on the Maine coast. There the condition of the shore zone emerged in post-Wisconsin time can best be explained by postulating uplift of the continental shelf during the Wisconsin stage, followed by resubsidence during the Recent isostatic rise of the glaciated region of the continent. If these synchronous movements were actually due to isostatic, viscous deformation of the earth's crust, similar movement might be expected in other parts of the belt peripheral to each ice-cap of the Pleistocene period. The corresponding test of the general hypothesis involves questions as to working of the abandoned shore-lines of Lake Passaic and of the Great Lakes; the origin of the submarine "channel" of the

Hudson River across the continental shelf; the origin of the "deeps" of the Susquehanna River; the cause or causes of many Pleistocene rearrangements of drainage in Pennsylvania, Ohio, West Virginia, Kentucky, and Nebraska. The relation of these problems to the general hypothesis may deserve discussion by the geologists who are most familiar with the different parts of this extra-glacial belt. Munthe's conclusion that Jamieson's hypothesis applies to Recent warpings in northwestern Europe is another strong reason for its serious consideration in the case of our own ice-cap area in eastern North America. Similarly, the reported warping of the highest shore-line of Glacial Lake Missoula (Montana-Idaho) and the problem of the Grand Coulee in Washington State may possibly indicate still a third ice-cap which deformed the earth's surface in the way Jamieson imagined.

The paper was discussed by several members of the Society.

340TH MEETING

The 340th meeting of the Society was held in the Auditorium of the Cosmos Club on Wednesday evening, November 26, 1919. The program consisted of the following three papers:

D. F. Hewett: *The Heart Mountain overthrust near Cody, Wyoming.*

This overthrust, recognized west of Cody by Dake in 1916, proves to be much more extensive than was at first suspected. Work in the region in 1919 shows that on two of the four principal summits of McCulloch Peak (6,200 feet) 12 miles east of Cody, caps of Madison and Bighorn (?) limestone 20 to 80 feet thick rest on beds that yield Bridger fossils (Upper Eocene). As these residual masses of limestone lie 28 miles east of the westernmost exposures of the fault, this distance measures the minimum extent of the overthrust. Data collected to date do not yield conclusive evidence whether the overthrust took place before or after the deposition of the andesitic tuff and breccia that make up the Absaroka Mountains. The extent of the overthrust is therefore comparable with the Bannock in southeastern Idaho, the most extensive known in North America. The Bannock overthrust took place before the Wasatch (Lower Eocene) beds were laid down, whereas the Heart Mountain overthrust can not have occurred before the deposition of the Bridger (Upper Eocene) beds.

Clyde P. Ross: *Geology of the Lower Gila region, Arizona.*

The region described lies in southwestern Arizona between Gila and Colorado rivers, south of Buckskin Mountains and west of Phoenix. The rock formations are divided into four groups: (1) basal complex; (2) intrusives of probable Mesozoic age; (3) Tertiary lavas and sedimentary rocks; (4) Quaternary alluvium and basalt. The basal complex is divided into highly metamorphosed schists included in batholithic masses of granitic gneisses, a thick series of metamorphosed marine sediments unconformably overlying the gneisses, and a series of comparatively slightly metamorphosed marine sediments of possible Paleozoic age. The Tertiary lavas far exceed the sediments in amount, totalling over 2,000 feet in thickness. They are latites, soda rhyolites, and similar rocks, with some basalts. The sedimentary rocks are, in part, of terrigenous origin and similar to those being deposited in the present valleys. There are also limestones containing indistinct fossils which were deposited in large bodies of brackish water which may have had connection with the sea through the Gulf of California. In the Quaternary, alluviation exceeded volcanism in importance. The sediments belong to three groups: (1) an older, disturbed and partly consolidated group; (2) a younger and only locally consolidated group; (3) the deposits of the present streams.

KIRK BRYAN: *Geology and physiography of the Papago country, Arizona.*

The Papago country is a large area in southwestern Arizona, lying south of Gila River and west of Santa Cruz River. Part of the results of a broad reconnaissance, covering nearly four square degrees, and made for the purpose of preparing a guide to routes of travel and watering-places in this desert region, was presented. The work was done in an automobile between September 4 and December 23, 1917. The speedometer mileage was 4,250 miles; logs for 1,920 miles of road were obtained; 240 photographs taken; and a topographic map containing much new geographic information, as well as a geologic map, were prepared.

The following broad generalizations can be made: (1) The mountains are not residual mountains in the old age stage of erosion, but the majority are fault block mountains in youth and maturity, or rejuvenated and resurrected mountains; (2) the valleys are with one exception drained and probably have never contained lakes.

Fifty-four of the sixty-eight mountain ranges and groups of hills in the area can be divided into three classes:

Class I consists of 21 mountain ranges composed in large part of alternating beds of lava, tuff, volcanic conglomerate and agglomerates, and stream-laid conglomerates, probably of Tertiary age. Two of these mountains are old volcanoes, 10 are rather simple fault-block and horst mountains, 11 are complexly faulted mountains and dissected plateaus with large or small masses of the underlying basal complex.

Class II consists of 17 mountain ranges composed largely of rocks of the Basal Series: granites, gneisses, quartzites, schists, and phyllites of pre-Cambrian age; felsites, both intrusive and extrusive, and granites of probable Mesozoic age; Paleozoic limestones; and Cretaceous sandstone and shales. While largely composed of rocks of the Basal Series, these mountains contain patches of lavas of Tertiary age tilted and dislocated and so disposed as to indicate that uplift followed the extrusion of the lava, and that the present mountains have been resurrected by the removal of a more or less continuous lava capping.

Class III consists of 14 mountain ranges composed wholly of rocks of the Basal Series, with no known association of Tertiary lavas. The mountains of this class approach most closely the prevailing conception of the mountains of the region as old age types. Two of them, however, the Estrella and Tinajas Altas mountains, have on their east flanks upland valleys separated from the lower canyons by steep grades and falls. Such valleys have been considered by Davis adequate evidence of renewed uplift of a fault-block mountain. Other ranges may fall in this class solely because they have been inadequately explored.

The remaining mountains and groups of hills, fourteen in number, are so little known that they can not be classified. Of the sixty-eight ranges, forty-two are young, mature, rejuvenated or resurrected mountains.

The intermontane valleys are in part formed of plains cut in rock, but McGee's estimate of 50 per cent of rock surface is an over-statement. The Gila, Santa Cruz, and Altar valleys are dissected not only by ephemeral streams which cut the alluvial slopes leading from the mountains, but by the axial streams. In none of the sections of the alluvium exposed by this dissection have lake beds been found. The axial trenches of Santa Cruz and Altar valleys fade out before reaching Gila River, and the terraces of the upper parts of these valleys can not be directly correlated with the terraces of the Gila. The axial streams of the smaller desert valleys are not entrenched except near Gila River, and the centers of these valleys are broad plains of alluviation with, however, no evidence of extinct lakes. The upper parts of the alluvial slopes are, however, nearly always dissected. This peculiarly arranged terracing and dissection presents one of the knottiest problems in the physiography of southern Arizona. On the successful correlation of the several stages of dissection and alluviation of these valleys will depend the interpretation of Pleistocene history in the region. Solution of this problem will also throw light on the validity of climatic terraces.

341ST MEETING

The 341st meeting of the Society was held in the Auditorium of the Cosmos Club on Wednesday evening, December 10, 1919. Mr. M. R. Campbell presided.

President E. O. Ulrich delivered the presidential address for 1919, entitled: *Major causes of land and sea oscillations.*

This paper will be published later in the Journal of the Academy.

After a recess, the twenty-seventh Annual Meeting was called to order by President Ulrich. The reports of the secretaries, treasurer, and auditing committee were read and accepted. The balloting on nominees for officers for 1920, proposed by the nominating committee, resulted as follows:

President, David White; *First Vice-President,* George W. Stose; *Second Vice-President,* W. C. Alden; *Secretaries,* R. S. Bassler, Laurence La Forge; *Treasurer,* George R. Mansfield; *Members-at-Large of the Council,* C. Wythe Cooke, J. M. Hill, H. D. Miser, Eugene Stebinger, R. C. Wells.

R. W. Stone, *Secretary.*

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

The Senate and House adjourned *sine die* on November 19, and the Sixty-sixth Congress convened for the regular session on December 1, 1919.

The bill to provide for an international conference on international communication (H. R. 9822), which is expected to have to deal with many technical questions such as wireless wave-lengths, has progressed to final action. It was reported in the Senate without further amendment and passed December 8, and was signed by the President on December 17 as Public Law No. 100.

On December 6 Mr. SUTHERLAND introduced S. 3496: "To amend an Act entitled: 'An Act to provide compensation for employees of the United States suffering injuries while in the performance of their duties and for other purposes,' approved September 7, 1916." The importance of this legislation to the members of the scientific bureaus has been recently emphasized by the accidental death of Mr. E. C. MCKELVY in one of the laboratories of the Bureau of Standards.

The act which it is proposed to amend is Public Law No. 267, Sixty-fourth Congress. The amendments provide, in addition to minor changes in details, for an increase of fifty per cent in the maximum and minimum monthly compensation; continuation of payments to a widow for two years after her remarriage; more liberal terms of payment to dependent parents, brothers, sisters, or grandchildren; and an increase from $100 to $150 per month as the maximum salary on which compensation to dependents may be computed. New sections provide for: payment of compensation to the heirs of a beneficiary who dies before he has received the amount due him; vocational education of an employee permanently disabled for work at his former occupation; maintenance of a temporarily disabled employee's right to reinstatement; and reduction of hazards by the aid of a safety engineer to be employed by the Compensation Commission. The bill was referred to the Committee on Education and Labor.

On December 5 Director VAN H. MANNING of the Bureau of Mines requested an appropriation of $100,000 to conduct an investigation into the ventilation of tunnels and subways for motor vehicles. The Secretary of the Interior also asked for $725,000 for the Bureau of Mines, with which to carry on a fuel inspection service to assure consumers that they get the grade of coal for which they pay.

[1] Preceding report: This JOURNAL 9: 645. 1919.

On December 8 Major General SIBERT, director of the Chemical Warfare Service, appeared before the Senate Finance Committee and argued that the building up of a chemical dyestuffs industry is essential to a complete program of military preparedness.

On November 7 Mr. DUPRÉ of Louisiana requested and received leave to print in the *Congressional Record* an article by Dr. W. B. SMITH, professor of mathematics in Tulane University, entitled "Not ten but twelve," and recently published in *Science*.[2] The article in question discusses the advantage of a duodecimal, as compared with a decimal system of numbers, and the author argues that the English system of weights, measures, coinage, time, etc., which is prevailingly duodecimal in character, should be retained pending the adoption throughout the world of a more perfect number system. The reason for inserting this article in the *Record* was stated to be its bearing on proposed reforms in the coinage system of this and other countries.

The Senate resolution for an investigation of the causes of influenza (S. J. Res. 76) was brought up on the calendar on October 22 and December 8, but was passed over. On October 16 Mr. FRANCE introduced a more comprehensive resolution (S. Con. Res. 13) providing for a survey of all governmental agencies concerned with public health, excepting the Army and Navy organizations. This was reintroduced on October 23, as S. Con. Res. 14, with the A my and Navy exception eliminated. The resolution provides for a joint commission of three members each from Senate and House, "to make a survey of and report on those activities of the several departments, divisions, bureaus, offices, and agencies of the Government of the United States which relate to the protection and promotion of the public health, sanitation, care of the sick and injured, and the collection and dissemination of information relating thereto." The commission is directed to report in June, 1920, on the powers, organization, and coordination of the federal agencies, and their cooperation with non-federal organizations. The resolution was agreed to by the Senate on December 16, and was then referred to the House Committee on Interstate and Foreign Commerce.

The Senate and House adjourned on December 20, until January 5, 1920.

NOTES

A joint meeting of the local sections of the American Society of Civil Engineers and the American Institute of Mining and Metallurgical Engineers was held at the Cosmos Club on Friday, December 19, 1919. The problem of securing closer cooperation among the engineering societies, both in the United States as a whole and in the District of Columbia, was discussed. At the close of the meeting the Civil Engineers met for the annual election of officers. The election resulted as follows: *President*, DAVID S. CARLL; *Vice-President*, JOHN C. HOYT; *Secretary-Treasurer*, JAMES H. VAN WAGENEN.

[2] Science 50: 239–242. 1919.

Dr. L. A. Bauer gave an illustrated address on *Observations of the total solar eclipse of May 29, 1919, at Cape Palmas, Liberia, and other places*, before the American Academy of Arts and Sciences at Boston, Massachusetts, on January 14.

Dr. Walter van Dyke Bingham, director of the division of applied psychology of the Carnegie Institute of Technology, Pittsburgh, has been elected chairman of the division of anthropology and psychology of the National Research Council for the term ending July 1, 1920.

Mr. R. M. Davis resigned from the Power Section of the Water Resources Branch, U. S. Geological Survey, in October, to take up work as statistician for the *Electrical World*. He takes the position of Mr. W. B. Heroy, formerly of the Survey, who has entered the employ of the Sinclair Oil Corporation.

Mr. B. E. Jones of the Water Resources Branch, U. S. Geological Survey, returned to Washington on November 7, after spending the season in the St. Mary and Milk River basins in Montana. Mr. Jones and Mr. S. G. Dawson of the Canadian Reclamation Service, were engaged in the division of the waters of St. Mary and Milk rivers under the direction of the International Joint Commission.

An anniversary publication of the *American Journal of Physical Anthropology* is being planned for March, 1920 in honor of the seventieth birthday of Dr. George M. Kober on March 28, 1920.

Mr. R. S. McBride resigned from the Bureau of Standards on January 15 to accept a position as technical editor with the McGraw-Hill Company of New York City. His headquarters will be in Washington in connection with the Washington office of the company.

Since the return of Mr. Eugene Stebinger from private work in the Tampico oil field of Mexico he has been appointed chief of the Foreign Section of the Mineral Resources Branch, U. S. Geological Survey.

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GEOLOGY.—*Major causes of land and sea oscillations.*[1] E. O. ULRICH, U. S. Geological Survey.

That the position of the strandline—hence the relation of land and sea levels—is and has ever been subject to change is a fact now established beyond all possible contradiction. The evidence shows that at times the shoreline retreated, leaving such features as elevated seaplains and cliffs on the enlarged land areas; at other times the seas advanced on the land, drowning previous river valleys, cutting new seaplains, and laying marine deposits much farther inland than before. These frequently recurring positive and negative movements of the strandline varied greatly in amount, but on the whole they were rhythmic in occurrence and volume. But neither the record of these movements nor the rhythm that runs through it is at all simple. Most of the criteria by which we determine that submergence has occurred in one case and emergence in another are relatively simple and easily applied. But when it comes to correlating the successive stages of emergence and submergence in different localities, or when we seek to arrange the movements in proper sequence and to determine their relative duration, the problems become involved and often exceedingly complex.

The evidence presented, especially in the past few years, by Vaughan, Daly, and Barrell seems to prove that at least the

[1] Presidential address delivered before the Geological Society of Washington, Dec. 10, 1919.

marginal parts of the continents have been subjected repeatedly in recent geologic ages to positive and negative displacements of the strandline; also that the vertical element of these oscillations is not uniform in amount at different places. Considering only the Pleistocene to Recent movements, their differential character at once suggests that these were in no case *wholly* due to either the alternate storing and unloading of water in the form of ice on the lands or, as Suess and Schuchert have it, to retreats occasioned by periodic deformation and deepening of oceanic basins and ensuing slow submergence by deposition of land detritus in the seas. Doubtless both of these processes contributed to the displacements of the strandline—clastic deposition continuously, and deglaciation more occasionally, in effecting submergence; accumulation of glacial ice and submarine deformation in effecting emergence. In all cases the work of these agents tended to produce an even rise or fall of the sea level. So far then as the coastlands are concerned the displacement of the strandline by these two causes would have been essentially eustatic.

But we know that, commonly at least, the displacement of the strandline was not entirely eustatic but more or less differential even in short distances. Other causes, such as deformation by loading, variable gravitational attraction, etc., must have contributed to produce the complex result. Of these other factors, I am sure locally varying movements within the land masses themselves, including the more or less submerged shelf, are the most important. What the relative effects of the several factors in each particular case may have been constitutes a most difficult and varying problem. These proportions can not possibly have been the same in all cases. Besides only one of the causes of submergence—namely, the filling of the sea basins with deposit—could have been constantly in operation though obviously most variable in the volume of result. Then, on the other hand, either sudden or gradual deepening of an ocean basin would by itself suffice in effecting emergence.

Up to a certain point I agree with the suggestions of Penck, Daly, and others concerning the competence of the Pleistocene ice sheets to effect considerable lowering of sea level; and the evidence indicating warping of the land surface, because of the uneven distribution of the ice load, as first pointed out by Jamieson, seems to me reasonably compelling. I believe also that in deglaciation the land surface largely re-established itself by elastic, or rather, isostatic rebound to preceding relief.

Though accepting in modified form the idea of glacial control of particularly Pleistocene sea levels, it is not to be denied that the present well-known occurrence in Newfoundland and in remote outlying stations along the coast of New England and the Maritime Provinces of many plants characteristic of the Coastal Plain of New Jersey and the south tends, as expressed by Barrell,[2] "to rule out the hypothesis that emergence was controlled only by the level of the ocean water as controlled in turn by glaciation." The extraordinary distribution of plants referred to could not be brought about by natural processes today. Evidently the northern occurrence of this flora is to be viewed as remnants of a preceding continuous distribution established when the climate of the northeastern coast was warmer and its coastal strip higher, wider and much less broken by water gaps. These required land conditions may be readily conceived as having obtained during, and as having resulted from, the ice loading of the glaciated regions to the west and northwest. As the latter sank under their growing load the continental shelf bulged its surface above sea level. But whether the plant migration could have been effected during the maximum extent of the Labrador Pleistocene ice sheet is so doubtful that Barrell[3] thought it necessary to assume delay in the settling back of the upwarped marginal zone after the removal of the ice sheet. As defined by Barrell, his hypothesis is "that the weight of the ice sheets caused crustal depression directly below the load, but moderate elevation in a wide zone beyond the load. Upon the removal of the ice it appears the first isostatic upwarping carried up higher this marginal upwarped zone with it. Being already an upswollen tract the broader regional movement car-

[2] Amer. Journ. Sci. 40: 17. 1915.
[3] Idem. pp. 19–21.

ried it up to a level where it became unstable and a slow settling back occurred as an after-effect, coincident with the last stages of upwarping over the centers of glacial load. The actual evidence at hand does not decide between these hypotheses. The association with the close of glaciation appears to favor a genetic connection with deglaciation, but, on the other hand, it remains to be demonstrated why the extra-marginal zone should rise together with the region directly glaciated, or that the cycle was restricted to such an extra-marginal zone."

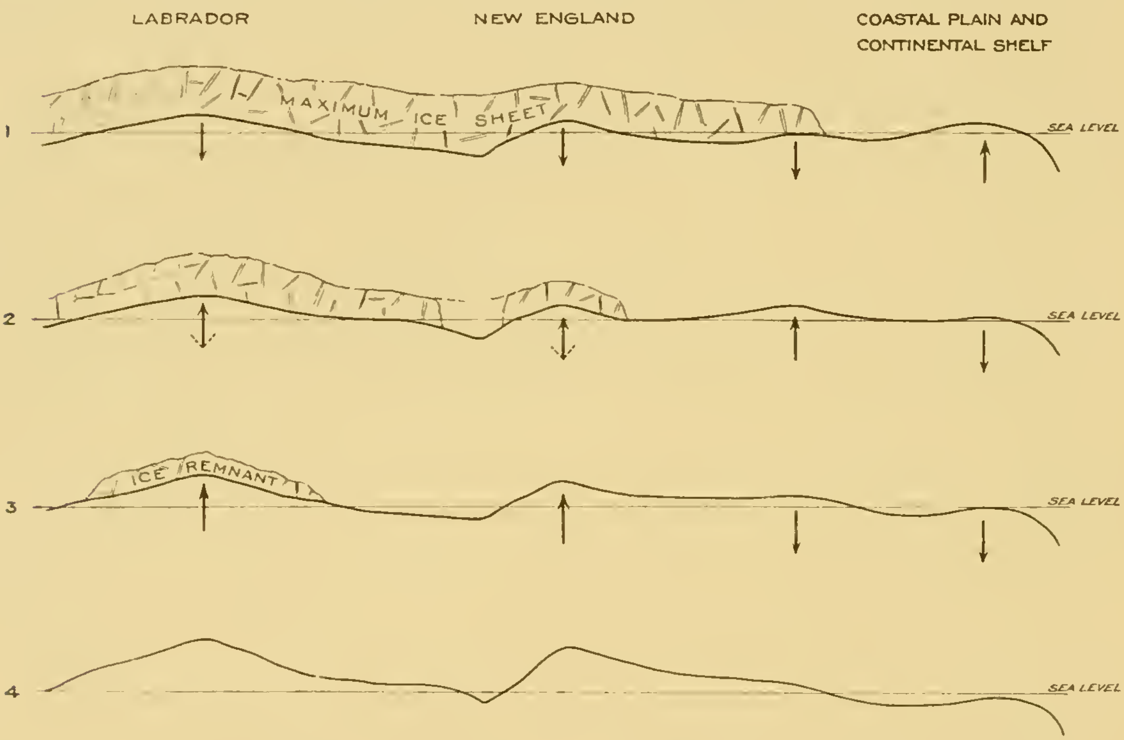

FIG. 1.—Generalized profiles of eastern North America in Pleistocene stages, indicating isostatic vertical movements of surface of lithosphere in process of deglaciation: 1, during maximum extent of ice sheet, when the outer part of continental shelf was emerged; 2, when the ice load had retreated from the present coastal strip; 3, a later stage when the ice sheet had been reduced to the area of Labrador; 4, present relief of land, with submergence of continental shelf. Approximately similar conditions may be supposed to have obtained in the growing stages of the ice sheet.

That the eastern margin of the continent, south of Labrador, did rise to higher levels than the present during the retreat of at least the last Pleistocene ice sheet seems, with Barrell's interpretation of Woodworth's[4] data and conclusions regarding

[4] N. Y. State Education Department, Bull. 84: 1905.

"Ancient Water Levels of the Champlain and Hudson valleys," highly probable. Indeed, supported as this evidence is by the facts concerning the distribution of the Coastal Plain flora just alluded to, emergence of this marginal area as this time may justly be accepted as reasonably established. As will have been observed in the quotation, Barrell's hesitancy in adopting this hypothesis arose mainly from the uncompleted demonstration of "why the extramarginal zone should rise together with the region directly glaciated."

In thinking this matter over the possible solution of the difficulty somewhat crudely illustrated in figure 1 has been reached. The diagram represents in generalized profile four Pleistocene stages of eastern North America, the profile running southeastwardly from Labrador to the edge of the continental shelf. The stages are represented separately, showing relief of land surface in each and the extent of the ice sheet in the maximum and two partly deglaciated stages. The fourth represents the present condition. One of the new features is that as the ice retreated the normally positive strip bordering the present eastern shore responded at once to the release from directly applied weight pressure by rising. Emergence of this Piedmont and Coastal Plain strip would be further insured by the necessity of maintaining isostatic balance with the outer strip of the continental shelf which had bulged to emergent status by subterranean flow from beneath the ice loaded land. In consequence, as the ice sheet retreated the emerged outer part of the continental shelf began to sink, whereas the strip along the landward side of the present shore rose. Among the physiographic changes that may be supposed to have occurred at the time of this southwardly decreasing elevation of the coast lands north of Baltimore is the cutting of the now buried deep channel of the lower Hudson; also the sharp southward deflection of the Delaware and Susquehanna rivers. During the preceding maximum extent of the ice sheet Maryland is supposed to have stood higher than at present and the lower stretches of these rivers either flowed northeastwardly or they emptied more directly and much sooner into the sea, which then probably covered the New Jersey part of the Coastal Plain and extended widely into the eastern valleys of the adjacent Appalachian region. As the ice sheet retreated Maryland settled back while the coast lands to the north rose. The resulting emergence and the reversal of the tilt of the land surface must have produced corresponding changes in the direction of flow of affected rivers. Obviously results like these required practically immediate isostatic response to both the accumulation and the removal of the burden of ice and not as Barrell thought, "a deferred intermittent, and possibly oscillatory, readjustment." (Op. cit. p. 21.) On further retreat of the ice front the upward movement of the latter was arrested and finally reversed, so that it shared in the general subsidence of the marginal area when the complete withdrawal of the ice sheet permitted isostatic rebound of the unloaded interior highlands to their preceding and present normal land altitudes.

In consequence of the bulging of the sea bottom adjacent to shore lines that in the maximum spread of the ice sheets had sunk beneath the load of ice, the capacity of the ocean basin must have been correspondingly lessened. This in turn would have tended to retard and finally reverse the downward direction of the change in sea level previously prevailing on account of subtraction of ocean water for the making of the ice sheet. That is, it would have caused actual raising of sea level except in those parts of the shore line that were covered by the ice sheet and therefore directly affected by its weight. The upward movement of the sea level thereby occasioned would have been worldwide and eustatic.

But the displacements of the Pleistocene strandline along the Atlantic Coast that were in any wise connected with glaciation must, because of varying conditions arising from the fact that the ice sheets did not reach the shore line south of New Jersey, have varied greatly in amount and direction at different places. It was only in the early stages of glaciation, before peripheral elevation of the surface of the lithosphere with respect to areas bearing ice loads had progressed to the stage wherein it caused material lessening of capacity of ocean basins, that the sinking of sea level could have been eustatic. On the reversal of this sea level movement, when the Pleistocene ice sheet stretched to the shore and when as stated above, the consequent bulging of adjacent parts of the continental shelf reduced the capacity of the ocean basin, the change in sea level as manifested in the advance and retreat of the Atlantic shore north of, say Cape Hatteras, was far from eustatic. During this maximum extent of the Labrador ice sheet, the ice-covered near-shore lands about the Gulf of St. Lawrence must have sustained extensive submergence. Southwardly from northern Maine to New Jersey the amount of this submergence decreased perhaps to its minimum. On the other hand, in Maryland, which I take to have lain at that time within the belt of peripheral isostatic elevation, the land was pushed up with resultant apparent or relative sinking of sea level. Farther south, beyond the belt of peripheral bulging, the Atlantic shore probably shared in the eustatic rise of sea level that prevailed generally because of the temporarily decreased capacity of ocean basins except in the areas affected immediately and differentially by the ice sheets.

Correlation of Pleistocene sea beaches in Maryland and Maine therefore suggests and perhaps requires comparison of the high beaches in Maryland with low beaches in New England.

Because of this dissimilarity in manifestation, it seems to me that it is only in the warm temperate and tropical zones lying well beyond the areas in which isostatic balance would be materially disturbed by known ice loading of lands, that the sequence and amount of the several glacially controlled Pleistocene changes of sea level are recorded in their proper relations to the actual fluctuations of the volume of sea water and to the capacity variations of the basins holding it. But even in tropical areas the complete sequence of the oscillations and the immediate cause of each cannot be worked out without taking strict account of what was happening at the same times in higher latitudes.

In thinking of the progressive and regressive sequences of movements it is well to remember that ice loading and sediment (rock) loading of epicontinental areas are comparable in their deformational effects on the lithosphere only in one respect—that is, in both cases the loaded area sinks. They differ, primarily, in that the ice cap originates on, and spreads outwardly from, normally positive areas whereas the rock sediments are laid only in areas of relatively negative tendencies. Subsidence because of ice loading, therefore, is an abnormal process in that it is carried on under unusual conditions, so that normal gravitational tendencies are reversed; in the other case not only the process but the results also are perfectly in accord with the normal gravitational tendencies of the affected areas. Next, they differ in that the ice sheets presently melt away, whereas the water-laid rock deposits commonly remain as a permanent asset of the area covered by them. A third difference is that in the first cases the removal of the ice load tends to re-establish the normally positive tendencies of the deglaciated areas, whereas in the areas loaded with rock deposits their normal negative tendency is not reversed.

Finally, there is the rather generally accepted belief among stratigraphers and students of paleogeography that in the past the advances of the sea usually were slow and gradual, whereas the retreats were more rapid and relatively impulsive. Many facts in Paleozoic stratigraphy are cited in my *Revision* in support of this belief, and Barrell, in 1915, expressed himself as favoring the view.

Now, if we accept this conclusion it certainly does not help the hypothesis of measurable sea level fall by storing of oceanic waters in continental ice sheets. Obviously, the subtraction of water from the seas to make the ice sheets must have been a slow and on the whole gradual process; and the time consumed in the growth of the ice sheets probably was not materially shorter or longer than that required in their melting.

From these considerations it is clearly evident how exceedingly difficult is the proper determination of the part actually played by glaciation and ensuing deglaciation in the emergence and submergence of the continental borders. The fall and rise of sea level directly resulting from the storing of oceanic water to make a great ice sheet that later is returned to the sea is so intricately connected and interwoven with genetically similar but at times oppositely directed general and local deformations of land areas and also of sea bottom areas adjacent to the strandline, that the reliable valuation of the two or more factors seems as yet practically hopeless. Moreover, it appears to me that only the early and the late stages of a period of glacial control could have made and left anything approaching world-wide and vertically equal records of consequent displacements of the strandline. The early stages would be those in which the lateral growth of the ice sheet had not yet reached the zone in which the weight of the ice would have caused extramarginal bulging and apparent lowering of sea level far in excess of the fall actually occasioned by transferal of water from the sea to the land. Similarly the later stages would be those following the retreat of the ice sheet to the same relatively innocuous limits.

It follows, then, that only the eustatic smaller shiftings of the Pleistocene sea levels may be definitely ascribed to storing and subsequent release of frozen water on the land. And for these even it is mainly their occurrence in a known ice age that induces one to admit their probable glacial origin. However, the larger and in most instances also much more local Pleistocene oscillations of the strandline, even granting that their causation is intimately connected with ice loading and unloading of land areas, belong to another category. Strictly speaking, these larger displacements have resulted from truly diastrophic causes and processes that are concerned with the maintenance of the isostatic equilibrium of the lithosphere.

Under the circumstances, then, I must agree with Barrell in concluding that the amount of water taken from the seas for the formation of the ice sheets was not a direct "major factor in the control of Pleistocene sea levels." Movements, acting within, beneath, and upon the lithosphere thus appear to have been the more effective factors.

That the marginal areas of the continents were at times elevated and folded is, of course, accepted by all—even by Suess and his followers, who speak of the continents as having the character of "horsts" and of the ocean basins as being permanently "sunken areas." Suess, however, believed that the median areas of the continents are essentially stable, a view adopted by Schuchert, who holds "that the continent (North America) is a horst, that the great medial region remained unmoved, while the margins were often folded and elevated. The seas periodically flowed over this medial land—in fact, were elevated over it—owing to the detrital materials unloaded into the oceanic areas, thus filling them and causing them to spill over on to the lands."

I can not subscribe to this opinion. On the contrary, though accepting the idea of permanent oceans and continents, it seems to me that the crust of the lithosphere was subject to periodic movement away from the poles; that the surface of the lands was exceedingly unstable in the median areas as well as along the borders of the continents. Schuchert's paleogeographic maps, indeed, offer convincing proof of such instability; and the more detailed maps made since his appeared, further substantiate my claim.

In reaching these conclusions I am mainly influenced by a lifetime study of Paleozoic formations and their faunas. The criteria and principles used in the course of these stratigraphic investigations are defined and discussed in my *Revision of the Paleozoic Systems* published in 1911. In this work more than 100 previously undescribed instances of differential vertical movements of lands and consequent shifting of seas are discussed in varying detail. Since 1910 much additional information has been gathered concerning such oscillations in North America.

On this occasion I shall mention briefly some of the more convincing of the published cases and in greater detail a few of the more recently determined instances—enough of both to show that from the beginning of Cambrian time the surface of the continents was exceedingly unstable and subject to frequent oscillation, and that the epicontinental seas were correspondingly inconstant, shallow, relatively small and frequently withdrawn in part or entirely. Even in the same geological provinces the outlines of the new sea may agree essentially and often very closely, in parts, with the next preceding or some earlier sea, but in other parts the new shoreline departs radically from the older.

These movements occurred in Paleozoic ages which, unlike the Pleistocene, have left no record of great ice accumulations. Doubtless even in the Paleozoic there were times of relative frigidity—when some of the higher parts of the marginal lands were ice-covered, in some instances attaining locally to glacial conditions. Here and there regular tillites are indicated, notably, as recently brought out by Dr. Edwin Kirk, in the Silurian deposits along the coast of Alaska. Occasionally, too, transportation of bulky erratics by heavy shore ice is suggested, as for instance by the late Ordovician Rysedorph hill conglomerate near Albany, N. Y., and the great masses of unworn limestone of Ordovician and Silurian ages found in the early Pennsylvanian Caney shale of eastern Oklahoma. But the Paleozoic history of North America so far as known affords no suggestion of icy ages comparable to the Pleistocene period in the amount of water abstracted for the formation of the ice sheets. Moreover, by far the majority of the displacements of the strandline in the continental seas occurred at times and places that give no indication whatever of particularly cool climates. On the contrary, the entombed faunas in the overlapping and interfingering marine formations could hardly have lived in the shallow seas if the climate of the adjacent lands had not been mild.

With the data in hand I feel warranted in asserting that the level of the Paleozoic continental seas was seldom appreciably affected and certainly never controlled by glaciation. Besides, the apparently irregular, though doubtless rhythmic, shiftings of the strandline almost without exception indicate local differential movement in the continental surface. And these movements must have been connected with other more general movements, requiring at times partial or complete withdrawal of the waters from the land depressions, at other times permitting readvance in the same or some other newly depressed land basin.

The varying distribution of marine deposits of successive ages naturally suggests differential upward and downward movement of the lands as the immediate cause. If the submergences had been occasioned solely by rise of the waters, the successive submergences would have been always similar in geographic pattern and different only in lateral extent. In fact, a general similarity or repetition of old patterns is recognizable, but there is also exceeding diversity of expression; and often the difference is greatest when directly succeeding stages are compared. Often again, when one stage appears to have been very different from the next, the following third or fourth may be very much like the first. Only oscillatory movements or warping of the land surfaces could produce such results. The area affected by such movements may be very large, as, for instance, during the middle Ordovician and middle Silurian, when nearly half of the continent of North America was involved. During these periods the Gulf waters seem at certain times to have been completely withdrawn from the southern part of the continent, the middle and northern parts at such times being tilted so that the boreal sea extended southward beyond Chicago and occasionally as far as northern Tennessee.

Strictly, these widely operating movements hardly fall under the category of epeirogenic movements. On the other hand, they are not truly orogenic, if that term is to be confined to movements originating in shrinkage of the centrosphere. Apparently they indicate a combination of causes, perhaps beginning or ending with the play of orogenic factors that built mountains in the submarginal areas whereas the warping and deformation of the more stable interior areas was mainly occasioned by the necessity of isostatic readjustments to stresses incident to the greater deformations of the orogenic movements.

Then there were many relatively local changes in the strandline of continental seas that may be explained only by assuming correspondingly local differential, vertical movements of the lithosphere. I do not refer to movements connected with volcanism. On the contrary, the best examples of the kind in mind are found in areas but rarely or not at all directly affected by volcanism. These differential movements indicate actual elevation of one area while another nearby was sinking. Moreover, in the next recorded age the directions of ensuing movements at the two places often were reversed. The phenomenon might be likened to a gently convex platform supported in the middle and tilted alternately to the east and west and at other times to the north and south. The condition is recognized by the alternate presence and absence of sediments of particular ages on opposite sides of the tilting platform. (See figure 2.)

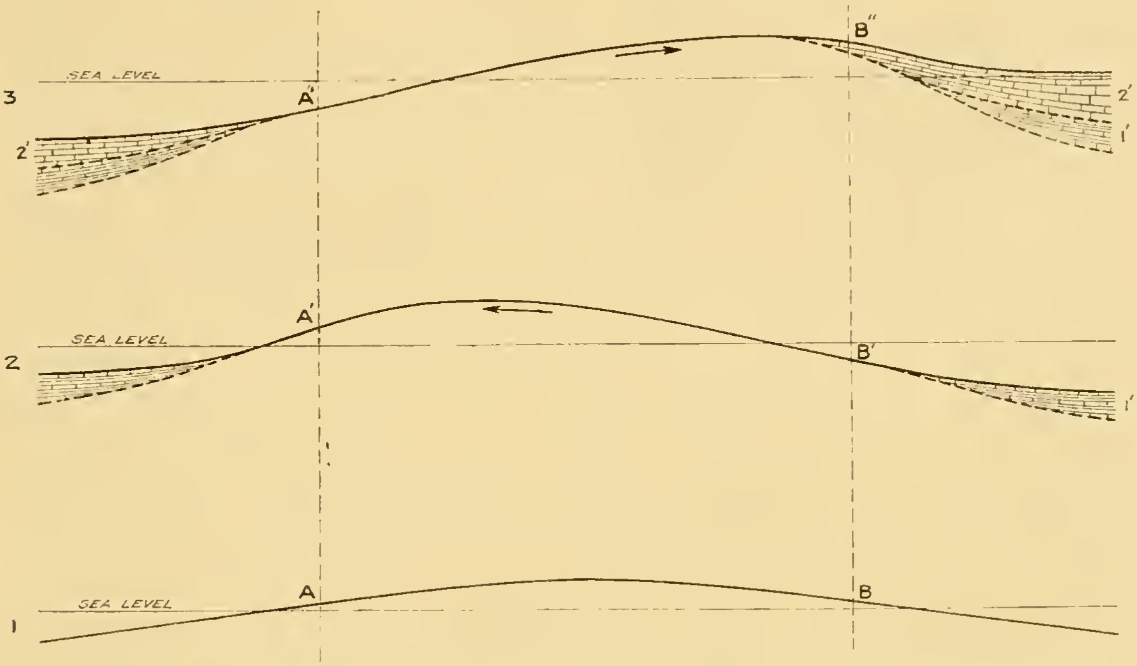

FIG. 2.—Diagram illustrating tilting of interior areas of uplift (for example, the Cincinnati dome), and the consequent variations in amounts of advance and retreat of the sea on their opposite sides. Arrows indicate direction of horizontal stresses. The letters A, A′, A″, on the one side and B, B′ and B″, on the other, mark the same points on the flanks of the dome in all of the three stages. In 1 the sea laps equally on both sides; in 2 the elevation of the dome is accentuated and its summit has migrated to the left, while the sea has advanced much more on the right side than on the left; in 3 the summit has migrated in the opposite direction so that the deposits of the preceding stage on the right flank are largely emerged whereas on the submerged left flank the new sea widely overlaps the deposits of the two preceding stages (1′ and 2′).

Comparative studies of the Paleozoic deposits in the Appalachian Valley region, from eastern Pennsylvania on the north and central Alabama on the south, have brought out over a hundred clearly defined examples of such oscillations. They are manifested by the restricted distribution or local deposition of many overlapping formations having maximum thicknesses of from 200 to over 2,000 feet. In many cases these formations are wholly or mainly confined to one or more narrow, trough-like, longitudinal divisions of the Appalachian geosyncline and commonly to one or another of three divisions of the geosyncline that are more or less effectively separated from each other by low transverse axes. The most northerly of these broad axes passes across the valley between Carlisle and Lebanon, Pennsylvania. It is known as the Harrisburg axis. The next to the south intersects the valley of Virginia between Staunton and Harrisonburg. The third or Wytheville axis passes across southwestern Virginia, which is today the highest and narrowest part of the great valley. The fourth axis crosses in a more northerly direction than the others through the belt lying between Rome, Georgia, and Gadsden, Alabama.

These transverse axes do not cross the longitudinal troughs of the geosyncline in continuous direct lines. On the contrary, their course zigzags within the varying limits of a broad band so that the northern head of a bay in one trough may extend 50 miles or more beyond the latitude of the southern head of another, younger or older, bay in an adjacent trough. The band is wide enough and was always low enough so that regional tilting occasionally permitted overlap of edges of formations transgressing from opposite directions. Often the axis formed an efficient barrier in one trough and was much less effective in the one next to the west or east. More rarely, a bay, terminated at the north by a transverse axis, connected laterally with waters in an adjoining trough in which the submergence was not stopped by the axis. Finally, at other times the axis offered no serious obstacle to the passage of the marine invasion. Of course, the individual troughs were submerged over and over again, but in none do we find representatives of all of the formations known to have been deposited in the Appalachian Valley.

Varying geographic expressions like these could have been made possible only by differential vertical movements in the concerned parts of the lithosphere, and these Appalachian oscillations in sea level were by no means small affairs. Most of them are measured by hundreds of feet and some by thousands.

Excellent and very interesting oscillations occurred about those more inland and very ancient positive areas known as the Cincinnati and Nashville domes, the Ozark and Adirondack uplifts, and the Wisconsin peninsula. Of the many formations that are found on their flanks and which failed to pass over them much the greater number are confined to one or the other side. The sequence of formations on either side therefore differs greatly from that on the opposite side.

Much space is devoted in my *Revision of the Paleozoic Systems* to a description of the inequalities in areal distribution of the formations that were laid down on the flanks of these epicontinental domes. With a few corrections and modifications, in every case tending to emphasize rather than to weaken the argument based on the observed phenomena, the published statements concerning them in that work have been further substantiated by more recent investigations. Instead of overstating the number of oscillations in that paper we can now prove many more instances than were known or even suspected by me in 1910.

In New York State alone, the joint investigations carried on in the Ordovician shales and limestones on the south and west sides of the Adirondack mass by Doctor Ruedemann and myself, and on the Medina and Clinton formations with Mr. Hartnagle have increased the established cases of sea shifting implying more or less decided differential vertical movements in the adjacent land masses to more than twice the number contemplated when I wrote the *Revision*.

Similarly, the work of Mr. Charles Butts and myself, on the Mississippian formations in Illinois, Kentucky, Tennessee, and Alabama has developed oscillations of like character that were scarcely suspected six years ago.

Very notable additions to our knowledge of Cambrian and Ozarkian oscillations also have been made in the course of my work on the Paleozoic formations in Wisconsin. Before closing permit me to give some details concerning at least one of many similar new discoveries in this and adjoining States.

Only a few years ago the stratigraphy of the Cambrian deposits in the upper Mississippi valley was practically unknown or at best only very imperfectly understood. Because of certain misapprehensions, now clearly understood, the correlations of the several sections by the State geologists of Wisconsin, Minnesota, and Iowa were not only inadequate but quite in error.

So long as the observed variations in character of deposits and their fossil faunas were supposed to indicate nothing more than merely local variations in contemporary seas and life it was almost impossible to work out the true relations of the beds in the largely drift-covered and hence discontinuous exposures of the Cambrian rocks. A new viewpoint was required; also closer investigation of bedding planes, greater accuracy in noting the vertical and geographic ranges of particular species and faunal associations and of particular beds. In short, it was necessary to employ more modern criteria, principles, and methods than had been used before.

When the work of revising the Paleozoic stratigraphy of Wisconsin was begun in 1914, the task seemed relatively simple in view of the success that had attended our investigations in the supposedly more difficult fields in the Appalachian region, about the Cincinnati and Nashville domes, and the Ozark and Adirondack uplifts. Indeed, the results of the first season's work in Wisconsin were so satisfactory to Doctor Walcott that he decided to publish my revised section in his work on the Dikelocephalid trilobites.[5] As therein given, the Upper Cambrian series in the Mississippi valley is divisible into six lithologically and faunally distinct formations, named from below upwards: the Mt. Simon sandstone, which rests on pre-Cambrian crystallines, followed in turn by the Eau Claire shale, the Dresbach sandstone, the Franconia (glauconite bearing) sandstone, the St. Lawrence formation of limestone, shale and sandstone, and the Jordan sandstone. Above these came the Lower Ozarkian Mendota limestone and the Madison sandstone, the last of which is overlain by the Oneota dolomite of the "Lower Magnesian" series. Aside from the determination

[5] *Dikelocephalus* and other genera of the Dikelocephalinae. Smith. Misc. Coll. 57: 1914.

of the lithologic and faunal sequence of the Cambrian in the western half of the State, the most important improvement brought about by the first season's work was the proof that the Mendota limestone and Madison sandstone are really post-Cambrian formations and not, as had been supposed previously, the eastern representatives of, respectively, the St. Lawrence limestone and the Jordan sandstone of Minnesota. In fact, it was then believed and has since been definitely proved that whereas the St. Lawrence extends uninterruptedly from Minnesota and Iowa across the southern half of Wisconsin and under cover of later formations into northern Illinois, the Mendota limestone is entirely absent to the west of a narrow trough running southeastwardly from the southern slope of the pre-Cambrain Baraboo quartzite range.

In the following field season of 1915 doubt arose as to the eastward extension of the Franconia formation to and beyond Madison. At this place there is a more or less decidedly calcareous sandstone formation, approximately 100 feet in thickness, which lies between unquestionable Dresbach sandstone and no less certainly established St. Lawrence limestone and shale. The intervening formation therefore seems to occupy the same stratigraphic position as the Franconia. But its lithological characteristics, except that it also contains considerable, though more disseminated glauconite, are quite different from those of the Franconia; and whereas good fossil remains of characteristic types are exceedingly abundant in the Franconia they appear to be much fewer and, so far as could be determined from the handful of fragments then procured, of different species.

In casting about for a means of determining the problem I thought of an old anticline that extends southwestward from the Baraboo range across southern Wisconsin into Illinois. This axis had previously been found to have had an important effect on the distribution of the Ordovician formations and it seemed worth while to see whether it had not been in existence, and functioning as a barrier, already in the Cambrian. Accordingly, a part of the season of 1916 was devoted to following the nearly continuous exposures of Cambrian rocks in the bluffs and valley walls along Wisconsin River.

Beginning at Boscobel and going upstream, the Franconia, in typical development, was found to hold its own for a distance of about 20 miles, when it began slowly to lose thickness by overlap. The succeeding 15 miles, which brought us to the town of Lone Rock, sufficed to pinch the formation out entirely. Beyond Lone Rock, for a distance of about 10 miles, in which we passed through the town of Spring Green, the Franconia is absent, the top of the underlying Dresbach sandstone has risen considerably above the river level and is immediately followed by characteristically fossiliferous shales and limestone of St. Lawrence age. (See figure 3.)

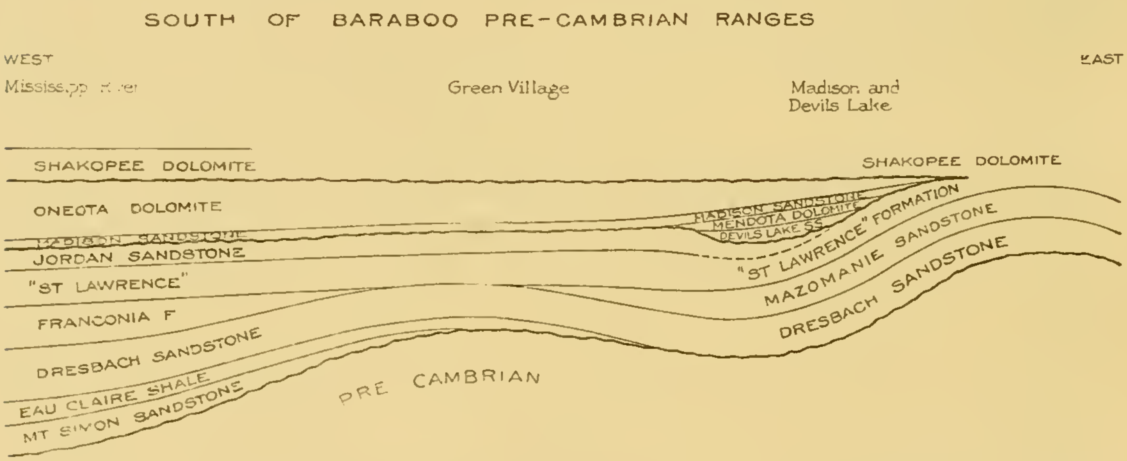

FIG. 3.—Section across southern Wisconsin, showing sequence of Upper Cambrian (St. Croixan) and Ozarkian formations, the apparently similar stratigraphic positions of the Franconia and Mazomanie formations, and the absence of both on the summit of the pre-Cambrian anticline.

Just east of Spring Green the closed contact between the Dresbach and St. Lawrence opens again to receive the wedge of magnesian sandstone whose age was the quest of the undertaking. Where first exposed in the bluffs east of Spring Green the Mazomanie sandstone, as the new formation is called, is about 10 feet thick. Four miles east of the town it has thickened to 80 feet, and at Fairy Bluff it reaches 100 feet. Wherever it rises to considerable heights above the valley bottoms in Dane, Sauk, and Columbia counties it forms cliffs, which is not at all true of the typical Franconia.

But, so far as positive evidence regarding the age relations of the Franconia and the Mazomanie is concerned, these investigations of the bluffs along Wisconsin River left the question as unsolved as before. Nor did we come any nearer to its satisfactory solution in the course of the following season's work when a series of sections was made on the south side and around the eastern end of the Baraboo range. But just before the close of the field studies in 1918 some very promising but under the circumstances inconclusive observations were made in sectioning the outliers and bluffs which dot the sandy plain of central Wisconsin. Namely, at one of these bluffs I found a perfectly characteristic Mazomanie cliff and beneath it a 2-foot

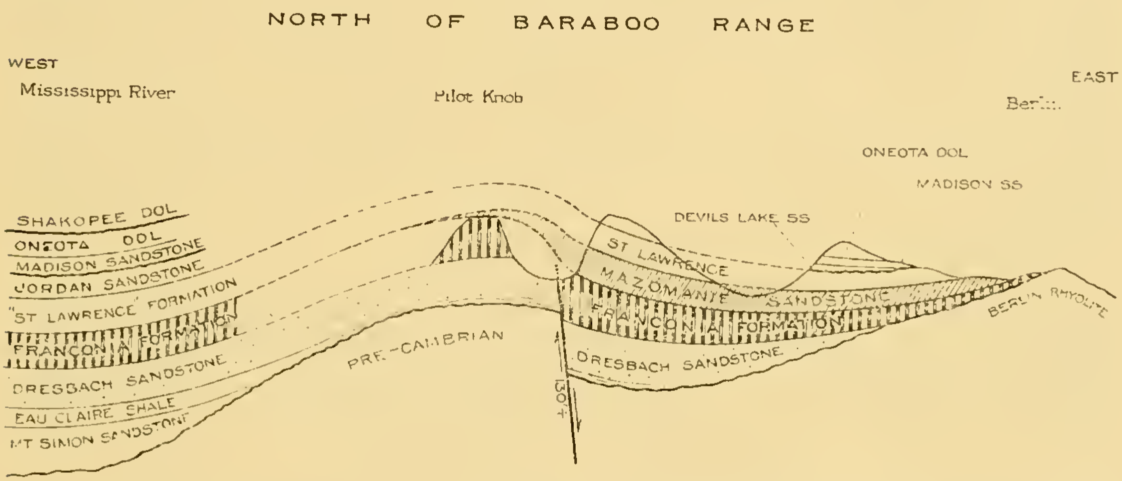

FIG. 4.—Section across central Wisconsin, showing greater eastward extent of the Franconia in this part of the State and intercalation of the Mazomanie between the top of the Franconia and the base of the St. Lawrence.

exposure of reddish sandstone that seemed to me to be of Franconia age.

However, the evidence at this place was not satisfactory to Doctor W. O. Hotchkiss, State Geologist, and Mr. F. Thwaites, who accompanied me on this as on most of the other trips through the State. Their doubts arose mainly from the fact that my interpretation required the assumption of a fault hitherto unsuspected between this bluff and Pilot Knob, which lies less than a mile to the northwest.

And so it was left to the work of the past summer to clear away all doubt, if possible. And it was cleared away. Other outliers in this vicinity were visited until finally we found two that were capped by Mazomanie and St. Lawrence and beneath the Mazomanie showed from 50 to 100 feet of profusely fossiliferous Franconia. Incidentally the presence of the fault just mentioned was unquestionably established. As an interesting and welcome confirmation of the earlier conviction that the Franconia is older than the Mazomanie—welcome despite the fact that it came to light after the case had been proved by actual superposition—I may add that two entirely new faunas, one from near the top, the other just above the base of the formation, were discovered in the Mazomanie. The upper of the two occurs rather widely distributed but in a sandstone so friable that it can not be picked up without crumbling in one's hand. Despite this difficulty a considerable collection was made and safely transported to Washington by soaking the sand with shellac.

I have described the solution of this problem in greater detail than may seem necessary, first because of its intrinsic value and interest as a new instance of oppositely overlapping formations, second because of its bearing on the question of differential surface movements, and third as an illustration of the thoroughness of modern stratigraphic investigations.

The case shows differential movement, first in the fact that the Franconia is confined to the western half of the State, whereas the preceding Dresbach was laid down on the east side and over the south side as well as the west. Next, the very different distribution of the Mazomanie shows reversal of the tilt from the west toward the east. Further—through the fact that the two formations are separated to the south of the Baraboo range by a broad strip, in which neither is present, whereas to the north of the pre-Cambrian range both formations were laid down so that the younger overlaps the older for a distance of at least 50 miles—it is proved that the movement was not simply an east-west reversal of tilt but that it was accompanied by additional local subsidence on the north where a depression was formed that subsequently lodged a considerable embayment of the Mazomanie sea.

But this does not exhaust the known record of diastrophic movements of this time in Wisconsin. Uplifts of the relatively evenly distributed floor of Dresbach sandstone are indicated in many places; and depressions occurred in other localities so that the Franconia lapped over in such places on to the pre-Cambrian rocks. This occurs at Berlin and at Taylors Falls, towns located on opposite sides of the area covered by the formation. At Osceola, on the other hand, there is a narrow ridge on the surface of the Dresbach that completely cuts out the Franconia, though the formation is well developed both to the north and south of Osceola. Finally, we recognize two longer upwarps of the Dresbach floor that extend in a southwesterly direction from the central pre-Cambrian land mass which formed the backbone of the Wisconsin peninsula. These buried ridges divided the Franconia sea into basins sufficiently distinct to show well-marked differences in their respective depositional sequences and faunas.

But why pile up the evidence, the sameness of which must weary you. Suffice it to say that the phenomena indicating differential vertical displacements of the strandline are everywhere about us, and as abundant and well displayed in the areas of Paleozoic rocks as in those of more recent ages. One need but to compare a series of paleogeographic maps which, even despite their admittedly generalized and synthetic nature, yet show—unmistakably and clearly—variations in outlines of successive continental seas that would have been impossible if the land surfaces periodically invaded by them had not been subject to frequent oscillation and warping.

Physiographers, apparently, have paid little attention to these paleogeographic maps and the discussions of stratigraphic correlations that usually accompany them. Perhaps the reason for this oversight lies in the fact that most of them have been made by paleontologists—a kind of geologist who should be seen but not heard on physiographic and diastrophic questions. But, after all, does not the stratigraphical paleontologist deal with a wider range of geological data and criteria than any other specialist in the science? Of them all, I regard the stratigraphical paleontologist the best equipped to bring out the dominant facts in questions of the kind before us. He has the same opportunities and desire to observe and note the phsyical factors of the problem, and in addition an appreciation of organic criteria that may not only be applied directly in the field but the tangible evidence—in the form of specimens usually small enough to be collected—may be carried to the laboratory and there be studied at leisure and as often as desired. I have found this of very great advantage.

For such reasons I would be disposed to prejudice in favor of earth students like Vaughan or Schuchert in cases of controversy with others who can not personally take into account and weigh the organic as well as the physical aspects of a problem. However, in the present instance, I have gathered so much competent evidence of my own that I feel warranted in reaching the conviction that the major factors in the control and migration of the strandline lie and have always lain in deformative movements within the lithosphere. These movements, whether large or small and whether due to shrinkage of the centrosphere, to local changes in crustal density, to unequal loading by rock or ice, or to erosion and further lightening of positive areas, are all primarily concerned with the maintenance of isostasy.

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.

PHYSICAL CHEMISTRY.—*Application of the thermionic amplifier to conductivity measurements.* R. E. HALL and L. H. ADAMS. Journ. Amer. Chem. Soc. **41**: 1515–1525. Oct., 1919.

As a part of the general plan for the investigation of two component systems under pressure, a study is being made of the changes in solubility of a salt which occur when its aqueous solution, in contact with crystals of the solid, is subjected to pressure. In order to measure the changes of concentration which occur in the solution, while leaving it *in situ* in the pressure bomb, we note the changes in the conductance of the solution. For the attainment of sufficient accuracy in these measurements, the telephone which indicates the balance position of the Wheatstone bridge must be extremely sensitive since the allowable current through the network is limited by heating effects in the conductivity cell. The terminals of the bridge which ordinarily are connected to the telephone are joined to the "input" of a thermionic amplifier, of the type used in wireless telephony and telegraphy. The telephone is then connected into the output circuit of the amplifier. This arrangement has resulted in effectively increasing by approximately 50 times the sensitivity of a sensitive high-resistance telephone. Any ordinary telephone becomes a more sensitive instrument with the amplifier than the best telephones without it. R. E. H.

PHYSICAL CHEMISTRY.—*Equilibrium studies upon the Bucher process.* J. B. FERGUSON and P. D. V. MANNING. Journ. Ind. Eng. Chem. **11**: 946–950. Oct., 1919.

An investigation of the Bucher or cyanide process for the "fixation" of atmospheric nitrogen was undertaken at the suggestion of the War Department. Experiments were made using pure chemicals and mixtures of pure nitrogen and carbon monoxide in known proportions. Curves were obtained showing (1) the relation between the carbon monoxide content of the furnace gases and the yield of cyanide, and (2) the relation between the carbon dioxide content of the furnace gases and the yield of cyanide, both at two temperatures. The curves indicate that under certain conditions producer-gas may be used in the process and that the dissociation of sodium carbonate is probably one of the controlling chemical reactions. J. B. F.

ANTHROPOLOGY.—*Prehistoric villages, castles, and towers of southwestern Colorado.* J. Walter Fewkes. Bur. Amer. Ethnology, Bull. **70**. Pp. 79, figs. 18, pls. 33. 1919.

This work is intended to meet the demand for information regarding the prehistoric ruins in and about Mesa Verde National Park which was created for the preservation of the more important remains in this region. The Bureau of American Ethnology, in cooperation with the Department of the Interior, has done much by the excavation and repair of these monuments to increase their educational value, and in order to make known the nature of that work, the Bureau is publishing from time to time short papers on these monuments and their builders. Most of the structures here enumerated have long been known to cowboys and sheep men, and many have been described by archeologists, but this knowledge is local or scattered in many publications, often inaccessible to the general public. It is the purpose of the bulletin to collect this material in one publication and to show the relation of towers, castles, and other remains to the great cliff buildings of the Mesa Verde National Park. Particular attention is paid to the architecture of the ruins and the fact is pointed out that we have in buildings an index of the social organization of the people to whom they owe their origin. J. B. Swanton.

OCEANOGRAPHY.—*Physical characteristics of the ocean depths.* G. W. Littlehales. U. S. Naval Institute Proceedings, **6**: 45. Pp. 16, figs. 15. Jan., 1919.

The extent to which the ocean has been sounded and the conformation of its basins are described. The depth and bulk of the ocean, and the salinity, density, gases, temperature, pressure, compressibility, and viscosity of its waters are discussed. The penetration of light into the depths, oceanic movements and circulation, and marine deposits on the bottom are subjects also included. G. W. L.

SCIENTIFIC NOTES AND NEWS

RECENT ACCESSIONS AT THE NATIONAL MUSEUM

The National Museum has recently acquired, through exchange with the Carnegie Museum of Pittsburgh, a complete skeleton of the small extinct camel, *Stenomylus gracilis*, one of about forty skeletons found in Sioux County, Nebraska. *Stenomylus* was very abundant during the Miocene. It was about the size of a large sheep, with the slender, graceful limbs of an antelope.

A model restoration, of about one-twelfth natural size, of the American mastodon has been acquired by the Section of Vertebrate Paleontology. The original of the model was made by Mr. Charles R. Knight, the animal sculptor.

240 specimens of Philippine Annelids, including types of several new species and comprising the remainder of the collection reported on by A. L. Treadwell and Ruth Hoagland, has been received from the Bureau of Fisheries. Mr. John B. Henderson has given a collection of 200 specimens of mollusks comprising 33 species of Sphaeridae and Naiades. Miss Emily A. Clark, of the Sudan Interior Mission, has presented a collection comprising 18 species of mollusks from southern Nigeria.

The Division of Birds has received 35 birds sent by Dr. W. L. Abbott from Santo Domingo; and 1,298 birds from the A. H. Jennings estate. The Jennings collection contains a skin of the extinct passenger pigeon.

The Mesa Verde collections of Dr. J. W. Fewkes are being classified by Mr. Ralph Linton, of Harvard University. The Bureau of Ethnology has also received part of Mr. Jeancon's collection of pueblo antiquities from the Chama district of New Mexico.

Dr. Walter Hough has arranged a new exhibit showing the development of illuminating devices.

An exhibit has been installed in the Division of Medicine to show the types of balances used in weighing medicines and the progress which has been made in these balances. The first of the series is a single beam, double arm prescription balance made about 1840.

NOTES.

A pre-organization meeting of those interested in an American Meteorological Society was called by Dr. C. F. Brooks at the Cosmos Club on December 20, following the meeting of the Philosophical Society. The Meteorological Society was formally organized at St. Louis during the meetings of the American Association for the Advancement of Science, with the following officers for 1920: *President*, R. deC. Ward, of Harvard University; *Vice-President*, W. J. Humphreys, of the Weather Bureau; *Treasurer*, R. E. Horton; *Secretary*, Charles F. Brooks, of the Weather Bureau. A coordinate meeting for presentation of papers was held in New York City on January 3, 1920.

Following the recommendation of the map-making conference,[1] a Board of Surveys and Maps has been created by executive order for the purpose of coordinating the activities of the map-making agencies of the Federal Government.

Life memberships in the National Geographic Society "in recognition of eminent services for the increase and diffusion of geographic knowledge" were awarded from the Jane M. Smith Life Membership Fund on December 22 to the following: FRANK G. CARPENTER, O. F. COOK, ROBERT F. GRIGGS, WILLIAM H. HOLMES, STEPHEN T. MATHER, E. W. NELSON, JOSEPH STRAUSS, and WALTER T. SWINGLE.

The magnetic-survey vessel *Carnegie* left Washington on October 9, on a two-year cruise of 64,000 nautical miles. She arrived at her first port of call, Dakar, Senegal, West Coast of Africa, on November 23, but on account of the bubonic plague sailed a few days later and is now enroute to Buenos Aires, Argentina, where she was expected to arrive about the end of January. The scientific personnel of the present cruise consists of the following: J. P. AULT, in command; H. F. JOHNSTON, magnetician, second in command; RUSSELL PEMBERTON, surgeon and observer; A. THOMSON, H. R. GRUMMANN and R. R. MILLS, observers.

Dr. EDSON S. BASTIN terminated his work as geologist in charge of the Division of Mineral Resources of the U. S. Geological Survey on December 26, 1919, to become Professor of Economic Geology at the University of Chicago. For the present he will retain his Survey connection, on the per diem roll.

Mr. E. F. BURCHARD, geologist in charge of the iron and steel section of the U. S. Geological Survey, has been granted a ten months' leave of absence and will make geologic investigations in the Philippines.

Mr. A. A. CHAMBERS, chemist in the Water Resources Branch of the U. S. Geological Survey, has resigned to accept a position with the Youngstown Sheet and Tube Company as chemist in their steel laboratory.

Mr. J. C. CRAWFORD resigned from the Bureau of Entomology on December 1, 1919, and has gone into the real estate business in Washington.

Mr. A. J. ELLIS has been appointed assistant chief of the Division of Ground Waters in the Geological Survey and will be acting chief of the division in the absence of Mr. MEINZER in Hawaii.

Mr. W. A. ENGLISH, geologist, has resigned from the U. S. Geological Survey to examine oil lands for the New Zealand government and also to make oil investigations in the Far East for New York interests.

Messrs. O. W. FERGUSON and P. M. TRUEBLOOD, of the Coast and Geodetic Survey, have completed a line of precise levels across New York State, from the northern end of Lake Champlain to Niagara Falls.

[1] See This JOURNAL, 9: 605. 1919.

Dr. J. A. Fleming, chief of the magnetic survey division of the Department of Terrestrial Magnetism, Carnegie Institution, sailed for Buenos Aires on December 31 in order to meet the *Carnegie* there, and will return to Washington by way of the Department's observatory at Huancayo, Peru.

Mr. Owen B. French, who has been professor of geodesy and practical astronomy in the Government Institute of Military Surveying, Peking, China, since April, 1918, returned to Washington in December, 1919, having completed the work he had under contract. Although requested to renew the contract, he preferred to return to the United States to resume his previous occupation as consulting geodesist.

Dr. E. C. Harder, geologist of the U. S. Geological Survey, has resigned to become geologist for the Republic Mining and Manufacturing Company and associated companies, with offices at 1111 Harrison Building, Philadelphia, Pa.

Mr. K. C. Heald is on leave of absence from the U. S. Geological Survey and is engaged in oil reconnaissance work in Colombia.

Dr. L. O. Howard, chief of the Bureau of Entomology, Department of Agriculture, was elected president of the American Association for the Advancement of Science at the St. Louis meeting in December. Dr. Howard has been Permanent Secretary of the Association since 1898. Prof. E. L. Nichols, of Cornell University, has been elected General Secretary of the Association under the new constitution, and the office of Permanent Secretary will probably be filled by the executive committee of the Council within a few months.

Dr. Ales Hrdlicka, of the Smithsonian Institution, left Washington early in January for the Far East, in the interest of his studies on the origin of the American Indian, and of the organization of anthropological research in China. He expects to return in May.

Prof. Tamiji Kawamura, assistant professor of zoology in the Imperial University of Kyoto, Japan, visited Washington in December, giving particular attention to the work of the Division of Physical Anthropology and the Division of Marine Invertebrates of the National Museum.

Dr. Bradford Knapp, director of extension work in the southern States for the Department of Agriculture, resigned on January 10, to become dean of the College of Agriculture, and director of the Experiment Station, University of Arkansas, Fayetteville, Arkansas.

Dr. Adolph Knopf, geologist of the U. S. Geological Survey, has been appointed lecturer in geology at Yale University for the second term of the present academic year.

Mr. C. E. Lesher, geologist in charge of coal statistics in the U. S. Geological Survey, has resigned to accept a position as statistical expert with the National Coal Association.

Dr. G. F. Loughlin has been appointed chief of the Mineral Resources Division of the U. S. Geological Survey, in the place of Dr. E. S. Bastin, who becomes professor of economic geology at the University of Chicago.

Dr. M. W. Lyon, Jr., formerly professor of pathology and bacteriology, George Washington University, and at one time connected with the Division of Mammals, U. S. National Museum, and Captain in the Medical Corps during the war, has left Washington to take charge of pathological work for a group of physicians at South Bend, Indiana. His present address is 214 La Porte Avenue, South Bend.

Dr. G. P. Merrill, of the National Museum, was elected vice-president of the Geological Society of America at the meeting at Boston, December 29–31, 1919.

Mr. John Mirguet, of the Division of Marine Invertebrates, National Museum, detailed to the U. S. Bureau of Fisheries' steamer *Albatross* to care for biological material secured, has returned to Washington after a trip along the southern Atlantic coast down to the Yucatan Channel.

Dr. Chase Palmer, chemist of the U. S. Geological Survey, has resigned to accept a position as chief chemist in the fuel oil department of the Southern Pacific Company, at Bakersfield, California.

Rear Admiral John Elliott Pillsbury, U. S. N. (Retired), president of the National Geographic Society, died on December 30, 1919, in his seventy-fourth year. He was born at Lowell, Massachusetts, December 15, 1846, and graduated from the United States Naval Academy in 1867. In addition to his varied service with the Navy, he spent one year at the Hydrographic Office and ten years with the Coast and Geodetic Survey. During this period he made extended investigations of the ocean currents off the south Atlantic coast of the United States.

Mr. S. A. Rohwer, of the Bureau of Entomology, has been appointed Honorary Custodian of Hymenoptera in the Division of Insects of the National Museum.

Mr. William L. Sclater, of the British Museum, visited Washington in December.

Dr. R. H. True, of the Bureau of Plant Industry, Department of Agriculture, was elected secretary of Section G (Botany) of the American Association for the Advancement of Science, at the St. Louis meeting in December.

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GEOLOGY.—*The functions and ideals of a national geological survey.*[1] F. L. Ransome, Geological Survey.

INTRODUCTION

During the period of unrest and uncertainty through which we are still painfully groping, the many distracting calls upon my time and thoughts have made performance of the duty to prepare a presidential address particularly difficult. In view of these circumstances I may perhaps hope for some indulgence on your part if my effort shows some lack of thoroughness in its preparation and falls somewhat short of the high standard set by some of my distinguished predecessors. The subject of a presidential address to the Academy should, I think, be of wider interest and more general character than would ordinarily be an account of work in the speaker's particular branch of science, and this condition I have attempted to fulfill. Although what follows will deal especially with national geological surveys much of it will apply in principle to any scientific bureau conducted as a government organization.

REASONS FOR THE EXISTENCE OF A NATIONAL GEOLOGICAL SURVEY

In the beginning it may be well to review briefly the reasons for the existence of a national geological survey. Why should the government undertake work in geology while investigations in other sciences are in general left to private initiation and enter-

[1] Address of the retiring president of the Academy delivered January 13, 1920.

prise? The reasons that may be adduced will differ with the point of view. The geologist will suggest that whereas some sciences, such as chemistry, physics, or astronomy, may be pursued with success with stationary and permanent equipment at any one of a number of localities, geology is regional in its scope and is primarily a field science as contrasted with a laboratory science. Geology, it is true, must avail itself of laboratory resources and methods, but the geologist cannot have the greater part of his material brought to him; he must himself seek it afield. Thus it comes that comprehensive geologic problems require for their solution the equipment of more or less expensive expeditions or travel over large areas. Such projects, as a rule, cannot be undertaken by individual geologists or by local organizations. The preparation of a geologic map of a whole country, with its explanatory text, generally recognized as essential fundamental work, is an undertaking that requires consistent effort by a central organization extending over a period of years. Such a map is not likely to result from the patching together of the results of uncoordinated local effort. From a broadly utilitarian point of view, the intelligent layman as well as the geologist must recognize that the development of a country's natural resources in such a manner as to secure their maximum use for the greatest number of its citizens necessarily depends upon reliable information concerning the character, location, and extent of these resources and that this information should be available before they are exploited, by those who have eyes only for their own immediate profit, or before they pass entirely into private control or are exhausted. Such information can best be obtained and published by an impartial national organization responsible for its results to the people as a whole. Such a layman will recognize also that knowledge of the mineral resources of a country must rest upon a geological foundation. As Professor J. C. Branner has recently said in his "Outlines of the Geology of Brazil:"

"After a life spent chiefly in active geologic work and in the direction of such work, I should be remiss in my duty to Brazil if I did not use this occasion to urge on Brazilian statesmen the serious necessity for the active encouragement and support of scientific geologic work on the part of the national and state governments. Knowledge must precede the application of knowledge in geology as well as in other matters; and unless the development of the country's mineral resources be based on and proceed from a scientific knowledge of its geology, there must inevitably be waste of effort, loss of money, and the delay of national progress inseparable from haphazard methods."[2]

Finally, the citizen of narrower vision will regard as sufficient justification for a national geological survey the fact that he himself can turn to it for information and assistance in the development of particular mineral deposits, to his own material advantage.

As a matter of fact, most of the progressive countries of the world maintain geological surveys so that the desirability of such an organization appears to have been generally recognized, whatever may have been the particular reason or reasons that set in motion the machinery of organization in each country.

Recognizing the fact that most of the principal countries have established geological surveys and granting that there are good reasons for considering the maintenance of such an organization as a proper governmental function, we may next inquire—What should be the ideals and duties of a geological survey? How may these ideals be realized and these duties performed?

GENERAL LEGAL FUNCTIONS

The organic act of the United States Geological Survey specifies indirectly and in general terms the field that the organization should occupy. It states, with reference to the director, "this officer shall have the direction of the Geological Survey and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain."

Doubtless the laws or decrees under which other national geological surveys have been established also prescribe to some

[2] J. C. BRANNER. *Outlines of the geology of Brazil.* Geol. Soc. Amer. Bull. 30: 194. 1919.

extent their duties. Such legal authorization, however, is as a rule so general as to leave room for considerable latitude in its interpretation. I propose first to discuss the functions of a national geologic survey without reference to legal prescription or definition and afterwards to consider the extent to which some of the actual conditions interfere with the realization of these ideals.

USEFULNESS IN SCIENCE

It has been the fashion in some quarters of late to emphasize usefulness as the chief criterion by which to judge the value of scientific research under government auspices. It has been intimated that this or that scientific bureau of the government must do "useful" work if it is to justify its existence and its expenditure of public funds. The statement is usually made with an air of finality, as if a troublesome question had been once for all disposed of and the path of the future made plain. As a matter of fact, however, when it is said that science must be useful in order to receive government support we have really made very little advance. Probably the most idealistic scientific man will admit that ultimate usefulness is the justification for scientific research, although that end may not enter into his thoughts when he undertakes any particular investigation with the hope of increasing human knowledge. Men will differ very widely, however, as to what is meant by usefulness in science. It is well known to all scientific men, although not yet as widely recognized by others as it should be, that the utility of research is not generally predictable. For example, the investigations on electricity for hundreds of years preceding the middle of the nineteenth century had, so far as could be seen, no practical bearing. The experiments of Volta, of Galvani, and even those of our own Franklin, outside of his invention of the lightning rod, were not conducted with any thought of utility and were probably looked upon by the people of the time as diversions of the learned, not likely to have much effect upon human life and progress. How erroneous such a view was it is unnecessary to point out to a generation accustomed to daily use of the trolley car, telegraph, telephone, and electric light. Not only is the utility of science not always predictable but it is of very different kinds. That astronomy has certain practical applications in navigation and geodesy is well known; but important as these applications are they seem insignificant in comparison with the debt that we owe to this science for enlarging our intellectual horizon. This, too, is usefulness which I venture to think is of a truer and higher sort than much that passes current for utility. The classic researches of Pasteur on the tartaric acids, on fermentation, on the anthrax bacillus, on the silkworm disease, and on rabies, were so-called applied science of the very highest type, indistinguishable in the spirit and method of their pursuit from investigations in pure science. They were not merely the application of knowledge to industry but were extraordinarily fruitful scientific investigations undertaken to solve particular industrial and humanitarian problems. They are especially interesting in the present connection as probably the most conspicuous example in the history of research of the merging of pure and applied science. Pasteur was doubly fortunate in that he not only enormously enlarged human knowledge but was able to see, at least in part, the practical application of his discoveries to the benefit of humanity. The value of his results measurable in dollars is enormous, yet this is not their only value. Professor Arthur Schuster, in a recent address, remarks: "The researches of Pasteur, Lister, and their followers, are triumphs of science applied directly to the benefit of mankind; but I fancy that their hold on our imagination is mainly due to the new vista opened out on the nature of disease, the marvelous workings of the lower forms of life, and the almost human attributes of blood corpuscles, which have been disclosed.

"The effect on a community is only the summation of the effect on individuals, and if we judge by individuals there can be little doubt that, except under the stress of abnormal circumstances, pure knowledge has as great a hold upon the public mind as the story of its applications."

Quite independently of any recognized usefulness, investigations that yield results that are of *interest* to the public are willingly supported by the people and this fact is significant in connection with what I shall have to say later on the function of education. As illustrations of this truth may be cited our government Bureau of Ethnology and our large public museums. Probably few who read the admirable government reports on the aboriginal antiquities of our country and on the arts and customs of the Indian tribes could point out any particular usefulness in these studies; but they have to do with human life and their popular appeal is undeniable. The average visitor to a museum probably has little conception of what to a scientific man is the real purpose of such an institution. He gazes with interest at the contents of the display cases without realizing that by far the greater part of the material upon which the scientific staff is working or upon which investigators will work in future, is hidden away in drawers and packing cases. The principle recognizable result so far as he is concerned is that he is interested in what he sees and feels that he is being pleasantly instructed.

In other words, it is as important for man to have his imagination quickened as to have his bodily needs supplied, and in ministering to either requirement science is entitled to be called useful or valuable.

It may be remarked in passing that Pasteur's work had this in common with pure science, or science pursued with the single aim of adding to human knowledge, in that Pasteur himself could not foresee all of the applications that would in future be made of his discoveries.

Enough, I think, has been said to show that the term "usefulness" as applied to science covers a wide range and that when employed by people of imagination and liberal culture may include much more than when used by those whose only standard of value is the unstable dollar.

FUNCTIONS UNDER AN IDEAL AUTOCRACY

If government were in the hands of a wise and benevolent autocracy a national geological survey would be so conducted as to be useful to the people whose taxes go towards its support; but it would probably be useful in the broader sense that I have outlined. It would give the people not perhaps what they think they want but what, in the wisdom of their government, seems best for them. I believe that a survey so directed would aim to encourage and promote the study of geology by undertaking those general problems and regional investigations that would be likely to remain untouched if left to private enterprise. It would lay the foundation for the most economic and efficient development of the natural resources of the country by ascertaining and making known the location, character and extent of the national mineral resources. As an aid to the intelligent utilization of these resources, and to the discovery of deposits additional to those already known, it would properly occupy itself with problems concerning the origin and mode of formation of mineral deposits. Last, but not least, it would accept the responsibility, not only for making known the material resources of the country but for contributing to the moral and intellectual life of the nation and of the world by seeing to it that the country's resources in opportunities for progress in the science of geology are fully utilized. I may illustrate my meaning by examples taken from the publications of the U. S. Geological Survey. In my opinion such works as Dutton's *Tertiary History of the Grand Canyon*, Gilbert's *Lake Bonneville*, and the investigations of Marsh, Cope, and their successors, on the wonderful series of reptile, bird, and mammal remains found in the Cretaceous and Tertiary strata of the west are fully as adequate and appropriate a return for the expenditure of public funds as a report describing the occurrence of a coal bed and giving the quantity of coal available in a given field. Many years ago when the United States Geological Survey was under heavy fire in Congress one member of that body in some unexplained way learned that Professor Marsh had discovered and had described in a government publication a wonderful fossil bird with teeth—a great diver up to 6 feet in length. He held this up to ridicule as a glaring example of the waste of public funds in useless scientific work, quite unaware of the light that this and similar discoveries threw upon the interesting history of the development of birds from reptiles and upon evolution, or of the intellectual value of such a contribution to knowledge. The representative of a people educated in the value of geologic science would, by such an exhibition of ignorance, discredit himself in the eyes of his constituents.

FUNCTIONS IN A DEMOCRACY

Our government, however, is not an all-wise benevolent autocracy but is democratic in plan and intent and suffers from certain well-known disadvantages from which no democracy has yet been free. The wishes of the politically active majority control, and these wishes may or may not coincide with those of the wisest and most enlightened of the citizens. The funds for government work in science must be granted by Congress and the vote of each congressman is determined by the real or supposed desires of his constituents. A national scientific bureau, if it is to survive, must have popular support, and to obtain and hold such support it must do at least some work that the majority of the people can understand or can recognize as being worth the doing. Here evidently compromise with scientific ideals is necessary. Something must be sacrificed in order that something can be done. Such concessions and compromises are inseparable from democratic government and the scientific man of high ideals who is unable to recognize this fact will inevitably fail as a director of the scientific work of a government bureau. Such a man is likely to insist that no concessions are necessary and that the public will support science that is not interesting to it or from which it can see no immediately resulting material benefit. One very eminent geologist with whom I was once conversing held this view. He said that he had always found that he could go before a legislative body and secure appropriations for scientific research by being absolutely frank and making no attempt to show that the results of the work would be what the average man would term "useful" within the immediate future. His confidence was possibly well grounded, but I am inclined to think that the success gained by him was rather a tribute to his earnest eloquence and winning personality than a proof that the people are yet ready to contribute their taxes to the support of investigations that, so far as they can see, are neither useful nor interesting.

CHARACTER OF COMPROMISES

Lest it be supposed that I am advocating the surrender of the high ideals of science to the political business of vote-getting, I hasten to point out that surrender and compromise are not synonymous and may be very far apart. Some compromise there must be, but in my opinion the most delicate and critical problem in the direction of a national scientific bureau is to determine the nature and extent of this compromise so as to obtain the largest and steadiest support of real research with the least sacrifice. Complete surrender to popularity may mean large initial support, but is sure to be followed by deterioration in the spirit of the organization and in the quality of its work, by loss of scientific prestige, and by final bankruptcy even in that popular favor which had been so sedulously cultivated.

The extent to which concessions must be made will depend largely, of course, on the general level of intelligence of the people and upon the degree to which the less intelligent are influenced through the press and other channels by those who are able to appreciate the value of science. The more enlightened the people the more general and permanent will be their support of science.

IMPORTANCE OF POPULAR EDUCATION IN GEOLOGY

This leads us to the consideration of what I believe to be one of the most important of the functions of a government scientific bureau, namely, education. Of all forms of concession, if indeed it is really a concession, this is the least objectionable and most fruitful. Its results are constructive and cumulative. It is not, like other concessions to popularity, corrosive of the scientific spirit of an organization and in so far as it calls for clear thinking and attractive presentation on the part of those putting it into practice as well as the ability to grasp and expound essentials, its educational effect may be subjective as well as objective. Whatever may be true of other sciences, geologists in this country have shown little interest in popularizing their science or in encouraging its pursuit by amateurs. Such attempts as have been made have often been inept and unsuccessful and the professional geologists have looked with more or less disdain upon those of their fellows who have tried to expound their science to the people. They have felt that men with unusual ability for research should devote all of their energy to the work of enlarging the confines of knowledge rather than to dissemination and popularization of what is known to the few. There is undoubtedly much to be said for this view and when applied to certain exceptional men it is strictly correct. When, however, we think of Darwin and compare the magnitude of his achievements with the pains that he took to make his conclusions comprehensible by the multitude, we are inclined to feel that only by extraordinary ability and performance in certain directions can an investigator in natural science be altogether absolved from the duty of making himself intelligible to more than a few specialists in his own line. There are undoubtedly many scientific men thoroughly and earnestly convinced of the importance of their researches, who would in the long run be doing more for humanity and perhaps for themselves if they would spare some time to tell us as clearly and attractively as possible what it is that they are doing. While I believe this to be true of scientific men in general, it is particularly true of those who are officially servants of a democracy. A democratic government might almost be characterized as a government by compromise, and this is one of the major compromises that confronts scientific men in the service of such a government. The conclusion that a very important function of a national geological survey is the education of the people in geology and the increasing of popular interest in that science, appears to be unavoidable, yet it is surprising how little this function has been recognized and exercised. The results of such education are cumulative and a direct and permanent gain to science, whereas, on the other hand, the consequences of prostituting the opportunities for scientific work to satisfy this and that popular demand for so-called practical results in any problem that happens to be momentarily in the public eye, is a kind of charlatanry that is utterly demoralizing to those who practice it and that must ultimately bring even popular discredit on science. A bureau that follows such a policy can neither hold within it nor attract to its service men animated by the true spirit of investigation.

METHODS OF EDUCATION

It is not practicable in the present address to discuss in detail the many possibilities of educational work in geology. Only a few general suggestions can be offered.

In the first place the importance of education by a national geological survey should be frankly recognized and the idea that it is beneath the dignity of a geologist to participate in this function should be discountenanced. A geological survey should include on its staff one or more men of high ability who are especially gifted in interesting the public in the purposes, methods, and results of geologic work—men of imagination who can see the romance of science; men of broad sympathy who know the hearts and minds of their countrymen from the Atlantic to the Pacific; men imbued with the truthful spirit of science; and finally, men skilled in the art of illuminating the cold impersonal results of science with a warm glow of human interest.

It should be the duty of these men to see that so far as possible all of the results of geologic work are interpreted to the people so that every citizen can benefit to the limit of his individual capacity. Magazines, the daily papers, moving pictures and all possible means of publication should be utilized. There should be close contact with educators and special pains taken to prepare material for use in schools and colleges. Carefully planned courses at university summer schools and elsewhere might be given by members of the educational or publicity staff, or by certain selected geologists from the field staff.

Geologists in preparing papers and reports should consider with particular care the question, "Who may be reached by this?" Some scientific results cannot be popularized and these may be written in the concise, accurate language of science. Others, however, may, by taking sufficient care and trouble, be made interesting to more than a small circle of scientific colleagues. Every effort should be made to enlarge this circle by simple and attractive presentation. In some cases I am inclined to think that a geologist might issue separately or as a part of his complete report, an abstract or résumé in which all effort is concentrated on an endeavor to be interesting and clear to as many people as possible. If this were done, I am sure that the writer would be in a position to appraise more truly the value of his complete report and might proceed to rewrite some portions of it and to omit others, without loss to science and at a saving in paper and printing.

RELATIONS WITH UNIVERSITIES

In connection with the subject of education attention may be called to the fundamental importance of establishing and maintaining close and cordial relationship between a government scientific bureau and the universities. The advantages of such a relationship are so many that it is difficult to enumerate them all but it may be pointed out that any plan of popular education in science will be seriously crippled if the professional teachers whose influence in molding the thoughts and determining the careers of the young men and women of the country is so great, are out of sympathy with the government organization that is attempting to quicken the interest of the people in a particular branch of science. Moreover, it is vital to such an organization that it should attract to its service young men of exceptional ability in science. This it is not likely to do if professors of geology feel that they must conscientiously advise their most promising graduates to avoid government service. Doubtless some teachers of geology in the universities fail to realize the necessity for some of the compromises inevitable in a government bureau, or in their impatience at some of the stupidities of bureaucratic procedure are inclined to place the blame for these where it does not belong; a few may cherish personal grievances. No class of men is without its unreasonable members and neither rectitude nor tact can prevent occasional clashes; but if a national geological survey cannot command the respect and hearty support of most of the geological faculties of the universities the consequences to the progress of geology must be deplorable. Any approach to such a condition demands immediate action with less emphasis on the question, "Who is to blame?" for in all probability there may be some fault on both sides, than on "What can be done to restore relations of mutual regard and helpfulness?"

THE AMATEUR IN GEOLOGY

In the present age of specialization we are apt to forget how much geology owes to amateurs, particularly in Britain and France. Sir Archibald Geikie in the concluding chapter of his "Founders of Geology" dwells particularly on this debt. He says:

"In the account which has been presented in this volume of the work of some of the more notable men who have created the science of geology, one or two leading facts stand out prominently before us. In the first place, even in the list of selected names which we have considered, it is remarkable how varied have been the ordinary avocations[3] of these pioneers. The majority have been men engaged in other pursuits, who have devoted their leisure to the cultivation of geological studies. Steno, Guettard, Pallas, Füchsel, and many more were physicians, either led by their medical training to interest themselves in natural history, or not seldom, even from boyhood, so fond of natural history as to choose medicine as their profession because of its affinities with that branch of science. Giraud-Soulavie and Michell were clergymen. Murchison was a retired soldier. Alexandre Brogniart was at first engaged in superintending the porcelain manufactory of Sévres. Demarest was a hard-worked civil servant who snatched his intervals for geology from the toils of incessant official occupation. William Smith found time for his researches in the midst of all the cares and anxieties of his profession as an engineer and surveyor. Hutton, Hall, DeSaussure, Von Buch, Lyell, and Darwin were men of means, who scorned a life of slothful ease, and dedicated themselves and their fortunes to the study of the history of the earth. Playfair and Cuvier were both teachers of other branches of science, irresistibly drawn into the

[3] Vocations would seem to be the right word here. F. L. R.

sphere of geological inquiry and speculation. Of the whole gallery of worthies that have passed before us, a comparatively small proportion could be classed as in the strictest sense professional geologists, such as Werner, Sedgwick and Logan. Were we to step outside of that gallery, and include the names of all who have helped to lay the foundations of the science, we should find the proportion to be still less.

"From the beginning of its career, geology has owed its foundation and its advance to no select and privileged class. It has been open to all who cared to undergo the trials which its successful prosecution demands. And what it has been in the past, it remains to-day. No branch of natural knowledge lies more invitingly open to every student who, loving the fresh face of Nature, is willing to train his faculty of observation in the field, and to discipline his mind by the patient correlation of facts and the fearless dissection of theories. To such an inquirer no limit can be set. He may be enabled to rebuild parts of the temple of science, or to add new towers and pinnacles to its superstructure. But even if he should never venture into such ambitious undertakings, he will gain, in the cultivation of geological pursuits, a solace and enjoyment amid the cares of life, which will become to him a source of the purest joy."

In this country at the present time, as Mr. David White, in an as yet unpublished address, has, I believe, pointed out, the amateur geologist, due partly to the way in which the subject is taught, is rare and few indeed are the contributions made to the science by those who follow geology as an avocation or hobby. This is unfortunate and an improvement of this condition should be one of the major objects of the educational program of a national geological survey. The science lends itself particularly to its pursuit as a recreation by men of trained intellect who must find in the open air some relief from sedentary professions. In a country still so new as ours geologic problems lie on every hand and many of these can be solved wholly or in part without elaborate apparatus or laboratory facilities. The standards for the professional geologist should be high, but there is no necessity that maintenance of such standards should be accompanied by a patronizing or supercilious attitude toward the work of the amateur. Rather, let the professional geologist cultivate sympathy, tolerance, and generosity toward all who are earnestly seeking for the truth; let him help by encouragement instead of deterring by disdain. There is no better evidence of a wide interest in geology than the existence of numerous amateur workers and it is decidedly to the advantage of the professional geologist and to the science to encourage in every way possible the efforts of such workers and to increase their number.

KINDS OF WORK TO BE UNDERTAKEN BY A NATIONAL GEOLOGICAL SURVEY

There has been considerable difference of opinion as to the kinds of work that should be undertaken by a national geological survey. Shall its field be confined to what may be included under geology or shall it embrace other activities, such as topographic mapping, hydrography and hydraulic engineering, mining engineering, the classification of public lands, the collection and publication of statistics of mineral production, and the mechanical arts of publication such as printing and engraving. These various lines of activity may be divided into two main classes—those that are more or less contributory to or subordinate to the publication of geologic results, and those that have little if any connection with geology.

The speaker is one of those who believe that a geological survey should be essentially what its name implies—that it should confine its activity to the science of geology. This opinion is held, however, in full realization of the fact that here as elsewhere some compromise may be necessary. This may be dictated by law or may be determined by policy.

The organic law of the U. S. Geological Survey, for example, includes among the duties of the organization "the classification of the public lands." There may be some difference of opinion as to what the framers of the law meant by this provision, but it is at least a reasonable conclusion that they intended the sort of classification adopted by the General Land Office. If so, the determination of the so-called "mineral" or "non-mineral" character of public lands is undoubtedly a proper function of the U. S. Geological Survey, although it is one that was neglected by that survey for many years and has not yet received the recognition of a specific appropriation, except recently in connection with the stock-raising and enlarged homestead acts.

TOPOGRAPHIC MAPPING

Inasmuch as the preparation of a topographic map is a necessary preliminary to accurate and detailed geologic mapping, a geological survey is vitally interested in seeing that satisfactory maps are available as needed. Whether a particular geological survey should itself undertake this mapping depends upon circumstances. If another government organization is equipped for doing this work and can provide maps of the requisite quality when needed, it would appear that the geological bureau should leave this work to the other organization, particularly as the maps required to keep abreast of geologic requirements are likely to constitute only a part of the work of the topographic bureau. There are certain decided advantages, however, in having the topographic work done by the geological survey and these advantages must be weighed against other considerations. With the topographic and geologic work under a single control, the geologist is more likely to be assured of getting the kind of map desired at the time needed. Cooperation between geologists and topographers is apt to be both closer and more flexible than were the two staffs in separate organizations. Finally the field work in topography and geology is in some respects alike and is carried out by similar methods and equipment. Occasionally the two kinds of work can be combined and carried on simultaneously.

The general question—whether a national geological survey shall do its own topographic mapping—appears to be one that cannot be answered once for all but must be determined for each country. In an old country where accurate and detailed maps have long been made by military and other organizations, a geological survey may be under no necessity of providing its own topographic base maps. In a new country, where exploration is still in progress, the geological survey may have to make its own topographic surveys. The main point, as I see it, is that the geological survey must have maps of the standard required by it with the least possible delay, but should not undertake to make them itself if other organizations that can and will provide the maps needed are already in the field.

We have seen that there is at least a very close connection between topographic and geologic mapping and that in this relation may lie a sufficient reason why both kinds of work should be undertaken by the same organization. Is there as good a reason why the study of geology and the collection of statistics of mineral production should be united?

STATISTICS OF MINERAL PRODUCTION

When shortly after the organization of the U. S. Geological Survey the collection of statistics was begun, those geologists who were most influential in urging that the Survey should undertake statistical work adduced as the principal reason that the people desired such figures and if the Geological Survey did the work it would be able to secure larger appropriations than if the task were left for others. It does not appear to have been thought at that time that geologists were the only men who could satisfactorily do statistical work or that it was necessary to impose this task on them. Subsequently, however, the work was apportioned among the geologists. The reasons for this step appear to have been, first, that the results of having the statistical reports prepared under contract by specialists who were not on the regular staff of the organization had proved unsatisfactory; second, that by apportioning the work among the geologists already on the staff not only would the apparent cost in money be less than under the former arrangement, but it would, in a bookkeeping sense, be very much cheaper than taking on new men for this particular work; finally, it was argued that geologists could apply their knowledge of the field relations of ore deposits to improve the character of statistical reports and would themselves benefit by additional opportunities to visit and examine many deposits that they might not otherwise see.

It is undoubtedly true that the statistical reports of the United States Geological Survey have greatly improved in accuracy, fullness, and general interest since this plan was adopted. It is also true that some geologists have turned their opportunities as statistical experts to good account both in enlarging their experience and by gathering material that has been worked into geological papers. Nevertheless, the policy has, in my opinion, been a mistake both economically and scientifically. It has insidiously filched the time of highly trained men who have shown originality and capacity for geologic research and has tied these men down to comparatively easy and more or less routine tasks. Some geologists who were once scientifically productive no longer contribute anything to geological literature but are immersed in work that men without their special geological training could do as well. To a certain extent the policy is destructive of scientific morale. A young geologist sees that a man who publishes, annually or at shorter periods, reports on the statistics of production of some metal becomes widely known to all interested in that metal and is considered by them as the United States Geological Survey's principal expert on that commodity. This easily won recognition, with all that it implies or seems to imply in the way of promotion and of industrial opportunity, must constitute a real temptation so long as a scientific man is expected to contribute his own enthusiastic devotion to science as part payment of his salary. The incidental geological opportunities offered by statistical work are found chiefly in connection with a few of the minor mineral resources, rather than with such industrially dominant commodities as petroleum, iron or copper, and these opportunities for the individual geologist are soon exhausted and are likely to be purchased at a price far out of proportion to their value. The supposition that geological training is essential for good statistical work in mineral products is a fallacy, and no man who shows promise of making real contributions to geologic science should be placed in such circumstances that he is virtually forced to worship an idol whose head may be of gold and precious stones but whose feet are assuredly of clay. I am emphatically of the opinion that the collection of mineral statistics is not logically a function of a national geological survey. If, however, such a survey is committed to this task by law, by the lack of any other organization to do the work, or by well-considered reasons of policy, then it is even more certain that the duty should not devolve upon geologists at the expense of their own science, but should be cared for by a special staff. Some cooperation between the statistical staff and the geologic staff may be advisable but the extent of this cooperation should be determined by those fully alive to the necessity of safeguarding geology against encroachments by statistical work.

WATER RESOURCES

Studies concerned with the occurrence of underground water are of course as much geological as those concerned with the occurrence of petroleum. Investigations of surface waters, however, including stream gaging and the study of water-power come within the field of engineering and have so little connection with geology that it is difficult to see any logical ground for their inclusion within the group of activities belonging properly to a geological survey. In an ideal apportionment of fields of endeavor among the scientific and technical bureaus of a government, stream gaging and estimation of water-power would scarcely fall to the national geological survey. As it happens, the United States Geological Survey does perform these functions and I am not prepared to say that there is not ample legal and practical justification for this adventitious growth on a geological bureau. There has been little or no tendency to draft geologists into hydraulic engineering and consequently the principal objection urged against the inclusion of statistical work within the sphere of a geological survey does not here apply. Apparently the only practical disadvantages are the introduction of additional complexity into a primarily scientific organization and the consequent danger of the partial submergence of principal and primary functions by those of adventitious character.

It should be pointed out in this connection that certain studies of surface waters, especially those that are concerned with the character and quantity of material carried in suspension and in solution in river waters, have much geological importance. Such studies supply data for estimating the rate of erosion and sedimentation. They are to be regarded, however, rather as an illustration of the way in which geology overlaps other branches of science and utilizes their results than as reason for considering hydraulic engineering as normally a function of a geological survey.

FOREIGN MINERAL RESOURCES

One of the results of the war was to suggest the advantage to the citizens and government of the United States of a central source of information concerning the mineral resources of foreign countries. The United States Geological Survey undertook to gather this information, primarily for the specific purpose of supplying data to the American representatives at the Peace Conference. As the Director of the Survey states in his fortieth annual report:

"Two general purposes were served—first that of obtaining a clear understanding of the relations between our own war needs and the foreign sources of supply from which these needs must or could be met; second, that of obtaining an understanding of the bearing of mineral resources upon the origin and conduct of the war and upon the political and commercial readjustments that would follow the end of hostilities."

This work, of a kind that so far as known had not been previously undertaken by any national geological survey, has been continued with the view that it is important for those who direct American industries to possess as much information as possible concerning those foreign mineral resources upon which they can draw or against which they must compete. The results aimed at are directly practical and are largely obtained by compilation of available published and unpublished material as it is manifestly impossible to make direct detailed investigation of the mineral resources of all foreign countries. Nevertheless the work appears to fall appropriately within the field of a geological bureau and if it can be made to furnish the opportunity, hitherto lacking, for geologists in the government service to make first-hand comparison between our own mineral deposits and those of other lands the experiment will probably bear scientific fruit.

CHEMISTRY AND PHYSICS

Mineralogy and paleontology are so closely related to geology that there can be no question of the propriety of including the pursuit of these sciences within the scope of a geological survey. The application of chemistry and physics to geological problems admits of more discussion. Chemical work, however, as carried on in connection with geological investigations is of such special character and must be conducted in such intimate contact with geological data as to make it almost certain that better results can be obtained with a special staff and equipment than would be possible were the routine and investigative work in geological chemistry turned over to some central bureau of chemistry. The same argument is believed to be applicable also to physics. Research in geophysics was at one time a recognized function of the United States Geological Survey but since the founding of the Geophysical Laboratory of the Carnegie Institution of Washington, this field has been left almost entirely to that splendid organization which is unhampered by some of the unfortunate restrictions of a government bureau. Under these particular and unusual conditions this course may have been wise, although it does not negative the conclusion that, in general, investigations in geophysics are logically and properly a function of a national geological survey.

SOILS

The study of soils, with reference to origin, composition, and classification, is unquestionably a branch of geology, but the geologist, with tradition behind him, generally looks upon soil as a nuisance and geological surveys have reflected his attitude. In the United States the classification and mapping of soil types has for some years been in progress by the Department of Agriculture. While quite devoid of any enthusiasm for engaging in soil mapping, I wish to point out merely that this work, if its results justify its performance by the government, and if the classification adopted is based on chemical, physical and mineralogical character rather than on crop adaptability, is properly a function of the national geological survey.

SEISMOLOGY

Another subject that is comparatively neglected by national geological surveys is seismology. It can scarcely be asserted that earthquakes have no economic bearing and conspicuous or destructive examples usually receive some official attention —after the event. The comparative neglect of systematic study of earthquakes is probably due to a number of causes. One of these is that few geologists specialize in seismology—a science in which little progress can be made unless the investigator possesses unusual qualifications in mathematics and physics. Another reason probably is that to most men the difficulties in the way of gaining real knowledge of the causes of earthquakes and especially of predicting with any certainty the time, place, intensity and effects of earthquakes appear rather appalling. Finally, earthquake prediction or even the recognition of the possibility of future earthquakes in a particular part of the country is likely to have consequences decidedly unpleasant to those responsible for the prediction. Experience in California has shown that a community still staggering from a violent shaking may insist with some acerbity that nothing of any consequence has happened and that it never felt better in its life.

Notwithstanding these difficulties, I believe that a national geological survey, in a country where serious earthquakes have taken place and may occur again, should consider the collection and interpretation of seismological data as part of its duty. Such work is regional in scope and cannot be carried far by local initiative and by individual investigators on their own resources. In spite of difficulties I believe that it is within the range of possibility that some day we shall be able to predict earthquakes with sufficient reliability to give the prediction practical utility.

SUMMARY

Briefly summarizing what has gone before, I conclude that the chief primary function of a geological survey is geological research and that the spirit of investigation should be the same whether the work is undertaken to increase knowledge and to serve as the starting point for further attacks on the unknown, or is begun with a definite economic or practical result as its desired goal. Compromise and concession are inevitable but the necessity for making them should not and need not permit the real purpose of the organization to sink from sight. If the members of a scientific bureau can confidently feel that those charged with its direction make such concessions wisely with the higher purposes of the bureau really at heart, their whole attitude towards their work will be entirely different from that into which they will fall if they become convinced that scientific ideals receive only perfunctory regard and that the real allegiance is directed elsewhere.

What may be called the chief secondary function of a national geological survey is believed to be popular education in geology both for the benefit of the people and as providing the most enduring basis for the support of such an organization by a democracy. Such education should be conducted through every possible channel and in close cooperation with all of the educational institutions of the country. One of its objects should be the revival and encouragement of amateur geological observation and study. In this connection I heartily approve the present trend in the policy of the American Association for the Advancement of Science and believe that this great organization will fulfill its purpose and advance science much more effectively than at present if it will leave to the various special scientific societies the holding of meetings devoted to the presentation of scientific papers, and devote itself to the popularization of science and to the encouragement of cooperation between different branches of science.

PERSONNEL

Finally a few words may be said concerning the relation between the personnel of a geological survey and the results obtained by the organization. If such a survey is to attract to its service men of first rate ability and to hold these men after their development and experience have made them of the highest value, certain inducements must be offered. Salary is unfortunately the first of these that comes to mind under conditions that continually force the scientific men in government service to recognize painfully how inadequate at present is the stipend upon which he had existed before the war. It is all very well to insist that the scientific man does not work for money and should not trouble his thoughts with such an unworthy consideration. Nevertheless if he is to do the best of which he is capable he must be lifted above the grind of poverty, be able to give his children those educational advantages that he can so well appreciate, have opportunity for mental cultivation and feel his social position to be such that he can mingle without humiliation with his intellectual peers. If it is destructive to the scientific spirit to set up material gain as an object it may be equally blighting to scientific achievement to force the attention continually downward to the problem of meager existence. The normal scientific man usually has other human beings dependent upon him and the traditional spirit of self-sacrifice and the indifference to material reward that are commonly attributed to the true investigator may, when these members of his family are considered, come very close to selfishness.

However, salary, important as it is, is by no means the only determinant. If it is reasonably adequate, most men who are animated by the spirit of science will find additional reward in their work itself if this is felt to be worthy of their best efforts. A man of first rate scientific ability, however, will not enter an organization in which consecutive application to a problem is thwarted, in which he is expected to turn to this or that comparatively unimportant task as political expediency may dictate or in which the general atmosphere is unfavorable to the initiation and prosecution of research problems of any magnitude. If a man of the type in mind finds himself in such an uncongenial environment he is likely to go elsewhere. The final effect upon the organization will be that its scientific staff will be mediocre or worse and it will become chiefly a statistical and engineering bureau from which leadership in geology will have departed.

If, on the other hand, a young geologist can feel that every possible opportunity and encouragement will be given to him in advancing the science of geology; that results on the whole will be considered more important than adherence to a schedule; that imagination and originality will be more highly valued than routine efficiency or mere executive capacity; that he will not be diverted to tasks for which, important as they may be, his training and inclination do not particularly fit him; that those directing the organization are interested in his development and will give him all possible opportunity to demonstrate his power of growth; and that appreciation and material reward will be in proportion to his scientific achievement; he will then be capable of the best that is in him and will cheerfully contribute that best to the credit of the organization that he serves.

A national geological survey should hold recognized leadership in geology in the country to which it belongs and attainment of this proud position must obviously depend upon the quality of its geological personnel. With respect to personnel, at least three conditions may be recognized—first, that in which the ablest geologists in the country are drawn to, and remain in, service; second, that in which geologists perhaps of a somewhat lower grade as regards scientific promise are attracted to the service for a few years of training and then pass out to positions where the opportunities for research or for increased earnings are greater; and third, that in which able young men no longer look upon the geological survey as a desirable stepping-stone to a future career. Who can doubt that it is the first condition that raises an organization to pre-eminence in science and the last that marks opportunities lost or unattained? Those responsible for the success of a geological survey, if they be wise, will watch the trend of the organization with reference to these conditions much as the mariner watches his barometer and, like him, if the indication be threatening, take action to forestall disaster.

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.

ENTOMOLOGY.—*Descriptions of seven new species of Opius (Hymenoptera-Braconidae).* A. B. GAHAN. Proc. Ent. Soc. Wash. **21**: 161–170. 1919.

This paper contains descriptions of seven new species of parasites of Dipterous insects. Five of the new species are from the United States and two are from Trinidad. S. A. ROHWER.

ENTOMOLOGY.—*The ants of Borneo.* WILLIAM MORTON WHEELER. Bull. Mus. Comp. Zool. **63**: 43–147. July, 1919.

This paper is a systematic annotated catalogue of the ants of Borneo and contains descriptions of new forms and phases with notes on geographical distribution and habits. The list records 256 forms representing 59 genera. Of these 256 forms, 58 are here recorded for the first time and 23 of these are new to science. S. A. ROHWER.

ENTOMOLOGY.—*Two new species of Asaphidion from North America (Coleoptera, Carabidae).* H. F. WICKHAM. Proc. Ent. Soc. Wash. **21**: 178–181. 1919.

In this paper two interesting new beetles belonging to a genus not heretofore recorded from North America are described from material collected in the interior districts of the Northwest (Alaska and Yukon Territory). S. A. ROHWER.

ENTOMOLOGY.—*Descriptions of new North American Ptinidae, with notes on an introduced Japanese species.* W. S. FISHER. Proc. Ent. Soc. Wash. **21**: 181–186. 1919.

In this article four new species and one new genus of beetles are described. All the new species are from Texas. Notes on a Japanese species which was introduced with an exhibit are also published. This introduced species has been taken in the field since the original discovery of it, but there is no evidence that it has become a dangerous pest.

S. A. ROHWER.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

821ST MEETING

The 821st meeting was held at the Cosmos Club, October 11, 1919. The meeting was called to order at 8 p.m. by President HUMPHREYS, with about 50 members and guests present.

C. G. ABBOT: *Solar studies in South America.*

The author went by way of the Panama Canal to Chile, Bolivia, and Argentina, returning by the same route. Slides illustrative of the scenes along the route were exhibited, also slides showing the total eclipse of the sun and measurements of the variation of the brightness of the sky during the course of the eclipse phenomena as observed at La Paz, Bolivia. The solar corona at the time of the eclipse proved to be of a type intermediate between that of the maximum and minimum period of sun spots and was especially grand on account of the great number and extent of the streamers of the corona and the immense prominence which cast a crimson glory over the whole. The point of observation, at 14,000 feet above sea level, looked out upon a horizon made up of snow-covered mountains about 20,000 feet high. The sky was clear, and on the whole the phenomenon was the grandest of the kind which the observers had ever seen.

A conference was held in Argentina with the Chief and Chief Forecaster of the Argentine Weather Bureau, who explained the methods employed and the success of the results obtained in forecasting by the aid of daily telegraphic reports of the variations of the sun as observed at the Smithsonian Institution station at Calama, Chile. They expressed themselves as very sanguine in regard to the value of the solar radiation work for this purpose.

Several weeks were spent at the Smithsonian observing station at Calama, Chile, where fortunately a new method of solar constant determination was worked out which is based upon observations made with the spectrobolometer, the pyrheliometer and the pyranometer at one epoch of time. All these observations may be made simultaneously by two observers within a period of about ten minutes and they are sufficient to furnish means of computing the solar constant of radiation which may be finished within two hours by one computer. Thus the result is obtained with ten minutes of observing and two hours of computing instead of three hours of observing and fifteen hours of computing, as formerly. Variations of the sky which might occur and spoil the result are avoided. By comparing results computed by the new method and by the old method (of six spectrobolometric observations distributed over several hours), it is found that the deviations between the two seldom exceed one per cent and almost never exceed two per cent. When such large deviations are found it is almost invariably seen that the transparency of the atmosphere was changing during the day in question so that the result by the old method was either too high or too low according as the sky was clearing or growing less clear. Thus the new method appears to be at least as accurate as the old and appears to avoid the errors which oftentimes occur when changes of transparency take place. Furthermore, the new method is applicable on any day in which a clear space of 30° diameter exists around the sun, while the old method requires uniform sky and total cloudlessness, for a period of about three hours, either immediately after sunrise or immediately before sunset.

The paper was discussed by Messrs. BAUER and HUMPHREYS.

L. A. BAUER: *The total solar eclipse at Cape Palmas, Liberia, May 29, 1919.*

The station at Cape Palmas, Liberia, was one of five principal stations at which magnetic and allied observations were carried out by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, in connection with the solar eclipse of May 29, 1919. Two of these stations, Sobral, Brazil, in charge of Mr. D. M. WISE, assisted by Mr. A. THOMSON, and Cape Palmas, Liberia, in the author's charge, who was assisted by Mr. H. F. JOHNSTON, were inside the belt of totality. A third station, at Huancayao, Peru, north of the totality belt, was in charge of Dr. H. M. W. EDMONDS; the fourth station south of the belt of totality, at Puerto Deseado, Argentina, was in charge of Mr. A. STERLING; and the fifth, about 100 miles north of the belt of totality, at Campo, Cameroun, was in charge of Mr. FREDERICK BROWN. Observations were also made at a secondary station, Washington, by Mr. C. R. DUVALL.

In addition to these stations, special magnetic observations were made at the Department's magnetic observatory at Watheroo, Western Australia, and at observatories all over the globe, both inside and outside of the region of visibility of the eclipse. Reports have already been received from many of these foreign observatories. The reports indicate that the magnetic conditions were ideal for the detection of a possible magnetic effect of the order to be expected from the Department's previous eclipse magnetic observations. As soon as the various observations have been examined and discussed, a paper will be presented before the Society upon the results obtained.

The prime object of the present paper was to give a general account of the expedition to Cape Palmas, Liberia, to relate the phenomena observed during the total eclipse, and the experiences encountered en-route to Liberia and in Liberia itself.

Totality lasted at Cape Palmas about 6 minutes and 33 seconds, longer than at any other station in the belt of totality. The general indications, as the eclipse occurred during the rainy season, were that Cape Palmas would not be a suitable station for the astronomer. However, for the purpose of the Department's investigations, it did not matter whether there was a clear sky or not, for a magnetic effect will pass through any layer of clouds. It happened, however, that in spite of general expectations, the weather was clear, and this now for the third time, whereas certain parties at other stations, which appeared more favorable according to past meteorological records, were unfortunate. The observation program included magnetic and electric observations, meteorological observations, shadow-band observations, times of contacts, and photographs such as could be obtained with small kodak cameras. This comprehensive program was carried out successfully, excepting the atmospheric-electric work which, on account of the deterioration of the dry-cell batteries purchased in England, had to be abandoned. Although three observers had been stationed, no shadow bands were observed this time, even greater precautions having been taken than at Corona during the eclipse of June 8, 1918, where they were observed.

The eclipse of May 29, as observed at Cape Palmas, was not nearly as dark, in spite of its long duration, as the much shorter one of June 8, 1918, at Corona, Colorado. There was a marked difference in light, both as seen visually and as shown by the photographs, between the inner corona and the outer extensions. The large red prominence was a startling object.

Clear indications were had with regard to a magnetic effect in accordance with the results obtained at previous solar eclipses.

There was a steady slight decrease in temperature from 12^h G.M.T., 0.7 minute after the first contact, to 12.7^h G.M.T., and then a more rapid decrease until 14^h G.M.T., when the minimum temperature of 79.4° F. was reached. This time (14^h) was approximately 0.4^h later than the middle time of totality. The increase in temperature after 14^h was rapid, the maximum of 82.7° F. being reached at 14.9^h G.M.T. The hydrogram for May 29 showed the following effect: the humidity, which was 71 per cent at 12^h G.M.T., steadily increased to 78 per cent at 14^h G.M.T. There was a more rapid decrease from 14^h G.M.T. to 15^h G.M.T. when the humidity was 66 per cent. The maximum humidity, therefore, occurred at 14^h G.M.T. or approximately 0.4 hour later than the middle time of totality. The barogram showed nothing marked during the time of the eclipse.

D. M. WISE: *The total solar eclipse at Sobral, Brazil, May 29, 1919.*

At Sobral, Brazil, the Department of Terrestrial Magnetism carried out a program of magnetic and atmospheric-electric observations very similar to that which it carried out at Lakin, Kansas, during the eclipse of June 8, 1918. Magnetographs were installed in a basement and control observations made in a tent nearby. These were operated for approximately twenty days. Atmospheric-electric observations were made in an open field formerly used as a race-course. The climate was dry and exceptionally good for observing atmospheric-electric phenomena. The mornings were generally cloudy and the total eclipse was witnessed through an opportune break in the clouds. The corona was very bright and the prominence gave a distinct lurid tinge to the light from it. Photographs of the eclipse were obtained with an ordinary kodak.

All the papers of the evening were illustrated by lantern slides.

Adjournment at 10.20 p.m. was followed by a social hour.

D. L. HAZARD, *Recording Secretary, pro tem.*

ARCHAEOLOGICAL SOCIETY

18TH MEETING

The eighteenth annual meeting of the Washington Society of the Archaeological Institute of America was held at the residence of the President, Col. R. M. THOMPSON, 1607 Twenty-third Street, on November 21, 1919. Officers for the year 1919–1920 were elected, as follows: *President*, ROBERT LANSING; *Vice-Presidents*, ROBERT M. THOMPSON, HENRY WHITE, Miss MABEL BOARDMAN, Mrs. H. F. DIMOCK; *Secretary*, MITCHELL CARROLL; *Associate Secretary*, Miss HELEN WRIGHT; *Treasurer*, JOHN B. LARNER; *Councillors*, ROBERT M. THOMPSON, WILLARD H. BROWNSON, CHARLES HENRY BUTLER, WILLIAM MILLER COLLIER, F. WARD DENYS, JOHN B. LARNER, JAMES PARMELEE, J. TOWNSEND RUSSELL; *Executive Committee*, the abovenamed officers and ALBERT DOUGLAS, GILBERT H. GROSVENOR, Mrs. JOHN HAYS HAMMOND, MARTIN A. KNAPP, CHARLES COLFAX LONG and Mrs. JAMES BROWN SCOTT.

Prof. MORRIS JASTROW, JR., of the University of Pennsylvania, gave an illustrated lecture on *The archaeological field in Asia Minor; results and prospects.*

MITCHELL CARROLL, *Secretary.*

SCIENTIFIC NOTES AND NEWS

A meeting of the Maryland, Virginia, and District of Columbia Section of the Mathematical Association of America was held in Washington on December 6, 1919.

The Physics Club of the Bureau of Standards was re-established in October, 1919, and the following lectures have been delivered before the Club since that date: October 27, R. C. TOLMAN: *Similitude;* November 3, 10 and 17, C. W. KANOLT: *Gravitation and relativity;* November 24, F. C. BROWN: *Recent development of bomb ballistics;* December 1, I. C. GARDNER: *Optical instruments for military work;* December 9 and 16, R. C. DUNCAN: *Some applications of science to ballistics;* January 5, W. F. MEGGERS: *Aerial photography;* January 12 and 26, E. A. ECKHARDT: *Sound ranging and recent developments in acoustics.* F. B. SILSBEE is president and H. F. STIMSON is secretary of the Club.

The U. S. Coast and Geodetic Survey steamer *Isis* had to be beached about five miles south of St. Augustine, Florida, on January 15, on account of damage due to collision with a submerged wreck. It was believed that the vessel could be salvaged if the weather remained favorable.

Representatives J. A. ELSTON, of California, F. L. GREENE, of Vermont, and L. P. PADGETT, of Tennessee, were appointed Regents of the Smithsonian Institution by the Speaker of the House on January 9.

The Board of Surveys and Maps recommended by the map-making conference,[1] and recently created by executive order, met on January 13 and elected the following officers: *Chairman,* O. C. MERRILL, Chief Engineer of the Forest Service; *Vice-Chairman,* WILLIAM BOWIE, Chief of the Division of Geodesy, U. S. Coast and Geodetic Survey; *Secretary,* C. H. BIRDSEYE, Chief Geographer of the U. S. Geological Survey.

The following commissioned officers resigned from the Coast and Geodetic Survey in December: H. R. BARTLETT, J. A. DANIELS, G. H. DURGIN, A. J. ELA, C. G. QUILLIAN and A. C. WITHERSPOON.

Mr. R. M. BROWN, formerly librarian of the Coast and Geodetic Survey, has accepted an appointment with Rand, McNally and Company, to prepare and edit material for a new edition of their atlas of the world.

Mr. ROBERT HOLLISTER CHAPMAN, topographical engineer of the U. S. Geological Survey, died on January 11, 1920, in his fifty-second year, while attending a meeting of the American Alpine Club in New York City. Mr. Chapman was born at New Haven, Connecticut,

[1] This Journal **9**: 605. 1919.

July 29, 1868. He became a topographer on the Survey in 1882 and had been with the organization since that date, serving also in 1909–1910 on a detail to the Geological Survey of Canada. During the European war he was a major in the Engineer Corps of the Army. He was a member of the ACADEMY and of the Archaeological, Engineers', and Geological Societies.

Dr. PAUL D. FOOTE, of the Bureau of Standards, has been appointed Editor of the *Journal of the Optical Society of America.*

A Coast and Geodetic Survey party in charge of N. H. HECK has been locating submerged trees in Lake Washington, Seattle, by the wire-drag method. The trees, which are a serious risk to navigation, are then removed by pulling up the trees or dynamiting the tops. The trees range from 60 to 100 feet in height and their tops are covered by 6 to 30 feet of water.

Mr. W. B. HICKS, chemist of the U. S. Geological Survey, resigned on February 1 to accept a position as chemist with the Solvay Process Company, of Syracuse, N. Y.

Mr. ANDREW KRAMER, of the Astrophysical Observatory, Smithsonian Institution, has recently completed a graphical computing machine, containing 8 slide rules, for use in reducing solar radiation observations.

Mr. GEORGE A. RANKIN, formerly with the Pittsburgh Plate Glass Company, and captain in the Chemical Warfare Service during the war, joined the staff of the Geophysical Laboratory, Carnegie Institution of Washington, in January.

Mr. R. W. SAYLES, of Harvard University, who came to Washington in January to make a study of the National Museum's collection of slates, is collecting data on the banding of slates and the modes of origin of banding.

Mr. DANIEL E. WISE, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, resigned in November to go into private business at Chambersburg, Pennsylvania.

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ZOOLOGY.—*On the relations of the sectional groups of* Bulimulus *of the subgenus* Naesiotu *Albers.* WILLIAM HEALEY DALL, U. S. National Museum.

The Naesioti are developed in considerable profusion in the Galapagos Islands. They are related to the small translucent ground snails of the genus *Bulimulus*, which are common to the elevated forest region of South America nearest to the islands and which were probably transported originally to the Galapagos group by high winds while attached in a state of hibernation to dead leaves or similar light material. After reaching the islands their opportunity for evolution into a variety of types was fostered by isolation, differences of food supply and the modifications due to volcanic dust from the disintegrating lavas. In a report to the California Academy of Sciences on the species collected by Mr. W. H. Ochsner of their Galapagos expedition, prepared in 1916, but still unprinted, their relation to situs, distribution among the islands, and apparent protective modifications are discussed at length, and in 1896[1] some of the probable causes of the peculiarities developed in such insular faunas were considered. Nothing in the landshell fauna lends weight to the hypothesis that these islands were ever connected by land with the continent of South America. The Tertiary fossils obtained by the Cal-

[1] *Insular landshell faunas especially as illustrated by the data obtained by Dr. G. Baur in the Galapagos Islands.* Proc. Acad. Nat. Sci. Phila. August, 1896, pp. 395 to 459, pl. 15–17. Also supplementary data in the same periodical for 1900, pp. 88–96, pl. 8.

ifornia Academy's Galapagos Expedition also indicate that isolation was complete at least as early as Pliocene time, and present an interesting admixture of west American and Indo-Pacific types.

By their superficial characters these shells are easily divided into more or less closely related groups, some of which are restricted in their range to particular islands or groups of islands. Sectioning reveals that some of these are more emphatically characterized by internal structure, the possession of internal laminae not visible from the aperture and features of the columellar axis. Of these groups at least fifteen are recognizable, and several of them are so well marked as to have received names from the earlier students. Only in recent years has the fauna been sufficiently well known to enable the less emphatically characterized groups to be recognized, and I believe no one hitherto has made a systematic study of the internal characters of the shells while the first contribution to a knowledge of their anatomy was contained in my monograph of 1896. A summary of the groups follows.

Group of *N. achatellinus* Forbes (*Rhaphiellus* Pfeiffer, 1851).

This species is strictly arboreal and appears to be rare. As with the Achatinellas it exhibits more attractive coloration and variability of pattern than the ground-loving species. The axis is tubular and quite simple.

Group of *N. nux* Broderip (*Naesiotus* Albers, 1850).

N. nux Broderip, with five varieties.
N. asperatus Albers (not of Reibisch).
N. bauri Dall.

These are chiefly arboreal, living on trees and bushes but descending to shelter on the ground, in some cases, for hibernation. They are confined to Charles and Chatham Islands and their associated islets. The axis in general is slender, partly twisted and simple, the anterior portion tubular. The aperture is unarmed, the surface dull and wrinkled, the form stout, and the shell substance solid.

Group of *N. planospira* (**Granucis** n.).

N. planospira Ancey.
N. rugulosus Sowerby.
N. invalidus Reibisch.
N. approximatus Dall.

This group is confined to Charles Island so far as authentic records go, except *approximatus*, which hails from Hood Island and differs in surface from the others. These shells are more elevated and delicate than the preceding group, the surface spirally more or less sharply striate, often forming a fine granulation with the incremental lines. There is a tendency to banding in the coloration. The axis is solid and twisted behind, the later part tubular and larger. The aperture is unarmed. Only *approximatus* lacks the spiral striation, if the single specimen available is normal.

Group of *N. ustulatus* (**Nuciscus** n.).

N. ustulatus Sowerby, with five varieties.
N. calvus Sowerby, with one variety.
N. elaeodes Dall.
N. haemerodes Dall.
N. pallidus Reibisch.
N. cinerarius Dall (+ *cinereus* Reibisch).
N. rugatinus Dall (+ *acutus* Reibisch).
N. jacobi Sowerby.
N. tanneri Dall.
N. perrus Dall.

This group is near the presumed original ancestor and is most widely distributed among the islands, being particularly numerous on the largest island, Albemarle. The shells are small, robust, rather stout and short, with fine spiral striations to which in dusty situs is added strong corrugation of the surface. There is a tendency to a pale band at the periphery and the species vary from whitish to brown. They are mostly ground lovers but ascend the bushes to some extent during the season of rains. The aperture is unarmed, the axis wholly tubular and hardly twisted.

Group of *N. hoodensis* Dall.

This is represented on the islands, as far as known, by a single species which resembles the continental type more than the other island forms. It is rather brightly banded and the adult has a thickened and reflected peritreme, a feature unique among the island species.

Group of *N. unifasciatus* (**Reclasta** n.).

N. unifasciatus Sowerby (not Reibisch).
N. olla Dall, with one variety.

By their thin and capacious shells these are readily separable from the other groups. They tend to brownish or dingy olive color with pale peripheral band. They are well distributed among the islands and in the active state appear to frequent shrubbery. They are finely axially wrinkled, polished and obscurely spirally striated with an occasional elevated line of granules which in the young bear short hairs which soon drop off. The aperture is unarmed and the axis as in the section *Nuciscus*.

Group of *N. eschariferus* (**Adenodia** n.).

N. eschariferus Sowerby, and one variety, *pileatus*.
N. ventrosus Reibisch.
N. subconoidalis Ancey.
N. perspectivus Pfeiffer.

These are residents of the more arid zone, mostly found under rocks, etc., and, like many of the other ground lovers, sometimes finely granulose. The shells are thin, slender, elevated, usually polished, but in the variety *pileatus* the periostracum is raised into close low dull spiral lamellae. Traces of these may be noted on some of the polished specimens, and in all the apical whorls are sharply tranversely ribbed. The peritreme is slightly expanded, the axis tubular, slender, and quite simple. The distribution is rather scattered.

Group of *N. snodgrassi* (**Stemmodiscus** n.).
N. snodgrassi Dall.
N. cucullinus Dall.
N. galapaganus Dall.

This group is confined to Hood, Gardner, Charles, and Barrington Islands, and externally is not to be distinguished from *Adenodia*. The internal structure is entirely different. The earlier part of the axis is simple and tubular as in many other Galapagos species, but in the first half of the last whorl, invisible from the aperture, a semi-circular disk-like flange projects (in the type) at right angles to the axis into the lumen of the whorl and about half way toward the outer wall of the whorl. This dwindles in front and behind into a short plaitlike ridge on the axis which does not enter the penultimate whorl or reach far enough forward to become visible from the aperture. This arrangement recalls the lamina in *Phenacotaxus umbilicatellus* Pilsbry, of Peru, except that it is confined to the first half of the last whorl, while in the Peruvian shell the lamina occupies part of three whorls and has its major expansion in the penultimate whorl.[2] In *N. cucullinus* the flange is shorter, rounder and less prominent than in *N. snodgrassi*, while in *N. galapaganus* it is thick and rounded.

Group of *N. amastroides* (**Olinodia** n.).
N. amastroides Ancey.
N. nucula Pfeiffer.
N. trogonius Dall.

This group of small greenish-olive, ground-loving species is known from Chatham, Charles, and Albemarle Islands. It must be rather close to the presumed ancestral type. The axis is simple, slender and twisted.

Group of *N. simrothi* (**Saeronia** n.).
N. simrothi Reibisch.
N. tortuganus Dall.
N. albemarlensis Dall.

This is a group peculiar to Albemarle Island and its associate islets as far as known; ground loving, found under leaves and on low bushes, and in the grassy zone. They are small, short and stout, dull surfaced, more or less roughly wrinkled or corrugated, the adults having a

[2] Smiths. Misc. Coll. 59: No. 14, p. 9, figs. 2. 1912.

nodule on the pillar and an inward projection on the middle of the outer lip. The axis is thin, slender and twisted except in the last whorl and usually has a purple stain on it not visible from the aperture. The figures named *simrothi* in my monograph of 1900, are really taken from specimens of *tortuganus*, a correction made possible by the receipt of authentic specimens of *simrothi*.

This group initiates the series of species with apertural armature which renders the group of *Naesiotus* so peculiar.

Group of *N. wolfi* (**Ochsneria** n.).

N. akanatus Dall.
N. adelphus Dall.
N. wolfi Reibisch.
N. lycodus Dall.
N. alethorhytidus Dall.
N. cymatias Dall.
N. ochsneri Dall.
N. sacronius Dall.

This group is confined to Indefatigable Island, and is a denizen of the arid zone though occasionally found on trees during the rainy season. The form is short and stout, the surface more or less corrugated, in some species to an extraordinary extent; there is a strong nodule on the pillar, another on the body, both usually more or less prolonged as a ridge into the interior of the last whorl; and sometimes one on the outer lip. *N. saeronius* is one of the smallest of the *Naesioti*. All the species are unusually solid.

Group of *N. duncanus* (**Granitza** n.).

N. duncanus Dall.
N. jervisensis Dall.
N. darwini Pfeiffer.

These species are found on James, Jervis, Duncan, and possibly Bindloe Islands. The shells are large, thin, short, with feeble tuberculations on the pillar, body and outer lips. The upper part of the axis is very slender and twisted. Only *N. darwini* has been found living.

Group of *N. sculpturatus* (**Granella** n.).

N. sculpturatus Pfeiffer.
N. rabidensis Dall.
N. rugiferus Sowerby.
N. naesioticus Dall.
N. reibischi Dall.
N. nudus Reibisch.

These forms are known from James, Rabida (or Jervis) and Indefatigable Islands. The doubtful *N. nudus* is reported from Charles Island. They are irregularly axially ribbed, sharply spirally striate, granulose and corrugated, slender and thin, with unarmed aperture, slender and more or less solid twisted axis and numerous whorls. They indicate the transition from the more normally formed species toward the peculiarly shaped *Pleuropyrgus*.

Group of *N. chemnitzioides* (*Pleuropyrgus* Martens).

N. chemnitzioides Forbes.
N. lima Reibisch.

N. habeli Stearns, and variety *terebra* Reibisch.
N. indefatigabilis Dall.

This group appears to be restricted to the arid zone of Chatham Island, except the last species which is reported from Indefatigable and James Islands. The species are very slender, with very numerous whorls usually axially ribbed, with a solid slender and twisted axis and unarmed aperture.

Group of *N. canaliferus* (*Pelecostoma* Reibisch).
N. canaliferus Reibisch.

This peculiar species has been found by Wolf only on Chatham Island on moss and ferns at from 900 to 2000 feet elevation. It has numerous flat-sided short whorls, a basal attenuation with a relatively large funicular umbilicus, and a prominent flange on the pillar, which on sectioning the shell is seen to continue as a strong concave plate, surrounding the axis and continued into the penultimate whorl, gradually becoming less prominent. Specimens were obtained by Ochsner from the dry zone, near the beach to 450 feet elevation. Reibisch's second species of *Pelecostoma* is *Tornatellina chathamensis*.

GEOPHYSICS.—*The internal constitution of the earth.* WALTER D. LAMBERT, U. S. Coast and Geodetic Survey.[1]

The title of this paper, "The internal constitution of the earth," was chosen chiefly for brevity. Many of the topics included under that comprehensive heading I shall not touch on at all, and shall deal chiefly with the mechanical properties of the matter in the interior of the earth, and more particularly with its density and its elasticity.

The view that generally prevailed down to recent times and that still persists to some extent as the dictum of popular science is that the interior of the earth is fluid and fiery hot, like molten lava. The volcanoes seem to be offering us samples of the matter within; mediaeval theologians saw in the hot interior of the earth the future abode of sinners. The molten mass of the earth is assumed to have cooled to some extent, thus forming on the outside a crust of undetermined thickness, upon which we live.

[1] The substance of this paper was read before the Maryland-Virginia-District of Columbia Section of the Mathematical Association of America on December 6, 1919.

The view that the interior is hot and fluid is certainly not wholly unsound. First, as to the heat. As far down as borings have been made into the earth, the temperature increases with the depth; the rate is very variable from place to place; 1° C. for each 35 meters may perhaps be taken as a fair mean, or in ordinary units say 1° F. for each 60 feet. The discovery of radium and of the great quantity of heat given out by even a minute quantity of it suggests the possibility that the heat supplied by radium may exceed the heat radiated into space so that the earth may be gaining instead of losing heat.[2] What the temperature of the interior is we cannot say. If the rate of increase of 1° C. for each 35 meters should hold good clear to the center, the temperature there would be 180,000° C. Such a temperature does not agree with present ideas. Men of science do not talk of a solar temperature of millions of degrees, as did their predecessors of a generation or two ago. They are content to accept a solar temperature of a few thousand degrees, and our estimates of terrestrial temperatures must be correspondingly lowered. It is almost certain, however, that the temperature is high enough to melt rock under the surface conditions of pressure, but the increased pressure may raise the melting point so much that no actual liquefaction occurs. Volcanoes are supposed to be isolated "pockets" of molten matter unconnected with any central reservoir.

As far as the fluidity is concerned, if the earth be not fluid, it acts in some ways as if it were. It seems improbable that a gravitating body the size of the earth and composed of any species of matter with which we are acquainted should sufficiently resist as a whole the long-continued action of the stresses that would arise from any great departure from the conditions of fluid equilibrium. The flow of rock may resemble that of ice in a glacier, which is a process of rupture followed by reunion under pressure. The theory of fluidity, at all events, has served us

[2] The phrase "gaining heat" is used advisedly instead of "rising in temperature." For a body sufficiently large, a rise in temperature would accompany a *loss* of heat, owing to the gravitational work done in contracting. It is possible that the earth is large enough for this to be the case, so that a loss of heat would accompany a rise in temperature and *vice versa*. See RUDZKI, *Physik der Erde*, p. 118.

well in the past, and is very probably valid, if we understand it in the above sense, that for large stresses, long continued, the earth acts on the whole like a fluid body.

The hypothesis of fluidity did not have the field all to itself, and as a matter of curiosity I will mention some of the more extravagant of the competing notions. Some of you may have heard of "Symmes's hole,"[3] an opening at both poles, admitting to several layers of habitable spheres in the interior of the earth. Symmes apparently put forward his idea in all seriousness and asked for the fitting out of polar expeditions to find the entrance to this unexplored and desirable territory. Equally strange ideas have been put forward by men of higher scientific standing than Captain Symmes. The astronomer Halley supposed the interior of the earth to be hollow, with inner spheres much like Symmes's, only with no hole to give access to them. These spheres were assumed to be magnetic, their rotation at a slightly different rate from that of the outer sphere causing the variation of the magnetic elements. A contemporary of Symmes, not as well known as Halley, conceived the idea of a magnetic planetoid within the earth. Benjamin Franklin, usually level-headed, supposed the interior of the earth to be filled with compressed air.[4]

Let us leave now these airy realms of fancy and consider what we know of the density of the earth. The rock on the surface is directly accessible. The extremes of rock density are about 3.3 and 2.1; the mean for the earth's surface as a whole may be put at 2.6 to 2.8. We can judge of the density below the levels accessible to us only by the mechanical effects of the matter of these inaccessible regions. One mechanical effect is the at-

[3] *The Symmes Theory of Concentric Spheres, demonstrating that the earth is hollow, habitable within, and widely open at the Poles. Compiled by Americus Symmes from the writings of his father, Capt. John Cleves Symmes.* Published at Louisville, Kentucky, in 1878. Capt. Symmes served with credit in the War of 1812.

[4] Convenient summaries of early speculations about the earth's interior, with references to the literature of the subject, will be found in THIENE, *Temperatur und Zustand des Erdinnern* (Leipsic, 1907), Chapter 1; and in GÜNTHER, *Lehrbuch der Geophysik,* Vol. 1. Thiene's version of Halley's ideas is, however, erroneous. See Phil. Trans., 1692, p. 563.

traction, and from this the mean density of the whole mass of the earth comes out as 5.5 or 5.6. There are several steps in the determination of this mean density. We start with the equation that expresses Newton's law of attraction

$$f = \frac{k\, m_1\, m_2}{r^2} \qquad (1)$$

where m_1 and m_2 are the masses of two bodies, preferably homogeneous spheres; r is the distance between the centers of gravity of the bodies, the linear dimensions of which are supposed to be infinitesimal compared with r, unless the bodies be homogeneous spheres; f is the force with which these two bodies attract each other; and k is the so-called gravitation constant. The first step in determining the earth's mean density is to determine k by a laboratory experiment. All quantities that occur in equation (1) are measured under laboratory conditions, and k is thus deduced. One form of the experiment, in which we observe the deflection of a torsion balance caused by the near approach of a large mass, is known as Cavendish's experiment. In the second step we use the same equation, with k now supposed known, to determine the mass of the earth. If m_1 be taken to represent this mass and m_2 the mass of another body near the earth's surface, then r is very nearly the earth's mean radius a. The force of attraction equals $m_2 g$ where g is the acceleration of gravity, so that

$$m_2 g = \frac{k\, m_1\, m_2}{a^2} \qquad (2)$$

which gives us m_1 in terms of known quantities. When the earth's mass is known, its mean density is computed from its known dimensions.

Since the surface density is less than the mean density, somewhere below the surface the density must exceed the mean. Just how that density is distributed from center to surface is a matter for hypothesis. One hypothesis often made is due to Legendre[5] and is based on the idea of the compression of the mat-

[5] The law to which this hypothesis leads is often called Laplace's law of density. Legendre and Laplace reached the same result from different starting points. See TODHUNTER, *History of the theories of attraction and figure of the earth*, 2: 117 and

ter due to the pressure of the matter above it computed as for a fluid. The modulus of compressibility is assumed to vary as the square of the density. We naturally expect this modulus, which measures the resistance to compression, to increase rather rapidly with the density, and Legendre's assumption is in accord with this idea and it has the further advantage of leading to fairly simple and manageable mathematical expressions. The density of ρ at any point whose distance from the center is x (x being expressed in units of the mean radius of the surface), is given by

$$\rho = \frac{\rho_1 \sin(\theta x)}{x \sin \theta} \tag{3}$$

where ρ_1 is the surface density and θ is a constant.

Table I shows the values of the density and also of the hydrostatic pressure p in megabars, a megabar being one million dynes per square centimeter or nearly one standard atmosphere.[6]

TABLE I

DENSITY, PRESSURE, AND MODULUS OF RIGIDITY ACCORDING TO LEGENDRE'S LAW.

Distance x	Density ρ	Hydrostatic pressure p	Modulus of rigidity by Legendre's law[a] μ
		megabars	C. G. S. units
Center 0.0	11.2	3.2×10^6	41×10^{11}
0.1	11.1	3.1×10^6	40×10^{11}
0.2	10.8	2.9×10^6	38×10^{11}
0.3	10.2	2.6×10^6	34×10^{11}
0.4	9.4	2.2×10^6	29×10^{11}
0.5	8.5	1.8×10^6	23×10^{11}
0.6	7.4	1.3×10^6	18×10^{11}
0.7	6.3	0.88×10^6	13×10^{11}
0.8	5.1	0.56×10^6	8.4×10^{11}
0.9	3.8	0.21×10^6	4.8×10^{11}
Surface 1.0	2.65	0.00×10^6	2.3×10^{11}
Mean (with regard to volume)	5.58	......	11.6×10^{11}

[a] For comparison: Modulus of rigidity of steel $= 8 \times 10^{11}$; of glass $= 2.5 \times 10^{11}$; of surface rock (average) $= 2.4 \times 10^{11}$; all in C. G. S. units.

337; also PRATT, *Attractions and figure of the earth* (4th ed.), p. 111. The starting point here adopted is that of Laplace rather than that of Legendre.

[6] One megabar = 0.987 standard atmosphere of 76 cm. of mercury at sea-level in latitude 45°.

The value of θ used in computing the above table is 2.5066 radians or 143.618°, which gives a flattening of 1/296.5. The column showing the modulus of rigidity will be explained later.

Another effect of the arrangement of density within the earth is the precession of the equinoxes. Theory shows that the annual precession, which is known accurately from the long series of available observations, is proportional to $(C-A)/C$, C and A being principal moments of inertia of the earth. Evidently $(C-A)/C$ depends on the distribution of density within the earth. With the law we have assumed, its value comes out 1/304.3. The observed precession requires more nearly $(C-A)/C = 1/305.3$. Agreement between computed and observed values can be obtained by increasing θ a little, thus changing very slightly the quantities in the above table and making the flattening equal to 1/297.2, which is in excellent agreement with the flattening derived from pendulum observations and from triangulation.

It might be supposed that this agreement is at least some evidence that the type of formula assumed for the law of density is nearly correct. It is a curious fact however, that almost any law of density will do exactly as well, so far as any of our means of observation go. That is, assume any type of law that you please that gives a density decreasing from center to surface, for example:

$$\rho = a - bx^c \tag{4}$$

a, b and c being constants to be determined, assume further that the hydrostatic equilibrium prevails and determine the constants a, b and c of your assumed law so that $(C-A)/C$ shall be equal to its observed value 1/305.3, then your flattening comes out almost exactly 1/297.2. This fact was first observed to be true when various hypothetical laws were tried, and mathematical demonstrations have been given by Poincaré and others.[7] These demonstrations set limits within which the flattening must lie for any permissible law of density, provided $(C-A)/C$ has its observed

[7] POINCARÉ. *Figures d'équilibre d'une masse fluide* (Paris, 1902). Chap. IV. VÉRONNET. Journal des Mathematiques pures et appliquées 77: 331. 1912. TISSERAND. *Mécanique Céleste*, 2: 221.

value, and the upper and lower limits are so close together and so close to $1/297.2$ that our determinations of the flattening from pendulum observations or from triangulation are not accurate enough for us to say that one law of density represents observed facts better than another.[8]

We can take hold of the matter by the other end. Let us assume as the data of observation the values of the flattening, of $(C-A)/C$, of the mean density and surface density of the earth, and of the ratio of the centrifugal force of rotation to gravity at the equator, a quantity whose value has already been tacitly assumed in our previous discussions. Let us see what conclusions about the density are allowable. We are still supposing hydrostatic equilibrium, and for this to be stable, densities must increase with depth; let us further suppose that the density changes continuously and that the rate of increase diminishes as the depth increases. The limits of density shown in table 2 have been derived by Stieltjes.[9]

The data assumed as the basis of table 2 are not quite the same as for the previous table, but the difference is of little consequence.

Before leaving the subject of densities, Wiechert's hypothesis should be mentioned. Legendre's law of densities and others

[8] The flattenings so far given have all been computed from formulas that are accurate only to small quantities of the first order in the ellipticity and the ratio of the centrifugal force at the equator to gravity there. Since these quantities are, respectively, about $1/297$ and $1/289$, it is seen that the terms of the second order, *i. e.*, in the squares and products of these quantities, might very well affect the tenths or even the units in the reciprocal of the flattening. It happens, however, that in determining the flattening from the law of density and the rate of rotation, the effect of the terms of the second order is small, *i. e.*, a few tenths only, and the general conclusions hold good as stated. See reference to Véronnet in previous footnote; also DARWIN, *The theory of the figure of the earth carried to the second order of small quantities.* Monthly Notices of the Royal Astronomical Society 60: 82. 1900. Scientific Papers 3: 79. In determining the flattening from pendulum observations the terms of the second order have a somewhat greater effect.

[9] Archives néerlandaises (Haarlem, 1884) 19: 456. See also TISSERAND, *Mécanique Céleste*, 2: 227.

TABLE 2.

STIELTJES' LIMITS OF DENSITY CORRESPONDING TO DIFFERENT DISTANCES FROM THE EARTH'S CENTER

x	Limiting densities.	
Center 0.0	7.6	12.2
0.1	7.6	11.3
0.2	7.6	10.4
0.3	7.6	9.3
0.4	7.6	8.9
0.5	7.5	8.3
0.6	6.9	7.8
0.7	6.0	7.0
0.8	5.1	5.8
0.9	4.0	4.6
Surface 1.0	2.6	2.6

like it assume a continuous change of density from surface to center, as of chemically homogeneous matter under pressure. Wiechert[10] assumes that the central portion or nucleus of the earth is of different material from the outer portion or shell, and that there is an abrupt change in passing from nucleus to shell. The nucleus is supposed to be of metal, chiefly iron, and the shell of rock. In the mathematical form of the hypothesis the density of the iron nucleus is 8.206,[11] its radius 0.78 of the earth's radius; the shell is homogeneous also and of density 3.2. These figures are not entirely arbitrary; they are determined by making the mean density 5.58 and the equilibrium hydrostatic with both the flattening and the value of $(C-A)/C$ conforming to their observed values. The supporters of this hypothesis adduce physical reasons in its favor which are not without weight, but into which I shall not enter. Apart from these it may be used, however, merely for mathematical convenience, as a first rough

[10] *Nachrichten Königl. Gesellsch. Göttingen*, p. 221. 1896–97.

[11] The density of iron is 7.8 under ordinary condition and we may attribute the extra 0.4 of density to pressure or to slight proportions of heavier elements.

approximation to an earth of continuously varying density, and sometimes it gives very nearly the same results as the hypothesis of a continuously varying earth. In some problems, particularly in the elasticity of the earth, the hypothesis is about our only resource, since the mathematical treatment is either beyond our powers or excessively complicated.

To sum up: as far as concerns the density, we know the mean density and the average surface density with some accuracy; the density at a given distance from the center is not known, and the prospect of determining it from its gravitational effects does not seem good. Legendre's law may be taken as, on the whole, the most satisfactory hypothesis, since it has a certain plausibility in its physical aspects and is mathematically convenient.

The doctrine of the earth's fluidity did not remain uncontested. The idea was put forward, and supported by mathematical reasoning that the force causing the precession of the equinoxes could produce the observed result only if the earth were solid or at least had a very thick and very rigid crust over its molten fluid interior. Even Lord Kelvin[12] for a while thought the argument sound but changed his view as the result of a talk with Newcomb. He says under date of September, 1876: "But doubt entered my mind regarding the so-and-so and so-and-so; and I had not completed the night journey to Philadelphia which hurried me away from our unfinished discussion before I had convinced myself that they were grievously wrong. So now I must request as a favor that each one of you on going home will instantly turn up his or her copies of the Transactions of the Royal Society for 1863 and of the first edition (1867) of Thomson and Tait's 'Natural Philosophy,' Vol. 1, and draw the pen through," etc., etc., naming the passages to be excised. What Lord Kelvin thought out that night on the train has been worked out in detail and published by Darwin[13]. It appears from their

[12] *Mathematical and Physical Papers* 3: 320.

[13] DARWIN. *On the precession of a viscous spheroid and on the remote history of the earth.* Phil. Trans., Part II, 170. 1879. Scientific Papers 2: 36. See also OPPENHEIM, *Über die rotation und präzession eines flüssigen sphäroids.* Sitzungsber. Königl. Akad. Wiss. Wien, Math. naturw. Kl. 92: 528. 1885.

work that the precession of a solid earth would be practically indistinguishable from that of a fluid one.

The first real evidence that the earth acts like an elastic solid rather than like a mass of fluid—at least in respect to forces acting over a short time only—came from the tides. The tides raised by the sun and the moon can be decomposed into partial tides falling into three classes: (1) Partial tides whose period is nearly a day; (2) partial tides whose period is nearly half a day, and (3) the so-called long-period tides whose period is nearly a fortnight or a month for the moon and six months or a year for the sun. With our present mathematical knowledge, we are utterly unable to predict, without recourse to observation, the tides of the first and second classes, the so-called diurnal and semi-diurnal tides, which are conveniently lumped together under one heading as the short-period tides. The diagrams in most text-books on astronomy intended to explain the origin of the tide generating forces almost inevitably suggest the idea that the tidal swelling travels round the earth keeping pace with the moon and remaining directly under it. Sometimes this statement is made in so many words, with qualifications for the effect of land barriers. This gives a very incorrect idea of the mechanics of the problem as far as it concerns the diurnal and semi-diurnal tides. Expressed in more mathematical form, the idea is that the ocean adjusts itself to the forces so that its surface is always an equipotential surface for the instantaneous field of force. The ability of the ocean to adjust itself thus to the forces depends on the depth and the period of the forces, and our actual ocean is far too shallow to adjust itself even approximately to the tidal forces with periods of half a day or a day. It appears to be otherwise with the long-period tides.

Lord Kelvin assumed that we can predict the amount of their rise and fall for the case of a rigid earth from the known masses and distances and positions of the sun and moon, because as far as these tides are concerned, the time is sufficient to allow the ocean surface to become an equipotential surface for the tide-generating forces. The assumption is not absolutely free from doubt, but the preponderance both of the argument and the observational evidence is in its favor.[14]

Let us accept the assumption and consider the consequences. We can predict these long-period tides for the case of a rigid earth; suppose the earth is not rigid at all but plastic, fluid in short, with a crust so thin as to yield to the pressure within and conform to the shape of the fluid within, which itself conforms to the tidal forces just as the water does. We measure the tides by the height of the water on the land. If the land yields as much as the water, no tide at all will be observed. If the earth is rigid, the full vertical tide should be observed. If the tidal forces make the earth yield, but yield as an elastic body, not as a plastic one, the observed tide will be intermediate between zero and the full theoretical amount for a rigid earth. From the observations of the long-period tides in various parts of the world, Kelvin[15] deduced a rigidity probably between that of glass and that of steel.

Mathematically parallel with the tides is the case of the zero of a pendulum. The tide-generating forces are also the forces that deflect the plumb-line slightly from its mean position. Since the surface of a fluid is perpendicular to the plumb-line, as the plumb-line is deflected, the water tips to follow it so that in theory the water in a wash basin is subject to tides. Instead of using a wash basin, Prof. Michelson,[16] of Chicago, used a long U-shaped pipe, and measured the changes in level by a delicate

[14] See DARWIN'S articles *Tides* in the 11th edition of the Encyclopedia Britannica; also LOVE, *Problems in geodynamics*, p. 51 (Cambridge, 1911). The effect of the continental barriers is an argument in favor of the assumption, as is also the frictional effect. This effect is underestimated if the coefficient of viscosity alone be considered. See HARRIS, *Manual of tides*, U. S. Coast and Geodetic Survey, Appendix 6 to Report of 1907, Part V, p. 273.

[15] See THOMSON and TAIT, *Natural philosophy* (2nd ed.), 2: 422–60. A much larger number of observations is discussed by SCHWEYDAR, *Beiträge zur Geophysik*, 9: 64. 1908.

[16] Journ. Geol. 22: 97. 1914. Astrophys. Journ., March, 1914. An important correction is given in Science, 50: 327. October 3, 1919. See also Astrophys. Journ., Dec., 1919.

method, depending on the interference of light. We can assert of the short-period tides of this artificial body of water, or of their mathematical analogue, the zero of the pendulum, what we cannot assert of the tides in the ocean, namely, that the water—or the direction of the vertical—adjusts itself to the forces almost immediately, so that we can predict even for these short-period motions of the water and the vertical what they should be for a rigid earth. Just as before, the observed movement is intermediate between the zero to be expected for a plastic earth and the full theoretical amount for a rigid earth. Interpreted in terms of the elastic constants of the earth, the short-period tides, the pendulum, and Prof. Michelson's pipe tides give about the same rigidity as the long-period tides of the ocean, or a rigidity a little higher.[17]

We get information about the rigidity of the earth also from the phenomenon of the variation of latitude. The history of this question is interesting. It was shown by Euler[18] that if by chance the axis of rotation of the earth should not coincide with the axis of maximum inertia, the former would shift its position, its pole describing a circle about the pole of the axis of inertia in a period of some 305 days, say 10 months, the exact period depending on the principal moments of inertia, which can be found with considerable accuracy from the phenomenon of the precession.[19] The astronomical latitude and longitude are dependent on the position of the instantaneous axis of rotation, and if it shifts, they change. Astronomers naturally tried to test the invariability of these latitudes by observation, but they looked either for a secular change or for a variation with Euler's period.[20] They did not find the secular change, but several times they seemed on

[17] The rigidity deduced in the article cited in the preceding footnote should be interpreted in the light of the later correction, and also with reference to what is said hereinafter in regard to the assumptions necessarily underlying a statement about the rigidity of the earth.

[18] *Theoria motus corporum solidarum seu rigidorum.* Greifswald, 1765.

[19] The number of sidereal days in the Eulerian period is the reciprocal of $(C-A)/C$, A and C being, as before, principal moments of inertia of the earth.

[20] See HELMERT, *Höhere Geodäsie*, 2: 394.

the point of demonstrating the reality of Euler's motion, only to be disappointed each time as the observations that had looked so promising ended by negativing the period sought. Finally S. C. Chandler[21] undertook the study of old observations with no presupposition as to the period, and found evidence of an annual period and of another period of about 14 months. The reality of these periods was proved by observations made specially for the purpose, and the matter is now being studied at a series of special observatories, the functioning of which has been somewhat affected by the war. The annual period[22] is naturally explained by seasonal changes in the distribution of matter, such as the unsymmetrical growth of the load of ice and snow in the polar regions. The reason for the 14-month period was for a while a puzzle. The idea of the earth's elasticity was comparatively novel then, and astronomers did not realize the natural consequence of that elasticity in prolonging the 10-month Eulerian period. Newcomb[23] appears to have been the first to suggest the idea, and further examination confirmed it. The rigidity required was rather higher than previous estimates had given, greater than that of steel by a third to a half.

I have been talking rather loosely of the elasticity of the earth. What I wish now to bring out is that what we get directly from tidal observations—and with these I include observations of the zero of a pendulum—and from the prolonging of the Eulerian period is not the modulus of rigidity or of compressibility of the earth as a whole or of any part of it, but simply two numbers—pure dimensionless ratios—which I shall call h and k, following a certain amount of precedent. To deduce from these numbers the elastic constants of the earth, we must make hypothesis as to the law of density within the earth, and as to the relation of the elastic moduli to each other and their law of variation within the earth. The theory of the numbers h and k is quite simple; their interpretation so as to deduce from them the elastic

[21] Chandler's work runs through several years of the Astronomical Journal, 11–22. 1892–1902. The 14-month period is announced in 11, No. 249.

[22] The annual period proper, not the "Kimura term."

[23] Monthly Notices Royal Astron. Soc. 52: 1892. Astron. Journ. 11, No. 251.

constants of the earth is difficult and leads to such intricate mathematics that we have to be content with very simple hypotheses about the elastic constants and with rough approximations.

The forces that deform the earth have a potential variable with the time and place on the earth. Suppose this potential to be expanded in a series of spherical harmonics, and let us consider only that portion due to the spherical harmonic of given order, which we shall denote by W. For the tidal deformation W is of order two. At the surface of the earth the force acts against gravity (g) so that the vertical displacement of a single particle would be W/g. This quantity measures the vertical displacement of the equipotential surfaces due to normal gravity. If the earth were covered with a non-attracting fluid whose sole function would be to make manifest the instantaneous form of the surface of equilibrium by conforming immediately to the forces, W/g would be the height of the tide in this fluid at the time and place in question, and the quantity W/g may be called the "equilibrium tide," due to the forces given by W. But the particles disturbed by the action of the forces are not weightless and non-attracting, which fact gives rise to new forces of the same type as these represented by W, but of different magnitude, the identity of type being, of course, a characteristic of the spherical harmonic expansion. These new forces cause further displacement which again cause new forces and so on indefinitely. The aggregate effect is, however, finite; the force called into being by a displacement of attracting matter is less than the force that produced the displacement. When equilibrium is attained,—we suppose that the period of W is long compared with the time necessary to adjust conditions to momentary equilibrium—the total vertical displacement of the equipotential surfaces at any point is no longer W/g, but a quantity of the same kind, hW/g; this defines h. h is a quantity such that hW/g measures the actual displacement when the displacement due to the equilibrium tide alone is W/g. Further, owing to the rearrangement of attracting matter, the potential of the force acting is no longer W alone, but a larger quantity $(1 + k) W$; this defines k. k is so taken that kW is the potential of the additional forces due to the rearrangement of matter.

The quantities k and h have no necessary connection with elastic yielding. The yielding may be a plastic one and the nature of h and k may be illustrated by using a result about the figure of the earth that is given in many works on mechanics.[24] If a spherical body the size of the earth, but with its mass concentrated at its center, its outer surface being defined by a non-attractive fluid existing for that purpose, were set rotating about its axis in 24 hours, the outer surface would take the form of a spheroid whose flattening is 1/578 or in more general terms

$$f = \frac{\omega^2 a}{2g}$$

f being the flattening, g the acceleration of gravity, ω the angular velocity of rotation and a the radius, so that $\omega^2 a$ is the centrifugal force at the equator. The disturbing force is the centrifugal force of rotation, the potential of which is

$$W = \frac{\omega^2 a}{2} \cos^2\phi$$

ϕ being the latitude. Thus the swelling of the equilibrium tide at the equator is W/g, as it should be. Our actual earth, however, does not have its mass concentrated at the center. The rotation produces a swelling at the equator, which rearrangement of matter produces a force that draws still more matter to the equator and so on till equilibrium has been attained. When this has happened, our actual earth has a flattening of 1/297 instead of 1/578. The quantity h represents the ratio of the actual displacement to the equilibrium tide, or $h = 578/297 = 1.95$, for plastic deformation. Since the potential is proportional to the flattening, we have

$$k = \frac{1/297 - 1/578}{1/578} = 0.95.$$

[24] *E. g.*, Pratt, *Attractions and figure of the earth*, 4th ed., p. 101; or Thomson and Tait, *Natural philosophy* (2nd ed.), 2: 370 and 394.

In the actual case of elastic yielding the variation of latitude gives us the quantity k by itself. Tidal observations give us $h-k$, since the observed motion is to the theoretical motion for a rigid earth in the ratio $1-(h-k) : 1$. The value of k from the variation of latitude is about 0.275. There are several difficulties in connection with the values of $h-k$ deduced from the tides, which I have not mentioned; probably the best value is $h-k = 0.29$, from Michelson's pipe.

What we should like to be able to do is to find the theoretical values of h and k corresponding to any system of values, varying from point to point, of the earth's density and elastic constants, so as to find by trial some plausible law of distribution that would fit the observations. What we are able to do is much less. The compressibility, in particular, introduces mathematical difficulties and the usual assumption is to make the earth incompressible. The errors due to this assumption are not so serious as might be supposed at first sight. If we further assume that the earth is of uniform density and has the same modulus of rigidity throughout the whole mass, its modulus of rigidity that will represent the lengthening of the Eulerian period comes out 16.3×10^{11} C. G. S. units. We can get rid of the assumption of uniform density by using Wiechert's hypothesis of a metal nucleus and an outer shell of rock, assuming, which is not very satisfactory, that both nucleus and shell have the same modulus. The latter must be 11.7×10^{11} to represent the latitude variation.[25] The hypothesis of a continuous change of density according to Roche's law[26], one of the many laws of density I mentioned earlier and one of the simplest, gives about the same, still supposing the rigidity constant. Roche's law is the one law of continuously varying density for which the theory has been worked out, and a rather formidable theory it is—a differential equation of the sixth order, and twelve new transcendental functions defined by infinite series.[27]

[25] For this result and the preceding one see LOVE, Proc. Royal Soc., A, 82: 73. 1909.

[26] Roche's law assumes that the density falls from center to surface proportionally to the square of the distance from the center, or $c = 2$ in equation (4).

[27] HERGLOTZ. Zeitschr. Math. u. Physik 52: 275. 1905.

Thus we see that if we assume uniform density, we overestimate the rigidity necessary to produce a given effect; if we assume, as we have done, incompressibility also, we underestimate the rigidity, though as nearly as can be made out not to as great an extent as we overestimated it in the first case.[28] If we wish to take account of a variation in the modulus of rigidity as well as in the density, about our only resource is the Wiechert hypothesis of density and with different moduli for nucleus and shell. This introduces an extra unknown, and we cannot determine both moduli from the latitude variation alone. If we try to satisfy the tidal observations also, and use the value of $h-k = 1/3$ formerly current, we get a modulus of 20×10^{11} for the nucleus, and 1×10^{11} only for the shell.[29] Since a representative rigidity of natural rock at ordinary pressure is about 2.4×10^{11}, the rigidity of the shell seems too low. There seems to be a tendency, however, towards smaller values of $h-k$ than the $1/3$ used above, of which Michelson's 0.29 is an example.[30] If these smaller values be accepted, it is easier to reconcile the modulus from the variation of latitude with that from the tidal observations, and with the known properties of rock. We should thus get a value of about 16×10^{11} for the nucleus and about 4×10^{11} for the shell. You will understand by this time, I think, something of the difficulties of the subject and the many assumptions that lie back of the statement, "The rigidity of the earth is thus and so."

There are, as you know, two theories of elasticity; one favored chiefly on the continent of Europe, which may be called the "rari-constant" theory and the other generally accepted in England, the "multi-constant" theory. According to the first theory there is only one independent elastic constant for an isotropic elastic body, and the modulus of rigidity of such a body is $3/5$ of its modulus of compressibility. According to the second, the

[28] LOVE. *Problems of geodynamics*, Chap. VIII. Cambridge, 1911.

[29] LOVE. Proc. Royal Soc. 82: 82. 1909. SCHWEYDAR. *Beiträge zur Geophysik*. 9: 76. 1908.

[30] For a downward revision of Schweydar's $h-k$, see Mem. Coll. Science and Engineering, Kyoto Imp. Univ., 4: 114. 1912.

"multi-constant" theory, there is no necessary relation between the two moduli. Without trying to decide between the two theories, it may be said that in many cases the relation indicated by the "rari-constant" theory seems to hold approximately.[31] If we accept the relation as holding, then any continuous law of density distribution is at the same time a law of distribution of the elastic moduli. The law of density gives a relation between the density (ρ) and the distance (r) from the center, and is likewise a relation between r and p, the pressure of the latter being hydrostatic, say $p = f(r)$ and $\rho = \varphi(r)$. The modulus of compressibility M is defined by

$$\frac{d\rho}{\rho} = \frac{dp}{M}.$$

By eliminating ρ and p, we get a relation between M and r, and $3/5$ of M gives us the modulus of rigidity, μ, for Legendre's law of density. The values of μ obtained in this way for Legendre's law of density were shown in table 1. Note that the surface value of μ is almost exactly what we have taken as representing surface rock, and the mean value of μ (averaged with respect to volume) is almost exactly what was deduced from the variation of latitude with Wiechert's law of density.

These must be taken as of the nature of curious coincidences, for the logic by which these values of μ were found is decidedly queer at first sight. If we assume hydrostatic pressure, we thereby assume zero rigidity. The next step is to deduce the modulus of compressibility from the law of density and the pressure, and to take $3/5$ of the modulus of compressibility to be the modulus of rigidity, thus getting a rigidity quite different from zero. The contradiction is less flagrant if we take into account the element of time. The law of density is for pressure extending over a very long time—geologic time—the compressibility is the ultimate compressibility for that pressure. The tidal forces and those arising in the variation have a period of a few days or a

[31] That the relation holds good, or nearly so, for the matter in the earth's interior is confirmed by observations on earthquake waves. See KNOTT, *Physics of earthquake phenomena*, p. 251. Oxford, 1908. Also a recent paper by him in Proc. Royal Soc. Edinburgh. **39**: 177. 1919.

few months. The modulus of compressibility for these stresses of short period would naturally be larger than the modulus of compressibility deduced from stress continuing unchanged over long periods,[32] and the modulus of rigidity which was zero for the long-continued forces might well be for the short period about 3/5 of the corresponding modulus of compressibility. The conclusion is that the numbers in the table are too small. The average of the tabular numbers agrees with what was deduced from the variation of latitude, but in the latter calculation the compressibility was neglected, leading to too small a result. This is another reason for believing the values in the table should be somewhat increased.

You see some of the difficulties in which the subject is involved. How much should those numbers be increased? I don't know; by a variable amount, perhaps not more than twenty per cent, at a guess. As the conclusion of this discussion of the rigidity of the earth, I can merely express my opinion or feeling that the average rigidity of the whole earth is over 12×10^{11}, that the modulus of rigidity must increase with the depth below the surface, and that probably the figures of table 1, all increased slightly, will give a fair idea of the variations of the modulus of rigidity.

Any discussion of the elastic constants of the earth would be incomplete without some mention of earthquake phenomena. Any adequate treatment of this, even a mere outline, would be impossible in the time available. The nature of the phenomenon may be described by saying that the earthquake shock is transmitted by radiations or waves analogous to those of sound and light. An ordinary elastic solid is a less specialized medium than the ether (if one dare mention the ether in these days of relativity), which transmits only the transverse vibrations of light, less specialized also than the air which transmits sound, for the modulus of rigidity of air is zero, and the air can transmit only the longitudinal waves (waves of condensation and rare-

[32] The modulus is the intensity of force necessary to produce a given deformation, and if the time be limited, it is natural to expect that the force required will be greater.

faction, characteristic of sound). The elastic solid can transmit both kinds of radiation at the same time. There is also a third kind of wave possible for which there is no familiar analogue. It is a surface wave whose amplitude diminishes rapidly with the depth, and its theory was worked out by the late Lord Rayleigh and by Lamb.[33] Seismologists discern in the records of their seismographs the preliminary tremors, which are separable into a first phase and a second phase, and the main shock. The first and second phases of the preliminary tremors are confidently identified by seismologists with the arrival of the longitudinal and transverse waves, which travel through the earth with velocities of about 12 and 6 kilometers per second, respectively. If the earth were homogeneous they would travel in straight lines but since this is not the case their paths are curved in a manner analogous to the curvature of a ray of light when passing through air of varying density. At surfaces of discontinuity there would occur reflections and refractions more complicated than those of sound and light because of the greater generality of the media. The main shock, called by seismologists the *long waves*, is believed to represent the arrival of the Rayleigh waves which travel more slowly than the other waves,[34] and, furthermore, travel around the surface.

The phenomena of the main shock are probably complicated by irregular reflections and refractions,[35] and there is more difference of opinion with regard to the main shock and its relation to the Rayleigh waves than with regard to the preliminary tremors.

From observations at three observatories the focus, or point of origin, of an earthquake can be determined,[36] and from the observed time that a tremor takes to travel from the focus to the point of observation, some interesting conclusions may be drawn as to the rigidity of the earth.

[33] RAYLEIGH. Proc. London Math. Soc. 17: 4. 1885; LAMB. Phil. Trans. A. 203: 1. 1904.

[34] Their velocity is 0.92 times the velocity of the transverse waves, which, as has been indicated, are in turn slower than the longitudinal waves.

[35] WALKER. *Modern seismology* (Longman's Monographs on Physics), p. 51. 1913.

[36] WALKER, *op. cit.*, Chap. VIII.

To deduce the modulus of rigidity from the earthquake data we must make certain assumptions, but it may be said that all results point to a modulus of rigidity increasing with the depth from that of rock at the surface (2.4×10^{11} C. G. S. units), to a value exceeding that of steel (8×10^{11} C. G. S. units), and perhaps three or four times as great.[37] It should be noted that owing to the scantiness of data for a distance from the focus greater than 13,000 kilometers, the information derived from earthquake data is limited to an outer shell whose thickness is about one-half the earth's radius.[38] This scantiness beyond 13,000 kilometers or even smaller distances has long seemed to need some explanation beyond that of mere distance and in this connection attention may be drawn to Knott's recent paper already referred to (footnote No. 31, p. 139), which is one of unusual interest. He suggests as a possible explanation that the central core of the earth, with a radius equal to perhaps 0.4 that of the earth, may be non-rigid or nearly so, but highly incompressible.

Even this very summary and dogmatic discussion has not covered even superficially the entire field. There remains the further discussion of the problem of the reason for the apparent fluidity of the earth for long-continued forces, and its rigidity under the action of forces of short period, also the theory of "firmo-viscosity" and its relation to the problem of viscosity and the retardation of the rotation by tidal friction. There remain also the hypotheses of various layers of fluid matter interposed between other layers of solid matter to satisfy this or that real or apparent result of observation. The subject of the interpretation of earthquake phenomena, extremely interesting both from a mathematical and a physical point of view, has been barely touched. Your patience and my knowledge

[37] The author has in hand some comparisons of the result of assuming the densities and moduli to be as given in table 1, together with similar comparisons for other laws of density, but the results are not complete. So far nothing has come to light to throw doubt on the general correctness of the opinion previously expressed in regard to the modulus deduced from Legendre's law, at least for the outer parts of the earth.

[38] One-half the radius is the maximum depth below the surface of a chord of 120° of great circle corresponding to a surface distance of about 13,000 kilometers.

would be quickly exhausted before even a small part of what remains had been outlined. I can only leave the subject to you with the assurance that the field is fertile in problems worthy of the attention of the ablest mathematicians, and extremely interesting also in their physical aspects.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

138TH MEETING

The 138th meeting of the ACADEMY, the 22d annual meeting, was held at the Carnegie Institution of Washington on Tuesday, January 13, 1920. The meeting was called to order by Vice-President W. J. HUMPHREYS. The retiring President, F. L. RANSOME, then delivered his presidential address, entitled: *Functions and ideals of a national geological survey.* This address has been published in the JOURNAL, **10**: 85.

Following the address a business meeting was held. The Corresponding Secretary, ROBERT B. SOSMAN, reported that 37 persons had qualified for membership in 1919 and one former member had been reinstated. 4 resignations had been accepted, 3 of which were of non-resident members. The membership of the ACADEMY had increased during the year by 25, and consisted at the end of the year of 6 honorary members, 3 patrons, and 532 members, one of whom was a life member. The total membership was 541, of whom 331 resided in or near the District of Columbia.

The members who died during the year were: JOSEPH BARRELL, GEORGE FERDINAND BECKER, JAMES MILTON FLINT, Mrs. PHOEBE APPERSON HEARST (patron), ABRAHAM JACOBI, ERNEST C. MCKELVY, EDWARD CHARLES PICKERING, LOUIS VALENTINE PIRSSON, GAILLARD SHERBURNE ROGERS.

The Corresponding Secretary also reported on the activities of the ACADEMY for the year 1919, and pointed out that the best quantitative index to the activity of such an organization was to be found in the number of members per hundred per year who resign or permit their names to be dropped for non-payment of dues. This index, which reached a maximum in 1917 on account of war conditions, fell in 1919 to the lowest value in many years.

The report of the Recording Secretary, WILLIAM R. MAXON, was read by G. F. LOUGHLIN. The report summarized the 8 lectures that were delivered during 1919.

The report of the Treasurer, R. L. FARIS, showed total receipts of \$4,929.75 and total disbursements of \$3,861.12. The cash balance on hand at the end of the year was \$1,480.02. The net increase in assets for the year was estimated at about \$1,060.00. The investments of the ACADEMY have a total par value of \$15,090.00. The cost of printing the JOURNAL in 1919 was about \$2,550.00.

The report of the Auditing Committee, consisting of G. R. Mansfield, William Blum and F. C. Cook, was then read, and the reports of the Treasurer and Auditing Committee were accepted.

The report of the Editors of the Journal was read by J. Franklin Meyer.

The committee of tellers, consisting of I. G. Priest, E. Posnjak and R. B. Sosman, reported that the following officers had been elected for 1920: *President*, C. L. Alsberg; *Corresponding Secretary*, Robert B. Sosman; *Recording Secretary*, William R. Maxon; *Treasurer*, R. L. Faris; *Non-resident Vice-Presidents*, Jacques Loeb, Elihu Thomson; *Members of Board of Managers, Class of 1923*, L. A. Bauer, T. Wayland Vaughan.

The following *Vice-Presidents*, nominated by the affiliated Societies, were then elected: *Philosophical Society*, W. J. Humphreys; *Anthropological Society*, George M. Kober; *Archaeological Society*, Ales Hrdlicka; *Biological Society*, A. D. Hopkins; *Chemical Society*, C. O. Johns; *Society of Engineers*, E. C. Barnard; *Entomological Society*, S. A. Rohwer; *Society of Foresters*, Raphael Zon; *National Geographic Society*, F. V. Coville; *Geological Society*, E. O. Ulrich.

G. F. Loughlin, *Recording Secretary, pro tem.*

BIOLOGICAL SOCIETY

602D MEETING

The 602d regular meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club on November 29, 1919.

Under the heading of "Communications," Dr. R. E. Coker presented a document issued by the Bureau of Fisheries, entitled *The life history of the blue crab*, by E. P. Churchill, Jr. In this paper it is brought out that spawning takes place in the south, so far as Chesapeake Bay is concerned; the young migrate north. After mating takes place, females move to the south, and males remain in the north.

Dr. H. C. Oberholser called attention to the appearance on that day of Volume 1, No. 1, of the *Journal of Mammalogy*, the organ of the recently formed Society of Mammalogists. Mr. Oberholser also mentioned, as a marked contribution to ornithological methods, a paper entitled *Bird banding by systematic trapping*, by S. Prentiss Baldwin. Although the experiments have been thus far conducted by a single individual, yet remarkable facts concerning the movements of birds have been learned.

Dr. H. M. Smith stated that he had observed a pair of swans and cygnets in a new nesting place, a small unnamed lake in Yellowstone Park.

Dr. T. S. Palmer spoke of the condition of Osborn's Caribou. About 100 individuals in Jasper Park, Alberta, are all that are known to exist. Forty individuals in good condition were recently observed. He also exhibited a copy of the *Journal of the Wild Bird Society*, a new journal. Dr. PALMER also spoke of a *List of the mammals of Siam* by NILS GYLDENSTOLPE, of Sweden. This is one of a series of memoirs by the Natural History Society of Siam, and is unusual as a rather complete list of an extended country.

Regular program: VERNON BAILEY, *The bean mouse of Lewis and Clark, Maximilian, and others.* The speaker exhibited in glass bowls living individuals of the meadow mouse, white-footed mice, pocket mice, and a pocket gopher, captured in North Dakota and Minnesota, and kept alive for the study of their habits. Mr. Bailey told of the beans procured from the Indians of the upper Missouri Valley by Lewis and Clark, Maximilian, Father De Swet, and other more recent travellers, and greatly prized by both Indians and whites as food. These beans are wild peanuts, growing underground, and gathered by some mouse or small rodent for a winter store of food. But the Indians find the food stores and appropriate them to their own use, paying for them by a return of corn or other food. Although the beans thus obtained have been known to white men for over a century, the species of mouse which stored them has not been determined until the past autumn, when Mr. Bailey took the mice at their store houses in close proximity to the stores of ground beans and artichokes. They prove to be a western form of our common eastern meadow mouse, *Microtus pennsylvanicus.* Mr. Bailey also told of many interesting habits of other species of the mice and gophers exhibited, and of his plans to continue the studies of such obscure small mammals in captivity until something is known of their every-day habits. A full account of these species will be published in his report on the Mammals of North Dakota.

The paper was discussed by Dr. M. B. WAITE, Dr. A. D. HOPKINS, Mr. H. C. OBERHOLSER and Mr. N. DEARBORN.

A. D. HOPKINS: *The bioclimatic law.* Dr. Hopkin's paper, which was illustrated by maps and lantern slides, has been published in this JOURNAL, **10**: 34–40. It was discussed by Mr. J. KOTINSKY, Mr. H. C. OBERHOLSER, Dr. M. B. WAITE, Dr. L. O. HOWARD and Mr. V. BAILEY.

603D MEETING

The 603d regular meeting (the 40th annual meeting) of the Biological Society of Washington was held in the lecture hall of the Cosmos Club on December 13, 1919, with President H. M. SMITH presiding, and 21 persons present.

The regular order was laid aside and the chair recognized Dr. T. S. PALMER, who introduced Mr. W. L. SCLATER, of London, Editor of *The Ibis*, Recorder for the *Zoological Record*, and a prime mover for the *Systema Avium.* Mr. Sclater spoke of the necessity of clearing the confusion as to nomenclature of birds which was in evidence in editing *Ibis.* Thus an authoritative list, "Systema Avium," as it may be called, may be prepared to reduce the lack of uniformity as to the names of birds, which is now quite prevalent. Differences of point of view of ornithologists and technical difficulties seem to be disappearing. The A. O. U. Check List is in the form desired, and the next edition should be one of the fundamental volumes. As to the *Zoological Record*, which is edited by the Zoological Society of London, a complete change in the manner of financing and collecting the data was necessitated by the action of Germany at the beginning of the war, and it was with great difficulty that the volumes of the *Zoological Record* for 1914, 1915, 1916 and 1917 were issued. The issue for 1918 is in press. The subscriptions do not by any means pay for the cost of publication, and the Zoological Society is not able fully to make up the deficit. It is to be hoped that subscriptions, at least to the several sections, will be greatly increased, and that some of the stronger institutions in the United States may furnish assistance.

On resuming the regular order, reports from the Treasurer, Mr. Ned Dearborn, and from the Chairman of the Publishing Committee, Mr. Chas. W. Richmond, were received and accepted.

The election resulted in the choosing of the following officers for 1920: *President*, A. D. Hopkins; *Vice-Presidents*, Ned Hollister, Vernon Bailey, A. S. Hitchcock and J. W. Gidley; *Recording Secretary*, A. A. Doolittle; *Corresponding Secretary*, Alexander Wetmore; *Treasurer*, Ned Dearborn; *Members of the Council*, William Palmer, H. C. Oberholser, E. A. Goldman, H. H. T. Jackson and S. A. Rohwer. A. D. Hopkins was nominated as *Vice-President* to represent the Society in the Washington Academy of Sciences.

A. A. Doolittle, *Recording Secretary*.

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

Following the rapid increase in influenza that took place in December and January, Mr. FRANCE obtained unanimous consent, on January 26, to call up S. J. Res. 76, providing for the investigation of the causes and methods of prevention of influenza. Mr. KING opposed the resolution on the ground that it represented too much interference by the Federal Government in State affairs. Mr. SMOOT opposed any appropriation larger than $250,000 (the original resolution called for $5,000,000), stating that not more than that sum could possibly be spent in preventing the spread of the disease before the epidemic would be over, or the regular appropriation bill carrying funds for this purpose would be considered; but that, nevertheless, if $5,000,000 were appropriated, "every dollar of that sum would be spent before the end of the fiscal year." This apparent lack of confidence in the Public Health Service was combated, and the resolution supported, by Messrs. TOWNSEND, SMITH of South Carolina, NORRIS, CHAMBERLAIN, and others. The resolution was finally passed with an appropriation of $500,000, and was referred to the House Committee on Interstate and Foreign Commerce.

On January 7 Mr. HARRIS introduced S. J. Res. 141: "To enable the Public Health Service to cooperate with the States in the investigation and control of malaria in the United States;" referred to the Committee on Public Health and National Quarantine.

The Joint Commission on Reclassification of Salaries, created by Public Law 314 of the Sixty-fifth Congress, requested in December an extension of time from January 12 to March 12 in order that it might complete its report. H. J. Res. 263, introduced by Mr. GOOD on December 15 for this purpose, was passed by the House on December 19 and by the Senate on January 6, but not without opposition. Mr. MANN stated in the House that "This is the most skilfully organized raid on the Treasury I have known. If I had my way about it I would bury the commission and the report beyond resurrection."

The rapid turnover in the Government's scientific bureaus, due to the lowered purchasing capacity of the dollar, coupled with the difficulties in the way of making corresponding changes in salaries, is reflected in a bill introduced on January 15 by Mr. STERLING, S. 3723: "To repeal the act prohibiting increased pay under lump-sum appropriations to employees transferred within one year." The bill was referred to the Committee on Civil Service and Retrenchment.

[1] Preceding report: This JOURNAL. **10**: 54. 1920.

Volcanologists will be interested in a bill introduced in the House on January 19 by Mr. RAKER, H. R. 11890: "For the protection and improvement of the Lassen Volcanic National Park, California, and for other purposes." The bill was referred to the Committee on Appropriations. A similar bill was introduced by Mr. Raker during the First Session (H. R. 1120).

The bill for a tariff on laboratory glass and porcelain ware, optical glass, and scientific, surgical, and dental instruments (H. R. 7785), which had been referred to the Senate Committee on Finance[2] came up for a hearing before a subcommittee consisting of Senators WATSON, CURTIS and THOMAS, on December 12 and 13, 1919. Manufacturers of glass and instruments were represented by Mr. C. G. FISHER, President of the Scientific Materials Company; Mr. J. B. O'BRIEN, representing glass-blowers' unions; Mr. J. M. ROBERTS, Secretary of the Scientific Apparatus Makers' Association; Mr. H. F. COORS, of the Herold China & Pottery Company; and Mr. H. N. OTT, of the Spencer Lens Company. Manufacturers of surgical instruments were represented by Mr. C. J. PILLING, of the George E. Pilling Company, and Mr. E. J. SOVATKIN, of the J. Sklar Manufacturing Company. Consumers and the public were represented by Lieut. Col. M. A. REASONER and Col. F. F. RUSSELL, both of the Medical Corps, U. S. A.; Mr. H. C. PARMELEE, Editor of *Chemical and Metallurgical Engineering;* Dr. C. E. McCLUNG, of the University of Pennsylvania; and Dr. C. H. HERTY, Editor of the *Journal of Industrial and Engineering Chemistry.* Letters were also introduced from a number of manufacturers and university professors of chemistry. All of the testimony favored the removal of the duty-free privilege, and the imposition of the duties on scientific and surgical instruments prescribed in the bill. Dental instruments were given only passing mention, and no arguments were introduced for or against their inclusion. Some of the opposing statements from universities, quoted by the Tariff Commission,[3] were repudiated as having come from purchasing agents and not from members of the faculties. The only opposition to the bill at the hearings came from Senator THOMAS, Democratic member of the subcommittee, who stated his belief that the duties would be of little use in protecting these industries from German and Japanese competition, and that only a rigid license system would accomplish their protection as "key industries," which was the ostensible purpose of the bill.

Hearings on the various tariff bills were re-opened before the subcommittee on January 27.

A convention of the National Public Works Department Association was held in Washington on January 13–14, 1920, to make plans for expediting action upon the Jones-Reavis bill (S. 2232 and H. R. 6649) for a Federal Department of Public Works.[4] Ninety-five delegates,

[2] This JOURNAL 9: 389, 421, 562. 1919.

[3] This JOURNAL 9: 562. 1919.

[4] This JOURNAL 9: 422. 1919.

representing 124 organizations with an aggregate membership of over 106,000, attended the conference.

Representatives of Engineering Council appeared before the House Committee on Military Affairs on January 28, and urged, in connection with plans for the Signal Corps, that technical and scientific graduates be commissioned in that Corps, and that physicists and electrical engineers be employed to carry forward research on its problems.

NOTES

A grant of $5,000,000 has been made by the Carnegie Corporation of New York to the National Academy of Sciences. A part of the fund will be used to erect a building in Washington for the Academy and the National Research Council. The remainder will be made a permanent endowment for the maintenance of the Research Council and other work of the Academy.

A popular exhibit of the wireless telephone was opened at the offices of the National Research Council, 1201 Sixteenth Street, on February 6. The exhibit was installed by the American Telephone and Telegraph Company and the Western Electric Company, with the cooperation of the Signal Corps and the Air Service of the United States Army. The exhibit included special apparatus designed to reproduce the more fundamental electrical discoveries of the nineteenth and twentieth centuries which have made possible the development of the wireless telephone, and moving line drawings illustrating the action of the wireless telephone.

A serum made in the Bureau of Animal Industry in connection with experiments on *Bacillus botulinus*, which is suspected of causing "forage poisoning" of horses, was used recently to save the life of one member of a family in New York who had been poisoned by spoiled olives. The serum was received too late to save the other members of the family. Two strains of *B. botulinus* have been recognized, and both produce poisons which have similar effects, but immunization against one does not afford immunization against the other.

Mr. ALBERT HUGH BRYAN, chief chemist of the firm of Arbuckle Brothers in New York City, and a non-resident member of the ACADEMY, died on January 20, 1920, of influenza, in his forty-sixth year. Mr. Bryan was born at Indianapolis, Indiana, July 27, 1874. After serving two years as assistant chemist of the Indiana Agricultural Experiment Station, and about eight years as chemist of the American Beet Sugar Company, he became assistant chemist in the Bureau of Chemistry, U. S. Department of Agriculture, in 1907, and chief of the Bureau's sugar laboratory in 1909. In 1913 he resigned to accept a position with Arbuckle Brothers. He made many contributions to the chemistry of the sugars, particularly methods of analysis of commercial sugar products. He was a member of the Chemical Society, and had been a member of the ACADEMY since 1912.

The National Research Council announces a series of public lectures "for the purpose of stimulating interest in broad scientific research, and to emphasize the vital connection between so-called scientific and industrial research." The first lecture of the series was delivered at the National Museum on February 6 by Mr. JOHN J. CARTY, Vice-President of the American Telephone and Telegraph Company, and formerly colonel in the Signal Corps, U. S. A., and was on the subject of *Science and the Industries*.

Mr. ARTHUR P. DAVIS, director and chief engineer of the U. S. Reclamation Service, was elected president of the American Society of Civil Engineers at its annual meeting in New York City on January 21, 1920.

Mr. GILBERT H. GROSVENOR, editor of the *National Geographic Magazine*, was elected president of the National Geographic Society on January 21, succeeding the late Rear Admiral JOHN E. PILLSBURY.

Mr. H. H. KIMBALL, of the Weather Bureau, left Washington in February for an extended trip through the West. He expects to return about the middle of April.

Mr. KENT K. KIMBALL, a graduate of the geological department of the University of Nebraska, has been appointed a geologic aid in the U. S. Geological Survey.

Mr. JOHN O. LAGORCE, associate editor of the *National Geographic Magazine*, has been elected to the Board of Managers of the Society, for the term 1919–1921, succeeding the late Rear Admiral JOHN E. PILLSBURY.

Mr. EMORY C. LEONARD, of the U. S. National Museum, left Washington in February to spend several months in botanical collecting in Haiti, in cooperation with Dr. W. L. ABBOTT, who is continuing his zoological explorations of the region.

Messrs. WILLIAM R. MAXON and ELLSWORTH P. KILLIT, of the U. S. National Museum, left New York on February 3 to spend the months of February and March in botanical explorations in Jamaica. The work is made possible by the cooperation of several botanical institutions.

Dr. SYLVANUS G. MORLEY, Research Associate of the Carnegie Institution of Washington, delivered a lecture under the auspices of the Institution on January 23, on the subject, *The foremost civilization of ancient America*.

Mr. ARTHUR H. REDFIELD, recently engaged in foreign mineral supply and tariff problems in the War Trade Board and Department of Commerce, has been appointed mineral geographer in the Section of Foreign Mineral Resources of the U. S. Geological Survey.

Mr. CLYDE P. ROSS, associate geologist, has been transferred from the Water Resources Branch to the Coastal Plain Section of the Geologic Branch of the U. S. Geological Survey.

Mr. J. D. Sears has been appointed associate geologist on the U. S. Geological Survey. He served as geologic aid on the Survey in 1915 and 1916, and has since been employed by the Sinclair Oil Corporation in oil work in Costa Rica and Panama, during which time he surveyed the manganese deposits of Panama for the Survey.

Mr. M. K. Shaler, formerly a geologist of the U. S. Geological Survey, who cooperated with Mr. Herbert Hoover in Belgian relief work during the war and has recently been visiting in the United States, returned to Brussels in January to take up again his geological engineering work, suspended during the war.

Dr. Roger C. Smith, of the Bureau of Entomology, U. S. Department of Agriculture, resigned in January to accept the position of assistant professor of entomology in the Kansas State Agricultural College, at Manhattan, Kansas.

Mr. Homer F. Staley, of the Bureau of Standards, has been appointed editor of the *Journal of the American Ceramic Society*.

Mr. W. T. Thom, Jr., of the U. S. Geological Survey, has been granted leave of absence to spend eight months in Vienna assisting in relief work under the auspices of the American Friends' Service Committee.

Dr. John R. Swanton and Dr. Truman Michelson, of the Smithsonian Institution, have recently been made corresponding members of the Société des Americanistes de Paris.

Miss Ingeborg M. Toll, a graduate of Brown University, has been appointed geologic aid in the U. S. Geological Survey, and will work in the Section of Foreign Mineral Resources.

Mr. Chester K. Wentworth, assistant geologist in the U. S. Geological Survey, has been engaged in a survey of the coal fields of Virginia in cooperation with the Geological Survey of Virginia.

Mr. W. P. Woodring, who has been recently engaged in oil work for the Sinclair Corporation in Panama and Costa Rica, has been appointed associate geologist on the U. S. Geological Survey and will be engaged in a study of the stratigraphy and paleontology of the Gulf and Caribbean regions.

JOURNAL

OF THE

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METEOROLOGY.—*A bundle of meteorological paradoxes.*[1] W. J. HUMPHREYS, Weather Bureau.

The scientific paradox is only an exception to some familiar but too inclusive generalization. It, therefore, has both the appeal of the riddle and the charm of surprise—the surprise, the instant the truth is seen, of a sudden and unexpected discovery—and thus affords the same sort of intellectual delight that I once knew a student of geometry to experience. The proposition, one of Euclid's best, was the Pythagorean, often carelessly called the *pons asinorum*. The boy in question was of that sturdy type that always insists on being "shown," and not understanding this proposition, flatly refused to accept it. A little coaching at the blackboard, however, soon got him past his initial troubles and so fixed his attention that as the truth flashed upon him with the final "therefore," he blurted out, in the ecstatic surprise of an Archimedes, and with the same oblivion to his surroundings, "Well, I'll be damned if it ain't so."

Whether the following paradoxes do or do not evoke such joyous acclamations as the one just quoted, they, nevertheless deserve to be concisely stated and fully explained for they express important facts of nature, unknown to, or, at most, but vaguely realized by the average person.

AIR PUSHED NORTH BLOWS EAST

This paradoxical behavior of the air is restricted, it should be said, to the northern hemisphere; but it seems just as contrarious

[1] Address of the retiring president of the Philosophical Society of Washington, delivered January 31, 1920.

on the other side of the equator, for there, pushed north it blows west, pushed south it blows east.

The push that causes the winds to blow is due to the existence of unequal amounts of air above a given level over adjacent regions—more at the place from which the air is pushed than at the place towards which it is pushed—and this in turn, usually, is due to the temperature differences, level for level, between the atmosphere at the two places. Obviously there tends to be, and, initially, actually is, a horizontal flow of the air (that is, a wind) at each level, in the direction of the most rapid horizontal decrease of pressure at that level. Such winds, however, frequently last so long (hours at least) that their directions are profoundly altered by a certain obscure factor, namely, the rotation of the earth—the secret of the above paradox—which is overlooked by almost everyone, and overlooked simply because its effect on the shooting of a marble, the pitching of a ball, and all the thousand other similar phenomena with which we are intimately familiar, is always negligible.

It is easy to demonstrate, as may be found in many books and articles, that an object moving in any horizontal direction tends so strongly to turn to the right north of the equator, and to the left south of it, as to exert a force, against a restraint preventing such deflection, given by the equation

$$f = 2\, m\omega v \sin\varphi,$$

in which m is the mass of the object, v its speed, φ its latitude, and ω the angular velocity of the earth's rotation.

Consider, then, the effect of applying a horizontal push of constant magnitude and constant geographic direction to a mass of air, m, and assume this air to be free from friction, as it very nearly is when appreciably above the surface. Let m, figure 1, be this mass of air, initially at rest with reference to the surface of the earth; let it be in the northern hemisphere, and let p be the push of constant magnitude and constant direction, north. Immediately the mass moves it begins to deflect from the north towards the east, and, owing to the curvature of its path, introduces a small centrifugal force. A little later p may be resolved, as shown, into two components, one normal and the other tangential to the path of travel. The first, like the deflective force and the centrifugal force, has no effect on the speed, being at right angles to the direction of motion, while the second steadily increases the speed, which, in turn, increases the deflective force and the deviation towards the east. In the end, therefore, the component of p along the path reduces to zero, and the direction of travel becomes exactly east. Hence winds that are continuous for even a few hours always blow more or less closely along isobars, that is, at right angles to, and not in the direction of, the sustaining force—around centers of pressure minima and maxima and not directly towards or from them.

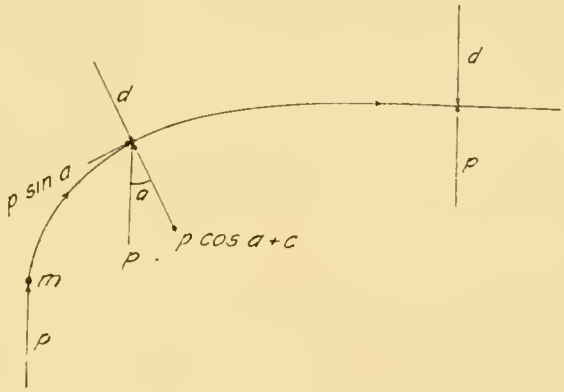

Fig. 1. Diagram showing deflection of particle of air towards the east.

No matter, therefore, how paradoxical it may be, air pushed north does blow east (in the northern hemisphere), pushed east blows south, pushed south blows west, pushed west blows north; while in the southern hemisphere it blows exactly contrariwise.

RAIN DRIES THE AIR

As everyone knows, there is continuous and often rapid evaporation from practically all parts of the earth's surface. Nevertheless, the atmosphere as a whole never becomes even approximately saturated. Water, as just stated, is always evaporating into the air and thus constantly tending to saturate it; but, on the other hand, the air is forever being dried by the precipitation out of it of rain, snow and other forms of condensation. Whatever the temperature and relative humidity of a given mass of air at any place along its convectional route, the total of water vapor it then contains obviously is less, in general, than when it left the surface of the earth by the amount of precipitation in the meantime abandoned by it. That is, on the average, air descends to the earth drier than it was when it ascended, and drier solely because of, and in proportion to, the amount of precipitation that fell out of it during its convectional journey. In short, as the paradox puts it, rain does dry the air—does prevent it from becoming and remaining everywhere reekingly and intolerably humid, as it otherwise would be.

MORE AIR GOES UP THAN EVER COMES DOWN

This is, perhaps, about as incredible a paradox as can be found, for it seems flatly to contravene the well known dictum that whatever goes up must come down. And indeed to make the explanation of it entirely clear and definite, it will be necessary to consider it independently under two heads: *a*, when the air is measured in terms of volume, and, *b*, when it is measured in terms of mass.

Measured in terms of volume.—As everyone knows, the vertical circulation of the atmosphere is only a gravitational phenomenon consisting of the sinking of relatively cold, and, therefore, also relatively dense air, and its consequent lifting or forcing up of adjacent air that happens to be comparatively warm and light. In short, contracted air descends and expanded air ascends (is buoyed up by the descending denser air). Hence, mass for mass, the *volume* of the ascending air is always larger than that of the descending air. The ratio between the actual ascending and descending volumes, however, or masses, may be anything, as illustrated by chimney circulation, in which the ascent is restricted to a comparatively small volume and mass moving rapidly, while the descent extends to a relatively large volume and mass settling slowly. On the average, though, considering both velocity of vertical movement and volume occupied, or velocity times volume, the atmosphere as a whole is always ascending, a fact not only interesting itself, but also of some importance to both the aeronaut and the aviator.

Measured in terms of mass.—Whatever the volume relations between ascending and descending air may be, it would seem that at least the mass that goes up and the mass that eventually returns must certainly be the same. But, on the contrary, they indeed are far from it, for one of the important constituents of

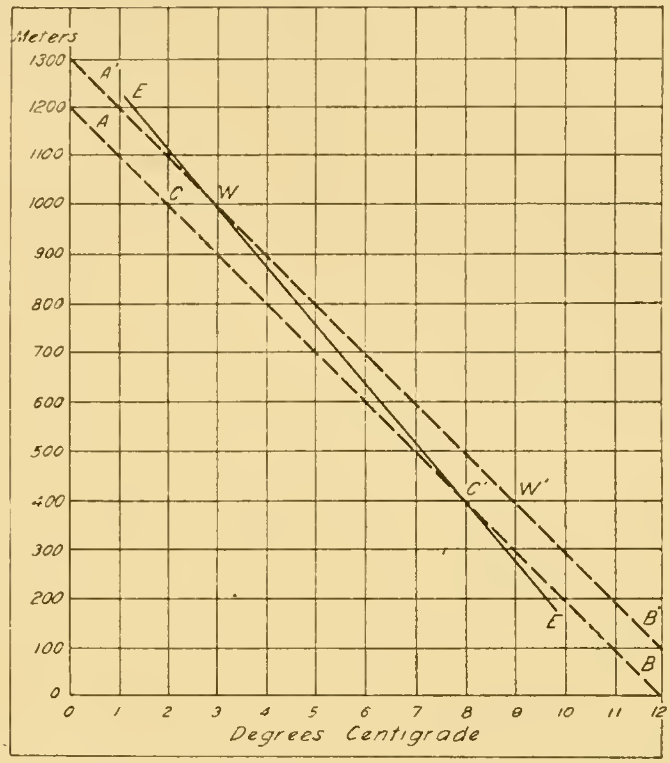

Fig. 2. Vertical temperature gradients of free air.

the atmosphere, water vapor, often amounting, in places, to 1 per cent, and occasionally to more than 2 per cent of the whole, invariably ascends as a gas, as a distinct part and parcel of the air; but descends, in great measure, not as a gas at all, not as any part whatever of the air, but as a liquid in the form of rain, or a solid, such as snow and hail.

Paradoxical, therefore, as it may be, a greater mass of *air* actually does go up—more by at least 20 million tons per second, the measure of world-wide precipitation—than ever comes down.

TO COOL AIR, HEAT IT

The air referred to in this seemingly absurd statement is not that topsy-turvy kind Alice might have found in Wonderland, but just that ordinary kind in which we have always lived; and the phenomenon itself, however contrary to experience it may seem, one of great importance and almost continuous occurrence.

This paradoxical result is easy to explain with a diagram. To this end let AB and $A'B'$, figure 2, be two adiabatic gradients of the free air; that is, let each indicate a temperature change of 1° C. for every 100 meters change in elevation—the relation between the temperature and elevation of a rising or falling mass of air that during its travel neither gains heat from, nor loses it to, any outside object, such as the surrounding atmosphere. Let EE be any actual temperature gradient (nearly always less than the adiabatic), in this case 1° C. per 120 meters change of elevation. If, then, under these conditions, a mass of air having the temperature and elevation indicated by C', say, of the figure, be heated 1° C., or shifted in the figure to W', it will correspondingly expand and consequently be forced up by the surrounding denser air—will ascend, as we say. As it rises, it will cool, by expansion, along the adiabatic gradient $A'B'$, and, therefore, will come into equilibrium with the surrounding atmosphere where this gradient intersects the actual gradient EE, or at the level and temperature indicated by W. Clearly, then, under the assumed conditions, such as are very common in nature, a mass of air heated 1° C. rises 600 meters, and in so doing cools 6° C., or to a temperature 5° C. lower than it had before it was heated. Of course, the warm air does not rise strictly adiabatically, though probably very nearly so; but in so far as it actually does *lose* heat it comes to equilibrium at a correspondingly *lower* level and *warmer* temperature.

It is precisely this paradoxical process of cooling by heating, the heating being mainly at the surface, however, that leads to the formation of cumulus clouds and generates the familiar "heat" thunderstorm. In fact, it is quite possible to produce a cumulus cloud, and even a local shower, through the action of a large surface fire. It should be noted in this connection that though combustion adds much water vapor to the air, five ninths the weight of the fuel consumed even in the case of absolutely dry cellulose, nevertheless, the cumulus cloud over the fire is due essentially to the expansional or dynamical cooling of the ascending air.

TO WARM AIR, COOL IT

This paradox is the converse of the one just discussed, and is readily explained in much the same way. Referring again to figure 2, let a mass of free air having the altitude and temperature indicated by *W* in the figure, be cooled 1° C., or its position shifted to *C*. It will at once become denser than it was, follow the adiabatic gradient *AB* as it falls to lower levels, and, therefore, come to rest at the level and temperature indicated by *C′*, or at the intersection of the adiabatic gradient followed and the existing gradient. That is, as a result of the initial cooling of 1° C., the given mass of air will fall 600 meters and become 5° C. warmer than it was before it was first cooled. In so far, however, as the falling air *gains* heat from the surrounding warmer atmosphere, it will come to rest at a correspondingly *greater* elevation and *lower* temperature.

This paradoxical phenomenon of warming by cooling is very frequently and very prettily illustrated by the evening disappearance of small detached clouds, such as alto-cumuli, fracto-stratus, etc. As soon as the sun has set, these clouds and the air masses they fill cool more rapidly than does the clear atmosphere. They, therefore, fall to lower levels, warm up to higher temperatures than they originally had, and evaporate.

It will be interesting, in this connection, to note the logical effect of a certain ingenious, often proposed, and at least once experimentally tried, method of artificially inducing rainfall, namely, the liberal sprinkling of a cloud mass with liquid air. The result is, of course, an initial cooling of the cloud, followed, as above explained, by a much greater warming. Instead of rain being induced by this process, as its many inventors would confidently expect, the chilled cloud is certain to grow warmer and diminish in size, and, if considerably chilled may grow so much warmer as to disappear entirely. Indeed, this particular liquid air scheme is not a rain making process at all, but, on the contrary, a rain deterrent!

NOT AIR THAT IS HEATED, BUT AIR THAT IS NOT HEATED, IS THEREBY WARMED

This particular paradox may suggest the superiority of "absent treatment;" nevertheless, it is perfectly sound. Heated air, as we know, is driven up by the surrounding denser air, and dynamically cooled, but the air that drives it does so by dropping to a lower level, where it is more or less compressed and correspondingly warmed. In other words, while the particular air that was heated rises and gets colder than it was initially, other air that was not heated at all falls lower and thus gets warmer. It is not the air that is heated, but air that is not heated, that gets warmer.

NOT AIR THAT IS CHILLED, BUT AIR THAT IS NOT CHILLED IS THEREBY COOLED

The explanation of this paradox is very similar to that of the one just given, and is equally simple. As the chilled air descends, certain other air is thereby raised and dynamically cooled. That is, while the particular air that was cooled descends and thus gets warmer than it was originally, other air that was not chilled at all is forced up, expands, and gets colder. It is not the air that is chilled (unless it happens to be on or near the surface where it cannot fall to a lower level) but air that is not chilled, that gets colder.

MIXING BRINGS THE AIR TO A NON-UNIFORM TEMPERATURE

To the laboratorian familiar with beakers and calorimeters; to the housewife skilled in the art of the cups and kettles; and to all the rest of us, nothing is more certain—nothing more in accord with daily experience—than that vigorous stirring establishes a uniform temperature throughout the agitated medium. And indeed this conclusion is quite correct in respect to the particular things we are likely to have in mind, but it does not apply to the open atmosphere. In fact if the temperature of the atmosphere were uniform through any considerable altitude, a complete stirring of it would immediately destroy this uniformity.

Let, then, the atmosphere, whatever its initial temperature distribution, be thoroughly mixed without the addition or subtraction of heat. This will bring it into such state (that of neutral equilibrium) that any portion of it on being adiabatically moved to a different place will, on arriving at that place, have the same temperature as the then adjacent air at the same level.

That is, it will have the same *potential* temperature throughout, or same actual temperature when subjected to the same pressure. The truth of the above statement is obvious from the fact that any temperature difference that might be developed by a transfer of the kind mentioned clearly could be reduced by further mixing.

But as a mass of this air is carried to higher levels it continuously expands against the diminishing pressure—diminished by the weight of the air passed through—thereby does work at the expense of its own heat energy and correspondingly cools to lower temperatures. The ratio of this cooling to increase of altitude evidently depends upon the nature of the gas and the change of pressure. In the case of our own atmosphere it is approximately 1° C. per 100 meters.

Although, therefore, stirring does bring an incompressible liquid to a uniform actual temperature, it brings the atmosphere only to a uniform potential temperature, or an actual temperature that is very non-uniform.

THE NEARER THE SUN THE COLDER THE AIR

The familiar fact that with increase of elevation and consequent approach (during the daytime) to the sun, the air nevertheless gets rapidly colder, at least through the first 10 kilometers, is very puzzling to the average person if he tries to explain it. Nor, indeed, is the explanation of this phenomenon quite so simple and obvious as we sometimes are asked to believe. Essentially, however, this temperature distribution depends on the following facts:

(1) The atmosphere, as we know from observation, is so diathermanous that half, roughly, of the effective radiation received from the sun, that is, half of the portion absorbed and not lost by reflection, goes directly to heating the surface of the earth. Consequently, it is this surface, where the energy absorption is concentrated, and not the atmosphere, through which absorption is diffused, that is most strongly heated by insolation. The heated surface in turn warms the air above it, partly by contact, and partly by the long wave-length radiation it emits, and

of which the atmosphere is far more absorptive than it is of the comparatively short wave-length solar radiation.

(2) Furthermore, and this is an equally vital part of the explanation, the lower atmosphere (below about 10 kilometers), under all ordinary conditions emits more radiant energy than it absorbs—the difference being supplied by conduction. It is these two phenomena, (*a*) the surface heating (warming below), and (*b*) the net loss of heat by radiation (cooling above), that together establish and maintain the vertical convections of the atmosphere under which, since the descending portions grow warmer through compression, and the ascending colder through expansion, the whole of the convective region is made to decrease in temperature with increase of elevation.

But since the coefficient of absorption of the air, as of other objects, changes but little if at all with the temperature, while its emissive power decreases rapidly as it grows colder, and since the intensity of the incident terrestrial (including atmospheric) radiation remains roughly constant up to an altitude of many kilometers, beyond the first 4 or 5, it follows that the upper limit of the convective region is not, as formerly supposed, the outermost extent of the atmosphere, but at that elevation (10 to 12 kilometers above sea-level) at which the temperature is so low ($-55°$ C. roughly) that the loss of heat by radiation is no longer in excess of, but now equal to, its gain by absorption. Beyond this level temperature does not decrease, or does so but slightly, with increase of elevation; nor would it so decrease (at least at anything like the present rate) beyond any level above the thin conducting surface layer, at which absorption and radiation became equal.

In short then, the air grows colder with elevation—the nearer the sun the colder the air—because (1) owing to its transparency to solar radiation it is heated mainly at the surface of the earth, and (2) because, at ordinary temperatures, it emits more radiation than it absorbs. These together so affect the density of the atmosphere as to induce vertical convections, and thereby to establish and maintain, throughout the region in which they are active, a rapid decrease of temperature with increase of elevation.

THE COLDEST AIR COVERS THE WARMEST EARTH

This paradoxical statement refers to the air of the stratosphere, with respect to which it is a well-known truth whatever the explanation may be.

It has doubtless been known since the dawn of intelligence that the top of a mountain is colder than the adjacent valleys, and that the highest among neighboring mountains has the coldest top. And for much more than a century, actually since November 30, 1784, it has been known from observations by balloonists, that the temperature of the free air also decreases with elevation, at least up to such altitudes as were attained by manned balloons. About the close of the last century, however, it became evident, through records obtained with sounding balloons, that in middle latitudes the temperature of the atmosphere continuously decreases, on the average, with increase of altitude up to only 10 or 12 kilometers above sea level, and then becomes substantially constant. Numerous subsequent records obtained at many places have shown the additional surprising fact that this isothermal region, or stratosphere as it is generally called, begins at a higher level, and is colder, over equatorial regions than over any other part of the world. Indeed, it seems to be 10° to 15° C. colder over the equator, where its average temperature is roughly −70° C., than, for instance, over the polar circles.

The temperature of the stratosphere appears to be determined chiefly by the intensity of the outgoing radiation from the earth and the intervening water vapor and hence it seems to follow that this radiation must be less intense over regions near the equator than over those of the middle and higher latitudes; a conclusion that merely shifts the burden of explanation from one paradox to another.

Obviously, the earth as a whole must emit, on the average, the same amount of radiant energy that it absorbs, but the distribution of the two certainly is different. In equatorial regions the upward movement of the atmosphere is so general and so strong that high haze, cirrus, and other types of clouds are exceedingly common, and the atmosphere necessarily humid and, therefore, highly absorptive of earth radiation, to great altitudes, especially as anticyclones with their extensive regions of descending air are there unknown. Clearly, then, a large part of the radiation through the stratosphere of this region must come from the clouds and from water vapor that are very high and correspondingly cold, and therefore its intensity, it would seem, must be correspondingly feeble. The pent up heat below can find an outlet through horizontal circulation and radiation from lower and warmer levels in higher latitudes.

This, perhaps, is at least the partial explanation of why the minimum temperature of the stratosphere occurs over the tropical regions—why the coldest air covers the warmest earth.

AS THE DAYS GROW LONGER THE COLD GROWS STRONGER

This old proverb paradox expresses the well-known fact that our lowest temperatures do not occur at the time of the shortest days, or when the heat supply from the sun is least, but some time afterwards, when the days have grown longer and the supply of solar heat has increased. That is, over a considerable period, the air grows colder as the sun grows warmer. In the far interior of continents, especially if arid, this lag may not be more than a couple of weeks, but on many islands and along several coasts whose winds are prevailingly on-shore it is from one to two months.

To understand this phenomenon consider an object (representing the earth) suspended within a thermally opaque shell (assumed the source of incoming radiation) whose temperature is everywhere the same. For simplicity let the enclosed object be a "black body," that is, a full radiator and a perfect absorber. Let the absolute temperature of the shell be T and that of the enclosed object $T \pm t$. Under these conditions the rate of heat absorption by the suspended body is AKT^4, where A is its "equivalent" area and K the "black body" coefficient, while the rate of its emission is $AK(T \pm t)^4$. If, now, t is small in comparison with T, the rate of net gain or loss of heat by the enclosed object is $4AKT^3t$, approximately, and the ratio of its rate of temperature increase or decrease to the temperature difference, t, a constant inversely proportional to its heat capacity, assuming high conductivity. The limiting temperature T

would, therefore, never be fully attained, but forever approached asymptotically. Clearly, then, if the temperature of the shell were T and that of the enclosed object $T + t$, the latter would continue to grow colder through any finite time unless, and until some time after, the temperature of the shell were raised above the then temperature of the enclosed object.

The reasoning in this special case applies also to the normal daily temperature of the atmosphere (substantially that of the surface of the earth), provided, as will be assumed for the moment, that there is neither circulation nor any thermal effects due to water transformations—freezing, thawing, etc. It applies because the normal daily loss of heat through radiation to space by any given region is as though it were a full radiator at a certain temperature, and its normal daily gain of heat from the outside as though it were completely canopied by another full radiator also at a certain (generally different) temperature.

During the autumn, therefore, while there is still stored in the earth much of its summer gain of heat, and while the daily supply of energy from the sun is growing less and less per unit area, the average 24-hour temperature of the surface, and of the surface air, must be appreciably higher than that of equilibrium with the simultaneous incoming radiation—higher because of the additional supply of heat by conduction from its reservoir beneath the surface—and as the summer storage of heat in the earth is very large and also near the surface (but little penetrating beyond a depth of 5 or 6 meters) it is obvious, from the preliminary explanation above, that the minimum temperature cannot occur until some time after winter solstice, or when the days have again grown longer, and that the delay must depend on latitude, nature of surface, and a number of other factors.

The date of this minimum temperature is still further delayed, in many places, by the trend of warm ocean currents and the warmer surface drifts toward the higher latitudes, and by onshore winds. It is also affected, though probably but slightly, by the thermal effects of freezing, thawing, evaporation, and condensation.

The storage of heat in the earth while the days are long, its gradual delivery back to the surface while the daily supply from the sun is comparatively small; and the poleward drift of warm water at all seasons, together produce, as explained, the paradoxical result so admirably expressed by the proverb,

As the days grow longer
The cold grows stronger.

AS THE NIGHTS GROW LONGER THE HEAT GROWS STRONGER

It will be recognized at once that this paradox is only the counterpart of the one just discussed, and that it must also have substantially the same explanation.

As the days continue to grow longer after the time of minimum temperature, it is clear that from then on for several months the earth's gain of heat must be at a faster rate than its loss—that, in terms of the above explanatory hypothesis, the effective temperature of the shell is T and that of the enclosed object $T-t$. Under these conditions the earth, because of its large but finite heat capacity, must continue to slowly grow warmer until the incoming radiation has become less, that is, until the nights have grown perceptibly longer.

This lag, the lag of maximum temperature after the summer solstice, is also, like the lag of minimum temperature after the winter solstice, a function of location; generally least in the interior of continents and greatest on islands and near coasts whose prevailing winds are on-shore.

AS THE SUN DESCENDS THE TEMPERATURE ASCENDS

By this paradoxical expression it is only meant to state tersely the well-known fact that the warmest time of the day is not when the sun is on the meridian, or when insolation is greatest, but sometime in the afternoon when the sun has descended considerably from its maximum elevation. As everyone knows, night cooling reaches its greatest effect, on the average, just after daybreak. Hence, as the sun ascends the temperatures of the warming surface of the earth and of the lower air lag behind equilibrium with the incoming radiation, and continue to do so until the intensity of the insolation has passed well beyond its maximum. That is, the temperature continues to rise for some time, generally 2 to 4 hours, after the sun has crossed the meridian—as the sun begins to descend from its highest point the temperature continues to ascend.

THE ABSOLUTE MAXIMUM DIURNAL INSOLATION (HEAT SUPPLY) IS AT THE SOUTH POLE

If I is the solar constant, or quantity of solar energy per minute per unit area, normal to the insolation at the limit of the atmosphere, then the total amount Q of solar energy per any consecutive 24 hours, per unit area of a horizontal surface, also at the limit of the atmosphere, is given by the equation

$$Q = \frac{1440}{\pi} I(\sin \varphi \sin \delta H + \cos \varphi \cos \delta \sin H)$$

in which φ is the latitude of the place in question, δ the declination of the sun at the time, and H the hour angle, in radians, between noon and sunrise, or sunset.

A great deal of interesting information is contained in this equation. The most interesting, perhaps, is the fact that if the value of Q for the equator at the time of the vernal equinox be represented by 1000, then that of the north pole at summer solstice is 1202, and that of the south pole at the corresponding solstice 1284; each being greater than the value of Q at that time for any other place in either hemisphere. The advantage in favor of the south pole is owing to the fact that the earth is then near perihelion, and, therefore, closer to the sun.

Not only does the absolute maximum diurnal insolation at the limit of the atmosphere occur at the south pole, but, owing to the great elevation of the south polar region, the dryness of its atmosphere and its comparative freedom from dust, so also does the corresponding maximum at the surface of the earth.

The days, however, of abundant insolation at the poles are comparatively few, nor is this insolation very effective in raising the temperature, owing to the high reflecting power and great heat of fusion of the always prevalent ice and snow. And so it happens that although for a time every year each pole receives more diurnal insolation than does any other place on the earth, it is always cold; and the south pole, though having the greater maximum diurnal insolation, is the colder of the two, owing to its elevation and greater distance from open water.

THE HOTTER THE SUN THE COLDER THE EARTH

It is not yet universally conceded that this paradox, "the hotter the sun the colder the earth," really is true; but the evidence in favor of it is already very strong. It is known, for instance, that several extensive studies of the temperature records of the earth have all shown that on the average, it is a little colder during the years of sunspot maxima than during the years of sunspot minima. Furthermore, numerous careful measurements of the solar radiation made during the past dozen years or more, seem to compel the assumption, at least tentatively, that the effective temperature of the sun is greater during spot maxima than during spot minima. If, then, both these conclusions are true—if the temperature of the earth is lowest during spot maxima and the solar constant highest—it follows that the above paradox is also true.

But by what possible process can the earth get colder when the sun grows warmer? It has been suggested that the increase of the solar constant causes a corresponding increase in the atmospheric circulation, and, therefore, a decrease in the surface temperature, owing to the greater flow of cold air from the higher towards the lower latitudes. But the very great mixing of the convective portion of the atmosphere, and the consequent prevention of the formation of over- and under-flowing strata, seems to render this suggested explanation untenable.

The key to this paradox, may, perhaps, be found in the greater extent and density of the solar corona at the times of spot maxima than at the times of spot minima. The corona, since in large measure it is only so much dust about the sun, obviously must interfere with the passage of radiation through it, and to a far greater extent with the ultraviolet radiation than with the visible and infrared. Hence, during spot maxima, or when the solar atmosphere is dustiest, the solar energy must, it would seem, be poorest in ultraviolet radiation.

Now when cold dry oxygen, such as exists in the upper atmosphere, is acted upon by certain regions, at least, of the ultra-violet spectrum, some of it is converted into ozone, a substance known to be in the upper atmosphere to a far greater extent than in the lower. Hence when sunspots are most numerous the upper air should contain a minimum amount of ozone. But ozone is intensely absorptive of earth radiation and that too in the spectral region of its greatest intensity, and where water is least absorptive and carbon dioxide not at all. That is, at the time of spot maxima when the solar constant is (apparently) greatest, the earth's blanket of ozone is (presumably) least. Even, therefore, if the earth should be receiving an increased amount of heat at this time it might, nevertheless, grow slightly colder because of the coincident depletion of the heat-conserving blanket of ozone.

A greater general prevalence of cirrus and cirrus haze during spot maxima than during spot minima (indicated by certain observations) would also account for this paradox; because such clouds, owing to the size of their particles, shut out the short wave-length solar radiation more effectively than they shut in the long wave-length earth radiation. And perhaps these clouds really are generally most prevalent during spot maxima, and, therefore, at least a contributing factor to the cause of the corresponding temperature minima. At any rate the auroras are then most frequent, and they obviously generate nitrous oxide and other hygroscopic compounds which, because of their density, slowly fall to the cirrus level where they may produce cloud particles in an atmosphere whose humidity is much below that which otherwise would be essential to cloud formation.

The maximum, then, of the cirrus screen and the minimum of the ozone blanket, coincident with the highest temperature of the sun, may very well account for the above paradox—the hotter the sun the colder the earth.

THE COOLER THE SUN THE WARMER THE EARTH

This paradox is practically included in the one just discussed. It means that at times of sunspot minima, when the solar constant seems to be least, the average temperature of the earth is highest.

At the times of spot minima the solar atmosphere is clearest; the extreme ultraviolet radiation presumably, therefore, at a maximum; the upper atmosphere richest in ozone, and the earth most conservative of its heat, and, because of the minimum (if that be the case) of cirrus, also most receptive of solar radiation—so receptive and so conservative, perhaps, as to gain slightly in temperature despite the decrease in the heat supply.

THE SUN RISES BEFORE IT IS UP

This paradox about the sun rising before it is up is equally true of the moon and the stars, and is also one of the best known and easiest explained of all meteorological paradoxes.

Everyone is familiar with the fact that as light passes slantingly from one medium to another, as from air to glass, for instance, it does not continue on in the same straight line, but abruptly changes direction at the interface according to well-known laws. And the same thing is true of the rays of light that pass from space into and through the atmosphere of the earth; except that, in this case, as the density of the atmosphere gradually increases from zero at its outer boundary to a maximum at the surface of the earth, so too the change in direction of the entering light is equally gradual. The total change of direction by the time the surface of the earth is reached depends upon the wave-length, or color, of the light; the slope at which it enters, or zenith distance of the luminous object; the temperature and barometric pressure at the place of observation; the humidity; and several other minor factors. On the average, however, light from a star for instance, that appears to be 90° from the zenith, and, therefore, on the horizon—just rising, say—has been bent out of its original course by about 34′.5. That is, it comes into view (rises) while actually more than half a degree below the horizon. And as the angular diameter of the sun and the moon are each less than this horizon refraction, it follows that when the sky is sufficiently clear the whole of either luminary may be seen before even its topmost portion is up; that is, before it is geometrically above the horizon, or actually within 90° or less of the zenith.

THE SUN SETS AFTER IT IS DOWN

Since the virtual wave-length of a given radiation of celestial origin and, therefore, the value of its astronomical refraction is modified by the rotation of the earth, as are also certain scintillation phenomena, it follows that the above paradox is not identical with the one just explained. Nevertheless, as the spectra of the stars and other celestial objects all overreach the visible portion at each end it follows that the Doppler effect produces no appreciable alteration in the ensemble of the light from any one—merely a minute shift of its entire spectrum that can be detected only in the positions of definite lines.

But even this displacement of the spectral lines, due to the rotation of the earth, is far too small, roughly one three-hundredth the distance between the sodium D's, to affect detectably astronomical refraction. Hence as the sun, the moon, and the stars all rise before they are up, so too they must all set only after they have gone down.

ENTOMOLOGY.—*The generic name* Ceropales *Latreille (Hymenoptera).* S. A. ROHWER, Bureau of Entomology.

In 1915 Morice and Durrant (Trans. Ent. Soc. Lond., 1914, pp. 403, 406) synonymize the generic name *Ceropales* Latreille with the name *Arpactus* Jurine and propose an entirely new name for those interesting Psammocharid wasps which for more than a century have been known to students under the name *Ceropales*. This is only one of a number of most disconcerting nomenclatorial changes suggested by these authors because of their study of a discarded book review by Panzer. While the present author is of the opinion that from the nomenclatorial standpoint there is no way to disregard the Erlangen List, for it is under this name that the Panzerian book review is now commonly known, he does not believe that all of the changes suggested by Morice and Durrant are in accord with the various rules and opinions of the International Commission on Zoological Nomenclature. Since the receipt of the paper by Morice and

Durrant the writer has spent considerable time investigating the question and collecting the opinions of the various workers on Hymenoptera and has completed a statement of the case for presentation to the International Commission. In the meantime, and until it is possible to receive an opinion from the Commission, he has refrained from adopting any of the changes. The question presented by the genus *Ceropales* need not, however, wait for this decision as it is largely a zoological problem which is satisfactorily covered by existing rules and opinions. Furthermore certain new names have been used for species of this genus, and it seems desirable to review the case with the hope that by so doing unnecessary confusion will be avoided.

The answer rests largely on the principle of accepting genera for which the included species are not mentioned by name, but also partly on the principle of genotype selection for such genera. In regards to the first point if the codified rules on Zoological Nomenclature do not satisfactorily cover the point of accepting the generic names proposed by Latreille in 1796, (Prec. Car. Ins.) opinion 46 is very definite, and it seems to the author that the question answered under this opinion is entirely analogous to Latreille's work of 1796. In regard to the validity of the genera proposed in this work the writer believes that according to the International Code they are valid and must date from 1796, and that the type species must be chosen in accordance with the conditions specified in opinion 46.

Accepting the validity of the name *Ceropales* in the 1796 publication we still have the question of its genotype. If Morice and Durrant are correct the name would have to be transferred from the Psammocharid wasps to the Sphecoid wasps. But even here it seems to the writer they have not used the correct interpretation of opinion 46 or adhered to all the principles of genotype selection covered by the Code. The Code specifically says, "The meaning of the expression 'select a type' is to be rigidly construed. Mention of a species as an illustration or example of a genus does not constitute a selection of a type." Since it is as an example that Latreille referred a species to the genus *Ceropales* in 1802 he did not designate its type. Additional discussion of this point is, however, not necessary for this particular case because the species referred to *Ceropales* in 1802 cannot be the genotype in accordance with opinion 46. Briefly reviewed the case is as follows.

In 1796 Latreille described the genus *Ceropales* but assigned no species to it. The description he gave, while rather general and applying in most points equally well to certain genera in the families Psammocharidae and Sphegidae, has two characters (viz. the semi-circular labrum and long hind legs) which as far as the groups concerned are involved, apply only to the genus belonging to the Psammocharidae. In 1802 (Hist. Nat. Crus. Ins., 3: p. 339) Latreille again characterizes the genus *Ceropales* and this time cites the species *quinquencinctus* Fabricius and doubtfully "*campestris ?* F." It would appear thus far that *quinquencinctus* would have to be the type of *Ceropales*, but this species does not agree with the original description in the following characters: "Levre superieure demi-circulaire" and "Pattes posterieures longues dans quelques especes." Since *quinquencinctus* does not agree with the description it cannot be the genotype (opinion 46 says, "the genus contains all of the species of the world which come under the generic description as originally published") and in fact Latreille corrected his error in 1804 (Nouv. Dict. Nat. Hist., p. 180) and 1805 (Hist. Nat. Crus. Ins., 13: p. 283) and placing *quinquencinctus* in a new genus, *Gorytes*, and citing *maculata* Fabricius as an example of *Ceropales*. Added proof that Latreille desired in 1804 to correct the error of 1802 is found in the fact that in 1804 *Ceropales* and *Gorytes* are the only genera to which species are assigned. The species *maculata* agrees with the original generic description of *Ceropales* and could correctly be named as the type of the genus. This is exactly what Latreille did in 1810 (Cons. Gen. Crust. Ins., p. 437).

It is almost certain and partly confirmed by Latreille's remarks in 1802 (Hist. Nat. Crust. Ins., 3: p. 335) that as characterized and understood in 1796 the genus *Ceropales* contained species now placed in *Ceropales* and also species now referred to the genus *Gorytes* (*s. l.*) but inasmuch as the characte of the description all apply to *Ceropales* (as now understood) and not to *Gorytes*, and because it is certain that Latreille intended the name for the groups of Psammocharid wasps it does not seem desirable or justifiable to go against the rules and opinions governing zoological nomenclature and change the interpretation of a name which has had standing for more than two generations. The following synonymy seems to the author to be correct:

Ceropales Latreille, 1796. Type.—*Evania maculata* Fabricius.
Agenioxenus Ashmead, 1902. Type.—(*Ceropales rufiventris* Walsh) *Ceropales robertsoni* Cresson.
Ceratopales Schulz, 1906 (an emendation which is accepted by Banks, Bul. Mus. Comp. Zool., 63: 1819, p. 248).
Hypsiceraeus Morice and Durrant, 1915. Type.—*Evania maculata* Fabricius.

Because of the controversy between Viereck and Ashmead (see Ent. N., 13: p. 275 and p. 318, 1902) concerning the generic name *Agenoxenus* a few words of explanation are necessary. In proposing the generic name *Agenioxenus* Ashmead definitely cited as the type *Ceropales rufiventris* Walsh. This species has been correctly synonymized with *Ceropales robertsoni* Cresson by Fox (Trans. Amer. Ent. Soc., 19: p. 57, 1892) and is a true *Ceropales*. The genus *Agenioxenus* is, therefore, a synonym of *Ceropales*. It so happens, however, that the probable specimen on which Ashmead founded his genus is a male of the variable *Batazonus interruptus* (Say.). Ashmead's statement that the specimen he had was probably a cotype of *C. rufiventris* is undoubtedly wrong as the specimen will not agree with the original description and bears only a name label in Ashmead's hand writing and the printed label "Through C. V. Riley." This case is covered by opinion 65.

RADIOTELEGRAPHY.—*Notes on beat reception.* L. W. AUSTIN and W. F. GRIMES, U. S. Naval Radio Research Laboratory.

Effect of Regeneration.—According to some authorities, the great sensitiveness of the oscillating tube is mostly due to its regeneration, while, according to others, the sensitiveness is inherent in the beat method. With the autodyne the two factors are impossible to separate, but with the heterodyne this can be done. The experiment was made as follows: The regular laboratory long wave set with magnetic back coupling and without grid condenser was used, but with the back coupling much too loose for local oscillations. Oscillations were then produced by a separate heterodyne and audibilities taken on Nauen, the heterodyne coupling being adjusted to give the best signal. Then the back coupling of the regular set was increased to a point just before autodyne oscillations were set up and where with spark signals strong regeneration would be noted, but no increase in Nauen signals was observed even with retuning. The removal of the plate coil and bridging condenser from the receiving set, thus reducing it to a primitive audion, also had no effect.

Next, with a heterodyne coupling too loose to give the best signal, autodyne regeneration increased the strength of signal; that is, it seems that the back coupling of the receiving set regenerates the local oscillations so as to bring them up to optimum value, but has no observable effect on the strength of received signals. It may be that the resultant increase in sensitiveness due to regeneration and that due to oscillation is the sum rather than the product of the two, so that when they are added, the smaller increase due to regeneration is hidden by the great increase due to the oscillations.

Best Strength of Local Oscillations.—For the range 1–5000 audibility, the best signal is obtained with the same strength of local oscillations for any given circuit and wave-length. The optimum value varies with different vacuum tubes and with different ratios of inductance to capacity, increasing with increasing capacity.

Law of Response and Autodyne and Heterodyne.—In 1915, it was discovered (Journ. Wash. Acad., 6: 81. 1916), that the law of response of the oscillating tube (autodyne) within the limits of observational error, was linear, that is, that the telephone current was proportional to the first power of the radio frequency received current in the antenna, instead of proportional to the square, as in the non-oscillating tube, the crystal, electrolytic, etc.

Recently experiments have been made which prove that the linear response law holds for tubes and also for crystal detectors when local oscillations are produced by a heterodyne. Dr. J. M. Miller has suggested that the linear law might not hold if the local oscillations were very weak, for example, if excited by a heterodyne with very loose coupling, but experiment shows that even here there is linear proportionality within the errors of observation.

Introduction of Resistance in the Oscillating Grid Circuit.—It was discovered in 1915 that if an oscillating vacuum tube (autodyne) be coupled to an antenna or loop, any amount of resistance can be introduced in the secondary circuit without reducing the strength of signal, provided the back coupling be strengthened so as to keep the local oscillations at the same strength. This resistance may amount to many thousand ohms, while a small fraction of this resistance, if placed in the antenna or loop circuit, will reduce the signal to silence. Recently it has been found that the same is approximately true with a plain vacuum tube, and even with a crystal detector, when excited to local oscillations by a heterodyne.

In the early experiments the phenomenon was ascribed to a negative resistance action, but this is hardly possible, since the grid circuit is out of tune with the signal, and of course the explanation could hardly be applied to the heterodyne or crystal. As a consequence of the above facts, it follows that with an oscillating receiving tube connected directly in a loop, the strength of received signal is independent of the loop resistance. This has been verified by experiment.

Effect of Varying the Capacity-Inductance Ratio in Oscillating Receiving Tube Circuits.—As the vacuum tube is a voltage operated detector of signals, it has been supposed that the sensibility will be greater, the greater the inductance capacity ratio in the grid circuit. It was reported in 1917 (Proc. I. R. E. 5: 245. 1917) that the sensibility was independent of this ratio. Recent experiments made on Nauen with inductances varying from 2.5 mh. to 36 mh. again showed no change in sensibility, provided the local oscillations were kept at the optimum value. The telephone current appears to be proportional to the square root of the antenna watts.

Heterodyne, Autodyne and Sensitizing Circuit.—Commander A. H. Taylor and also Mr. Israel have found that for long waves the heterodyne with vacuum bulb is more sensitive than the autodyne. The explanation being that with the heterodyne the secondary can be set exactly on the signal wave-length, while with the autodyne it must be detuned to produce the beats.

In the Research Laboratory it has been found that there is no difference in sensibility, provided the optimum coupling between the primary and secondary is maintained in both cases. With a loose coupling as used by Commander A. H. Taylor, the signal with heterodyne is stronger unless a sensitizing circuit is used with the autodyne. The sensitizing circuit reported in 1915 (Proc. I. R. E., 4: 251. 1916) is a circuit consisting of an inductance and condenser so coupled to the secondary that the latter is given two free wave-lengths, one of which corresponds to the wave-length of the incoming signal, while the other gives the beat frequency. With the sensitizing circuit the autodyne is equal to or better than the heterodyne in sensibility at any coupling. Probably at the optimum main coupling the antenna itself acts to a certain extent as a sensitizing circuit.

While the sensitizing circuit has the advantage of being far simpler than the heterodyne, it is found that the heterodyne is less subject to interference.

Regeneration of Spark Signals.—It has been suggested that possibly the strengthening of spark signals observed with the autodyne when the back coupling is closed to a point just before the note is roughened by the local oscillations may be due to very weak oscillations not strong enough to effect the note. Experiments have, therefore, been made with weak heterodyne coupling to see if the same phenomenon could be found as with the autodyne. No strengthening in the spark signal was observed until the note was roughened.

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.

TECHNOLOGY.—*Effects of glucose and salts on the wearing quality of sole leather.* P. L. WORMELEY, R. C. BOWKER, R. W. HART, L. M. WHITMORE and J. B. CHURCHILL. Bur. Standards Techn. Paper **138**. Pp. 38, pls. 2, figs. 23. 1919.

This paper contains a description of the methods used and the results obtained from the first of a series of tests to be made on this subject. Four brands of leather were tested; two tannages to which very small amounts of glucose and salts were added and two tannages to which larger amounts of these materials were added. The experimental work consisted of actual service tests on shoes, tests on a laboratory wearing machine, water absorption tests and complete chemical analyses of the original and worn leathers. Results are presented which show the variation in wear of the different leathers, the variation in wear of soles cut from different locations on the hide, the water absorption qualities of the leathers and the variation in chemical composition of the leathers in different parts of the hide for both the new and worn soles. From the results of the test there is no indication that the addition of glucose and salts is either beneficial or detrimental to the durability of the leather and it is conclusively shown that the greater part of the added glucose and salts was lost from the leather during wear while the other water-soluble materials appeared to be retained in the leather. P. L. W.

ANTHROPOLOGY.—*Native villages and village sites east of the Mississippi.* DAVID I. BUSHNELL, JR. Bur. Amer. Ethn. Bull. **69**. Pp. 111, pl. 17, figs. 12.

The material for this paper has been drawn mainly from the writings of early travelers, supplemented to a large extent by the results of modern archaeological explorations. A short description of the country and people, embodying the results of the latest researches, introduces the subject, and a bibliography of 71 titles concludes it.

J. R. SWANTON.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

822D MEETING

The 822d meeting was held at the Cosmos Club, October 25, 1919, and was called to order at 8.25 p.m. by President HUMPHREYS. Attendance, 52.

J. H. DELLINGER: *Principles of radio transmission and reception with antenna and coil aerials.*

The paper was illustrated by lantern slides and was discussed by Messrs. G. W. LITTLEHALES, W. J. HUMPHREYS, C. E. MENDENHALL, WILLIAM BOWIE, and General G. O. SQUIER. This paper has been abstracted in this JOURNAL (9: 641. Dec. 4, 1919).

F. L. MOHLER, PAUL D. FOOTE and H. F. STIMSON: *Ionization and resonance potentials for electrons in vapors of lead and calcium.* This paper was presented by Mr. FOOTE and was illustrated by lantern slides.

Measurements of electron currents in three-electrode vacuum tubes of the type previously described have been made in vapors of lead and calcium. The lead and calcium were boiled in porcelain tubes at temperatures of about 1000° and 900° C., respectively. Current-voltage curves in lead showed a resonance potential of 1.26 volts and an ionization potential of 7.93 volts. Applying the quantum relation $Ve = h\nu$ we find that 1.26 volts corresponds, within experimental error, to the frequency of a strong infrared spectrum line at λ = 10,291 Å, giving a theoretical value of the resonance potential 1.198 volts.

In calcium two resonance potentials were found at 1.90 volts and at 2.85 volts, of which the first is the more prominent. Ionization occurred at 6.01 volts. The ionization potential corresponds to the limit of the principal series $1.5\ S$, λ = 2027 Å, giving as the theoretical value V = 6.081 volts. The first resonance is determined by the line $1.5\ S-2\ p_2$, λ = 6572.78 Å, V = 1.877 volts. The second resonance corresponds to the line $1.5\ S-2\ P$, λ = 4226.73 Å, V = 2.918 volts.

The spectral relations of the first resonance potential and ionization potential are analogous to the relation found with other metals in this group. Work of other observers shows that both the lines $1.5\ S-2\ P$ and $1.5\ S-2p_2$ appear below the ionization potential in most metals of this group.

This paper was discussed by Mr. WHITE.

E. C. CRITTENDEN, *Corresponding Secretary.*

823D MEETING

The 823d meeting was held at the Cosmos Club, November 8, 1919, with President HUMPHREYS in the chair, and 55 persons present.

R. W. G. WYCKOFF: *The nature of the forces between atoms in solids.* This paper, which has since been published in this JOURNAL (9: 565. Nov. 19, 1919) was illustrated by lantern slides and discussed by Messrs. SOSMAN, WHITE, HUMPHREYS and BRAY.

H. L. CURTIS, R. C. DUNCAN and H. H. MOORE: *Methods of measuring ballistic phenomena on a battleship.* The paper was presented by Mr. CURTIS.

In 1917, apparatus was designed for obtaining the relative time of ejections of the three shells, when the three guns of one turret of a battleship were fired simultaneously. The method consisted in having a condenser charged to a high potential and circuits so arranged that when the shell emerged from the gun it short-circuited two wires which were stretched in front of the gun, thus completing the electric circuit and discharging the condenser through a point on a chronograph drum. The method was satisfactory although the spark which was produced was not as vigorous as had been expected. It was later shown that this was caused by the discharge taking place through the hot ionized gas which preceded the shell. This, however, did not appreciably affect the results, since approximately the same interval existed in all the guns.

It was soon found advisable to use a method which would be more flexible than the spark method outlined above. After careful consideration of the possible methods available, it was decided to use an oscillograph as a timing instrument. An oscillograph is simply a galvanometer of very high period which is critically damped, and which is arranged for photographing the movements of the mirror on a moving film. Three of these galvanometers or oscillograph elements are usually mounted in one instrument, all giving records on one film. To use this for timing various events, it is simply necessary to arrange an electric circuit in such a way that the events will produce a change in the electric circuit through the oscillograph element, thus causing a deflection of the mirror of the oscillograph element which is registered on the photographic film. It is also necessary to know the velocity of the film.

To obtain the velocity of the film, a tuning fork having small plates on the prongs is employed. When the tuning fork is at rest, a fine slit is cut through the two plates. The tuning fork is then mounted so that a beam of light passes through this slit and makes a line on the film when both the fork and the film are at rest. If now the fork vibrates and the film is in motion, lines will be produced on the film giving an accurate record of the velocity of the film. This method has already been described in a paper before the Society.[1]

The above method has been used to obtain with a single oscillograph

[1] Meeting of May 24, 1919, abstracted in this JOURNAL, 9: 642., Dec. 4, 1919.

element a number of time intervals between the closing of the firing circuit and the ejection of the shell from the gun. It is only necessary to so arrange the circuits that each event will produce a characteristic record on the film.

To obtain a record of a motion which is continuous, such as the recoil of the gun, a step-by-step method has been adopted. This consists of a series of contacts so arranged that at definite distances there will be a sudden change in the resistance of the circuit. This will produce a small but definite movement of the oscillograph element so that the time when this occurred is recorded on the oscillograph film. Then, from the known positions of the contacts, and the measured times, a curve can be plotted which will show the rate at which the movement took place.

This step-by-step method has the advantage that both the distances and the time can be accurately measured. Hence, at the points where the change in resistance takes place, the position and time are determined with a high degree of accuracy. If a curve is plotted, using time and position as coordinates, this curve is very accurate at all points, excepting where the motion is changing direction. If the total motion is known, the curve can be made accurate at this point also.

The above method has been used in the design of a recoil-meter. The steps are not the same throughout the entire length of recoil, but are shorter during the first part of the curve and longer during the latter portion. This increases the accuracy during the first part of recoil where a study of the motion of the gun is most important. Very satisfactory curves have been obtained.

The same principle has also been employed in the design of a kinemeter, which is an instrument for obtaining the motion of the gun in a direction perpendicular to its axis. This instrument is designed on the same principle as a seismograph, and has also given satisfactory results.

This paper was illustrated by lantern slides, and was discussed by Messrs. L. J. Briggs, White, Hawkesworth and Hull.

The meeting adjourned at 10.10 and was followed by a social hour.

S. J. Mauchly, *Recording Secretary.*

WASHINGTON SOCIETY OF ENGINEERS

Fourteen meetings of the Society were held during the year 1919, as follows:

January 15, 1919: Charles R. Mann, Professor of Education and Director of Educational Research, *Engineering education.*

February 5, 1919: Major C. H. West, Chemical Warfare Service, U. S. Army, *Use of poisonous gases in modern warfare.*

February 19, 1919: Brigadier-General Samuel T. Ansell, Acting Judge Advocate General of the Army, *Relationship of the engineer to the Army.*

March 5, 1919: MARSHALL O. LEIGHTON, Consulting Engineer, *Great Falls water power and its relation to the District of Columbia.*

March 19, 1919: CHARLES H. PAUL, Assistant Chief Engineer, Miami Conservancy District, Dayton, Ohio, *Flood prevention works in the Miami Valley.*

April 2, 1919: R. B. CANFIELD, Electrical Engineer, *Development of electric traction.* Motion picture, *King of the rails.*

April 16, 1919: Rear Admiral C. P. PLUNKETT, U. S. Navy, *The Fourteen-inch Naval Battery in France.*

May 7, 1919: Inspection trip to Camp A. A. Humphreys, Virginia.

October 1, 1919: C. T. CHENERY, Secretary of Conference on National Public Works, *A national department of public works.*

October 15, 1919: Hon. LOUIS BROWNLOW, President, Board of Commissioners, District of Columbia, *The proposed building zone plan for Washington, D. C.* Captain JOHN T. TALMAN, U. S. A., *Plans and progress of the Key Bridge.*

November 5, 1919: H. T. CORY, Consulting Engineer, U. S. Reclamation Service, *Reclamation of land in the South.*

November 19, 1919: General discussion of preliminary report of Engineering Council's Committee on Classification and Compensation of Engineers in the service of the Federal Government, led by JOHN C. HOYT, Hydraulic Engineer, U. S. Geological Survey. Members of all of the affiliated Societies of the ACADEMY were invited to attend this meeting.

December 3, 1919: Annual dinner. Speakers: Hon. EDWIN F. SWEET, Acting Secretary of Commerce; Hon. HENRY W. TEMPLE, Member of Congress; Dr. HOLLIS GODFREY, President, Drexel Institute; Mr. PHILIP N. MOORE, Consulting Engineer.

December 17, 1919: Annual meeting for the election of officers. The following officers were elected for the year 1920: *President*, E. C. BARNARD; *Vice-President*, R. L. FARIS; *Treasurer*, G. P. SPRINGER; *Secretary*, W. E. PARKER; *Directors*, E. F. WENDT, MORRIS HACKER, JOHN C. HOYT, OSCAR C. MERRILL, ANTHONY F. LUCAS, C. H. BIRDSEYE, J. S. CONWAY, F. W. ALBERT; *Committee on Membership*, R. L. FARIS, J. S. CONWAY, C. H. BIRDSEYE; *Committee on Meetings*, F. W. ALBERT, OSCAR C. MERRILL, R. H. DALGLEISH, B. P. LAMBERTON, JR., JAMES H. VAN WAGENEN.

W. E. PARKER, *Secretary.*

SCIENTIFIC NOTES AND NEWS

The Committee on Nomenclature, of the American Ornithologists' Union, consisting of Messrs. WITMER STONE (*Chairman*), editor of *The Auk*; JONATHAN DWIGHT, of the American Museum of Natural History; H. C. OBERHOLSER, of the Biological Survey and C. W. RICHMOND, of the National Museum, met in Washington on February 11–12, to consider the revision of the A. O. U. check-list of North American birds.

The Bureau of Biological Survey, U. S. Department of Agriculture, has begun a campaign, with State and local assistance, against pocket gophers in Arizona. The gopher destroys fruit trees and crops and also does considerable damage to irrigation ditches.

Several European starlings, all captured near the District of Columbia, have been presented recently to the National Zoological Park. This imported bird is becoming increasingly numerous around Washington.

A fundamental mercurial standard for testing sphygmomanometers, used for the measurement of blood pressure, has been constructed at the Bureau of Standards. There appears to be a great variation in the different types of blood-pressure gages now in use, and a fundamental study of their accuracy and design is needed.

A special camera for taking panoramic photographs of the interior of gun barrels which have been subjected to firing tests has been designed at the Bureau of Standards and is now under construction.

Recent investigations at the Bureau of Standards on wood columns from some of the temporary war buildings erected in Washington, made of green timber which has warped and cracked in seasoning, show that when warping and bending have occurred the strength is considerably reduced, but that cracking due to seasoning does not weaken the columns as long as they remain straight.

Mr. L. B. ALDRICH, of the Astrophysical Observatory, Smithsonian Institution, has built and partly tested a new "honeycomb pyranometer" for measuring nocturnal radiation. Tests so far completed are very promising. The flat-black surface of the ordinary pyranometer, which is not a physically perfect "black body" for the long wave-lengths radiated by the earth, is replaced by a surface made up of about 200 triangular cells, each about 3 mm. on a side by 13 mm. deep. A silvered mirror below effectively doubles the depth.

Dr. PAUL BARTSCH, of the National Museum, gave an illustrated lecture before the Nature Study Section of the Twentieth Century Club in February on "The ferns of the District of Columbia."

Mr. Harvey Bassler, who has held a temporary appointment on the U. S. Geological Survey since 1911 while a student at Johns Hopkins University, has joined the permanent staff of the Survey as assistant geologist, and has been engaged in field work in the Virgin River Oil Field, Utah.

Mr. Hoyt S. Gale, geologist in charge of the section of non-metalliferous deposits of the Division of Geology, U. S. Geological Survey, who recently returned from Europe where he examined and reported on the potash deposits for the Geological Survey and Bureau of Mines, is on furlough for five months to make an examination of the oil fields of eastern Bolivia.

Mr. K. C. Heald, geologist of the U. S. Geological Survey, is returning from Bolivia by way of the Amazon to the east coast of Brazil.

Mr. George Livingston, who has been acting chief of the Bureau of Markets, U. S. Department of Agriculture, since the resignation of Mr. Charles J. Brand, was appointed chief of the Bureau on January 27. Mr. Livingston came to the Department in 1915 as assistant marketing specialist.

Sir Oliver Lodge gave two lectures in Washington on February 10 and 11 on psychical subjects.

Rear Admiral Robert Edwin Peary, U. S. N. (Retired), died at his home, 1831 Wyoming Avenue, on February 20, 1920, in his sixty-fourth year. Admiral Peary was born at Cresson, Pennsylvania, May 6, 1856. He began his government service as a draftsman in the U. S. Coast and Geodetic Survey, and in 1881 became a lieutenant in the U. S. Navy. In 1886 he began the series of Arctic explorations which culminated in his attainment of the North Pole on April 6, 1909.

Dr. Waldemar T. Schaller has resigned as chemist in the Division of Physical and Chemical Research, U. S. Geological Survey, and has accepted a position with the Great Southern Sulphur Company, Incorporated, of New Orleans, Louisiana, operating at Orla, Texas.

Dr. Charles D. Walcott, Secretary of the Smithsonian Institution, has been elected a foreign member of the Kungliga Svenska Vetenskapsakademien (Royal Swedish Academy) of Stockholm.

ERRATUM.

On page 34, line 14 from the bottom of the page for 1718 read 1817.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 10 APRIL 4, 1920 NO. 7

MATHEMATICS.—*A graphical method for plotting reciprocals.*[1] F. E. WRIGHT, Geophysical Laboratory, Carnegie Institution of Washington.

In the search for a mathematical function which shall represent satisfactorily the data obtained from a series of experiments it is convenient in certain instances to plot the reciprocals of one of the variables and from the curve thus obtained to deduce the form of the desired equation. Thus a rectangular hyperbola under these conditions becomes a straight line from the equation of which that of the hyperbola can be written down directly. The obvious procedure is either to compute the reciprocals of the given data or to use paper so ruled that the ordinate-scale is the reciprocal scale $1/y$.

A second method may, however, be employed which does not require special computations. The principle of the method is illustrated in figure 1. Ordinary cross-section paper is used; the ordinate-scale (Y-scale) remains unchanged; the X-scale (not necessarily x but any function of x which it may be desired to use) is transferred from the X-axis (OD) to the horizontal line at unit distance (FA, $y = 1$) from the axis; a series of radiating lines is drawn from the origin through the divisions of the X-scale, each radiating line (x'_1) corresponding to the X-scale division which it intercepts. The intersection of one of these diagonal lines (x'_1) with the ordinate (y'_1) is the point P′ in projection, just as the intersection of the ordinate (y_1) and the abscissa (x_1) in ordinary projection fixes the position of the point

[1] Received February 11, 1920.

P. In the similar triangles *ADO* and *CED* (Fig. 1) $AD = 1$, $OD = x$, $CE = y' = BD = y$, and $OE = x'$; also $OE/CE = OD/AD$ or

$$x' = x.y \text{ and } y' = y. \tag{1}$$

The expression for a curve obtained in the one projection can

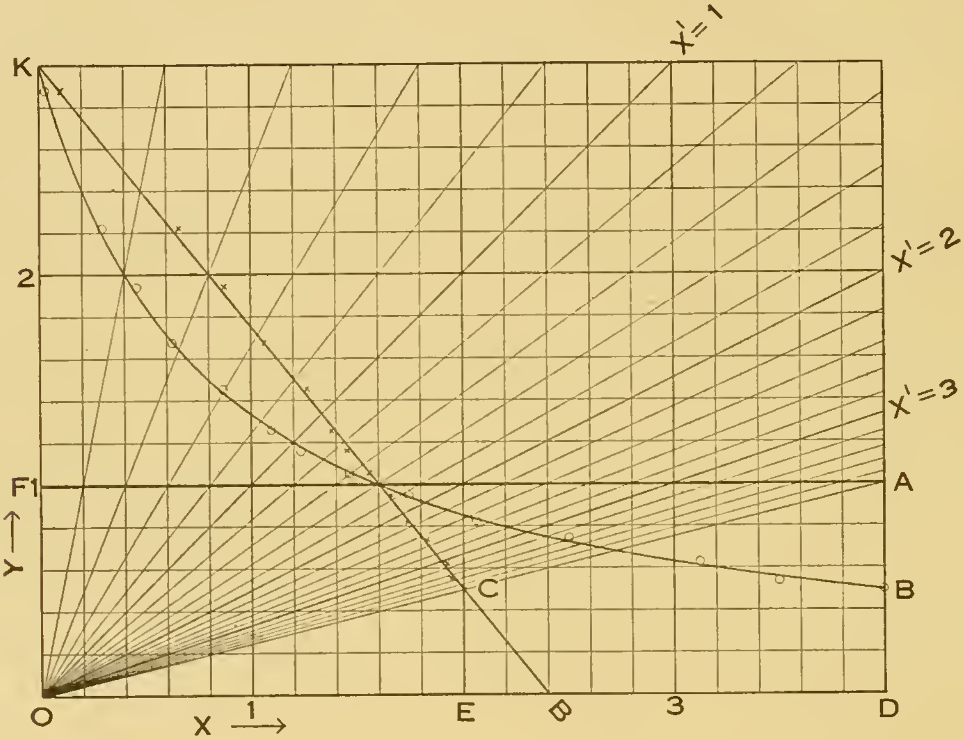

Fig. 1.—In this figure a series of straight lines are drawn through the origin *O* and the divisions of the *X*-scale along *FA*, which has been displaced to unit distance from the *X*-axis. The radiating lines correspond in this projection to the vertical lines in the usual rectangular coordinate projection. Thus the point *B* of the curve *KB* in the ordinary projection becomes the point *C* (intersection of the ordinate *Y* with the radial line *OA*).

be transformed to that for the corresponding curve in the second projection by substituting in it for x' the value xy (equation (1)) in the first expression.

To illustrate the method and the significance of the projection let the encircled points in figure 1 represent the data obtained in a series of experiments and plotted in the usual manner on coordinate paper. To ascertain the equation of the curve *KB* which passes through these points draw the radiating lines (x') from the origin through the *X*-scale plotted on the line ($y = 1$); find the points of intersection of the ordinates y' ($= y$) with the corresponding radiating lines (x'). In figure 1 these points of intersection are indicated by crosses. The curve KB' passing through the x' points may prove to be a straight line as in the case shown in figure 1. In this particular case the line intersects the X-axis at 2.4 and the Y-axis at 3.0; its equation is accordingly

$$y = -1.25x' + 3.00.$$

The equation of the x,y curve is therefore (by equation (1))

$$y\,(1.25x + 1) = 3.00$$

the equation of a rectangular hyperbola. In case the line KB' is not a straight line, but a curve for which the mathematical expression can be ascertained, this expression can be converted directly into the desired equation in ordinary coordinates.

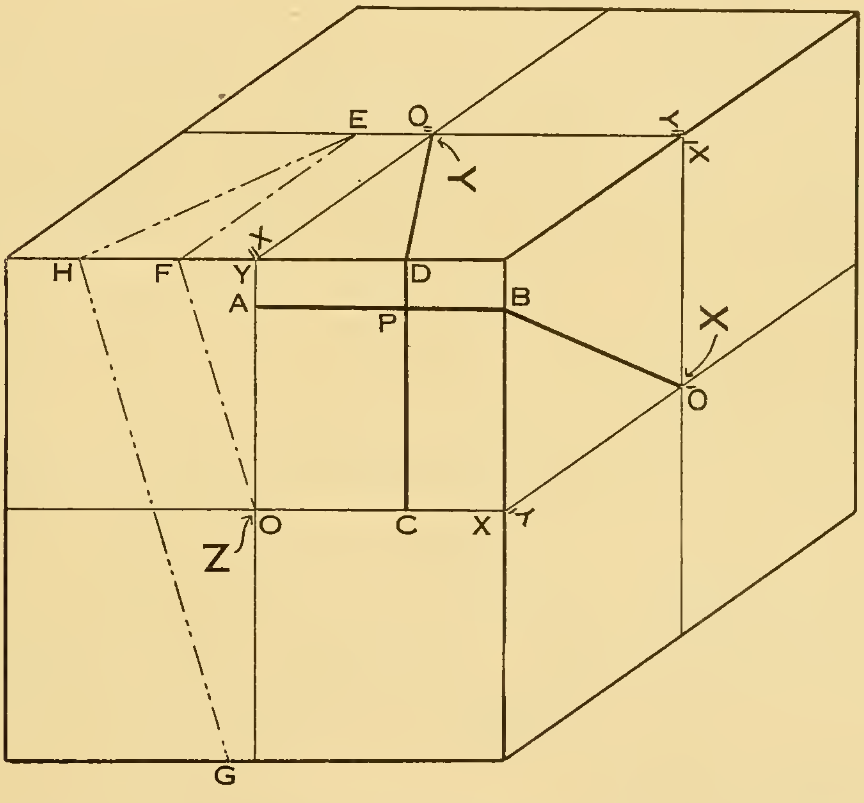

Fig. 2.—Illustrating the principle on which the foregoing method of plotting reciprocals is based. Thus the rectangular coordinate projection normal to the Z-axis (front face of cube) becomes a projection with lines radiating from the center in the projection planes normal to the X-axis or the Y-axis of the orthogonal system of spacial coordinates.

The lengths of the intercepts of the radiating x' lines on the vertical line at unit distance from the origin ($x = 1$) are, moreover, the reciprocals of the X-scale values, or $1/x$.

The principle of this method of plotting on radiating lines instead of parallel ordinates becomes clear when it is realized that all parallel lines in a projection meet at a point at infinity. If we consider the projection plane to be one of the faces of a cube in which a sphere of unit radius is inscribed, and each point in the projection to be the intersection of a line from the center of the sphere with the projection plane (gnomonic projection); then an ordinate (CP) in the projection plane normal to the Z-axis (front face of the cube, figure 2) represents a plane which contains the Y-axis, and hence becomes a radiating line (OD) in the projection plane normal to the Y-axis (top face of the cube, figure 2).

If the coordinates of the projections normal to the Z-X-Y-axes be designated x,y, x',y', and x'',y'', respectively (Fig. 2), the coordinates of a point $P(x,y)$ become $y = x'/y' = 1/x''$ and $x = 1/y' = y''/x''$ in the other projections, respectively. A straight line $y = ax + b$ (such as GH, Fig. 2) becomes $by' = x' - a$ and $ay'' = -bx'' + 1$ (as line HE, Fig. 2), in the other projections.

BOTANY.—*Notes on North Dakota Plants.* F. P. METCALF, Biological Survey.

During the summer of 1917 the writer and D. C. Mabbott were engaged in conducting an extensive survey of the marsh and aquatic plants of North Dakota for the Biological Survey, U. S. Department of Agriculture. This was an exceedingly valuable opportunity to study intensively the marsh and aquatic flora throughout the state. The results of this work were so interesting from the standpoint of plant distribution that it was thought advisable to make known the most salient features in a preliminary paper.

Before this work could be completed the writer was called to the military service and for nineteen months had no time to think of North Dakota and its plants. This was fortunate for one reason, at least, in that in September, 1918, Bergman's *Flora of North Dakota*[1] was published. This made additional

[1] BERGMAN, H. F. *Flora of North Dakota.* Sixth Biennial Report, North Dakota Soil and Geological Survey, 1911–12. Published September, 1918.

notes more valuable than if based on the less complete and out-of-date flora of Bolley & Waldron.[2]

Eighteen species were observed by us that have not previously been reported in the state.

Amphicarpa Pitcheri Torrey & Gray
Carex riparia W. Curtis
Carex scirpoides Schkuhr
Chenopodium humile Hooker
Cornus Amomum Miller
Juncus alpinus Villars
Cyperus diandrus Torrey
Erigeron annuus (L.) Persoon
Najas marina L.
Potamogeton praelongus Wulfen
Prunus Besseyi Bailey
Prunus serotina Ehrhart
Rumex Brittannica L.
Salix prinoides Pursh
Scirpus nevadensis Watson
Sparganium americanum Nuttall
Suaeda linearis (Ell) Moquin-Tandon
Utricularia minor L.

The majority of these plants are from stations that fall well within the range of manuals covering the region, from which they have been omitted partly by mistake and partly from the lack of intensive work throughout the state. *Erigeron annuus* L., *Carex riparia* W. Curtis, and C. *scirpoides* Schkuhr are exceptionally good examples of this occurrence. Others of the plants listed were found on the extreme western border of their known general range, as *Cyperus diandrus* Torrey and *Juncus alpinus* Villars. By far the most interesting of all, however, were the plants whose known range previously did not extend into North Dakota.

Eastern plants extending westward	Western plants extending eastward
Amphicarpa Pitcheri Torrey & Gray	*Scirpus nevadensis* Watson
Cornus Amomum Miller	
Najas marina L.	
Rumex Brittannica L.	
Sparganium americanum Nuttall	
Suaeda linearis (Ell) Moquin-Tandon	

No striking northern or southern extensions were recorded. Of the eastern group, four out of six are known to occur westward to Minnesota or South Dakota and rarely (in one case)

[2] Bolley, H. L., and Waldron, L. R. *Preliminary list of seed-bearing plants of North Dakota.* North Dakota Agric. Coll. Exp. Station, Bull. 46. 1900.

to North Dakota, but the other two are extremely unusual, one, *Sparganium americanum* Nuttall not having been recorded west of Iowa and the other *Suaeda linearis* (Ell) Moquin-Tandon being known only along the coast and in the extreme southwest. The appearance of this alkaline-saline-loving plant inland may very well be compared to that of a few of the salt-loving plants known only from the coast and isolated inland stations in Western New York. As an addition to this group should be mentioned *Salix serissima* (Bailey) Fernald, and *S. tristis* Allioni, both previously known from the state but found by us growing in localities considerably more western than previously reported.

Scirpus nevadensis Watson seems to hold alone the distinction of being a new plant to North Dakota that has a more western range; this plant is rather common throughout the state and it appears strange that it has not been recognized before; it is always restricted to the strongly alkaline-saline lakes. One may add also three other species known previously in North Dakota, two of which, however, are here first reported east of the Missouri River, *Munroa squarrosa* (Nuttall) Torrey and *Stanyleya pinnata* (Pursh) Britton, and one, *Thelypodium integrifolium* (Nuttall) Endlicher, which was known from Dawson but was found in the vicinity of Sink Lake, a few miles farther northeast.

A number of other records have been given also; these fall into two main groups, first those of plants that are decidedly rare throughout North Dakota and for which one or more new localities are cited, and second those whose distribution in the state as given in manuals is inadequate and often incorrect. Listed below are the most important of the first group or rarer plants:

Arctostaphylos Uva-ursi (L.) Sprengel
Juncus longistylis Torrey
Opuntia fragilis Haworth
Potamogeton Friesii Ruprecht
Potamogeton zosterifolius Schumacher
Sagittaria latifolia Willdenow
Salix candida Fluegge
Spiranthes romanzoffiana Chamisso

Most of these are rare on account of their restriction to certain definite ecological conditions such as are afforded by sand hills, swampy bogs or fresh water all of which are only occasionally or locally found in the state.

The second group, namely, plants of imperfectly known distribution is taken up in detail in the subjoined list; here also will be found complete data for all plants mentioned in this article, with actual citations of specimens collected. It may be well to add that all specimens collected by D. C. Mabbott are so labeled; the others recorded were obtained by the writer. All specimens have been placed in the U. S. National Herbarium at Washington.

There is no doubt in the writer's mind that the number of new plants added by this paper to the flora of North Dakota is small in comparison with the number that will be found upon further collecting. North Dakota is a great field for intensive botanical field investigation especially in working out interesting problems in eastern and western distribution.

Grateful acknowledgement is hereby made to Carleton R. Ball of the U. S. Department of Agriculture, for determinations of species of *Salix* and to W. L. McAtee for assistance and timely suggestions.

LIST OF PLANTS

Sparganium americanum Nuttall. Not previously recorded from the state. Range here greatly extended westward as formerly unknown west of Iowa. Rather common in Riverside Marsh, Mandan, Morton Co. (No. 377, Aug. 27, 1917), and frequent along border of Bismarck Slough, Burleigh Co.

Potamogeton Friesii Ruprecht. Lunell[3] reports this from "Jamestown in James River and Lake Ibsen (extinct)." Bergman, however, does not give this record. Found only in Upsilon (No. 479, Sept. 8, 1917, D. C. Mabbott) and Jarves Lakes, Rolette Co., in the Turtle Mountains.

Potamogeton heterophyllus Schreber. Found abundantly in Bismarck (No. 355, Aug. 24, 1917) and King (No. 345, Aug. 24, 1917) Sloughs, Burleigh Co.; Max Slough and Big Slough (No. 471, Sept. 6, 1917), near Underwood, McLean Co. Bergman reports this plant from four localities (Kulm, Spiritwood, Leeds and Wahpeton).

Potamogeton natans Linnaeus. Frequent throughout the Turtle Mountains, rare elsewhere. Bergman reports this only from Lake

[3] Lunell, J. "Enumerantur Plantae Dakotae Septentrionalis Vasculares." Am. Mid. Nat. 4–5: July, 1915–July, 1917.

Metigoshe and St. John, Turtle Mountains. Also observed there (No. 544, Sept. 21, 1917) and in Roland Twp.[4] S. 16, S. 4–9, and Pelican Lakes, Bottineau Co.; Upsilon (No. 459, Sept. 7, 1917, D. C. Mabbott) Carpenter, Crowell and Jarves Lakes, Rolette Co. and Foothill Twp. S. 20–39, Burke Co.

Potamogeton perfoliatus Linnaeus. Abundant in the northern counties of the state, less abundant in the southern tier of counties; prefers shallow, slightly alkaline or fresh water. This species was represented by two forms, one of which was characterized by sessile, lanceolate to narrow ovate-lanceolate leaves with acuminate apex agreeing with *P. Richardsonii* (Bennet) Rydberg (*P. perfoliatus Richardsonii* Bennett); the other with clasping perfoliate, ovate-lanceolate to ovate leaves with acute apex representing *P. perfoliatus* L. Every possible intermediate intergradation between these two forms was found, suggesting that all should be treated as belonging to a single species.

Potamogeton praelongus Wulfen. Not previously reported from the state but comes within general range commonly given. Found sparingly in Pelican Lake, Bottineau Co. in the Turtle Mountains (No. 546, Sept. 24, 1917).

Potamogeton zosterifolius Schumacher. Rather rare, only found in King Slough, Burleigh Co. (No. 344, Aug. 24, 1917); Painted Woods Lake, McLean Co. (No. 440, Sept. 3, 1917) and Jim Lake, Stutsman Co. (No. 315a, Aug. 14, 1917, D. C. Mabbott). Bergman reports this only from St. John and Lake Ibsen (extinct).

Ruppia maritima Linnaeus. Abundant throughout the state in slightly alkaline-saline or saline water. A few plants were noted that approach very closely to *R. occidentalis* Watson of Britton and Brown's Manual (sheaths $1\frac{1}{2}'$–$2'$ and achenes $1\frac{1}{2}''$–$2''$); others less vigorous (sheaths $3''$–$4''$ and achenes $1''$) resemble *R. maritima;* another approaches var. *longipes* Hagstrom and one, very much stunted seems identical with *R. maritima* var. *rostrata* Agardh. (Rhodora, Vol. 16, No. 167, pp. 119–127). However, the large forms that approached *R. occidentalis* were always found in the least alkaline lakes under the most favorable conditions (Brush Lake, McLean Co., No. 457, Sept. 5, 1917, total concentration of salts 1103 parts per million and Thompson Lake, Burke Co., No. 564, Oct. 2, 1917, no fruit); forms representing typical *R. maritima* in somewhat similar or slightly more alkaline lakes (Isabel Lake, Kidder Co., No. 209, Aug. 6, 1917, total concentration of salts 2512 parts per million; Long Lake, Underwood, McLean Co., No. 405, Sept. 1, 1917, total concentration of salts 457 parts per million; Salt Lake, Dawson, Kidder Co., No. 209, Aug. 6, 1917, total concentration of salts 3906 parts per million), while on the other hand the less vigorous forms, var. *longipes* Hagstrom were found under adverse conditions in the strongly alkaline-saline lakes (Moon Lake, Barnes Co., No. 220, Aug. 3, 1917, D. C. Mabbott, total concentration of salts 5,779 parts per million), and the most stunted of all *R. maritima* var. *rostrata* was found in the very salt Kellys Slough, Grand Forks

[4] Township, Section 16, Section 4–9, etc.

Co. (No. 507, Sept. 20, 1917, D. C. Mabbott), similar to Minto Lake with a total concentration of salts of 25,210 parts per million. Unfortunately fruit in many cases could not be found but after this summer's investigation of numerous lakes of extremely different types, evidence in North Dakota seems to point to the fact that the so-called species and varieties of this plant are primarily connected with the concentration of salts in the water. Bergman reports this plant only from Dawson.

Najas marina Linnaeus. Not previously reported from the state. Range extended westward as manuals give Minnesota as the extreme northwestern limit. Only observed in Lake Elsie (No. 60, July 23, 1917) and Mud Lake (No. 148, July 24, 1917), Richland Co., where it was fairly abundant.

Sagittaria latifolia Willdenow. Rare; only reported from Mud Lake Richland Co. (No. 135, Aug. 24, 1917); Dawson Slough and Horseshoe, Lake, Kidder Co. (No. 325, Aug. 18, 1917). Bergman reports this from Neche.

Elodea canadensis Michaux. Frequent throughout the state in fresh water ponds and sloughs; observed in Bismarck Slough, Burleigh Co. (No. 358, Aug. 24, 1917); John Wilde Lake, Emmons Co.; Mercer and Max Lakes, McLean Co.; Ward Lake (No. 569, Oct. 2, 1917), Clayton Twp., S. 30–29 Lake (No. 590, Oct. 5, 1917), and Foothills Twp., S. 28 Lake in Burke Co. and Jim Lake (No. 321a, Aug. 14, 1917, D. C. Mabbott) in Stutsman Co. Bergman records this plant from La Moure, Jamestown and Leeds.

Munroa squarrosa (Nuttall) Torrey. This plant was found near Wanitah Lake, Foster Co. (No. 387, Aug. 22, 1917, D. C. Mabbott), much farther east than hitherto reported. Previously it has not been observed east of the Missouri River, the only two localities known in the state being Mandan and Medora, west of the Missouri River (Bergman).

Sphenopholis obtusata (Michx) Scribner var. *lobata* (Trinius) Scribner. Not previously recorded from the state. Frequent; Bergman considered all the material collected as the true species *obtusata;* all the plants collected by the writer were clearly the variety *lobata;* Buckhouse Slough, Richland Co. (No. 94 and No. 116, July 23, 1917); Moon Lake, Barnes Co. (No. 212, Aug. 3, 1917, D. C. Mabbott).

Scolochloa festucacea (Willdenow) Link. Very common throughout the state; the characteristic grass of Mallard Slough; reported from over twenty-one counties. Bergman lists this plant only from Fargo, Valley City and Ft. Totten.

Cyperus diandrus Torrey. Not previously reported in the state, considered here to be at the extreme western border of its range. Found only along border of Moran Lake, Richland Co. (No. 182, July 27, 1917).

Scirpus occidentalis (Watson) Chase and *Scirpus Validus* Vahl. The former is abundant throughout the state in marshes and sloughs, and the latter frequent but not clearly distinguishable from *S. occi-*

dentalis; these two intergrade so completely that it is very doubtful if *S. occidentalis* should exist as a separate species; it is unfortunate that the majority of the specimens can be referred to the type *S. occidentalis* but *S. validus* having priority must stand. Under favorable conditions when *validus* was found in springy places, the soft, light green, thickened culm was apparent and distinguishable from the much harder olive-green culm of *S. occidentalis*, but here usually this character was too variable to be used for identifying the two species. Again, the broader achene and longer spikelet of *S. occidentalis* are considered valuable characters in distinguishing this species from *S. validus*. Numerous measurements and comparisons were made in the field with the result that all normal or extreme variations of both factors were found in a single patch that was all of the hard olive-green culm type. The character of the rays, whether flexuous or stiff, was subject to the same variation. In the east such extensive variation has not been observed. However, in North Dakota, until definite work has been done in growing these two species under different conditions of alkalinity it is still a question whether *S. occidentalis* is a valid species. Present evidence points in the opposite direction.

Scirpus nevadensis Watson. Not previously recorded from the state. Rather common throughout, having been reported from 35 lakes in 10 counties. This plant has not been observed previously east of Wyoming so that its known range is greatly extended eastward. Specimens collected from Salt Lake, Dawson, Kidder Co. (No. 215, Aug. 6, 1917); Bird Lake, Dawson, Kidder Co. (No. 263, Aug. 10, 1917); Smoky Lake, McHenry Co. (No. 426, Aug. 29, 1917, D. C. Mabbott).

Carex cristata Schwein. (*Carex cristatella* Britton.) Elsie Lake, Richland Co. (No. 72, July 23, 1917) and Dion Lake, Rolette Co. (No. 472, Sept. 8, 1917, D. C. Mabbott). Bergman reports this from Wahpeton and Walhalla.

Carex diandra Schrank var. *ramosa* (Boott) Fernald. Buckhouse (No. 93, July 23, 1917) and Stack (No. 169, July 26, 1917), Sloughs, Richland Co.; Swamp Lake, Logan Co. (No. 195, Aug. 2, 1917); Falkirk Lake, McLean Co. (No. 445, Sept. 3, 1917); Salt Lakes, North of Ryder, Ward Co. (No. 481, Sept. 11, 1917). Bergman reports this from Pleasant Lake and Fort Totten.

Carex riparia W. Curtis. Not previously reported from the state, which, however, comes within the range commonly given. Frequent along the border of lakes and sloughs; Arrowwood Lake, Stutsman Co. (No. 331, August 15, 1917, D. C. Mabbott); Girard Lake, Pierce Co. (No. 436, Aug. 31, 1917, D. C. Mabbott); Hester Lake, McHenry Co. (No. 445, Sept. 4, 1917, D. C. Mabbott); Rock Lake, Towner Co. (No. 493, Sept. 13, 1917, D. C. Mabbott). Also observed in Cavalier, Griggs, Foster and Ramsey Counties.

Carex rostrata var. *utricularia* (Boott) Bailey (*Carex ultricularia* Boott). Frequent throughout the state; Elise Lake, Richland Co. (No. 81, July 23, 1917); South Napoleon Lake, Logan Co. (No. 185, Aug. 1, 1917); Isabel Slough, Dawson, Kidder Co. (No. 232, Aug. 8, 1917); Arvidson Slough, Burke Co. (No. 567, Oct. 2, 1917); Red Willow Lake, Griggs Co. (No. 376, Aug. 20, 1917, D. C. Mabbott). Common in the Turtle Mountains. Bergman reports this from Ft. Totten, Leeds and Towner.

Carex scirpoides Schkuhr. (*Carex interior* Bailey.) Not previously reported from North Dakota, which, however, falls within the range commonly given. Only collected from grassy bog along border of Elsie Lake, Richland Co. (No. 74, July 23, 1917).

Carex stipata Muhlenberg. Also found at Elsie Lake, Richland Co. (July 23, 1917). Bergman reports this plant from Fargo and Walhalla.

Lemna trisulca Linnaeus and *L. minor* Linnaeus. Both of these plants are common throughout the state in fresh water ponds, sloughs and springs; the former was reported from over eighteen counties, the latter from fifteen or more. Bergman gives only three localities for the former (Grand Forks, Walhalla and Turtle Mountains) and six for the latter.

Juncus alpinus Villars. Not previously reported from the state, although included within the southern border of its range. Rather frequent throughout the state in grassy bogs or wet shores bordering lakes; reported from Elsie Lake, Richland Co. (No. 73, July 23, 1917); Isabel Lake, Kidder Co. (No. 224, August 8, 1917); Metigoshe Lake, Bottineau Co. (No. 524, Sept. 9, 1917); Lostwood S. 28–29, Mountrail Co. (No. 574, Oct. 3, 1917); Hobart (No. 240, Aug. 4, 1917, D. C. Mabbott) and Eckelson Lakes, Barnes Co.; Smoky Lake, McHenry Co. (No. 428, Aug. 29, 1917, D. C. Mabbott) and Upsilon Lake, Rolette Co. (No. 449, Sep . 4, 1917, D. C. Mabbott).

Juncus longistylis Torrey. Rather rare throughout the state only being reported from the borders of Lostwood, S. 28–29 Lake, Mountrail Co. (No. 577, Oct. 3, 1917); Lake George and Round Lakes (No. 396, Aug. 25, 1917, D. C. Mabbott) in McHenry Co., and McDonough Lake, Pierce Co. Bergman records this plant from Williston.

Spiranthes romanzoffiana Chamisso. Rare, found along swampy border of Lake George, Drake, McHenry Co. (No. 421, Aug. 28, 1917, D. C. Mabbott). Bergman records this plant from McLeod, Towner and Devils Lake.

Salix candida Fluegge. Rather rare, reported from boggy borders of Lake Elsie, Richland Co.; Camp Lake, McLean Co. (No. 410, Sept. 1, 1917) and Coville Twp. S. 1–2, Mountrail Co. Bergman lists this from Valley City, Walhalla and Butte.

Salix prinoides Pursh. Not previously reported from the state. Rare, only reported from borders of Red Willow Lake, Griggs Co. (No. 375, Aug. 20, 1917, D. C. Mabbott); Rush Lake, Cavalier Co.; Denbigh Lake, McHenry Co.; Upsilon Lake, Rolette Lake and Sweetwater Lake, Ramsey Co.

Salix serissima (Bailey) Fernald. Very rare, being reported only from swampy border of Upsilon Lake, Rolette Co. in the Turtle Mountains (No. 464, Sept. 7, 1917, D. C. Mabbott). This extends the known range of this plant westward as Bergman reports this plant only from Walhalla, Pembina Co.

Salix tristis Allioni. Very rare, found only in Sand Hills, near Lake George, Drake, McHenry Co. (No. 416, Aug. 28, 1917, D. C. Mabbott). This extends the range of this plant westward as previously the farthest westerly record was that of Bergman, namely, Hankinson, Richland Co.

Rumex Brittannica Linnaeus. Not previously reported from the state. Range extended westward as manuals give Minnesota-Kansas as the western limit of distribution. Collected only from border of Camp Lake, McLean Co. (No. 416, Sept. 1, 1917).

Polygonum amphibium Linnaeus. Rather rare, reported with the exception of Emmons County, only from the more northern counties—Ward, Ramsey, Rolette, Towner, Burke and known from but one lake in each of these. Another form of this species masquerading under the name *P. amphibium* Linnaeus Var. *Hartwrightii* (Gray) Bissel, was rare, only reported from partially dried out mud flats of Section 13–14, Frettin Lake, Kidder County and Upsilon Lake, Rolette County. Still another form of this same species known as *P. Muhlenbergia* (Meisner) Watson was common throughout the state growing in water and in moist meadows bordering fresh water lakes. These so-called species can only be considered forms of *P. amphibium;* this species is very variable, all forms intergrading one into the other, depending on ecological conditions. Poole has written as follows:[5] "The development of the hydro-mesophytic mode of life by these species is a fact of every-day observation. In the marshy areas of the sandhills one can trace a perfect series of changes from the typical form called *P. amphibium* through *P. Hartwrightii* and finally to *P. emersum* (*Muhlenbergia*). The first two forms, though often very different appearing plants, may commonly be collected from the same rhizome. The latter species is almost as variable and it seems a plain case that these three 'species' are merely extreme variations that may be found arising from the same rootstock," a fact verified by the author in North Dakota. To continue to give distinct rank to these forms as is done in Britton and Brown's "Illustrated Flora" and Gray's "7th Edition Manual" is a mistake.

Chenopodium humile Hooker. Not previously reported from the state but possibly included rightfully within the species *C. rubrum.* On the shores of Middle Des Lac Lake, Ward Co. (No. 561, Oct. 1, 1917) were a few plants that were clearly *C. humile* Hooker but along with these were a number of forms that represent intermediate steps between the two species, showing that *C. humile* was in all probability only a form growing under unfavorable conditions.

Suaeda linearis (Elliott) Moquin-Tandon. Not previously recorded from the state. Range extended greatly westward as apparently no inland stations are known for this plant. Found along border of strongly saline lakes—Holmes Lake, McLean Co. (No. 466a, Sept. 5, 1917) and Minto Lake, Walsh Co. (No. 511, Sept. 21, 1917, D. C. Mabbott).

Spergularia marina (Linnaeus) Grisebach. Frequent throughout the state, recorded from Cushion Slough, Burke Co. (No. 583, Oct. 3,

[5] Poole, Raymond I. *A study of the vegetation of the sandhills of Nebraska,* p. 287.

1917); Moon (No. 217, Aug. 3, 1917, D. C. Mabbott) and Eckelson (No. 291, August 8, 1917, D. C. Mabbott) Lakes, Barnes Co.; Addie Lake, Griggs Co.; Kellys Slough, Grand Forks Co. (No. 508, Sept. 20, 1917, D. C. Mabbott); Salt and Minto Lakes, Walsh Co. and Stump Lake, Nelson Co. Bergman records this only from Eckelson and Kulm.

Ceratophyllum demersum Linnaeus. Common throughout the state, in fresh water lakes and sloughs; observed in nineteen counties. Specimens collected from Wallace, S. 27–34 Lake, Kidder Co. (No. 302, August 16, 1917), Clear Lake, Kidder Co. (No. 323, Aug. 17, 1917) and King Slough near Bismarck, Burleigh Co. (No. 348, Aug. 24, 1917). Bergman reports this plant from Lake Ibsen and St. John.

Stanleya pinnata (Pursh) Britton. This plant has not been recorded previously east of the Missouri River, the only record for the state being along the extreme western border, namely, Medora, Billings Co., by Bolley. Specimens were observed or collected from Jim Lake, Stutsman Co. (No. 324, Aug. 14, 1917, D. C. Mabbott); Jessie Lake, Griggs Co.; Round, Brush, Doctor, Hester and Girard Lakes, McHenry Co. In the vicinity of these lakes the plants were fairly common. The first mentioned counties are far east of any other known locality and the latter, McHenry Co., is somewhat farther north than previously recorded.

Thelypodium integrifolium (Nuttall) Endlicher. Local, only found on the borders of the following alkaline lakes where it was exceedingly abundant: Big Alkali Lake, southeast of Dawson, and Sink Lake, north of Dawson, Kidder Co. (No. 221, Aug. 6, 1917). It is interesting also that the only previously known collection of this plant in the state was near Dawson, by Bolley. One of the two records above is however, slightly east and the other slightly farther north than that of Bolley so that its northeastern range has been slightly extended.

Prunus Besseyi Bailey. Not previously recorded from the state, which, however, comes within the general range of the plant as commonly given. Found only along roadside, 20 miles S. E. of Bismarck, Burleigh Co. (No. 327, Aug. 24, 1917). This plant was shown to the writer by Dr. M. R. Gilmore, Curator, State Museum of North Dakota. He stated that this was the only locality where he knew it east of the Missouri River, but that he had observed it to be fairly common west of the river.

Prunus serotina Ehrhart. Not previously reported from the state; observed only at Elsie Lake, Richland Co.

Amphicarpa Pitcheri Torrey and Gray. Not previously reported from the state; range is extended westward as manuals give S. Dakota as the extreme northwestern limit. Found along border of Mud Lake, Richland Co. (No. 136, July 24, 1917) and in Riverside Marsh, South of Mandan, Morton Co. (No. 382a, Aug. 27, 1917).

Opuntia fragilis Haworth. Found in sand hills near Lake George, Drake, McHenry Co. Bergman reports this plant from Svea and Dickinson

Cornus Amomum Miller. Not previously reported from the state; observed at Riverside Marsh, south of Mandan and also along the Missouri River, Morton Co. (Aug. 26, 27, 1917) and Strawberry Lake, McLean Co.

Arctostaphylos Uva-ursi (L.) Spreng. Found also in sand hills near Lake George, 15 miles north of Drake, McHenry Co. (No. 415, Aug. 28, 1917, D. C. Mabbott). Previously reported from three localities: Walhalla, Milton and Wogansport. Should occur also in the sand hills near Hankinson.

Utricularia minor Linnaeus. Not previously recorded from the state, although the range commonly given is exceedingly general. Very rare, found growing only in Dawson Slough, Dawson, Kidder Co. (No. 255, Aug. 9, 1917).

Aster angustus (Lindley) Torrey and Gray. [*Brachyactis angusta* (Lindley) Britton.] Rather common throughout the state, reported from 13 or more counties. Bergman records this from three localities, Fargo, Leeds and Dickinson.

Erigeron annuus (Linnaeus) Persoon. Not definitely reported previously from the state although the range as ordinarily defined covers the entire northeastern United States. One specimen found near Elsie Lake, Hankinson, Richland Co. (No. 68, July 23, 1917).

Bidens comosa (A. Gray) Wiegand. Rather common in northern part of state, especially in Rolette Co., bordering lakes. Bergman reports this plant from Fargo and Leeds.

PALEONTOLOGY.—*Some relationships of the foraminiferal fauna of the Byram calcareous marl.*[1] JOSEPH A. CUSHMAN.

Introduction

The Byram calcareous marl as it is exposed at the bridge over the Pearl River at Byram, Hinds County, Mississippi, is the type locality for this division of the lower Oligocene. The formation is mainly a sandy glauconitic marl with thin beds of impure limestone, clay and sand.

A small sample consisting of a few cubic centimeters of the marl from the type exposure was examined, and gave 68 species and varieties of Foraminifera. These are probably not all, and more will be added by continued search of material.

Notes on the fauna

Of the 68 species which I have found from Byram 27 appear to be undescribed, and 8 are recorded under the genus only

[1] Published by permission of the Director of the U. S. Geological Survey. Received February 24, 1920.

because specimens were not abundant enough for specific determination. These may be compared with the data given by Cooke,[2] who mentions 136 species of mollusks and 6 of corals, 55 of which are peculiar to the marl at Byram. Most of the species indicate that they lived in warm water at no great depth.

Distribution of a few of the species

A few of the species found in the Byram marl are especially interesting in showing relationships of this fossil fauna with those now living. Of these *Textularia folium* Parker and Jones shows this point very well.

Textularia folium Parker and Jones is known only as a living species with the following records: Mauritius, the Kerimba Archipelago off southeastern Africa; shore-sands of Melbourne, Australia; off East Moncoeur Island, Bass Strait, 38 fathoms; off Raine Island, Torres Strait, 155 fathoms; off Kandavu, Fiji, 255 fathoms; off Levuka, Fiji; Nares Harbour, Admiralty Islands, 17 fathoms; and Honolulu coral reefs, 40 fathoms. Other records are from the lagoon at Funafuti; off the coast of Victoria; off Laysan, and numerous localities off the Hawaiian Islands. Most of the records for this species are in 40 fathoms or less although a few are at somewhat greater depths. It seems to be most abundant on tropical coral reefs in the South Pacific, but as these records show, it is well scattered over the Indo-Pacific region. The finding of very typical specimens of this species in the Byram marl has led to the examination of the distribution of other species found with it. A few of these will be mentioned.

Bolivina amygdalaeformis H. B. Brady. This is known from the South Pacific, Australian, East Indian and Philippine regions at the present time.

Bolivina nitida H. B. Brady. This is a very rare species described by Brady from two *Challenger* stations off Australia, and not known elsewhere.

Polymorphina regina H. B. Brady, Parker and Jones. This is known from the Miocene of the Coastal Plain, the Calvert formation of Chesapeake Beach, Maryland, and from the Duplin

[2] This Journal 8: 197. 1918.

marl of Mayesville, South Carolina. It is unknown from the Tertiary of Europe but is a typical species in recent seas in the shallow water of the tropical and subtropical waters of the Pacific and Indian Oceans.

Discorbis sp. A peculiar species of *Discorbis* found at Byram is interesting not only because it is undescribed but because of its relationships to other species. It is probably nearest in its affinities to *D. corrugata* Millett, described from the Malay Archipelago and recorded by Heron-Allen and Earland from the Kerimba Archipelago off the southeastern coast of Africa; from the coast of Burmah; and from West Australia, thus giving it a wide Indo-Pacific range. In the characters of the ventral surface it is also related to *D. patelliformis* H. B. Brady and *D. tabernacularis* H. B. Brady, both of which are typical Indo-Pacific species. This is, then, a representative of a group now living in the shallow water of the Indo-Pacific.

Hauerina fragilissima H. B. Brady. All the known records for this species are Indo-Pacific. Brady's records are: Off Tahiti, Society Islands; off Kandavu, Fiji Islands; and the northern and southern coasts of New Guinea. Millett records it from the Malay Archipelago, and Heron-Allen and Earland from the Kerimba Archipelago off the southeastern coast of Africa. I have recorded it off the Hawaiian Islands. There are a number of very typical specimens from the marl at Byram showing again close relations of the Byram fauna with that of the Indo-Pacific.

Truncatulina sp. This shows another relation of the fauna from Byram. It is a species with peculiar lobed chambers related to two other species I recently described from the Miocene of South Carolina and Florida.

Truncatulina americana Cushman. This species is known from the Miocene of the Coastal Plain; from the upper Oligocene of the Culebra formation of the Panama Canal Zone; and appears at least in a modified form in the Byram marl.

Lepidocyclina supera Conrad. This is the largest species of the Byram marl and may be taken as the index fossil as far as the foraminifera are concerned, having been found at no other horizon. Conrad described it from the upper bed of Vicksburg which is the equivalent of the Byram marl.

Of the species to be described as new a considerable proportion are represented in the Indo-Pacific region by closely allied species.

Relationships to other lower Oligocene formations

A number of the species of the Byram marl are found also in the Mint Spring calcareous marl member of Marianna limestone, and a smaller number in the Red Bluff clay formations, which are found respectively below the Byram marl in Mississippi. Some of these are also found in Marianna limestone of Alabama and Florida.

Summary

The marl at Byram was deposited in warm (temperature, 20°–24° C.), rather shallow water (depth, 10–25 fathoms = 18 to 46 meters). Its fauna shows that the larger proportion of the species are closely related to or identical with those now living in the general Indo-Pacific region. Some of its species have persisted from the lower formations of the lower Oligocene, the Red Bluff clay, the Marianna limestone, and the Mint Spring marl member, while some of them have persisted in the Coastal Plain region, at least into the Miocene.

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.—*Lead poisoning in waterfowl.* ALEXANDER WETMORE. U. S. Dept. Agric. Bull. **793**: 1–12. Pl. 1–2. 1919.

Lead poisoning in water fowl has only recently attracted much attention. It results from the swallowing of pieces of lead in the form of shot obtained by birds in the mud of their feeding grounds. As many as 76 pellets of shot have been found in the stomach of a single duck, but 20 to 25 is the ordinary number. The poisoning results from particles of lead that have been ground away in the gizzard and passed into the intestines where they are absorbed. The most conspicuous symptom is paralysis of important muscles; and as the disease progresses, the bird becomes unable to walk, and rarely recovers. Experiments show that 6 pellets of No. 6 shot are always fatal, and sometimes death results from a single pellet in the stomach. The following waterfowl are known to have been affected in the wild state: *Anas platyrhyncha*, *Dafila acuta tzitzihoa*, *Aristonetta valisineria*, *Olor columbianus*, and *Limosa fedoa*. In addition to these, *Nyroca americana* has died from the same cause in captivity. Although some alleviation by the administering of magnesium sulphate has been noticed in the laboratory, there is really no satisfactory remedy yet known for the disease.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*A revision of the subspecies of Passerculus rostratus (Cassin).* HARRY C. OBERHOLSER. Ohio Journ. Sci. **19**: 344–354. 1919.

The large-billed sparrow, *Passerculus rostratus*, has been of much interest to ornithologists, perhaps by reason of the elusiveness of the breeding grounds of two of its races. Moreover, this bird has always presented a difficult problem for the systematist. A large amount of material has been brought together, by which three recognizable subspecies are now indicated. The typical *Passerculus rostratus rostratus*

(Cassin) breeds about the Gulf of California; *Passerculus rostratus guttatus* Lawrence, with which *Passerculus rostratus sanctorum* Ridgway is identical, nests on the San Benito Islands, Lower California; and *Passerculus rostratus halophilus*, which proves to be a perfectly good race, breeds at Abreojos Point, western Lower California. For birds so well subspecifically differentiated, the subspecies of the large-billed sparrow occupy exceedingly restricted localities. The most astonishing feature of their life history is the curious migration of at least two of the subspecies, for these travel regularly both to the north and south of their breeding grounds to winter. Such a migration is almost, if not quite, unique, for no other North American passerine bird follows even similar routes. H. C. O.

ORNITHOLOGY.—*Life histories of North American diving birds, order Pygopodes.* ARTHUR CLEVELAND BENT. Bull. U. S. Nat. Mus. **107**: 1–13, 1–245. Pls. 1–55.

The work on the life histories of North American birds begun by Major Charles E. Bendire has remained unfinished since his death. The present bulletin is intended in a sense as a continuation of Major Bendire's work, although the method of treatment is entirely changed. This first installment takes up the birds included in the families Colymbidae, Gaviidae and Alcidae. Information regarding the life histories of the species of these families is particularly desirable, since no modern work treats the North American forms with sufficient fullness. In the present contribution all the available information regarding these groups has been brought together and though original data are used in preference whenever obtainable, these are supplemented by pertinent quotations from literature. Eacn of the 36 species and subspecies is treated in detail but undue repetition is avoided. The method of treatment is decidedly modern, and facilitates reference to any kind of information desired. The account of each bird is divided into two parts, one relating to habits, the other to distribution. The data under the former are presented under the following headings: "Spring," "Courtship," "Nesting," "Eggs," "Young," "Plumages," "Food," "Behavior," "Fall," and "Winter." The distribution, given at considerable length under the headings "Breeding Range," "Winter Range," "Spring Migration," "Fall Migration," "Casual Records," and "Egg Dates," reflects the present knowledge of this important subject. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The birds* [*of Glacier National Park*]. FLORENCE MERRIAM BAILEY. Wild Animals of Glacier National Park, 103–199. 1918.

This is the final report to which the previously published list of the birds of Glacier National Park was but preliminary. The introductory matter consists of general information regarding the altitudinal distribution of birds in the Park, together with a key to the commoner summer residents. In the main body of the text, the 187 birds now known from the Park are treated in systematic sequence. Brief descriptions are given of some species, but the annotations consist chiefly of remarks on habits, records of occurrence, and distribution in the Park. The accounts of some birds, such as *Histrionicus histrionicus pacificus*, *Lagopus leucurus altipetens*, *Pandion haliaetus carolinensis*, *Seiurus noveboracensis notabilis*, and *Cinclus mexicanus unicolor*, are somewhat extended. The illustrations consist of 15 full page plates and numerous smaller figures, all in black and white.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on Dr. W. L. Abbott's second collection of birds from Simalur Island, western Sumatra.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. **55**: 473–498. 1919.

Simalur Island lies somewhat less than 100 miles off the western coast of Sumatra, and about 200 miles from its northwestern end. The collection here discussed was made by Dr. W. L. Abbott in 1902, and consists of 70 specimens, representing 38 species. Two species are actual additions to the avifauna of the island, and these, together with those previously known, make a total of 79 now known to occur on Simalur Island. In this annotated list the data from Dr. Abbott's specimens and various critical notes are given. A number of forms from Simalur Island originally described as species are treated here as subspecific forms because found to be connected by individual variation with the typical races of their respective species. A re-examination of the *Ramphalcyon javana* case indicates that the identification of the original description of this bird with the Philippine race is unwarranted, and that *Ramphalcyon javana* should still remain the name for the Bornean race. Only one new subspecies is here described, an interesting new rail, *Hypotaenidia striata reliqua*. H. C. O.

ORNITHOLOGY.—*Winter birds of East Goose Creek, Florida.* R. W. WILLIAMS. Auk **36**: 45–56. 1919.

Field observations carried on in November, 1917, on East Goose Creek, Wakulla County, Florida, a narrow neck of shallow water situated twenty-five miles southwest of Tallahassee, show this locality to be an excellent one for birds. The present list of 90 species and subspecies, combined with a similar list previously made by Ludlow Griscom, makes a total of 111 species recorded in this immediate vicinity during the months of November and December alone. The annotations of the present list consist chiefly of remarks on habits and the local distribution of the various forms. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Mutanda ornithologica. VII.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **32**: 127–128. June 27, 1919.

The names of the following four species of South American birds require to be changed because their present designations are preoccupied by earlier homonyms. The species known as *Attila cinereus* (Gmelin), therefore, becomes *Attila rufus* Lafresnaye; *Knipolegus comatus* (Lichtenstein) must stand as *Knipolegus lophotes* Boie; *Euscarthmus gularis* (Temminck) becomes *Euscarthmus rufilatus* (Hartlaub); and *Mimus lividus* (Lichtenstein) must bear the new name *Mimus antelius.* Moreover, the Chilean bird now known as *Curaeus aterrimus* (Kittlitz) has an earlier name and must stand as *Curaeus curaeus* (Molina).

H. C. O.

ORNITHOLOGY.—*Notes on North American birds. VIII.* HARRY C. OBERHOLSER. Auk. **36**: 406–408. July, 1919.

Investigation of the relationships of *Anthus rubescens* (Tunstall) proves that it is clearly but a subspecies of the Old World *Anthus spinoletta*, and its name, therefore, should be *Anthus spinoletta rubescens* (Tunstall). The Alaskan *Acanthopneuste borealis kennicotti* (Baird), although not recognized by most recent authors, proves to be undoubtedly a good subspecies, differing from *Acanthopneuste borealis borealis* in its somewhat smaller size and more grayish upper parts. Although *Salpinctes guadeloupensis* Ridgway was originally described as a subspecies of *Salpinctes obsoletus*, it is commonly considered a distinct species. A careful study of a large series of this and related forms unquestionably substantiates Mr. Ridgway's opinion in regard to its subspecific relationship. In all characters the two birds completely inosculate, wherefore the Guadaloupe Island race should stand as *Salpinctes obsoletus guadeloupensis* Ridgway; and the form described as *Salpinctes guadeloupensis proximus* Swarth should become also a subspecies of *Salpinctes obsoletus*. H. C. O.

ORNITHOLOGY.—*Washington region [April to May, 1918]*. HARRY C. OBERHOLSER. Bird-Lore 20: 303–305.

The height of the spring migration of birds at Washington is ordinarily from May 10 to 15. The spring of 1918 was an unusually good season for birds, although some species were remarkably scarce, notably *Thryothorus ludovicianus*, *Tringa solitaria solitaria*, and *Iliornis flavipes*. On the other hand, many were more than ordinarily numerous, such as *Vermivora peregrina*, *Dendroica castanea*, *Hylocichla ustulata swainsoni*, and *Larus philadelphia*. Several ducks lingered later in the spring than ever before; and *Rallus virginianus* until May 11, more than a month later than its previous latest date—April 6, 1892. Although some species were late in putting in their appearance, a number of arrivals were earlier than previously known. In the latter category are *Seiurus motacilla*, *Riparia riparia riparia*, *Melospiza lincolnii lincolnii*, *Passerina cyanea*, *Vireosylva philadelphica*, *Protonotaria citrea*, *Peucaea aestivalis bachmanii*, and *Sterna caspia*. H. C. O.

ORNITHOLOGY.—*The races of the Nicobar megapode, Megapodius nicobariensis* Blyth. HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. 55: 399–402. 1919.

The Nicobar megapode, *Megapodius nicobariensis*, is of interest as marking the extreme western limit of the geographic range of the Megapodiidae. Its distribution is limited to the Nicobar Islands; and it is apparently divisible into two subspecies. The birds inhabiting the southern islands of this group differ from those from more northern localities in their darker coloration, and will therefore stand as a new subspecies, *Megapodius nicobariensis abbotti*. H. C. O.

ORNITHOLOGY.—*The geographic races of Hedymeles melanocephalus* Swainson. HARRY C. OBERHOLSER. Auk 36: 408–416. July, 1919.

The separation of *Hedymeles melanocephalus* into two subspecies was originally made on the basis of the differences existing between the birds of California and those of the Rocky Mountain region of the United

States. It has been found, however, that the birds breeding in Mexico are referable to the California race. Since, therefore, the species was described from Mexico, it becomes necessary to unite the Mexican birds with those of California under the name *Hedymeles melanocephalus melanocephalus*, of which *Hedymeles melanocephalus capitalis* Baird becomes, therefore, a synonym. The breeding bird from the Rocky Mountains of the United States and southwestern Saskatchewan, which differs from the typical race in its larger size, particularly of the bill, becomes, therefore, unnamed, and is here christened *Hedymeles melanocephalus papago*. H. C. O.

ORNITHOLOGY.—*The status of the subgenus Sieberocitta* Coues. HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **32**: 135–137. 1919.

The subgeneric group *Sieberocitta* was originally proposed for *Aphelocoma sieberii* and its subspecies. This species proves to be structurally different from its allies in the genus *Aphelocoma*, but since it is connected by an intermediate, *Aphelocoma unicolor*, it must be separated as a subgenus instead of a distinct genus, to include *Aphelocoma sieberii* and *Aphelocoma unicolor*, together with their subspecies. It is an excellent example of the real difference between a genus and a subgenus, for here two groups which are well characterized by structural differences are connected by a species that is perfectly intermediate. H. C. O.

ORNITHOLOGY.—*Description of a new red-winged blackbird from Texas*. HARRY C. OBERHOLSER. Wilson Bull. **31**: 20–23. March, 1919.

A previously unrecognized subspecies of *Agelaius phoeniceus* from northern Texas is here named *Agelaius phoeniceus megapotamus*. It differs from *Agelaius phoeniceus richmondi* in its larger size, and, in the female, in more grayish coloration. It ranges from central southern Texas to northeastern Mexico. H. C. O.

ORNITHOLOGY.—*Another purple martin roost in the City of Washington*. HARRY C. OBERHOLSER. Bird-Lore **21**: 96–99. 1919.

The behavior of birds at their roosting places is a matter of considerable biological interest. The location of the roost of *Progne subis* was changed in 1918 to the vicinity of the Red Cross Building, where it was under observation from July 19 to August 24, after which date the birds took up their nightly abode on the edge of the Capitol grounds. The number of birds present at the Red Cross roost reached about 35,000 on August 9, but subsequently there was a gradual diminution. Smaller numbers of *Quiscalus quiscula quiscula*, *Sturnus vulgaris vulgaris*, and *Riparia riparia riparia* roosted at times with the martins or in their immediate vicinity. H. C. O.

ANALYTICAL CHEMISTRY.—*The hydrochloric acid color method for determining iron.* J. C. HOSTETTER. Journ. Amer. Chem. Soc., **41**: 1531–1543. Oct., 1919. (Geophysical Lab. Papers on Optical Glass, No. 17.)

Conditions have been found under which the yellow color developed by dissolving ferric iron in hydrochloric acid may be used for the determination of iron. The temperature coefficient for this color varies from 2 to 3 per cent per degree, depending on the concentration of iron and probably also on the acidity. The color developed by a given amount of iron varies with the acid concentration, reaching the maximum intensity at from 26 to 28 per cent HCl. The relative increase produced by acid is greater the higher the concentration of iron; this is especially true above 20 per cent HCl, but below this concentration the relative change is independent of the iron content. Inasmuch as solutions must frequently be boiled in order to insure the complete solution of iron present as "scale," the use of constant-boiling acid is recommended and its use has been found to be altogether satisfactory. The effects of salts on the color indicate that sulfates cause bleaching and chlorides intensification; detailed study of the effect of the very soluble calcium chloride shows that an intensification of 2.5 may be attained by the addition of this salt; consequently, when testing for iron in a very soluble chloride the standard iron solution must be made up to possess the same salt concentration. Some applications of the method are given and some results are presented. J. C. H.

ANALYTICAL CHEMISTRY.—*A method for determination of the volatile matter in oxides of lead.* OLAF ANDERSEN. Journ. Amer. Ceram. Soc., **2**: 782–783. Oct., 1919. (Geophysical Lab. Papers on Optical Glass, No. 18.)

The amount of volatile constituents in a sample of litharge or other oxide of lead can be accurately determined by conversion of the PbO into $PbSiO_3$. The sample is mixed with a weighed quantity of silica, equal to about one-third the weight of the PbO; heated in a platinum crucible in an electric furnace at 800° to form lead silicate glass; quickly raised to 1000° for a few minutes; cooled and weighed. O. A.

PHYSICAL CHEMISTRY.—*The term "inversion."* J. B. FERGUSON. Science **50**: 544–546. December 12, 1919.

The diversity among the phenomena which are referred to by the name "inversion" is so great that at present the word has lost any precise meaning which it may have had in the past. In this paper the suggestion is made that inorganic chemists confine the word *inversion* to solid single-phase phenomena such as the change of rhombic to monoclinic sulfur, and the term *transition* to phenomena such as an incongruent melting, instead of the present synonymous use of these terms for all these phenomena. J. B. F.

GEOLOGY.—*Artesian waters in the vicinity of the Black Hills, South Dakota.* N. H. DARTON. U. S. Geol. Survey, Water-Supply Paper **428**. Pp. 64, pls. 13, figs. 11. 1918.

In the arid plains surrounding the Black Hills of South Dakota the matter of water supply is one of the most important questions. Surface waters in streams, springs, and shallow wells are meager in volume, and in most places considerably mineralized. Fortunately the area is underlain by water-bearing sandstones which receive water at their outcrops in the Black Hills and will yield it when tapped by wells. In order to ascertain the position of these sandstones and to delimit the area of flow the geology of the region has been studied in considerable detail, and the results are set forth in this report. The general structure is a monocline dipping away from the Black Hills, and the water-bearing Dakota, Lakota, Minnelusa, and Deadwood sandstones lie at various distances beneath the surface of the plains. The stratigraphy of the various formations from Cambrian to Tertiary is described in considerable detail, and in maps and cross-sections the underground relations of the water-bearing sandstones are indicated. An account is given of all deep wells and borings in the region, and a resumé is presented as to the conditions and prospects in the various districts. N. H. D.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BOTANICAL SOCIETY OF WASHINGTON

137TH MEETING

The 137th regular meeting of the Botanical Society of Washington was held at the Cosmos Club at 8 p.m., October 7, 1919. Thirty-five members were present. The following paper was presented:

JOHN A. STEVENSON: *Some botanical aspects of Porto Rico.*

Porto Rico is essentially tropical, lying approximately in 18° 15′ N. latitude. The mean average temperature is 78° F. The rainfall varies greatly, from 135 inches in the east to as low as 20 inches on the south coast, with an average of 76 inches. The island is very rugged, a central range running from east to west, reaching heights of not over 4500 feet. The soil is typically a heavy red clay.

At the time of its discovery (1493) it was heavily wooded, but with the rapid agricultural development that took place, was soon practically denuded. Practically all that now remains of the original cover is the small area included in the Luquillo National Forest. Most of the island is devoted to sugar cane, tobacco, fruit, coffee, and pasture.

Of botanical formations there are notably the coastal mangrove swamps composed chiefly of *Rhizophora*, *Languncularia*, *Avicennia*, the dry coastal areas grown up to *Coccolobis* and various other shrubs, the limestone hills or foot-hill formation, composed of *Psidium*, *Casearia* spp., many species of Melastomaceae, and other shrubs or small trees. The rain forest (Luquillo) is of limited area, marked by tree ferns, mountain palm, and large growing hardwoods (*Sideroxylon*, etc.). On the dry south coast an open park-like growth occurs, particularly marked by shrubby leguminous plants (chaparral) and various cacti.

Following the temporary use of much of the land by peasant farmers a second growth of shrubs springs up (*Eugenia jambos*, *Casearia* spp., *Psidium*, many melastomaceous species and others). Coffee plantations in the uplands are extensive, forming a forest type, with *Inga* spp. and *Erythrinia* spp. as shade. Coconut plantations occur along the coast. The phanerogamic flora consists of about 2400 species, the fungus flora of at least 1500 species, with other groups in proportion.

19TH ANNUAL MEETING

The 19th annual meeting of the Society was also held at the Cosmos Club on October 7, 1919. The following officers were elected for the ensuing year: *President*, HAVEN METCALF; *Vice-President*, A. J. PIETERS; *Recording Secretary*, CHAS. E. CHAMBLISS; *Corresponding Secretary*, R. KENT BEATTIE; *Treasurer*, L. L. HARTER. L. H. DEWEY was nominated as Vice-President to represent the Society in the ACADEMY.

138TH MEETING

The 138th regular meeting was held at the Cosmos Club, at 8 p.m., November 4, 1919. Ninety members and five guests were present.

An illustrated paper on *The vegetation of New Zealand* was read by Mr. A. D. Cockayne, Biologist of the Department of Agriculture, Industries and Commerce of New Zealand.

The speaker described New Zealand as being composed of two main islands located in the South Pacific between latitudes 43° and 33° S., being about the size of the State of Wyoming. He described fifteen principal botanical regions, noting in considerable detail the great variation in the vegetation. The temperate rain forests, the beech forests and the grass lands are the most important vegetation types. The rain forests abound in dense vegetation, including tree ferns; the beech forests are dominated by a species of *Nothofagus;* the grass lands are tussock lands and not prairies.

The land presents every elevation from sea-level to over 13,000 feet, and every rainfall from 14 inches to 150 inches. One-third of the area of the islands is in farm lands. The agriculture centers around stock production and animal products, because of the distance to outside markets.

New Zealand is preserving large areas of natural parks, containing her most interesting vegetation, much of which is not open to tourists.

139TH MEETING

The 139th regular meeting was held at the Cosmos Club at 8 p.m., December 2, 1919. Fifty members and four guests were present. Mr. W. S. Fields, of the Federal Horticultural Board, and Mr. C. C. Thomas, of the Bureau of Plant Industry, U. S. Department of Agriculture, were elected to membership.

In a paper entitled *Mycorrhiza, Cytrids and related fungi in the roots of our common economic plants,* Mr. E. G. Arzberger described, with the aid of lantern slides, numerous organisms belonging to the little-known group of endophytic fungi that are found abundantly in the growing parts of the roots of all cereals, the important grasses, cotton, tobacco, forage crop plants, hemp, flax and some truck crops.

Mr. L. O. Kunkel in a paper entitled *Wart of potato* gave the history of the discovery of this disease in the United States and described the great damage done by it to the potato crop in the British Isles and other European countries. In his variety tests for resistance to this disease, he found that our best commercial varieties seemed to be immune, and that several varieties of tomatoes were quite susceptible to the wart.

140TH MEETING

The 140th regular meeting was held at the Cosmos Club at 8 p.m., January 6, 1920. One hundred members and ten guests were present.

In a paper entitled *Parks and gardens of Buenos Aires,* Prof. F. Lamson-Scribner described with the aid of many beautiful lantern slides this great metropolis of South America as a city of broad avenues and shaded boulevards and of beautiful parks and squares, varying in size from parks of two or three acres to the great Palermo Park, containing approximately one thousand acres. Palermo Park is to Buenos Aires what Bois de Bologne is to Paris, Central Park to New York and Golden Gate to San Francisco. It contains many drives and walks and a number of small lakes and an excellent restaurant. Many kinds of trees have been planted along the drives and about the miniature lakes, and evidently much time has been given to the development of pleasing landscape effects.

Within the Botanical Gardens have been assembled plants from all parts of the world. It was planned and directed by Dr. THAYS and will stand as an everlasting monument to him as a scientist and landscape gardener. Some of the plants are only decorative, but for the most part the plants and trees have an economic value, or a scientific interest. There are groups of medical plants, oleaginous species and fiber plants, narcotic plants and also many valued for their perfume. There are collections of palms, bamboos and cacti, coniferous species and grasses, totaling more than 3500 species.

Dr. DAVID GRIFFITH read a paper entitled *Experiments in bulb culture*, in which he described the various phases of the bulb investigations conducted by the U. S. Department of Agriculture at Bellingham, in the State of Washington, and Arlington Farm, Virginia, using many lantern slides to illustrate the methods of planting, harvesting, storing and shipping. The illustrations also showed the bulb plots in bloom and the results obtained in the production of various varieties of Dutch bulbs, lilies, etc.

CHAS. E. CHAMBLISS, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

THE FEDERAL BOARD OF SURVEYS AND MAPS

Acting on the report of the map-making conference which was held in September, 1919,[1] the President of the United States issued an Executive order on December 30, 1919, creating a "Board of Surveys and Maps of the Federal Government," to be composed of one representative from each of certain Federal organizations, as follows: (1) Corps of Engineers, U. S. Army (Col. C. O. SHERRILL); (2) U. S. Coast and Geodetic Survey (WILLIAM BOWIE); (3) U. S. Geological Survey (C. H. BIRDSEYE); (4) General Land Office (FRANK BOND); (5) Topographic Branch, Postoffice Department (J. H. ROBINSON); (6) Bureau of Soils (C. F. MARBUT); (7) U. S. Reclamation Service (E. C. BEBB); (8) Bureau of Public Roads (C. D. CURTIS); (9) Bureau of Indian Affairs (W. M. REED); (10) Mississippi River Commission (R. L. FARIS); (11) U. S. Lake Survey (F. G. RAY); (12) International (Canadian) Boundary Commission (J. H. VAN WAGENEN); (13) Forest Service (O. C. MERRILL); (14) U. S. Hydrographic Office, Navy Department (G. W. LITTLEHALES). These representatives were appointed by the chiefs of the several organizations named.

The Board is directed by Executive order to make recommendations to the several departments of the Government or to the President for the purpose of coordinating the map-making and surveying activities of the Government and to settle all questions at issue between the executive departments relating to surveys and maps, in so far as their decisions do not conflict with existing law. The Executive order also directs that the Board shall hold meetings at stated intervals, to which representatives of the map-using public shall be invited for the purpose of conference and advice; and that the Board shall establish a central information office at the U. S. Geological Survey for the purpose of collecting, classifying, and furnishing to the public, information concerning all map and survey data available in the several government departments and from other sources.

All government departments are directed by the Executive order to make full use of the Board of Surveys and Maps as an advisory body and to furnish all available information and data called for by the Board.

So much of the Executive order of August 10, 1916, as grants additional advisory powers to the U. S. Geographic Board, is rescinded and these additional powers are transferred to the Board of Surveys and Maps. The Executive order in question had granted to the U. S. Geographic Board advisory powers concerning the preparation of maps

[1] See this JOURNAL, **9**: 605–607. 1919.

compiled or to be compiled in the various bureaus and offices of the Government, with a special view to the avoidance of unnecessary duplication of work; and for the unification and improvement of the scales of maps, of the symbols and conventions used upon them, and of the methods of representing relief.

The representatives of the Federal organizations mentioned above met early in January to perfect an organization, and adopted by-laws and methods of procedure on January 16, 1920. The officers elected for 1920 are: *Chairman*, O. C. MERRILL, Chief Engineer of the Forest Service; *Vice-Chairman*, WILLIAM BOWIE, Chief of the Division of Geodesy, U. S. Coast and Geodetic Survey; *Secretary*, C. H. BIRDSEYE, Chief Geographer, U. S. Geological Survey.

The by-laws provide for a number of standing committees, whose duties are to care for the various phases of the problem of surveying and map-making. These committees, with their chairmen, are as follows: (1) Executive, O. C. MERRILL; (2) Coordination, C. O. SHERRILL; (3) Cooperation, FRANK BOND; (4) Technical Standards, W. M. REED; (5) Topographic Maps, E. C. BEBB; (6) Highway Maps, C. D. CURTIS; (7) General Maps, J. H. ROBINSON; (8) Hydrographic Charts, R. L. FARIS; (9) Control, WILLIAM BOWIE; (10) Photographic Surveying, E. H. MARKS; (11) Information, C. H. BIRDSEYE.

Each committee is composed of five members who are representatives on the Board of Surveys and Maps or are other officials of the organizations having representation on the Board. There will be appointed representatives of organizations interested in surveying and mapping which are outside of the Federal Government, on each of the committees except the Executive Committee and the Photographic Surveying Committee.

The Map Information Office was organized, with headquarters at the U. S. Geological Survey, as directed by the Executive order. The Office is in charge of J. H. WHEAT, of the Geological Survey.

The first stated public meeting of the Board of Surveys and Maps was held on March 9, 1920, at the auditorium of the Interior Department. Stated public meetings will be held on the second Tuesday of January, March, May, September and November of each year. There will be held executive meetings immediately after the stated public meetings and also on the second Tuesday of February, April, October and December. No regular meetings will be held during the months of June, July and August. W. B.

NOTES

As the result of a conference held on February 24, the Bureau of Public Roads has begun the standardization of tests and specifications under which highway testing engineers in most of the States will work. Confusion and difficulties have arisen in the past from the use in different States of varying tests of the materials used in road construction.

A new outline base map of the United States on the Lambert zenithal equal-area projection, scale 1 : 7,500,000, has been issued by the U. S.

Coast and Geodetic Survey. This is the first publication of a projection of this type by the Survey. Besides its useful property of equal area, the projection has smaller scale and direction errors than the polyconic projection map which has been used frequently for political, census, or statistical purposes.

Mr. A. C. BENT, of Taunton, Massachusetts, visited the Division of Birds of the National Museum on February 25–27, for the purpose of picking out eggs to illustrate the second volume of his work on the life histories of North American birds.

The term of office of Surgeon General RUPERT BLUE expired by law on January 15. Dr. HUGH S. CUMMING, of Hampton, Virginia, was nominated as his successor, and the nomination was confirmed by the Senate on February 24, 1920. Dr. Blue will remain with the Public Health Service and will continue his research work on influenza and allied problems.

Mr. C. F. BOWEN, former geologist of the U. S. Geological Survey, has been appointed chief geologist of the Standard Oil Company of New Jersey.

Mr. WILLIAM BAYLES COFFMAN, assistant classifier in the Water Resources Branch, U. S. Geological Survey, died at Emergency Hospital on January 21, 1920, in his twenty-fifth year. He had been with the Survey since December, 1917.

Dr. C. WYTHE COOKE, of the U. S. Geological Survey, has been granted leave of absence to accompany Mr. O. B. HOPKINS, of the Imperial Oil Company, on a six months' trip to Colombia.

Dr. ALLERTON S. CUSHMAN, of the Institute of Industrial Research, will deliver the 1920 course of lectures on "*Chemistry and civilization*" under the Richard B. Westbrook Foundation at the Wagner Free Institute of Science, of Philadelphia.

Dr. ARTHUR L. DAY, director of the Geophysical Laboratory, Carnegie Institution of Washington, who has been on leave of absence since October 1, 1918, returned to Washington to resume active charge of the Laboratory on April 1, 1920.

A unique addition to the exhibit of vertebrate fossils at the National Museum has recently been made in the form of three beautifully preserved skulls of an extinct peccary, collected by Mr. J. W. GIDLEY from a cave near Cumberland, Maryland.

Mr. CHARLES S. GRINDLE, examiner of interferences in the Patent Office, has resigned to become a member of the patent law firm of Watson, Coit, Morse and Grindle (formerly Foster, Freeman, Watson and Coit) with offices at 916 G Street.

Mr. D. F. HEWETT, of the U. S. Geological Survey, will spend three months in private work in Cuba while on leave from the Survey.

Prof. A. S. Hitchcock of the Division of Plants, U. S. National Museum, returned from British Guiana on February 17. He left Washington, October 1, 1919. Collections were made at many of the West Indian Islands. Collections of all the flowering plants and ferns were made, though special attention was given to the grasses. Over 1100 numbers were obtained, including 108 sets of grasses.

Mr. O. B. Hopkins, geologist of the U. S. Geological Survey, specializing in oil investigations, has resigned to accept a position as geologist with the Imperial Oil Company, of Toronto.

Mr. Hennen Jennings, retired mining engineer, died at his home, 2221 Massachusetts Avenue, on March 5, 1920, in his sixty-sixth year. Mr. Jennings was born at Hawesville, Kentucky, May 6, 1854. After graduation from the Lawrence Scientific School of Harvard University, he took up mining engineering. His principal work was in South Africa, where he was connected with mining companies from 1879 until 1905. He had been a resident of Washington since 1906. He was a member of the Archaeological, Engineers', and Historical Societies, and had been a member of the Academy since 1916.

A noteworthy accession to the diatom collection of the National Museum is from the Lompoc California deposit, sent by Dr. David Starr Jordan, for a study of the physical conditions connected with the fossil remains of vast quantities of herring embedded in the diatom material of this deposit.

Mr. Robert W. Pack, formerly oil geologist of the U. S. Geological Survey, has been appointed chief geologist of the Sun Company, at Dallas, Texas.

Prof. W. H. Shiedler, of Miami University, is spending three months in the study of the fossil bryozoa of the Division of Paleontology, U. S. National Museum.

Mr. George W. Spier, who has been associated for many years with the watch-making industry, has been appointed Honorary Custodian of Watches at the National Museum. Mr. Spier plans to arrange an exhibit, showing the developments in the watch-making art in the United States and incidentally showing the development of the individual mechanisms which enter into a watch movement.

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CHEMISTRY.—*Determining soil acidity and alkalinity by indicators in the field.*[1] EDGAR T. WHERRY, Washington, D. C.

About a year ago the writer[2] recorded a series of tests on soil acidity and alkalinity made by the indicator method[3] in the laboratory, the soil samples having been collected from stations where forty species of native orchids grew. These samples exhibited such characteristic differences in reaction that it seemed worth while to study other groups of plants in a similar manner. The bringing in of samples of soil in sufficient number to make the results significant would have involved, however, carrying numerous containers on field trips. It was, therefore, decided to work out a method for applying the tests in the field, so that only a few bottles of indicator solutions would have to be carried along.

The following outfit proved to fill the requirements.[4] First, a rectangular box about 3.5 × 5 × 9 cm. in dimensions. In the box, six vials for the indicators, 1.5 × 5.5 cm., capacity 8 cc., each provided with a cork or rubber stopper, into which is inserted a glass rod flush with the top of the stopper, and extending nearly to the bottom of the vial; to prevent undue compression upon inserting the stoppers, a groove may be cut in the side of each, so as to reach nearly to the lip of the vial. Then, three or four vials in which to extract the soils, about

[1] Received February 5, 1920.

[2] This JOURNAL 8: 589. 1918.

[3] CLARK and LUBS. Journ. Bacteriology 2: 1. 1917. GILLESPIE. This JOURNAL 6: 7. 1916.

[4] Sets of indicators similar to that here described are for sale by the La Motte Chemical Products Co., 13 W. Saratoga St., Baltimore, Md.

2 × 5 cm., made of heavy glass, to prevent undue breakage; a container for water, which may conveniently be a screw-capped jar holding 200 cc. or more, or an aluminum canteen: and a pipette, most simply constructed of two pieces of glass tubing a few cm. in length, connected by a rubber tube.

The six indicators which have proved most satisfactory in work with soils are: bromphenol blue, bromcresol purple, bromthymol blue, phenol red, methyl red, and *o*-cresolphthalein or phenolphthalein. The first three are used, as recommended by Clark and Lubs[5], in about a 1 per cent solution in water, titrated with dilute sodium hydroxide to their intermediate colors; and the phenol red in a 0.5 per cent solution similarly titrated. The methyl red and phenolphthalein are used as 0.02 per cent solutions in 50 per cent alcohol. It should be noted here that litmus paper, which is often recommended for testing soil reaction, is much less sensitive than the above indicators, and may give misleading results.[6]

Most of these indicators are dichroic, showing different colors as viewed by reflected and by transmitted light, and in the writer's paper, above referred to, several of their colors were rather inaptly characterized. In the new table here the former descriptions have been improved upon, the colors given being those produced by adding a drop of each indicator solution to a few cc. each of buffer solutions with different reactions, as seen through a 1 cm. layer against a white background. It has also seemed desirable to add the numbers assigned to the various colors in Ridgway's *Color Standards;* although in two cases, bromophenol blue in liquid of specific acidity 1000, and bromcresol purple in that of specific acidity 10, the colors are nondescript and cannot be accurately placed.

The special terms used in this table to describe the reactions have recently been defined by the writer.[7] By way of summary it may be stated here that the specific acidity is the amount of acid present in a given solution, as measured by hydrogen ion,

[5] Journ. Bacteriology **2**: 135. 1917.

[6] Gillespie and Wise. Journ. Amer. Chem. Soc. **40**: 796. 1918.

[7] This Journal **9**: 305. 1919.

with reference to that of water as a unit.[8] Correspondingly, specific alkalinity is the amount of alkali, as measured by the hydroxyl ion, the unit being the same. Specific acidity and alkalinity numbers can be readily transposed into P_H values by anyone preferring that mode of statement. Find the power of 10 corresponding to the number; if acid, subtract from 7; if alkaline, add 7; the result is the P_H.

Under the most favorable conditions it is possible by the indicator method to measure acidity and alkalinity with much greater precision than is here attempted. By treating the indicators with buffer solutions of known ionic concentration, many hues intermediate between those here tabulated can be distinguished. On comparing the colors thus produced with those developed by mixing clarified soil extracts with the same indicators, specific acidities differing by a factor of $\sqrt[5]{10}$ or 1.59 (P_H = 0.2) can be recognized. In the field, where it is inconvenient to carry buffer solutions to prepare standards for comparison, and where the turbidity of soil extracts is difficult to remove, it is impracticable to work closer than values differing by a factor of $\sqrt{10}$ or 3.16 (P_H = 0.5) which is rounded off for simplicity to 3 +. This degree of precision is, however, entirely adequate for the purpose in view, for it has been repeatedly found that from one to another plant of the same species, or indeed, from one to another root on the same individual, separate observations of reaction may differ by a factor of 10 or more. To give a specific example, a plant of *Rhododendron maximum* growing in glacial drift near Williamsport, Pennsylvania, was found to have some of its roots in soil with a specific acidity of 1 (neutral), and other roots in soils with acidities of 3, 10 and 30. It seems obvious that nothing would be gained by measuring the acidity on any one of these to a high degree of precision, when the soils around the plant as a whole varied by a factor of 30.

[8] Only acidity in this sense is considered here; the effect variously termed latent, potential or negative acidity, and often shrouded in mystery by writers who fail to appreciate the significance of adsorption and other physical-chemical phenomena, has no bearing on the problem in hand.

TABLE I.

CLASSIFICATION OF SOIL REACTIONS AND INDICATORS.

	← ACID							NEUTRAL	ALKALINE →						
Specific reactions.....	3000+	1000	300+	100	30+	10	3+	1	3+	10	30+	100	300+	1000	3000+
P_H values.....	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5
Descriptive terms........	superacid		mediacid		subacid		minimacid (circumneutral)	minimalkaline (circumneutral)		subalkaline		medialkaline		superalkaline	
Typical soils...		← bog-peat →		← upland-peat →			← leaf-mold →		← limestone-soil →				← "alkali"-soil →		
Bromphenol blue.........	dull green, 23k	brown-green	violet, 59	→											
Methyl red.....			← violet-red, 67	red, 1	orange, 11	yellow, 23	→								
Bromcresol purple.......				←	yellow 21	brown-green	violet-red, 69'''	purple, 63	→						
Bromthymol blue..					←	yellow, 21	green-yellow 27	green, 35	blue, 49	→					
Phenol red.....						←	yellow, 23	orange-ylw. 17	orange 11	red 1	violet-red, 69	→			
Phenolphthalein....									←	white	pale pink, 69 f	deep pink, 69 d	violet-red, 67	→	

In accordance with the above considerations, a simplification of the procedure previously recommended has been adopted; modifications may still be desirable in special cases. But before giving the directions, a word should be added concerning the water used for mixing with the soil. If calcium bicarbonate is present in this water, the soil acidity will be diminished; while if neutral salts, such as sodium chloride, and especially calcium sulfate, are present in any considerable amount, the acidity will be appreciably increased. The former effect is a direct neutralization; but the latter is due to the fact that the clay and the humus[9] in the soil adsorb the basic elements from neutral salts, and set the acid free.[10] In the laboratory, distilled water can be used, and to attain the greatest precision, air freed from carbon dioxide can be blown through it until it reacts quite neutral; when one is traveling, distilled water can usually be purchased from a drug store, and will give satisfactory results without special purification. In the wilds the best that can be done is to obtain spring or well water rising through rocks as free as possible from soluble constituents—such rocks as sandstone, shale or schist. In calcareous regions it may be necessary to test waters from one source after another until a sample is found which reacts neutral—is colored green by a drop of bromthymol blue indicator—and to arrange the trip so that the water supply can from time to time be replenished from this source.

With these points in mind, the following approximate directions have been drawn up:

A sample of soil a gram or two in weight is shaken from living roots into an empty vial, and 5 cc. of the most nearly neutral and salt-free water available is added, the vial being shaken well to insure complete mixing. After the soil and water are thoroughly mixed, the solid matter may be compacted with a glass rod or a stick, and the vial then supported at an angle of

[9] GILLESPIE and WISE, *op. cit.*

[10] This is, of course, the reason that the so-called lime-requirement methods in which a neutral salt solution is mixed with a soil yield so much higher results than can be obtained by direct titration of water extracts of the soils.

45° and allowed to stand until the bulk of the suspended matter has settled. The more or less clear liquid is then decanted or pipetted off into another vial, a drop or two of bromthymol blue or one of the other indicators, the color changes of which occur near the neutral portion of the table, are added, and the color assumed is noted. If either of the extreme colors is shown, the process is repeated with the indicator whose color changes come next in the corresponding direction; and this is continued until either an intermediate color of one indicator, or opposing extremes of two overlapping ones, are obtained, whereupon the specific acidity or alkalinity can be read off from the table.

The more turbid the liquid, the more indicator must be added, and the less certain are the results obtained. The turbidity can, of course, be removed by the addition of coagulating agents or by filtration through paper; but it is essential to make certain that these do not in themselves show an acid or an alkaline reaction. The most satisfactory results of all can be obtained by running a quantity of the soil through a paper filter until two successive portions yield the same value when tested with indicators. But such procedures are more suited to laboratory than to field studies, and after a little experience one can tell the indicator color-change with certainty, even in the presence of considerable brown mud.

To illustrate the procedure followed in actual practice, two typical cases encountered by the writer may be cited here.

(1) A black soil in pockets in limestone rock, supporting spleenwort ferns, was treated as above, and on testing the soil extract with bromthymol blue indicator, a strong blue color was obtained; reference to the table showed that the reaction must be alkaline, and the value of specific alkalinity 3 or more (P_H = 7.5). The process was repeated with the indicator the color changes of which lay next toward the alkaline side of the table, namely, phenol red. With this indicator a clear red color was obtained, showing the reaction to be actually specific alkalinity 10 (P_H = 8.0).

(2) Soil from a dry blueberry thicket was tested, and, since upland peat is usually distinctly acid, the first indicator tried

was bromcresol purple, the color changes of which occur just to the acid side of the neutral point; with this indicator a yellow color was obtained, indicating a specific acidity of at least 30. The soil was accordingly tried again with methyl red, which lies next toward the acid side, and this gave a violet-red color, corresponding to a specific acidity of 300 o1 more. It was accordingly necessary to try an indicator working at still higher acidities, namely bromphenol blue; and this yielded a violet color, indicating 300 or less. The last two indicators agreed, then, in fixing the reaction of this soil as: specific acidity 300 ($P_H = 4.5$).

In spite of certain limitations, this method is capable of giving definite information as to soil reaction in many cases. And the results obtained by the writer on a number of species of native plants, to be described shortly in other communications, have been of such significance that the method is now published for the benefit of students of plant distribution and others interested in soil acidity and alkalinity.

RADIOTELEGRAPHY.—*Musical reception with continuous waves without local oscillations.* L. W. AUSTIN, U. S. Naval Radio Research Laboratory.

The principle of what is now known as the slipping contact detector or ticker, was first applied to the detection of direct currents with the telephone by the author in 1900[1] and later applied to the reception of radio signals in 1906.[2]

This does not in general give a musical note in reception either for damped or continuous oscillation, on account of the irregularity of the contacts. If, however, a toothed wheel or any equivalent contact maker, such as is shown in figure 1, be provided with a brush bearing on the face of the wheel or axle in such a way as to produce a steady contact, while a second brush is adjusted so as to touch the teeth, musical reception can be obtained with continuous oscillations. For this purpose the alternating E. M. F. is impressed at D E and the wheel rotated at such a speed that the contacts of the brush E are made with

[1] Phys. Rev. 11: Aug., 1900.

[2] This JOURNAL 1: 6. 1911. Physik. Zeitsch. 12: 867. 1911.

the teeth at a frequency a little greater or less than the frequency of the applied voltage. Under these conditions an alternating current will flow in the telephones of a frequency equal to the difference in frequencies of the contacts and the applied E. M. F. The process is shown in figure 2 where the dots represent the contact points and the broken line the telephone current, the ripples being smoothed out by the reactance of the telephones. The resulting tone is not strictly a beat tone, although the result is exactly the same as though true beats had been produced. This device produces musical continuous wave reception by mechanical instead of by electrical means as in the Fessenden heterodyne.

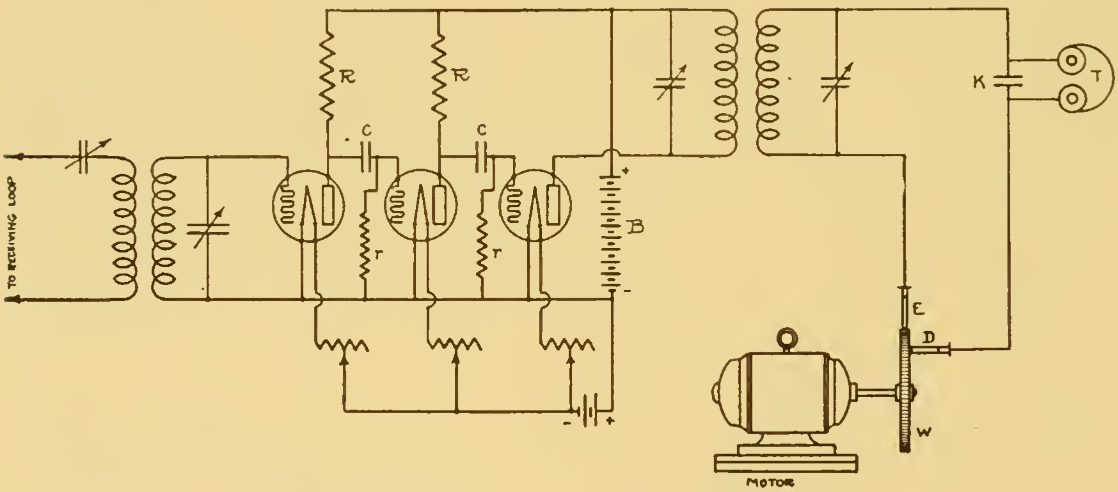

Fig. 1.—Diagram of connections for toothed wheel contact maker.

In 1913, R. Goldsmith devised the first practical application of this principle in his tone wheel (U. S. Patent No. 1087113, Feb. 17, 1914), although the circuits shown in the patent were somewhat more complicated. It was used for some time with the simple circuit described above, both at Arlington and Tuckerton in 1914. While entirely successful as a receiver in long distance continuous wave communication, it was less sensitive and less adaptable than the oscillating vacuum tube introduced in 1914 and was, therefore, generally superseded by it.

Recently the Research Laboratory has again taken up the study of the simplified tone wheel or musical contact maker which was interrupted in 1914, the object of the present work being the determination of its sensibility, the law of response, and its general applicability to modern receiving conditions, especially with amplifiers.

The contact maker used in the experiments (figure 1) was an old tone wheel having a steel disk about 28 cm. in diameter and 754 teeth (with brushes arranged as described above). With

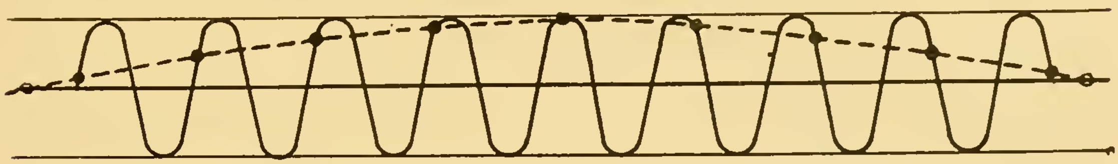

Fig. 2.—Diagram showing contact points and telephone current.

this a contact frequency corresponding to a wave length of 10,000 meters is obtained at a speed of approximately 2400 R. P. M., the power consumed by the motor being about 1/10 H. P. In order to reduce disturbances in the telephones, the steel disk was insulated from the motor, and the frame connected to ground. With the motor run from a storage battery no trouble was experienced in keeping a practically constant speed with which the European stations could be read for hours at a time without speed adjustment. For unsteady sources of power, a speed regulator is of course required. The telephones employed were Baldwin's of 2000 ohms resistance. Figure 1 shows the circuits employed with radio frequency amplification.

Comparisons of the sensibility of the oscillating vacuum tube and tone wheel without amplification were made on Annapolis changing the strength of the signal from 10 audibility to several thousand by inserting resistance in the receiving loop, and also in some experiments by varying the main capacity. The results were as follows:

(1) The sensibility of the tone wheel without amplification varies from 1/6 to 1/3 of the sensibility of the oscillating vacuum tube, depending upon the tone and brush adjustment.

(2) The law of response between telephone current and radio frequency current is linear as in the oscillating vacuum tube.

The tone wheel has, therefore, all the advantages of the latter in keeping out interference and static. In fact, it seems somewhat superior in keeping out strong interference.

(3) It may be used either with radio or audio frequency amplifiers. Radio frequency amplification is in general to be preferred on account of possible induction and brush noise.

(4) While less adaptable to wave length changing than the vacuum tube, this could be accomplished for predetermined wave lengths by a set of automatic speed regulators.

(5) The brush action would probably be improved by filling in the spaces between the teeth of the wheel with insulating material so as to present a smooth surface to the brush.

METEOROLOGY.—*The use of solar radiation measurements for weather forecasting in Argentina.*[1] C. G. ABBOT, Smithsonian Institution.

Mr. H. H. Clayton, the well-known American meteorologist now in charge of the forecast division of the Meteorological Service of Argentina, has employed solar radiation observations for more than a year as a forecasting element. I am not informed as to the precise details of his methods. In a conversation I held with him in June, 1919, at La Quiaca, Argentina, he told me that he has maintained for years an impartial quantitative mathematical record of both the success and failure of the Argentine official weather forecasts, and that this record showed marked and considerable gain in forecasting from the time of the introduction of this new element. He stated to me quantitatively the results before and after this event, but as I do not fully understand his system of accounting, I will not venture to repeat them.

This new departure rests on the fact that our sun is a variable star. This result was reached by the Smithsonian Institution in its investigations of the intensity of solar radiation. For nearly 15 years the Smithsonian Astrophysical Observatory has maintained a solar radiation observing station at Mount Wil-

[1] Presented before the Washington Academy of Sciences on January 29, 1920.

son, California. This station is usually occupied from May to November. Its main investigation comprises spectro-bolometric determinations of the so-called "solar constant of radiation" after the general method of Langley. This term designates the amount of heat per square centimeter per minute which would be produced by completely absorbing the sun's radiation outside our atmosphere at the earth's mean solar distance.

Early results indicated that this quantity is not really a constant, but varies over a range of several per cent, both from year to year and in short irregular periods of days or weeks. Confirmation of these results has been secured in many ways, so that now there remains, I think, but one possible explanation of the phenomenon other than that the sun itself varies in its emission by several per cent from time to time. This alternative possibility is that atmospheric changes occur simultaneously over the whole earth which lead to variable erroneous determinations of the so-called "solar constant," and that the errors thus produced are nearly equal and introduce apparent variations in the same sense, however far apart the two simultaneously observing stations may be. I believe it is easier to admit that the sun itself is variable as supposed. Other irregularly variable stars are numerous. There is no reason why the sun, too, may not be variable.

It is true that recently Dr. Guthnick of the Berlin-Babelsberg Observatory has made a good many photo-electric measurements of the relative brightness of the planets Jupiter and Saturn compared to reference stars. His results thus far have not confirmed the variability we have found. But they have not disproved it. His observations have, heretofore, seldom been taken on coincident days with ours. This inconvenience we expect will be remedied for the year 1920. Guthnick's results show a range of several per cent. This may be in part really solar. If no solar variation was suspected one would attribute it to experimental error. If it should prove that Guthnick in the future finds variations in planetary brightness similar to our solar changes but not coincident in time, we must recall that the planets generally lie in different directions. If the solar changes are due to what we might call solar cloudiness, the effects should not occur coincidentally in different directions from the sun.

One of the most convincing proofs of the essential soundness of the measurements which indicate solar variability comes from Clayton's investigations of terrestrial temperatures. These have been published in Argentina, but also simultaneously by the Smithsonian Institution in its Miscellaneous Collections.[2]

In his first paper Clayton discusses the departures from normal temperatures for about 30 stations widely distributed over the earth, as related to the "solar constant" values determined on Mount Wilson. He does this largely by the mathematical method of correlations, but not wholly so.

If two quantities vary in the same sense wholly dependently the one on the other, as for instance the lengths of the radii and circumferences of circles, they are said to have a correlation coefficient of +1. If the dependence is complete but the variations occur in opposite senses, as the widths and lengths of rectangles of constant area, the correlation coefficient is −1. Between these limits there are all magnitudes depending on degrees of dependency between the two variables. If entirely unrelated, the coefficient is zero. In this method of investigation, quite common in agriculture, eugenics and other sciences, we must take account especially of the algebraic sign of the coefficients and of their magnitude, compared to their probable errors, in forming an opinion of the nature and degree of dependence of the qualities examined.

As has been said, the Mount Wilson solar observations indicated irregularly recurring variations sometimes reaching extremes of 10 per cent in the solar heat available to warm the earth. These changes often ran their course in a week or ten days. Ranges of 10 per cent are rare but those of 2 or 3 per cent are common.

Clayton found that coefficients of correlation ranging from +0.54 to −0.50 occurred as between solar and temperature changes. His studies covered not only the day of the solar

[2] Vol. 68, No. 3, and Vol. 71, No. 3.

observation itself, but the five days next following. He found that the largest temperature effects occurred generally from the third to the fifth day after the solar event.

Correlation coefficients numerically as large as 0.50 are practically always certain evidence of strong dependence between the variables. Clayton, therefore, very justly concluded that for some regions, at least, the observed variations of the sun so greatly influence temperatures that the effects are not masked by terrestrial influences. Furthermore the delay of several days between the solar cause and the terrestrial effect gave promise for useful forecasting.

A remarkable result is the opposing signs of correlation. An increase of solar radiation is attended at some stations by positive and at others by negative temperature departures. Clayton marked his stations on a world map and seemed to find that while in the tropics and polar zones positive correlations prevail, negative ones are found generally in both north and south temperate zones.

These early results of Clayton's seemed so interesting and promising that the Smithsonian Institution appeared justified in establishing a new solar radiation observing station in the most cloudless available region in the world, in order to furnish solar values regularly through the entire year. After a disappointing expedition to North Carolina, a region chosen only because of war conditions, the station was located in July, 1918, at Calama, Chile. Two observers, Mr. A. F. Moore, Director, and Mr. L. H. Abbot, Assistant, have occupied this desert station continuously up to the present time. Their zeal and success have been remarkable. The station has not quite satisfied our hopes for cloudlessness but determinations of considerable weight have been made on about 75 per cent of all days since July 27, 1918.

In the meantime, Mr. Clayton and his colleagues in Argentina have diligently continued their computations of the terrestrial effects produced by solar variations. The results they reached, up to June, 1919, have just been published by the Smithsonian Institution.[3] They are indeed remarkable, though confined al-

[3] Misc. Coll. Vol. 71, No. 3.

most exclusively to Argentine weather stations, and mainly to Buenos Aires.

Clayton carries on the study of what happens after a change in solar radiation for many days, sometimes even 40 days after the event. This leads to the surprising result that the largest effects come not 3 days, but even 10 days and 17 days after the event. As he has shown this result clearly by the ordinary method of graphical comparison, not involving mathematical correlation coefficients, I am able to show you the result with

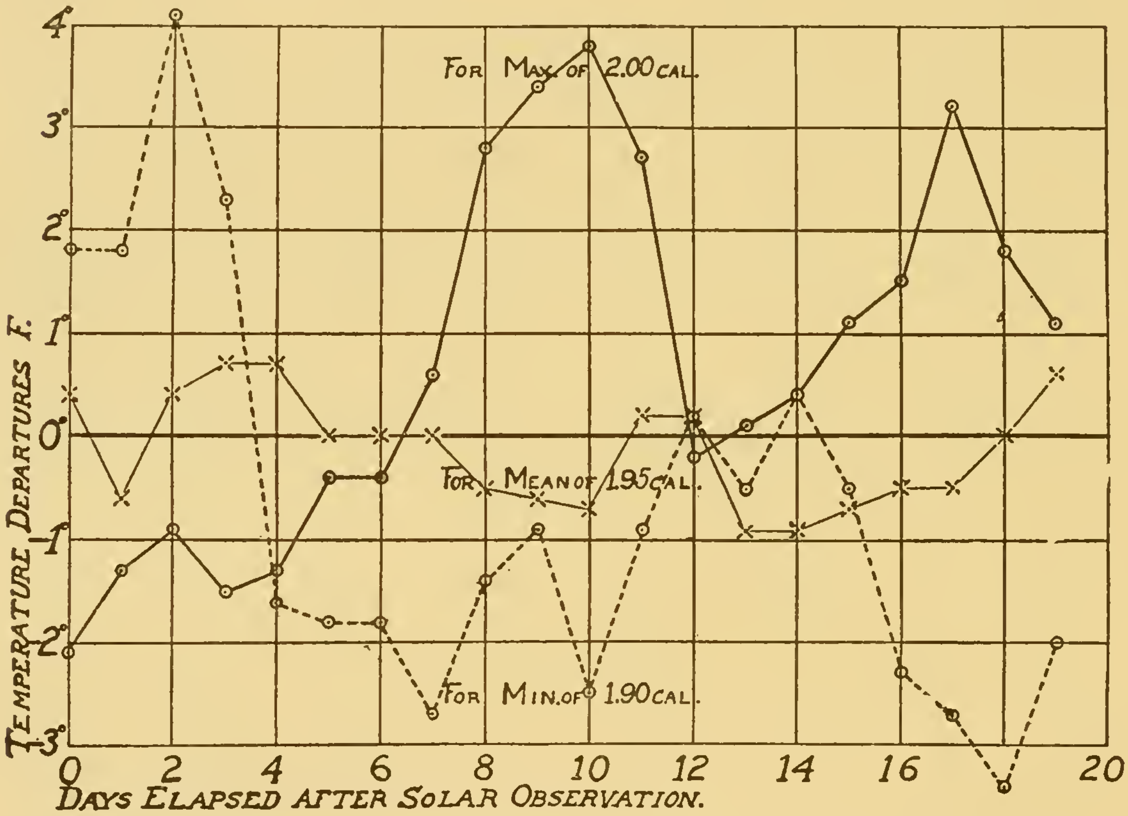

Fig. 1.—Curves showing departures from mean temperatures at Buenos Aires.

perfect simplicity in figure 1, which I have re-drawn on the Fahrenheit scale from his table II. Three curves are shown representing the average progress of the departures from mean temperatures at Buenos Aires. These cover the 10 days next following dates when the "solar constant" was determined as 2.00, 1.95, and 1.90 calories per square centimeter per minute, respectively. The curves give the mean results of the years

1913, 1914, 1915 and 1916,[4] for the months May to November. The solar observations were made at Mount Wilson. Note the pronounced and opposite courses of the temperature departures after high and low solar radiation values, and the nearly normal temperature following mean solar values. Note, too, that the temperature departures are not small. They amount to several whole degrees, not mere tenths of degrees. In fact on the second, tenth, and seventeenth day after the event, the temperature departure after the high solar radiation differs in each case more than 6° F. from the corresponding departure after low values. This corresponds to 5 per cent change in the sun's radiation. Meteorologists need not be reminded that 6° F. change in the mean temperature of a whole day is not trifling. People in general would also very easily recognize a day whose mean temperature was 90° from one of 84° F., or one of 10° F. from one of 16° F.

Perhaps equally or more important in Argentina, where there is hardly adequate rainfall, are Clayton's results on the dependence of precipitation on solar radiation, if confirmed.[5] He finds that heavy rains are apt to occur from three to five days after large decreases of the solar radiation. He shows this result by table 1.

At times of nearly stationary solar intensities there seems to be practically no precipitation in these cities of Argentina. In a few instances precipitation follows large increases of radiation. But almost universally great decreases of solar radiation are followed in from 3 to 5 days by heavy precipitation. Such information is of great value for vineyard growers and agriculturists in other lines if it proves to be well founded.

These are but specially striking samples of the results which Clayton lays before us. He has discussed all of the Mount Wilson and Calama solar observations for their bearing on the

[4] Clayton did not have solar results of 1916 and 1917 available for study when he obtained these results.

[5] Clayton's statement is not specific at this point, but I think his precipitation table depends only on a few months of observation, not on the mean of 4 years like the temperature data.

weather of Argentina. His studies have great variety. They deal especially with the discovery of periodicities in the phenomena which he treated by harmonic analyses as well as by simpler methods.

TABLE 1.

RELATION BETWEEN RAINFALL AND "SOLAR CONSTANT."

Solar changes in calories	Average daily rainfall in mm.						
	3 to 4 days later			5 days later			
	Mar del Plata	Buenos Aires	Cordoba	Parana	Corrientes	Tucuman	Mean
+0.050 to +0.070.....	0	9	3	0	2	2	2.7
+0.030 to +0.050.....	0	0	0	0	0	2	0.3
+0.010 to +0.030.....	6	6	0	0	2	6	3.3
—0.010 to —0.030.....	0	2	5	5	1	10	3.8
—0.030 to —0.050.....	8	11	4	3	8	14	8.0
—0.050 to —0.070.....	4	7	2	15	17	12	9.5

In December, 1918, Clayton began to employ the results furnished by the Smithsonian observers at Calama, Chile, for actual forecasting. Fully convinced of the value of such data, Prof. C. C. Wiggin, Chief of the Argentina Weather Service, arranged for a daily telegraphic service from Calama to Buenos Aires. By their great skill and zeal, Messrs. Moore and Abbot, the Smithsonian observers at Calama, have completely reduced the "solar constant" value on each day of observation. They send a code telegram from Calama via Antofagasta and Valparaiso, Chile, to Buenos Aires on the evening of each observing day. This states the intensity of solar radiation outside our atmosphere, and the quality of the determination. The value is available in Buenos Aires for the forecasting on the following morning, within 24 hours of the time of observation.

Fortunately, during my visit at Calama in June, 1919, with the cooperation of the observer there, I was able to perfect a new empirical method of "solar constant" determination, based upon data obtained by Langley's methods, but independent of gradual changes of transparency of the atmosphere during observations. Hitherto it has required several hours of uniform atmospheric transparency to enable us to make the proper observations. If the sky was growing clearer our result was too high, and if more hazy, too low. The new method of "solar constant" determination is based on the fact that the atmospheric transparency varies in an opposite sense to the variations of the brightness of the sky. Increased haziness means more reflecting surface to scatter the solar rays indirectly to the earth. At the same time it means more obstructing surface to cut off the direct solar beam. We have found accordingly that from measurements of the brightness of the sky near the sun it is possible to infer the atmosphere transmission coefficients at all wave lengths. In our new process all the observations can be made in 15 minutes, and the "solar constant" value can be completely worked out in a couple of hours. The following great advantages may be claimed for the new method: 1. Great saving of labor. 2. Possibility of making several independent determinations each day. 3. Greater accuracy because independent of the variability of the atmospheric transparency. 4. Availability on partly cloudy days. On the other hand the new method is empirical, and must be frequently checked against the old to make sure that no new atmospheric conditions have arisen to invalidate it.

In letters just received from Mr. Clayton, he states that his most recent studies have but increased his enthusiasm for the value of solar radiation observations in forecasting. He encloses curves showing a striking direct correspondence between the temperature departure for Buenos Aires and other South American cities in November and December of 1919, and the slightly antedating solar radiation changes. The direct temperature effects lag from two to three days behind the solar fluctuations.

We now come to the most interesting and puzzling feature of these new discoveries. It is that the dependence between solar variations and changes of terrestrial temperatures at Buenos Aires occur in opposite senses at different seasons of the year. From October to February, inclusive, low values of solar radiation are followed for several days by negative temperature departures from the normal, and the reverse is true for the months March to September, inclusive. Naturally the intervals of transition in March and October from one of these conditions to the other are periods when the solar radiation results are at present of little value for forecasting purposes. Besides this inconvenience, it occasionally happens in the midst of one of the long periods of positive or of negative correlation, that a sporadic regression to the other type of correlation will occur to mar the forecast. It may be that with further investigation these things will be understood. Something about the prevailing direction of the winds or of the condition of the upper air may come to light to serve as a basis of prediction whether the correlation will be positive or negative at a given epoch.

It has been mentioned that Mr. Clayton discovered in his early studies that in different parts of the world correlations of opposite algebraic signs between solar radiation and temperatures prevail simultaneously. It must, therefore, be tha tthere are geographical regions of transition, as well as transition time epochs at a single region. Hence the new means of forecasting cannot yet be regarded as either simple or fully satisfactory. Much investigation must be made before they take established rank in meteorology. Enough has been done to show that there is promise. Before the promise can come to fruition we must have continuous daily records of well determined solar constant values. These cannot be secured with the means now available. The solar radiation station at Mount Wilson is not occupied more than six months per year, and never yields more than 130 values of the "solar constant" in that period. Of those not all are good. The station at Calama yields about 250 good values per annum now that the new method of observing is adopted. These are the only stations of the kind in the world. There should be two or three others, widely separated in the most cloudless regions available. I have in mind Egypt, Southern California and Middle Australia.

The cost of a solar radiation station need not exceed $25,000, and its upkeep $10,000 per annum. Since the accuracy of the determinations of the solar variations would be enhanced by uniformity in the methods of observing, it is quite desirable that the measurements at the several stations should be made under a common control and direction.

The methods of observing and reducing have been devised and perfected at the Smithsonian Institution but they would very willingly be communicated to any international organization which was prepared to take up measurements of the "solar constant." On the other hand, if the Smithsonian Institution had the means, preferably $1,000,000, to devote to the subject, it would be practical for the Institution to carry on "solar constant" determinations in perpetuity in such a manner as to afford a satisfactory groundwork for any application of them which meteorologists may wish to make hereafter.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

139TH MEETING

The 139th meeting of the Academy was held in the Assembly Hall of the Cosmos Club at 8.15 p.m., on Thursday, January 29, 1920; President Alsberg presided. Dr. C. G. Abbot, Director of the Astrophysical Observatory, Smithsonian Institution, delivered an illustrated lecture on *The use of solar radiation measurements in weather forecasting in Argentina.* The substance of the lecture is published in this number of the Journal.

Discussion. Professor C. F. Marvin, Chief of the Weather Bureau, presented the following discussion:

We must all admire and commend in the highest terms the persistent and conscientious effort which Mr. Clayton has expended in carrying forward for several years the tedious studies he has executed to exhibit a correlation between daily and short-period fluctuations in observed values of intensities of solar radiation and terrestrial temperature and other phenomena of weather. I wish especially to commend in the highest terms the splendid work done by the Astrophysical Observatory of the Smithsonian Institution under the able directorship of Dr. Abbot in perfecting methods and apparatus for the exact measurement of solar radiation intensities, and in securing almost daily values thereof. I do not know of any one element of observation possessing greater fundamental importance to theoretical meteorology than that of the intensity of solar radiation. Dr. Abbot's investigations command our unqualified appreciation and his work deserves to be encouraged and extended as far as possible, purely on the basis of the great value of the work itself.

With reference to Mr. Clayton's findings, I feel compelled to say I cannot at present join with Dr. Abbot in his seeming enthusiastic acceptance of the former's views. Mr. Clayton's latest paper has been in my hands only a few days and has received but a very hasty examination. The hesitation I feel in accepting its conclusions is based on certain general principles and convictions and may be overcome by a critical and detailed study which such a paper must receive before its merits or faults are fully disclosed.

It is obviously impossible, in the few minutes available to me this evening, to attempt to discuss any details of this highly complex and intricate problem—I must confine myself to a very few fundamental considerations and convictions.

There are at least three basic questions which must be answered in the affirmative before we can accept Mr. Clayton's views; these are: (1) Are they in accord with the theoretical, physical or scientific principles which we believe govern the phenomena? (2) Are the data employed so entirely free from systematic errors as to be practically unimpeachable for the purposes for which Mr. Clayton has used them? (3) Are the methods of analysis and treatment of the data sufficiently *conclusive* to command confidence and carry conviction?

From my understanding of the whole question at the present time, I am obliged to entertain a negative reply to each one of these questions to such an extent as to make me believe Mr. Clayton's proposition is not yet conclusively proven. (1) In 1916, I was called upon to decide concerning the merits of another case of correlation between terrestrial weather and certain well-known solar features; in this case the spottedness of the sun. At that time I formulated a physical principle which seems to me to serve as a guide in questions of this kind. This was published in the Monthly Weather Review for January, 1919, and is as follows:

"Meteorologists have long been accustomed to ascribe practically all atmospheric motions, both local and general, to the gravitational flow resulting from the local and general contrasts of temperature over the surface of the earth. The atmosphere derives its heat, not directly from the sun, except to a small extent, but chiefly from the surface of the earth itself. The daily sequence of sunshine and darkness; the varied distribution of clear and cloudy skies; diversities of surface cover added to contrasts of land and water areas, including the phenomena of evaporation, condensation and precipitation; the cycle of the seasons, and above all the fluctuating but nevertheless perpetual contrasts of surface temperatures, ranging all the way from the heat of the tropics to the intense cold of the polar zones constitute a complex series of varied and changeable influences seemingly abundantly adequate to cause and explain every feature of our weather conditions, however changeable we may find them.

"These differences and contrasts on the one hand perpetually disturb the orderly arrangement of air densities and pressures demanded by gravity. The latter, on the other hand, as perpetually and continuously sets portions of the air in motion, in order to establish and maintain a state of equilibrium, which, however, is never attained, or rather we must clearly recognize that *the ceaseless complex changes in and motions of, our atmosphere represent in fact the only state of equilibrium possible between gravity on the one hand and solar heating of the earth on the other.*

"Seemingly with little regard for the considerations just mentioned, many have sought and still seek to ascribe terrestrial weather—that is to say, *all* the characteristic features of atmospheric variations—to *minor* features of solar activity, as, for example, to the spots and faculae of the sun or to its magnetic manifestations, or to the relatively small and irregular fluctuations in the intensity of its thermal radiations, or to some of these variously in combination, etc.

"Even suppose these solar phenomena directly influence terrestrial weather in some way yet to be proved, is it not plainly most essential in detecting and analyzing cause and effect relations that we adequately segregate and make due allowance for the complex phenomena which clearly must result if solar insolation were perfectly constant and if the other manifestations of solar activity were entirely absent?

"Those who have been most ready to find convincing evidence of definite relations between terrestrial weather and minor features of solar activity have seemingly disregarded the obligation devolving upon them to make the segregation between the major and the minor influences. . .

"Variations in the intensity of thermal radiations from the sun must, of course, be reflected in terrestrial weather phenomena, but such reflected effects must stand in appropriate relation quantitatively to the variations themselves."

These considerations prevent me from concurring in Mr. Clayton's conclusions which he states in his own words as follows:

"The results of these researches have led me to believe: 1. That if there were no variation in solar radiation the atmospheric motions would establish a stable system with exchanges of air between equator and pole and between ocean and land, in which the only variation would be daily and annual changes set in operation by the relative motions of the earth and sun. 2. The existing abnormal changes, which we call weather, have their origin chiefly, if not entirely, in the variation of solar radiation."

Mr. Clayton's paper in no way defines what constitutes a "stable system" of atmospheric motions nor does it offer a direct proof of these conclusions. They are simply generalized inferences drawn by him from his investigations.

I realize that my own statement as well as that of Mr. Clayton is of a kind that it is difficult or impossible to prove or disprove. They are contradictory, however, and I leave them to your reflection as to their physical soundness.

(2) I am most reluctant to raise any question as to the final accuracy of Dr. Abbot's solar radiation values, because I know the conscientious care he has taken to eliminate systematic errors due to terrestrial causes. However, this is a matter about which we must have a definite answer, yes or no. Dr. Abbot fully recognizes the importance of this issue, and, in his introductory note to Clayton's paper, he states the question in this way:

"I now anticipate the question of the reader: . . . . is it possible that the apparent variations of radiation were not truly solar, but were caused by changes in the transmissibility or other properties of the air which affected the solar radiation measurements in one way and the temperature and rainfall of the earth in another?"

The negative answer he offers to this question in the immediate context is based in part on very indirect evidence drawn wholly from Clayton's work itself. This is too much in the nature of reasoning in a circle to carry conviction and can not outweigh the very direct adverse evidence derived from a critical examination of the simultaneous data showing atmospheric transmission and solar radiation intensities. A study of this kind has been carried on at the Weather Bureau for the past several months by Mr. Clough, whom I regard as a most conscientious and astute student of questions of this nature, and I am unable to refute the results of the studies he has thus far shown me, and these seem to me to indicate that in at least some of the observations employed by Mr. Clayton the value of the solar constant comes out high for low atmospheric transmission, and the value is low for high transmission. This question of the accuracy of the data must be removed before Mr. Clayton's views can be established.

(3) Finally, I must express skepticism as to the conclusiveness of a demonstration resting mainly or alone on correlation coefficients and the comparison of somewhat similar curves. Correlation coefficients are quite meaningless without the probable error of the coefficient, and I notice the probable errors of the correlation coefficients have been completely omitted from Mr. Clayton's last account of his work. This makes it impossible to properly weigh the evidence submitted.

Every problem in the correlation of two variables can be graphically represented by a so-called dot chart in which the position of each dot with reference to the conventional coordinate axes represents the simultaneous values of the two variables. In nearly all problems of this kind with which I have any acquaintance the dots fall in a widely scattered "star cluster" sort of arrangement, signifying a large measure of inconsistency. The correlation coefficient serves simply to define the straight line of least-square best fit for the given cluster of dots. The probable error of the correlation coefficient is an index of the amount of scatter of the dots. In a great many cases the clusters of dots are nearly as broad as they are long, and the direction of the straight line of best fit in such cases is determined almost wholly by a small number of pairs of the variables which have extreme high or low values. The great bulk of the dots serve no other purpose than to fix the origin of the coordinate axis at the center of gravity of the system. We may use results of this sort with a high probable error as a basis for rough estimations, approximations, or even forecasts. But I cannot feel justified in accepting them as demonstrations of cause and effect relations.

Summarizing my views, I may say, first, I am not convinced of the entire physical soundness of Mr. Clayton's first and second conclusions stated. Second, I think it is still possible there may be some residual error in measurements of solar radiation intensities by which a portion of those values, sufficient to influence final conclusions, are systematically high with low atmospheric transmission and low with high atmospheric transmission. Third, I am not convinced of the conclusiveness of Mr. Clayton's methods of analysis of the data employed.

In conclusion, I wish to make it very clear that my skepticism is not in the slightest degree directed against the work of the Astrophysical Observatory. Dr. Abbot's work should be supported and extended in the fullest possible manner purely on its own merits and on account of the importance of observations of intensity of solar radiation to general meteorology. For example, I wish we might have, and I am ready to recommend urgently that we have, say 12 stations, maintained throughout the world. These should be located as nearly as possible in four groups of three each, the three located on the same meridian of longitude, the four groups separated by approximately 90° of longitude. Such a system of stations would make possible simultaneous measurements of intensity every six hours. This proposal is submitted largely as a scientific desideratum. It is recognized that geographical and meteorological conditions operate in a very material way as obstacles to its complete realization.

Dr. W. J. Humphreys, of the Weather Bureau, said that it is now quite certain that the sun is a variable star. Explosions, or something analogous thereto, cause spots in the sun, and naturally lead us to expect variability in its radiation such as is actually found in Dr. Abbot's measurements. It is not to be expected that more stations will disprove the variability of the sun; they will only establish more accurately its amount. Since all weather phenomena are the result of the sun's radiation, any change in that radiation must produce a corresponding change on the earth. The only question is as to the kind and magnitude of this change. The sun's radiation is partly reflected from the outer atmosphere, and partly absorbed, mainly in the lower levels, while the remainder is absorbed at the earth's surface. If the sun's variability is known, a rough computation can, therefore, be made of the kind of result to be expected. Abbot and Clayton have gone far enough to show that there is considerable value in the effort to correlate the variations in the solar constant and in the weather, and at least six stations should be established to carry forward the study of the solar constant.

All of Clayton's deductions, however, are not sound. What he calls a "stable system" would not necessarily result if there were no variation in solar radiation. A river with a constant supply of water and undisturbed at its mouth by tides may still be full of turbulent currents. The weather cannot be dependent *solely* on changes in the sun.

The location of Buenos Aires is unfortunate for an attempt to correlate weather and solar variation. An inland high-level station would be much better. The lower levels of the atmosphere near the sea are usually moist and dusty and do not respond as quickly as the high levels; variations in the wind direction, especially as between on and off shore, are also most disturbing near the coast.

Dr. C. F. Brooks, of the Weather Bureau, referred to the difficulty which positive and negative correlations occurring at different seasons introduce into any attempt to use solar variations in forecasting. In a lecture before the Academy in 1918 Nansen[1] showed how surface temperatures at different places on the earth varied either directly or oppositely with the sun spot numbers, and how the direction of variation changed from time to time, due evidently to shifts in the centers of action of the atmosphere. There are "fixed" centers of action, as at the Azores, which control seasonal weather; but it is the moving centers (the high and low pressure areas) that control our weather from day to day. If the actual positions of Highs and Lows be taken into consideration, we may find it possible to predict whether a given variation in the solar constant will have a positive or negative result at a particular place. Increasing the strength of a High, for instance, would have opposite effects on temperature at stations on the east and west sides of the High.

As an example of a probable correlation between solar and weather phenomena, the speaker called attention to six successive recurrences of abnormally high pressures somewhere in the United States or Canada in the fall and winter of 1917–1918; these recurred at about 27-day intervals, or about the synodic rotation period of the sun in low latitudes. The maxima occurred, however, at different places.

The time is perhaps not distant when the weather forecaster, having before him the existing and expected locations of the Highs and Lows, may be able to use solar constant data to predict most of the now inexplicable changes in the intensities of those centers.

Dr. L. A. Bauer, of the Department of Terrestrial Magnetism, Carnegie Institution, made special mention of the achievement of the Astrophysical Observatory in introducing new methods that so greatly diminished the time and labor of obtaining solar constant data. He hoped that a continuous record of the solar constant might some day be possible.

Dr. Abbot stated his gratification that all the speakers had agreed on the need of additional stations to obtain more and better values of the intensity of solar radiation. The data available to Clayton were far from being completely satisfactory, for the measurements were frequently interfered with by cloudiness at both Mt. Wilson and Calama. Nevertheless, he believed the correlation of the radiation and temperature observations too striking to be avoided, whatever the theoretical application may be. Dr. Brooks' suggestion regarding the movement of action-centers may well account for Clayton's varying correlations. In reply to a question by Col. T. L. Casey he pointed out that the average value of the solar constant has not changed in the right direction to account readily for the great difference between the winters of 1918–19 and 1919–20 in Washington, but that the weather depends to

[1] This Journal 8: 135–138. 1918.

a great extent on the direction of wind, and the relation between solar constant and the direction of wind in Washington may be very complex. The solar constant for the period 1902–1912 averaged 1.93 and values as low as 1.85 appeared often. During the years 1914 to 1920 it averaged 1.95 and seldom fell as low as 1.90. In September, 1919, 1.93 was again the mean value, while for October, November and December it had risen to 1.96. Notwithstanding this recent increase we have a cold winter in the United States.

ROBERT B. SOSMAN, *Corresponding Secretary.*

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

On February 19 Mr. Tilson introduced a joint resolution (H. J. Res. 299) "extending the life of the National Screw Thread Commission for a period of two years from March 21, 1920." The Committee on Coinage, Weights and Measures reported it in the House on February 24 (Rep. 671), and it was passed on March 1. The Senate passed the resolution on March 17.

This Commission was appointed under an act approved July 18, 1918, and consists of two representatives each from the Army and Navy, and four members nominated by the national engineering societies, with the Director of the Bureau of Standards as chairman. The Commission has investigated and formulated standards of commercial screw-thread practice which have been made accessible to engineers and manufacturers and have been tested in use. The life of the Commission is extended in order to give opportunity for minor modifications in the proposed standards before its final report is promulgated.

The bill for a tariff on scientific instruments, chemical glass and porcelain, and surgical and dental instruments[2] (H. R. 7785) had been in the hands of the Senate Committee on Finance for several months, and it had been agreed in the Committee that the dyestuffs bill (H. R. 8078) should have the right of way as the most important of the tariff bills. An attempt was, therefore, made by Mr. Watson on February 25 to bring the dyestuffs bill before the Senate, but objections were made by Mr. Poindexter and others on the ground that the other tariff bills passed by the House (magnesite, scientific instruments, etc.) had not been reported and that dyestuffs had no right to special consideration. The result was that no action was taken on any of the bills at that date. Later, on March 4, the bill for a tariff on scientific instruments, etc., was reported in the Senate without amendment (Rep. 459) and recommended for passage. The report laid special stress on the testimony of Mr. J. M. Roberts, Secretary of the Scientific Apparatus Makers' Association, whose figures showed that a tariff of 60 per cent ad valorem would equalize Japanese and American costs of production on the six items quoted by him, with a maximum deviation of 8 per cent.

The Patent Office reform bills[3] (H. R. 5011, 5012 and 7010) were combined by the House Committee on Patents into a new bill (H. R. 11984) "To increase the force and salaries in the Patent Office, and for other purposes," which was introduced by Mr. Nolan, and passed by the House on March 5.

[1] Preceding report: This Journal 10: 148. 1920.

[2] See this Journal 9: 389, 421, 562. 1919. 10: 149. 1920.

[3] This Journal 9: 422. 1919.

The Senate Committee on Military Affairs finished in January its work on the Army reorganization bill (S. 3792) and in the bill as reported in the Senate on January 28 (Rep. 400) the Committee provided for a separate Chemical Warfare Service in the Army. 126 officers and 1200 enlisted men are provided in this Service. The corresponding House bill (H. R. 12775) which was reported February 26 (Rep. 680) provides 91 officers and 1500 men. During the debate on the bill in the House the Chemical Warfare paragraph was criticized as prescribing no duties for the Service, but no change was made. The bill was passed by the House on March 18.

A committee of the House made a tour of inspection to the Government nitrate plants near Muscle Shoals, Alabama, in the latter part of January, to obtain information relative to the feasibility of their private operation. Hearings on the Senate bill[4] to establish the United States Fixed Nitrogen Corporation (S. 3390, Mr. Wadsworth, November 7, 1919) were begun before the Senate Committee on Agriculture in the latter part of March.

A new departure in weights and measures is embodied in S. 3943, introduced (by request) by Mr. King, one of the Senators from Utah, on February 18. The bill is entitled: "A bill to establish the standard and decimal divisions of the weights, measures and coins of the United States." A similar bill, with minor changes, was introduced in the House by Mr. Welling, a representative from Utah, on March 1 (H. R. 12850). The character of the plan may be indicated by the fact that the English foot is made the fundamental unit, with subdivisions into a "decimal inch" which is one-tenth of a foot, and a "common inch" which is one-twelfth of a foot. This plan of a multiple set of factors is carried through the system, which is intermittently octaval, decimal or duodecimal. The bills were referred to the Senate Committee on Standards, Weights and Measures, and the House Committee on Coinage, Weights and Measures, respectively. Editorial writers in the technical press seem in some doubt as to whether the bill is a serious proposal, a practical joke, or a "smoke screen" in anticipation of metric legislation.

Metric legislation has been compiled into the form of a bill, but has not yet been introduced, at this writing. Meanwhile, an extensive brief in opposition to the introduction of a "metric system bill" was submitted in March to the House Committee on Coinage, Weights and Measures, by the American Institute of Weights and Measures.

The report of the Joint Commission on Reclassification of Salaries[5] was presented to Congress on March 12, but at this writing no legislation based on the report has been introduced.

[4] The House bill is H. R. 10329. See this Journal 9: 646. 1919.

[5] This Journal 10: 148. 1920.

NOTES

The following program of papers was presented at the public meeting of the Board of Surveys and Maps at the Interior Department on March 9, 1920:

1. *Coordination of Government mapping and surveying through the Board of Surveys and Maps*, O. C. MERRILL, Chairman of Board. 2. *Report of Joint Committee of Non-Federal Agencies*, M. O. LEIGHTON, Chairman of National Service Committee, Engineering Council. 3. *Need for a general topographic map of the United States and means by which its preparation may be expedited:* (*a*) *From a highways standpoint*, THOMAS G. MACDONALD, Director, Bureau of Public Roads. (*b*) *From a railroads standpoint*, A. C. BALDWIN, Vice-President, Illinois Central Railroad. (*c*) *From a military standpoint*, Col. C. O. SHERRILL, Corps of Engineers, U. S. Army. (*d*) *Present status of map, and rate and cost of completion*, G. O. SMITH, Director, U. S. Geological Survey, and WILLIAM BOWIE, U. S. Coast and Geodetic Survey. 4. *Extent and means of cooperation between the Board and other agencies:* (*a*) *Federal agencies*, EDWIN F. WENDT, District Engineer, Interstate Commerce Commission. (*b*) *State and municipal agencies*, F. W. DEWOLF, State Geologist of Illinois. (*c*) *Non-Governmental agencies*, ALFRED D. FLINN, Secretary, Engineering Council. 5. *Public needs which a central map information office may serve*, E. B. MATTHEWS, Chairman of Division of Geology and Geography, National Research Council. A general discussion followed the fixed program of the meeting.

International Exchange shipments of publications are now being made direct to Finland in the care of the Delegation of Scientific Societies of Finland, at Helsingfors.

Brood No. 19 of the 13-year race of the periodical cicada ("seventeen-year locust") will be the subject of special observation in Tennessee this spring, to determine the effect of unfavorable weather upon its development. This brood has been subjected twice in its history (in 1894 and 1907) to the unusual condition of freezing weather following its emergence, in May, causing the death of a large proportion of the cicadas before they had begun laying. It is possible that the brood may have been exterminated thereby over a large part of its original territory.

Dr. C. G. ABBOT, of the Astrophysical Observatory, announces that solar radiation measurements at Calama, Chile, have indicated, almost without exception, extremely high values since October 7, 1919. At the same time there has been an unusually severe winter in the northeastern United States and extraordinary cloudiness and precipitation in the Southern Andes.

Mr. WALTER M. BERRY, Associate Gas Engineer, has been appointed Chief of the Gas Engineering Section of the Bureau of Standards, succeeding Mr. R. S. MCBRIDE, who recently resigned to join the staff of the McGraw-Hill Company.

Captain W. R. Birks, of Chatswood, New South Wales, Australia, visited the Department of Agriculture in February. Captain Birks has been absent from Australia for nearly five years, being connected with the British Army on the western front in France during most of this time. Since the signing of the Armistice he has been studying agricultural conditions in Europe.

Dr. Rupert Blue, of the U. S. Public Health Service, went to England in March to represent the United States at the international conference of physicians, surgeons and hygienists, which convened at London on April 12.

Mr. S. R. Capps, geologist in the Alaskan division of the U. S. Geological Survey, has applied for furlough and will spend several months in European Turkey studying oil possibilities for the Standard Oil Company. He will be accompanied by Mr. T. P. Pendleton, topographer in the Alaskan division.

Mr. W. E. Chambers, microscopist and illustrator in the Bureau of Plant Industry, U. S. Department of Agriculture, died on March 5, 1920, in his fifty-fifth year. Mr. Chambers was born at Birmingham, England, in 1866. He had been with the Bureau since August 1, 1908.

Mr. Theodore Chapin, geologist of the U. S. Geological Survey stationed at Anchorage, Alaska, has taken a furlough for four months and will go to the Tampico oil fields, Mexico, for the Standard Oil Company.

Mr. N. H. Darton, geologist, is on furlough from the U. S. Geological Survey, and will conduct reconnaissance geological surveys for an oil company in northern Mexico.

Prof. Henry S. Graves, for the past ten years Chief Forester of the Forest Service, U. S. Department of Agriculture, resigned from the Service in March, giving as his reason for retirement his belief that "the pecuniary returns afforded professional and scientific men in the Government service inadequately provide against the exhaustion of the working powers which must inevitably take place in time, and entail sacrifices from which employment elsewhere is free."

Mr. Paul Greeley has been appointed an assistant at the Calama, Chile, station of the Smithsonian Astrophysical Observatory. He expected to sail from New York about March 20.

Mr. W. B. Greeley, Assistant Forester, and recently lieutenant colonel in charge of the forestry service of the American Expeditionary Forces in France, has been appointed Chief Forester of the Service, to succeed Prof. H. S. Graves on his retirement on May 1.

Dr. Ralph E. Hall, physical chemist at the Geophysical Laboratory, Carnegie Institution of Washington, resigned in March to take charge of physical researches for the Firestone Tire and Rubber Company at Akron, Ohio.

Mr. E. T. Hancock has resigned as geologist of the U. S. Geological Survey to represent the Standard Oil Company in Roumania in its oil operations.

Messrs. A. A. Hansen and F. V. Coville, of the Bureau of Plant Industry, and Paul Bartsch, of the National Museum, delivered in March and April an illustrated lecture course on "Wild Flowers" under the auspices of the Wild Flower Preservation Society of America in cooperation with the Community Center Department of the Public Schools of the District of Columbia.

Mr. John B. Henderson, a regent of the Smithsonian Institution, who for the past two years has devoted the major part of his time to molluscan research in the Division of Marine Invertebrates, has gone to Cuba and Jamaica to secure certain anatomical material of the West Indian operculate landshells necessary to complete a new classification of these mollusks, upon which he and Dr. Paul Bartsch are now at work.

Prof. James T. Jardine, in charge of the Office of Range Research of the U. S. Forest Service for the past thirteen years, resigned from the Service in March to become Director of the Oregon State Agricultural Experiment Station at Corvallis. The work of the office of which he has been in charge embraces a study of the classification, improvement, and use of western range lands, and the period of his administration has seen the development of fundamental principles in range management and their application to 153,000,000 acres of grazing lands in the National Forests.

The following hydrographic and geodetic engineers resigned from the U. S. Coast and Geodetic Survey in January and February: G. R. A. Kantzler, W. H. Overshiner, J. D. Powell, P. M. Trueblood, E. M. Wilbur, and S. D. Winship.

Mr. W. S. W. Kew, who has been studying the oil fields of California for the U. S. Geological Survey, will take a furlough for six months to investigate oil fields in Colombia, South America.

Mr. Henry Lindenkohl, cartographer of the U. S. Coast and Geodetic Survey, died on February 19, 1920, in his eighty-second year, after fifty-nine years of service with the Survey. Mr. Lindenkohl was born in Hesse-Cassell, Germany, January 26, 1839, and became an American citizen in 1861. He made many contributions to the military maps of the Federal armies during the Civil War, and had been engaged in active cartographic work from that date until the time of his death.

Mr. J. B. Norton, physiologist in the Bureau of Plant Industry, has resigned to go into commercial plant breeding work at Hartsville, South Carolina.

Mr. Albert F. Potter, Associate Chief of the Forest Service, resigned from the Service in March, requesting that his resignation be made effective April 15.

Mr. E. W. Shaw, geologist, is on leave of absence from the U. S. Geological Survey for six months and will make a reconnaissance of a large tract in Bolivia and the Argentine Republic with a view to its development by an oil syndicate. Messrs. R. H. Sargent, chief topographer of the Alaskan division, and G. L. Harrington, Edwin Kirk and C. P. Ross, geologists of the Survey, also on furlough, will accompany Mr. Shaw.

Mr. Edward A. Sherman, assistant forester, has been appointed associate forester of the Forest Service, U. S. Department of Agriculture, to succeed Mr. Albert F. Potter, who resigned from the Service in March.

Installments of the large collection of Hawaiian marine mollusks which Mr. D. Thaanum, of Hilo, Hawaii, has donated to the National Museum in order that Dr. Dall's report upon the molluscan fauna of the Hawaiian Islands may be rendered complete, began to arrive in March.

Dr. W. H. Weston, of the Office of Cereal Investigations, U. S. Department of Agriculture, has completed two years' investigation of downy mildews in the Philippine Islands and will return soon to the United States for conference and preparation of additional papers for publication.

Dr. J. Franklin Meyer, physicist, of the Bureau of Standards, is acting as secretary of the American Engineering Standards Committee, during the absence of the Secretary, Dr. P. G. Agnew, who is in Europe as a delegate to the International Electrotechnical Commission.

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GEOCHEMISTRY.—*An unusual deposit of aragonite from sea-water.* ROGER C. WELLS,[1] U. S. Geological Survey.

A few months ago the writer had occasion to examine for the United States Bureau of Fisheries some samples of standard sea-water contained in sealed glass tubes as originally furnished by the Copenhagen Laboratory of the Conseil Permanent International de la Mer. The tubes bore the date April 15, 1913, and had remained at rest, awaiting use, for most of the intervening interval. A slight deposit had formed on the inside of several of the tubes, apparently around air bubbles, but nevertheless insoluble in the water after long agitation. As it was feared that the chloride content of the water had changed, very careful determinations were carried out by the gravimetric method, which showed that the chloride content marked on the tubes was substantially correct, the value 19.386 being found, whereas the value on the labels was 19.379 parts of chlorine per 1,000 parts of sea-water.

Attention was next directed to the crystals. A few simple tests showed them to be calcium carbonate. They had a prismatic or needle-like appearance and were arranged in stellate groups. Some of them were a few tenths of a millimeter in length. Dr. E. S. Larsen of the Geological Survey very kindly determined their indices of refraction as follows:

$$\alpha = 1.525 \pm 0.003$$
$$\beta \text{ and } \gamma = 1.675 \pm 0.003$$

The crystals are therefore aragonite, and represent a deposit under apparently very definite conditions. Some of the crystals

[1] Published by permission of the Director, United States Geological Survey,
Received March 26, 1920.

were well washed with distilled water, dissolved in acid, and tested for the presence of sulfate. A small amount of sulfate was shown. This agrees with the results of others on natural aragonite formed from the sea.[2] No lead could be detected, and hence the possibility that lead carbonate nuclei determined the formation of the aragonitic form seems to be excluded.

One might account for the deposition of this aragonite on the theory that the water was originally supersaturated with it. It seems more reasonable, however, to assume that some change must have occurred in the water. The most plausible explanation appears to be that very slow attack of the glass by the water caused a series of chemical reactions leading to the deposition of calcium carbonate in the less stable form of aragonite. The carbon dioxide in sea-water exists principally in the form of bicarbonate ions, HCO_3^-, which constitute a very small fraction of all the anions present. Na^+ and Cl^- are present in relatively great excess. The alkali dissolved from the glass yields hydroxide ions, OH^-. The following reactions may be assumed to have occurred:

$$OH^- + HCO_3^- = CO_3^{--} + H_2O \qquad (1)$$

$$CO_3^{--} + Ca^{++} = CaCO_3 \qquad (2)$$

Another possible explanation of the deposit is that some of the carbon dioxide was boiled out of the water before the tubes were sealed up. This explanation, however, seems less probable than the other.

Several writers have pointed out that recently formed deposits of calcium carbonate in nature are likely to be aragonite, whereas the oldest deposits are principally calcite. The facts here noted obviously have a bearing on the deposition of aragonite in nature, the principal difference in conditions being that a loss or gain of carbon dioxide from the water in the tubes was impossible. As there is a large literature on the subject of the deposition of calcium carbonate from sea-water it appeared to the writer worth while to make further analytical determinations on this water with special reference to the question of the solubility of calcium

[2] Johnston, Merwin, and Williamson. Amer. Journ. Sci. 41: 508. 1916.

carbonate in sea-water. The results of the determination are as follows. The p_{H^+} value, from which the hydrogen-ion concentration of the water may be calculated, was found to be 8.18. The titration alkalinity of the water was found to be 0.0019 normal, and the alkalinity caused only by carbonates and bicarbonates 0.0017. The total carbon dioxide was 0.057 gram per liter.

The titration alkalinity and total CO_2 of this water are lower than usually found in sea-water. What is really required, however, to show the degree of saturation with calcium carbonate is an evaluation of the expression $[Ca^{++}][CO_3^{--}]$, in which the brackets represent concentrations of the ions indicated. In the present state of physical chemistry it is extremely difficult to make this evaluation with certainty. Nevertheless, by a series of approximations, the writer has calculated that the expression indicated has the value 7.2×10^{-10} at 25° C. for the water under discussion, as compared with 19.1×10^{-10} for surface sea-water studied at the Marine Laboratory of the Carnegie Institution at Tortugas, Florida. Johnston[3] gives for the solubility-product constant of calcite at 25°: $K = 87 \times 10^{-10}$.

The above values agree well in view of the uncertainties attending the calculations for sea-water. As a matter of fact, however, the solubility-product constant of aragonite is generally thought to be greater than that of calcite, so that the results do not fall in the right order. This may possibly be explained by the lack of information about the temperature to which the tubes containing the standard water had been exposed, or it may indicate that some error exists in the method of calculating the ionic concentrations involved. Or, lastly, the results found may indicate a very slow time adjustment of the solubility. In other words it may be that the solubility-product constant obtained after the course of a very long adjustment is lower than the value deduced from experiments made on fresh material over relatively short intervals.

It seems inadvisable to enter here into a discussion of all the rules and assumptions used in making the above calculations.

[3] Journ. Amer. Chem. Soc. 38: 982. 1916.

What follows is therefore a very brief statement of the methods employed, which may serve to indicate the nature of the problem and the methods used. For the most part the ion concentrations have been calculated from freezing-point data, using certain empirical equations for the ionic equilibria involved.

The calcium concentration of sea-water [Ca] is about 0.0108 molal. This calcium doubtless exists in sea-water in the form of various molecules and complex ions, but on account of the great excess of sodium chloride it seems probable that the other calcium compounds must be very largely transposed into calcium chloride. If so, the calcium-ion concentration can probably best be approximated by considering the equilibrium

$$CaCl_2 \rightleftharpoons Ca^{++} + 2Cl^- \qquad (3)$$

Neglecting intermediate ions and assuming that the ionization of calcium chloride is similar to that of barium chloride, as deduced by G. N. Lewis from freezing-point data,[4] the writer has found that this equilibrium can be represented by the following empirical equation over a moderate range around 0.01 molal.

$$\frac{[Ca^{++}]\,[Cl^-]^2}{[CaCl_2]^{2.034}} = 0.216 \qquad (4)$$

In order to compute the calcium-ion concentration $[Ca^{++}]$ by means of equation (4) it is necessary to assume a value for the chlorine-ion concentration $[Cl^-]$ in sea-water. For the reason given above a quantity of chlorine sufficient to combine with the calcium and magnesium may be subtracted from the total chlorine and the remainder considered to be present as sodium chloride, ionized and un-ionized. The result is about 0.432 mol of sodium chloride. From extrapolation of the curve for the ionization of sodium chloride based on the data of Lewis for dilute solutions it is assumed that the ionization at 0.432 molal would be about 55 per cent. This gives 0.237 for $[Na^+]$ and $[Cl^-]$, which is the value that will be used in calculating the extent to which the ionization of the minor constituents is repressed by the excess of sodium and chlorine ions in sea-water.

From equation (4) it is calculated that when $[Cl^-]$ equals 0.237 and $[Ca^{++}] + [CaCl_2] = 0.0108$, $[Ca^{++}]$ will have the

[4] Journ. Amer. Chem. Soc. 41: 1959. 1919.

value 0.000359. If the assumptions made are approximately correct this figure shows that the ionization of the calcium compounds in sea-water is enormously repressed by the excess of chlorine ions.

In the same way, for the equilibrium

$$NaHCO_3 \rightleftharpoons [Na^+] + [HCO_3^-] \qquad (5)$$

the following equation was found to hold over a moderate range around the concentration 0.002 molal. The ionization is taken as equal to that of sodium chloride at the same concentrations.

$$\frac{[Na^+]\,[HCO_3^-]}{[NaHCO_3]^{1.27}} = 0.746 \qquad (6)$$

This yields, when $[Na^+] = 0.237$, $[HCO_3^-] = 3.15[NaHCO_3]^{1.27}$. A consideration of the relations required by this equation shows that the ionization of the bicarbonates in sea-water must be largely repressed in spite of their low concentration. For simplicity the un-ionized carbonate and bicarbonate in the solution under study will be considered to be present as the sodium compounds, a logical view on account of the great excess of $[Na^+]$.

The ionic concentrations $[HCO_3^-]$ and $[CO_3^{--}]$ may now be evaluated from the analytical data for the water under consideration. Let a, b, c, d, and e represent the molal concentrations of H_2CO_3(the free CO_2), CO_3^{--}, HCO_3^-, Na_2CO_3, and $NaHCO_3$, respectively. The following equations are available:

$$44(a + b + c + d + e) = 0.057 \qquad (7)$$

$$2b + c + 2d + e = 0.0017 \qquad (8)$$

$$c = 3.15\, e^{1.27} \qquad (9)$$

$$c = 53a \qquad (10)$$

$$b = 0.00743c \qquad (11)$$

The last two equations are derived from the equations

$$[HCO_3^-] = \frac{k_1[H_2CO_3]}{[H^+]} \qquad (12)$$

$$[CO_3^{--}] = \frac{k_2[HCO_3^-]}{[H^+]} \qquad (13)$$

in which k_1, the first ionization constant of carbonic acid, has the value 3.50×10^{-7} at 25°, according to Kendall,[5] and k_2, the

[5] Journ. Amer. Chem. Soc. 38: 1486. 1916.

second ionization constant, is given by Seyler and Lloyd[6] as 4.91×10^{-11}. The value for $[H^+]$ is 6.61×10^{-9} for the water under scrutiny, which yields equations (10) and (11) given above.

It may be noted in passing that the free CO_2, or H_2CO_3, must have a very small concentration in this water as $[HCO_3^-]$, according to equation (10), must equal 53 $[H_2CO_3]$, thus requiring a very large proportion of the total CO_2.

The solution of equations (7) to (11) gives $[H_2CO_3] = 4.49 \times 10^{-6}$, $[CO_3^{--}] = 1.96 \times 10^{-6}$, $[HCO_3^-] = 2.64 \times 10^{-4}$.

From the preceding data $[Ca^{++}][CO_3^{--}] = 3.59 \times 10^{-4} \times 1.96 \times 10^{-6} = 7.23 \times 10^{-10}$ for the Copenhagen water.

The analytical data for unaltered surface sea-water studied at Tortugas are: $P_{H^+} = 8.20$, titration carbonate alkalinity = 0.00223, total CO_2 = 0.090 gram per liter. Calculations similar to those indicated above give the results shown below with the values first obtained for the Copenhagen water.

	$[H^+]$	$[HCO_3^-]$	$[CO_3^{--}]$	$[Ca^{++}][CO_3^{--}]$
Copenhagen water......	6.61×10^{-9}	2.64×10^{-4}	1.96×10^{-6}	7.2×10^{-10}
Tortugas water........	6.03×10^{-9}	6.85×10^{-4}	5.33×10^{-6}	19.1×10^{-10}

It may be noted that there is little difference in $[H^+]$ in the two waters, the principal differences being in the figures for $[HCO_3^-]$ and $[CO_3^{--}]$. This illustrates the buffer action of the carbonates in sea-water.

With reference to the low "solubility-product" value for the Copenhagen water, the Tortugas water appears to be fully saturated with calcium carbonate. A similar conclusion was reached by J. F. McClendon from experiments in which sea-water was agitated with calcite and aragonite, and the changes in p_{H^+} and titration alkalinity observed.[7] The Copenhagen water, however, shows a relatively large loss in total CO_2. It is hoped that further data for sea-water collected under definite conditions will be available shortly. It is also hoped that in a future paper attention can be given to the possibility of improving the expressions for the mass-law equilibria used in the present paper.

[6] Journ. Chem. Soc. London 111: 158. 1917–1918.

[7] Carnegie Institution Publication 252: 255.

PHYSICAL CHEMISTRY.—*Reduction potentials of mixtures of indigo and indigo white, and of mixtures of methylene blue and methylene white.*[1] W. MANSFIELD CLARK. Dairy Division, Bureau of Animal Industry, United States Department of Agriculture.

Oxidation-reduction indicators have been used to some extent in volumetric analysis, but it is in various biochemical studies that they find their widest and most interesting applications. The reduction of methylene blue by bacteria in milk is regarded as one of the first observable evidences of bacterial action. Not all bacteria reduce this dye, and this differential property is therefore used in the identification and biochemical classification of species. An important class of bacteria seem to require the complete absence of oxygen before they will grow, and since reduced methlyene blue and reduced indigo can be used to detect minute traces of oxygen these indicators have played a most interesting part in the development of conceptions regarding the so-called anaerobic state. Anaerobiosis is a large subject whose various phases have not yet been satisfactorily resolved. There is abundant evidence, however, that one or another phase of it is intimately associated with the reducing tendency of cellular activity in general. The recognition of this tendency has come about in large measure through the use of reduction indicators such as methylene blue. It has even been claimed that reduction of this dye by a tissue indicates the presence of life and the failure of reduction indicates the death of the cells. Yet there seem to exist different powers of reduction in various tissues, as was shown in Ehrlich's classic work and confirmed by some of the more recent staining investigations of the histologists.

So far as the writer is aware such indicators have not been regarded in their possible relation to oxidation reduction potentials in a manner analogous to the now well-systematized relation of hydrogen-ion indicators to hydrogen-electrode potentials. That such a relationship if established will aid in the interpreta-

[1] Published by permission of the Secretary of Agriculture. Received February 12, 1920.

tion of various biochemical phenomena will be evident, but the significance of such data is of broader scope, because the efforts that have previously been made to bring organic compounds within the range of potential measurements have yielded few data of value.

In a subsequent paper the writer hopes to discuss in detail some of the theoretical aspects concerned in the measurement of reduction potentials, together with certain biochemical applications. But for the present only the data obtained with indigo and methylene blue will be presented.

The original sample of the indigo used in the following experiments was labeled "Indigo sodium sulfonate dye." Mr. Zoller made a sulfur determination upon the purified material which indicated that it was $C_{16}H_9N_2O_2SO_3Na$.

Mr. Zoller prepared from the original material some purer material by precipitating the dye from its aqueous solution with pure alcohol. This was dried in a current of air and then in an air oven at 105° C. It was this material that was used in the following experiments.

The methylene blue was prepared by Mr. Zoller from Schumaker and Busch's "medicinal methylene blue." For the purification the method of Bernthsen[2] was followed in the main. The crystals were dried *in vacuo* over stick KOH and concentrated sulfuric acid. It thus attained constant weight.

The most convenient form of these two substances is their oxidized state. Therefore it is required to find a reducing agent whose own oxidation-reduction equilibrium does not seriously overlap the range of potential covered by the dyes in question. Titanium trichlorid has been used by Knecht and Hibbert[3] for the quantitative estimation of methylene blue, indigo, and a variety of other dyes. However it is customarily used in very acid solutions and in a range of P_H which would have little significance for biochemical studies. Titanium, however, like iron, enters into complexes with hydroxy-acids and then remains

[2] Ann. 230: 139. 1885.

[3] *New reduction methods in volumetric analysis.*

unprecipitated even in markedly alkaline solution. Citric acid is one of the hydroxy-acids which form such complexes, and it also makes an excellent material with which to buffer the hydrogen-ion concentration throughout a considerable range of P_H. Reduced titanium in the form of titanium trichlorid was therefore added to citrate and the solution was buffered either with citrate mixtures alone or with citrate in addition to a preponderance of other buffer mixtures. The buffer salts were kept about tenth molecular while the titantium was present at about 0.003 N concentration. The dye solution containing about the same normal concentration of the dye was buffered by the salt solution. Thus a constant p_H was guaranteed throughout the titration. Hydrogen-electrode measurement of these mixtures was impracticable because of the oxidizing action of the dye in the one case and of the unreduced titanium in the other. Therefore dependence was placed on the hydrogen-electrode measurements of the P_H of the buffer solutions made up without the oxidizing and reducing agents. The addition of these reagents in concentrations of only 0.003 N should not have seriously affected the P_H of 0.1 molecular buffer mixtures.

The procedure was as follows:

The indicator solution was placed in an electrode vessel similar to that described by Hostetter and Roberts[4] for the electrometric titration of iron, but provided with gas-tight connections. The vessel was then flushed with nitrogen from a tank. This tank nitrogen contained a little oxygen and was therefore run through a heated tube containing copper wire previously reduced with hydrogen. The solution was then boiled in a vigorous current of nitrogen and while steam was still escaping the tip of the burette containing the reducing agent was forced into a tight-fitting hole on the head of the apparatus. There were then passing into the flask through the "head": The burette tip which delivered the reducing agent above the surface of the solution; the entering tube for the nitrogen which delivered the gas above the middle of the solution surface; the exit for the gas, which was flush with

[4] Journ. Amer. Chem. Soc. 41: 1337. 1919.

the surface of the stopper; the calomel electrode arm drawn to a fine gooseneck tip; and the electrode. The electrode was a platinum wire wound as a spiral and plated with gold. The electrode itself was kept immersed in the solution. It was fused into a glass tube carrying a mercury contact. Since it was not the intention to make a careful study of liquid junction potentials these were reduced so far as is practicable by the customary use of saturated potassium chlorid. This was accomplished by employing directly the "saturated" calomel electrode. Its potential was frequently checked against that of four very constant and carefully made tenth-normal calomel electrodes whose average potential in terms of the normal hydrogen electrode[5] was considered to be +0.3370. Both calomel electrode and titration vessel were immersed in an oil bath maintained at 30° C. The potentiometer equipment was that used in the writer's previous work with the hydrogen electrode. Its principal features were a Leeds and Northrup type *K* potentiometer and the same company's type *R* galvanometer with a megohm sensitivity of 1973.

The reducing agent, as mentioned before, was titanium in the presence of citrate and an excess of buffer. Since these solutions are unstable in the presence of oxygen they were prepared by adding the titanium to the previously prepared buffer mixture, quickly bubbling oxygen-free nitrogen through it, and flushing the whole system, burette and reservoir, with nitrogen.

The titrating vessel was so arranged that it could be thoroughly shaken after each addition of reducing agent. When this was done electrode equilibrium was reached within a minute or two except in certain of the more extreme conditions.

In the following tables there are given in the first column the number of cubic centimeters of reducing agent added. By plotting these against the potential it will be found that at certain p_H values there is not the sharp-end point that occurs at other acidities. Such relationships will place upon a more quantitative basis the empirical findings of Knecht and Hibbert, who discovered that a sharp-end point in the titration of many dyes such

[5] See CLARK and LUBS. Journ. Biol. Chem. **25**: 479.

as indigo can be obtained only in the presence of such substances as tartrates. Perhaps there is a specific action here to be accounted for, but the more probable explanation is that the proper relations for a sharp-end point are determined by the hydrogen-ion concentration, which mixtures such as the tartrates can control.

In the next column of the tables is given the percentage reduction estimated from the total amount of reducing agent required to completely reduce the dye. As was just mentioned, it was not always possible to estimate with precision the total requirement by determining the end point potentiometrically. In such cases the disappearance of color or merely a judgment of the end point from the form of the titration curve was used. In any case the error was not large.

In the third column are given the single electrode potentials observed. These were determined from the potential of the calomel electrode and the difference of potential between calomel and gold electrodes. In each case the standard reference value was used, so that the values given are in terms of the hypothetical normal hydrogen electrode. The sign indicates the sign of the electrode.

Since both methylene blue and indigo are reduced in accordance with reactions which may be written as

$$\text{Dye} + 2 \text{ electrons} = \text{reduced dye},$$

the potential equation of Peters becomes at 30° C.

$$E \text{ observed} = E_0 + \frac{0.06}{2} \log \frac{[\text{Oxidation product}]}{[\text{Reduction product}]}$$

The ratios

$$\frac{\text{Concentration of oxidation product}}{\text{Concentration of reduced product}}$$

multiplied by 0.03 are given in column four of the tables. In the last column are given the values of E_0 obtained from the application of the equation written above.

It will be seen that there is a substantial constancy in the values of E_0. Since no correction had been made for the true concentration of these products as influenced by the various factors of the solution the agreement is remarkable in some instances.

In the case of methylene blue it will be noted that only the potentials taken during the early part of the titration are given when the p_H of the solution is greater than 4.55. This is because in the more alkaline solutions the methylene white base precipitates. During the early part of the titration the solution remains clear and the potentials follow a smooth curve which begins normally. The curve of potentials soon tends to flatten and there comes a moment when the potential rises. It is at this moment that the reduced compound separates from its now supersaturated solution. Its removal leaves the oxidation product in greater excess and the potential of the electrode becomes more positive. Perhaps there is at hand in such phenomena the means of accurately determining the solubility of such compounds.

When there thus arose the impossibility of obtaining a complete titration curve of methylene blue at the concentration used, the part of the curve that was obtained was plotted and overlaid with the theoretical form which applies to all the curves. The probable position considered in conjunction with the calculated values of E_0 which were obtained, determined the "probable values" of E_0 which are given.

It is sometimes customary to consider a reduction electrode as a hydrogen electrode under diminished hydrogen pressure. Although the hydrogen pressures so estimated become impossibly small in some instances this may be a legitimate way of correlating reduction potentials at different acidities. We may consider the relation in the following form.

Suppose our reduction electrode were a hydrogen electrode under that pressure of molecular hydrogen which is in equilibrium with the oxidation-reduction products of the solution. Let the same solution be in contact with a hydrogen electrode under a pressure of one atmosphere of hydrogen, and let the two electrodes and the solution be connected as in a cell.

The potential of this cell will then be at 30° C.

$$E_R - E_H = 0.03 \log \frac{1}{(H_2)}$$

where E_R is the potential of the reduction electrode, E_H that of the hydrogen electrode and (H_2) represents the pressure in atmospheres of the hydrogen at the reduction electrode.

As mentioned before, we cannot accurately measure the hydrogen-electrode potential of the mixtures now under consideration, but the hydrogen-electrode potentials of the buffer mixtures without the small proportion of the oxidizing agents were carefully measured. These are given in table 13 together with the reduction potentials. The values of $\log \frac{1}{(H_2)}$ for methylene blue and for indigo differ sufficiently to distinguish between the two substances, but it may appear that the agreement among the values for either one of the substances is not satisfactory. However, when these values are plotted against p_H they will be found to fall upon a fairly smooth curve.

We may just as well consider only the differences of potential instead of calculating the hypothetical hydrogen pressure as was done above, but the values of $\log \frac{1}{H_2}$ furnish convenient numbers with which to characterize the intensity of oxidation-reduction actions.

TABLE 1

REDUCTION OF INDIGO BY TITANIUM AT P_H 1.55
Buffer: $M/10$ KCl with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_o
0.0	0.0	+0.338	....	......
1.0	6.4	+0.2517	+0.0349	+(0.2168)
2.0	12.8	+0.2365	+0.0250	+(0.2115)
3.0	19.2	+0.2276	+0.0187	+0.2089
4.0	25.6	+0.2220	+0.0139	+0.2081
5.0	32.1	+0.2176	+0.0098	+0.2078
6.0	38.5	+0.2138	+0.0061	+0.2077
7.0	44.8	+0.2104	+0.0027	+0.2077

TABLE 1—(*Continued*)

Cc. Ti solution	Per cent reduction	E_H	0.03 1 g ox./red.	E_o
8.0	51.3	+0.2070	—0.0007	+0.2077
9.0	57.7	+0.2035	—0.0041	+0.2076
10.0	64.1	+0.2000	—0.0076	+0.2076
11.0	70.5	+0.1961	—0.0114	+0.2075
12.0	76.9	+0.1917	—0.0157	+0.2074
13.0	83.3	+0.1859	—0.0210	+0.2069
14.0	89.8	+0.1784	—0.0283	+0.2067
15.0	96.2	+0.1657	....	......
15.5	99.4	+0.1505	....	......
15.6	100.0	End point	....	......
15.7	.....	+0.1414	....	......
				Average, +0.2076

TABLE 2

REDUCTION OF INDIGO BY TITANIUM AT P_H 2.45
Buffer Solution: $M/10$ Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_o
0.0	0.0	+0.3962	....	....
1.0	3.6	+0.2076	+0.0429	+(0.1647)
2.0	7.1	+0.1899	+0.0334	+(0.1565)
3.0	10.7	+0.1813	+0.0276	+(0.1537)
4.0	14.3	+0.1746	+0.0233	+0.1513
5.0	17.9	+0.1712	+0.0199	+0.1513
6.0	21.4	+0.1682	+0.0170	+0.1512
7.0	25.0	+0.1655	+0.0143	+0.1512
8.0	28.6	+0.1628	+0.0119	+0.1509
9.0	32.2	+0.1605	+0.0097	+0.1508
10.0	35.7	+0.1583	+0.0077	+0.1506
11.0	39.3	+0.1562	+0.0057	+0.1505
12.0	42.9	+0.1541	+0.0037	+0.1504
13.0	46.4	+0.1523	+0.0018	+0.1505
14.0	50.0	+0.1503	±0.0000	+0.1503
15.0	53.6	+0.1484	—0.0018	+0.1502
16.0	57.1	+0.1464	—0.0037	+0.1501
17.0	60.7	+0.1444	—0.0057	+0.1501
18.0	64.3	+0.1424	—0.0077	+0.1501

TABLE 2—(*Continued*)

Cc. Ti solution	Per cent reduction	E_H	0,03 log ox./red.	E_0
19.0	67.9	+0.1402	—0.0097	+0.1499
20.0	71.4	+0.1380	—0.0119	+0.1499
22.0	78.6	+0.1329	—0.0170	+0.1499
24.0	85.7	+0.1260	—0.0233	+0.1493
25.0	89.3	+0.1215	—0.0276	+(0.1491)
26.0	92.9	+0.1152	....	....
27.0	96.4	+0.1051	....	....
28.0	100.0	+0.082	....	....
				Average, +0.1504

TABLE 3

REDUCTION OF INDIGO BY TITANIUM AT P_H 2.87

Buffer Solution: $M/10$ Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_0
0.0	0.0	+0.3642	....	....
1.0	8.8	+0.1595	+0.0305	+(0.1290)
2.0	17.5	+0.1462	+0.0202	+0.1260
3.0	26.3	+0.1387	+0.0134	+0.1253
4.0	35.1	+0.1327	+0.0080	+0.1247
5.0	43.9	+0.1278	+0.0032	+0.1246
6.0	52.6	+0.1232	—0.0014	+0.1246
7.0	61.4	+0.1183	—0.0061	+0.1244
8.0	70.2	+0.1133	—0.0112	+0.1245
9.0	78.9	+0.1069	—0.0172	+0.1241
9.5	83.3	+0.1032	—0.0210	+0.1242
10.0	87.7	+0.0984	—0.0256	+0.1240
10.8	94.7	+0.0857	....	....
11.0	96.5	+0.0808	....	....
11.2	98.2	+0.0721	....	....
11.3	99.1	+0.064	....	....
11.4	100.0	+0.055	....	....
				Average, +0.1246

TABLE 4

REDUCTION OF INDIGO BY TITANIUM AT P_H 4.55
Indigo and Titanium about 0.003 N
Buffer Solution: N/10 Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_o
0.0	0.0	+0.3522	....	....
0.5	4.4	+0.0812	+0.0401	+(0.0411)
1.0	8.9	+0.0566	+0.0304	+(0.0262)
2.0	17.7	+0.0427	+0.0200	+0.0227
3.0	26.6	+0.0352	+0.0133	+0.0219
4.0	35.4	+0.0291	+0.0078	+0.0213
5.0	44.2	+0.0240	+0.0030	+0.0210
6.0	53.1	+0.190	—0.0016	+0.0206
7.0	61.9	+0.0140	—0.0064	+0.0204
8.0	70.8	+0.0085	—0.0115	+0.0200
9.0	79.6	+0.0021	—0.0178	+0.0199
10.0	88.5	—0.0076	—0.0266	+0.0190
10.5	92.9	—0.0152	—0.0335	+0.0183
11.0	97.3	—0.0334	—0.0469	+(0.0135)
11.2	99.1	—0.0510	....	....
11.3	110.0	—0.0620	End point	....
				Average, +0.0205

TABLE 5

REDUCTION OF INDIGO BY TITANIUM AT P_H 6.69
Indigo and Titanium about 0.003 N
Buffer Solution: M/10 Na_2HPO, M/40 Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.030 log ox./red.	E_o
0.0	0.0	—0.022	....	....
0.5	4.6	—0.0588	+0.0397	—(0.0985)
1.0	9.1	—0.0688	+0.0300	—0.0988
2.0	18.2	—0.0802	+0.0196	—0.0998
3.0	27.3	—0.0895	+0.0128	—0.1023
4.0	36.4	—0.0953	+0.0073	—0.1026
5.0	45.5	—0.0982	+0.0024	—0.1006
6.0	54.5	—0.1038	—0.0024	—0.1014
7.0	63.6	—0.1081	—0.0073	—0.1008
8.0	72.7	—0.1133	—0.0128	—0.1005

TABLE 5—(*Continued*)

Cc. Ti solution	Per cent reduction	E_H	0.030 log ox./red.	E_0
9.0	81.8	—0.1208	—0.0196	—0.1012
10.0	90.9	—0.1321	—0.0300	—0.1021
10.5	95.5	—0.1438	—0.0397	—(0.1041)
10.7	97.3	—0.1533	....	....
10.9	99.1	—0.1737	....	....
11.0	100.0	—0.198	End point	....
				Average, —0.1010

TABLE 6

TITRATION OF INDIGO BY TITANIUM AT P_H 8.58
Buffer Solution: M/10 Borate, M/40 Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_0
0.0	0.0	+0.074	....	....
1.0	8.3	—0.1266	+0.0312	—(0.1578)
2.0	16.7	—0.1398	+0.0210	—0.1608
3.0	25.0	—0.1466	+0.0143	—0.1609
4.0	33.3	—0.1518	+0.0090	—0.1608
5.0	41.7	—0.1563	+0.0044	—0.1607
6.0	50.0	—0.1603	+0.0000	—0.1603
7.0	58.3	—0.1647	—0.0044	—0.1603
8.0	66.7	—0.1694	—0.0090	—0.1604
9.0	75.0	—0.1743	—0.0143	—0.1600
10.0	83.3	—0.1814	—0.0210	—0.1604
11.0	91.7	—0.1931	—0.0312	—(0.1619)
12.0	100.0	—0.2438	End point	....
				Average, —0.1609

TABLE 7

REDUCTION OF METHYLENE BLUE BY TITANIUM AT P_H 1.55
Buffer Solution: M/10 KCl with HCl

Cc. Ti solution	Per cent reduction	E_H	0 03 log ox./red.	E_0
0.0	0.0	+0.4812	....	....
1.0	4.3	+0.4216	+0.0404	+0.3812
2.0	8.6	+0.4112	+0.0308	+0.3804
3.0	12.9	+0.4050	+0.0248	+0.3802

TABLE 7—(*Continued*)

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_o
4.0	17.2	+0.4006	+0.0204	+0.3802
5.0	21 6	+0.3969	+0.0168	+0.3801
6.0	25.9	+0.3937	+0.0137	+0.3800
7.0	30.2	+0.3909	+0.0109	+0.3800
8.0	34.5	+0.3884	+0.0084	+0.3800
9.0	38.8	+0.3861	+0.0059	+0.3802
10.0	43.1	+0.3838	+0.0036	+0.3802
11.0	47.4	+0.3817	+0.0014	+0.3803
12.0	51.7	+0.3796	−0.0009	+0.3805
13.0	56.0	+0.3677	−0.0032	+0.3808
14.0	60.3	+0.3755	−0.0055	+0.3810
15.0	64.7	+0.3733	−0.0079	+0.3812
16.0	69.0	+0.3712	−0.0104	+0.3816
17.0	73.3	+0.3688	−0.0131	+0.3819
18.0	77.6	+0.3663	−0.0162	+0.3825
19.0	81.9	+0.3632	−0.0197	+0.3829
20.0	86.2	+0.3595	−0.0239	+0.3834
21.0	90.5	+0.3542	−0.0294	+0.3836
22.0	94.8	+0.3442	−0.0379	+0.3821
23.2	100.0	+0.3095	....	....
				Average, +0.3811

TABLE 8

REDUCTION OF METHYLENE BLUE BY TITANIUM AT P_H 2.45

Buffer Solution: M/10 Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_o
0.0	0.0	+0.4242	....	....
2.0	3.4	+0.3474	+0.0438	+0.3036
4.0	6.7	+0.3354	+0.0343	+0.3011
6.0	10.1	+0.3292	+0.0285	+0.3007
8.0	13.4	+0.3248	+0.0243	+0.3005
10.0	16.8	+0.3215	+0.0209	+0.3006
14.0	23.5	+0.3163	+0.0154	+0.3009
18.0	30.3	+0.3129	+0.0109	+0.3020

TABLE 8—(*Continued*)

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_0
22.0	37.0	+0.3102	+0.0069	+0.3033
25.0	42.0	+0.3086	+0.0042	+0.3044
30.0	50.4	+0.3044	—0.0003	+0.3047
34.0	57.1	+0.3012	—0.0037	+0.3049
38.0	63.9	+0.2984	—0.0073	+0.3057
42.0	70.6	+0.2957	—0.0113	+0.3070
46.0	77.3	+0.2923	—0.0161	+0.3084
50.0	84.0	+0.2880	—0.0216	+0.3096
54.0	90.8	+0.2805	—0.0300	+0.3105
58.0	97.5	+0.2592	—0.0475	+0.3067
59.0	99.2	+0.2382	—0.0621	+0.3003
59.5	100.0	+0.2272	....	....
				Average, +0.3042

TABLE 9

REDUCTION OF METHYLENE BLUE BY TITANIUM AT P_H 2.87
Buffer Solution: $M/10$ Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_0
0.0	0.0	+0.3902	....	....
2.0	12.0	+0.2877	+0.0259	+0.2618
4.0	24.1	+0.2763	+0.0149	+0.2614
6.0	36.1	+0.2690	+0.0074	+0.2616
8.0	48.2	+0.2636	+0.009	+0.2627
10.0	60.2	+0.2585	—0.0054	+0.2639
12.0	72.3	+0.2531	—0.0125	+0.2656
14.0	84.3	+0.2458	—0.0219	+0.2677
16.0	96.4	+0.2270	—0.0426	+0.2696
16.2	97.6	+0.2207	....	....
16.4	98.8	+0.2096	....	....
16.6	100.0	+0.1832	....	....
				Average, +0.2641

TABLE 10

REDUCTION OF METHYLENE BLUE BY TITANIUM AT P_H 4.55
Methylene Blue and Titanium about 0.003 *N*
Buffer Solution: *M*/10 Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_o
0.0	0.0	+0.275	....	....
0.5	2.9	+0.179	+0.0459	+(0.133)
1.0	5.8	+0.1617	+0.0364	+(0.1253)
2.0	11.6	+0.1429	+0.0265	+0.1164
3.0	17.3	+0.1385	+0.0204	+0.1181
4.0	23.1	+0.1330	+0.0156	+0.1174
5.0	28.9	+0.1287	+0.0117	+0.1170
6.0	34.7	+0.1251	+0.0082	+0.1169
7.0	40.5	+0.1218	+0.0050	+0.1168
8.0	46.2	+0.1190	+0.0020	+0.1170
9.0	52.0	+0.1162	—0.0011	+0.1173
10.0	57.8	+0.1136	—0.0041	+0.1177
11.0	63.6	+0.1109	—0.0073	+0.1182
12.0	69.4	+0.1081	—0.0107	+0.1188
13.0	75.1	+0.1050	—0.0144	+0.1194
14.0	80.9	+0.1015	—0.0188	+0.1203
15.0	86.7	+0.0967	—0.0245	+(0.1212)
16.0	92.5	+0.0885	—0.0327	+(0.1212)
17.0	98.3	+0.0537	—0.0524	+(0.1061)
17.2	99.4	+0.015	....	....
17.3	100.0	—0.026	End point	....
				Average, +0.1178

TABLE 11

REDUCTION OF METHYLENE BLUE BY TITANIUM AT P_H 6.69
Buffer Solution: *M*/10 Na_2HPO_4, *M*/40 Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_o
0.0	0.0	+0.345	....	....
0.5	2.6	+0.0677	+0.0471	+0.0206
1.0	5.2	+0.0481	+0.0377	+0.0104
2.0	10.5	+0.0351	+0.0280	+0.0071
3.0	15.7	+0.0295	+0.0219	+0.0076
4.0	20.9	+0.0264	+0.0173	+0.0091
5.0	26.2	+0.039	....	....

Methylene white precipitate formed.
Potentials unsteady.

TABLE 11—(*Continued*)

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_0
18.3	95.8	—0.056	....	....
19.1	100.0	—0.122	....	....
		End point		

Probable value of E_0 + 0.007.

TABLE 12

REDUCTION OF METHYLENE BLUE BY TITANIUM AT P_H 8.58

Buffer Solution: $M/10$ Borate, $M/40$ Citrate with HCl

Cc. Ti solution	Per cent reduction	E_H	0.03 log ox./red.	E_0
0.05	0.2	+0.0018	....	....
0.5	2.2	—0.0136	+0.0496	—0.0632
1.0	4.4	—0.0190	+0.0403	—0.0593
2.0	8.7	—0.0244	+0.0306	—0.0550
3.0	13.0	—0.0278	+0.0247	—0.0525
4.0	17.4	—0.0300	+0.0203	—0.0503
5.0	21.7	—0.0315	+0.0167	—0.0482
6.0	26.1	—0.0322	....	....
7.0	30.4	—0.0322	....	....

Methylene white precipitate separates.
Potentials unsteady. End point by color about 23.0 cc. Ti.
Probable value of E_0 — 0.050.

TABLE 13

COMPARISON OF CHARACTERISTIC DATA OF INDIGO WITH THAT OF METHYLENE BLUE

Indigo

P_H	H electrode potential	Reduction potential	Difference	log 1/H_2
1.55	—0.0936	+0.2076	0.3012	10.0
2.45	—0.1471	+0.1504	0.2975	9.9
2.87	—0.1727	+0.1246	0.3073	9.9
4.55	—0.2737	+0.0205	0.2942	9.8
6.69	—0.4021	—0.1010	0.3011	10.0
8.58	—0.5155	—0.1609	0.3546	11.8

TABLE 13—(*Continued*)
Methylene Blue

P_H	H electrode potential	Reduction potential	Difference	log $1/H_2$
1.55	—0.0936	+0.3811	0.4747	15.8
2.45	—0.1471	+0.3042	0.4513	15.1
2.87	—0.1724	+0.2641	0.4365	14.6
4.56	—0.2737	+0.1178	0.3915	13.1
6.69	—0.4021	+0.007	0.409	13.6
8.58	—0.5155	—0.05	0.47	15.3

PETROGRAPHY.—*Italite: a new leucite rock.* HENRY S. WASHINGTON. Geophysical Laboratory, Carnegie Institution of Washington.[1]

Last October, while in Rome, there was brought to my attention by Dr. G. A. Blanc, of the University of Rome, and Ing. F. Jourdain, a small piece of a very remarkable leucite rock, that they had collected from a flow on the west slope of the volcano of Rocca Monfina, north of Naples. I am indebted to their kindness for the small specimen and for permission to publish the results of my study. A full description will be published later in the *American Journal of Science.*

The rock is rather coarsely granular and very friable, composed almost wholly (90 per cent) of spheroidal crystals of leucite from 3 to 5 mm. in diameter. These show the twinned structure remarkably well and carry few inclusions, these not being regularly arranged. These crystals are cemented by a small amount of a colorless glass, which contains many margaritic microlites. There are also present, in very small amount, prismoids of aegirite-augite and grains of titaniferous melanite, with rare small crystals of biotite, magnetite, and apatite. The glass and the microstructure show that the rock is a lava, not a tuff.

Chemical analysis yielded the results shown in table 1.

The rock is seen to have a quite exceptional composition, and shows the highest percentage for K_2O yet recorded, the next highest (11.91) being that of an orendite from the Leucite Hills,

[1] Received March 30, 1920.

closely followed by some Italian leucite trachytes and tephrites. The noselite, whose presence is indicated by the SO_3 and high CaO, probably forms part of the glass, as does melilite, the presence of which is also indicated by the norm.

In the quantitative classification the position of the rock is shown by the symbol I.9.1.1, and the new perpotassic subrang is called *monfinose.* No rock at all analogous to this is represented in the usual or modal classifications and, though the name "leucitite" might logically be applied to it, implying a rock composed essentially of leucite, as suggested by Cross many years ago, this name cannot be used, because of its present connotation and the inadvisability of redefining old names. The new name given the rock is *italite*, after the country in which it occurs, and which is so famous for its abundance in leucitic lavas.

A partial analysis (made on 0.0639 gram) of the garnet showed that it is a highly titaniferous melanite, analogous to schorlomite. Its refractive index, n = 1.94, is remarkably high, in which it resembles other titaniferous garnets, whose refractive indexes have also been recently determined by Merwin.

TABLE I

ANALYSIS OF ITALITE

SiO_2	51.02	CO_2	None
Al_2O_3	22.21	TiO_2	0.57
Fe_2O_3	1.48	ZrO_2	0.06
FeO	0.57	P_2O_5	0.02
MgO	0.14	SO_3	0.76
CaO	2.31	Cl	0.08
Na_2O	1.67	$(Ce,Y)_2O_3$	Trace
K_2O	17.94	MnO	0.01
H_2O^+	0.82	BaO	0.20
H_2O^-	0.11		
			99.97

Supplementary Note.—While the above was in press I have studied another similar, remarkable leucite rock, that forms an "ejected block" at Monte Somma. It is much like the italite just described, both megascopically and microscopically, the leucite crystals being almost identical. Small crystals of greenish, non-pleochroic augite are, however, more abundant, and there is considerable melilite, in thickly tabular crystals interstitial between the leucites and in cavities in the specimen. The rock contains no glass, the melilite taking its place, and neither garnet, biotite, nor olivine is present. The rock contains about 65 per cent of leucite, 18 of melilite, 20 of pyroxene, and 2 of magnetite. An analysis gave the results shown in table 2.

TABLE 2

ANALYSIS OF VESBITE

SiO_2	45.49	H_2O^+	0.93
Al_2O_3	17.66	H_2O^-	0.05
Fe_2O_3	0.81	TiO_2	0.13
FeO	1.45	P_2O_5	0.16
MgO	4.27	SO_3	None
CaO	16.72	Cl	0.03
Na_2O	1.66	MnO	Trace
K_2O	11.44		
			100.80

This rock is essentially a melilite italite, and the name of *vesbite* (from a Latin name of Vesuvius) is given it. Vesbite is intermediate between italite and venanzite, and is also related to the melilite leucitites or cecilites, to use an old name of Cordier for them. It falls in the position II.9.2.2, of the quantitative classification, and the name *vesbose* is given to this subrang.

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.

PALEONTOLOGY.—*A catalogue of the Mesozoic and Cenozoic plants of North America.* F. H. KNOWLTON. U. S. Geol. Survey Bull. **696**: Pp. 815. 1920.

This volume contains a bibliography of 32 pages, a catalogue of 618 pages, biologic classification of genera, index of genera and families, and floral lists of the North American Mesozoic and Cenozoic plant-bearing formations, covering 118 pages. It is an extension or up-to-date edition of *Bulletin 152* published in 1898. This catalogue should be of inestimable value to paleobotanists. R. W. STONE.

GEOLOGY.—*Conservation through engineering.* FRANKLIN K. LANE. U. S. Geol. Survey Bull. **705**. Pp. 38. 1920.

The annual report of the Secretary of the Interior to the President contained a plea for constructive policies that deserves a hearing also by the engineers and business men who are developing the power resources of the country. The largest conservation for the future can come only through the wisest engineering of the present. The conditions under which the utilization of natural resources is demanded are outlined by Secretary Lane, who recommends a program that calls for the cooperation of engineer and legislator.

The Secretary advocates saving coal by taking more power from each ton, and using each kind of coal for the particular purpose to which it is best adapted. He believes that our water power should be developed and hydro-electric power used instead of coal, and that all power plants serving a common territory should be coordinated. Our petroleum supply is exhaustible and the oil problem should have deliberate attention. A rigid policy of saving oil is urged, and it is argued that we should have a foreign supply of petroleum.

To bring this power inventory to the attention of the men who furnish the country with its coal and oil and electricity, this extract from the Secretary's administrative report is reprinted as a bulletin of the United States Geological Survey.

R. W. STONE.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

BOARD OF MANAGERS

The 234th meeting of the Board was held on November 24, 1919. In accordance with a suggestion transmitted by the Librarian of Congress, a set of the publications of the ACADEMY was sent to the library of the University of Louvain, destroyed by the German army in 1914. At the 235th meeting, on December 22, 1919, a committee consisting of R. L. FARIS, A. KNOPF, S. A. ROHWER, and R. B. SOSMAN was appointed to revise the "free list" of the *Journal.* At the 236th meeting, held on January 26, 1920, the budget for 1920 was adopted, and the following appointments for the year 1920 were announced:

Executive Committee: The *President, Treasurer,* and *Corresponding Secretary, ex officio;* WILLIAM R. MAXON and T. WAYLAND VAUGHAN.

Committee on Meetings: H. H. KIMBALL, *Chairman;* W. S. EICHELBERGER, H. L. SHANTZ, J. R. SWANTON, and R. C. TOLMAN.

Committee on Membership: L. A. FISCHER, *Chairman;* W. M. CLARK, S. A. ROHWER, J. N. ROSE, and CARL VOEGTLIN.

Editor of Journal, 1920–1922: ALEXANDER WETMORE.

The Board elected the following *Vice-Presidents* to represent societies which had not presented nominations at the Annual Meeting: *Botanical Society,* LYSTER H. DEWEY; *Institute of Electrical Engineers,* FRANCIS B. SILSBEE; *Columbia Historical Society,* ALLEN C. CLARK; *Medical Society,* FRANCIS R. HAGNER.

At the 237th meeting, held on February 9, 1920, the Board voted funds in payment for the publication of the Preliminary Report of the Federal Government Section of Engineering Council's Committee on Classification and Compensation of Engineers, published by Mr. J. C. HOYT with aid from several of the affiliated societies of the ACADEMY, and distributed to all of their membership. The Standing Rules of the Board were amended to provide for the appointment of the Committee on Meetings in June, instead of in January, as heretofore.

The following persons have become members of the ACADEMY since the last report in the *Journal:*

Mr. SAMUEL TRASK DANA, U. S. Forest Service, Washington, D. C.

Mr. EARL H. FROTHINGHAM, U. S. Forest Service, Washington, D. C.

Dr. FRANCIS R. HAGNER, 900 17th Street, Washington, D. C.

Mr. EDMUND CECIL HARDER, care Republic Mining and Manufacturing Company, 1111 Harrison Building, Philadelphia, Pennsylvania.

Dr. ALEXANDER WETMORE, Bureau of Biological Survey, U. S. Department of Agriculture, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

824TH MEETING

The 824th meeting was held at the Cosmos Club, November 22, 1919. President HUMPHREYS in the chair; 56 persons present.

Mr. R. C. TOLMAN presented the first paper on *A conception of the business of mathematical physics.*

Like other sciences, Mathematical Physics is in a process of development from a descriptive to a deductive form. As soon as the main body of a science can be handled deductively, it becomes desirable to pick out the most suitable deductive system for this purpose.

In performing this task for Mathematical Physics, use should be made of the methods developed for handling deductive systems, by Pierce, Royce, Mrs. Ladd-Franklin, Russell, Whitehead, and Meinong. The universe of discourse in such systems should be generated from a set of indefinables. These indefinables should be chosen so as to be sufficient for defining all the concepts in the particular branch of inquiry, and, if possible, should be few in number, simple in nature, familiar to previous workers in the field, independent of each other, of course should be applicable, not merely to the generation of the universe of discourse, but also applicable to the particular field of science under discussion.

After the definition of the concepts in the universe of discourse has been completed, a set of postulates should be chosen from which the various theorems of the logical system can be deduced. These postulates should be chosen so as to be sufficient for deducing all the theorems desired, so as to be consistent with one another, if possible, so as to be independent from one another, few in number, simple in nature, self-evident if possible, familiar, and of course must be true, *i. e.*, applicable to the particular field under investigation.

For defining the subject matter of Mathematical Physics, the fundamental relation "is greater than," five fundamental kinds of magnitude—mass, length, time, charge, entropy—and five fundamental operations—addition, multiplication, inner multiplication, outer multiplication, and differentiation—may be chosen as indefinables.

As postulates for Mathematical Physics, we may choose:

1. The principle of dimensional homogeneity.
2. The principle of the relativity of size. (Similitude.)
3. The principle of the relativity of motion.
4. Hamilton's principle. (Corollary Conservation of Energy.)
5. The principle of the constant velocity of light.
6. The principle of the indivisibility of the electron.
7. The principle of entropy increase.
8. The principle that crystals have zero entropy at the absolute zero.
9. Some principle for quantum action which is not yet known.

These postulates furnish the methods of operation for handling the greater bulk of the material treated in Mathematical Physics.

Discussion: The paper was discussed by Messrs. HUMPHREYS, HAWKESWORTH, LLOYD, HULL, FOOTE, BAUER, WHITE, AGNEW, and TUCKERMAN.

Mr. E. F. MUELLER next presented a paper on *The standard scale of temperature* by C. W. WAIDNER, E. F. MUELLER, and P. D. FOOTE.

The standard scale of temperature which it is attempted to realize in practice is the centigrade thermodynamic scale. Owing to the experimental difficulties involved in the use of the gas thermometer, it is necessary to establish a working scale, which should represent the thermodynamic scale as closely as is possible in the light of existing knowledge. It is equally important, however, that the working scale be characterized by a high degree of definiteness and reproducibility. The working scale is defined by means of certain fixed points, such as freezing or boiling points, and by specifying the method of interpolation between the fixed points. In 1914, the three leading national laboratories, the Physikalish-Technische Reichsanstalt, the National Physical Laboratory and the Bureau of Standards had practically agreed on the details of a working scale. While the scale was not formally adopted, each laboratory has adopted it independently, there being only minor differences between the three. In the interval —190 degrees to +450 degrees, the fixed points are those defined by the boiling point of oxygen, sublimation point of CO_2, freezing and boiling points of water, and the boiling point of sulphur, and the platinum resistance thermometer is used as the interpolation instrument. In the interval 450 degrees to 1100 degrees the platinum—90 per cent platinum, 10 per cent rhodium thermocouple is used as interpolation instrument, being calibrated at the freezing points of zinc, antimony and copper. A number of fixed points in addition to those given were also agreed upon.

In the negotiations between the laboratories, no attempt was made to define a scale above 1100 degrees. Present practice, however, tends toward using the disappearing filament type of optical pyrometer as an interpolation instrument, using one or more metal freezing points for calibration. An outstanding discrepancy of 7 degrees in the values obtained by different methods for the melting point of palladium makes the adoption of uniform scale for temperatures above 1200 degrees a difficult matter at present.

Discussion: The paper was discussed by Messrs. WHITE, ADAMS, TOLMAN, and TUCKERMAN.

The Society adjourned at 10.06.

S. J. MAUCHLY, *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

322ND MEETING

The 322nd regular meeting of the Society was held in the auditorium of the Cosmos Club on May 1, 1919. Vice-President WALTON was in the chair and there were present sixteen members and one visitor.

The regular program was as follows:

A. B. GAHAN: *The black grain-stem sawfly of Europe in the United States.* This paper dealt with *Trachelus tabidus* (Fab.), the establishment of which in the United States has been recently discovered. This insect may become a serious pest of small grains, especially wheat. Some of the points discussed were distribution both in the United States and in the Old World, character of injury, description of adult and larva, and a comparison with related species, suggestions for control, and bibliography. The illustrations consisted of drawings of the adult, the larvae of this and two allied species of similar habit, and a map of the distribution in the United States.

In the discussion Mr. WALTON stated that Mr. McCONNELL of the Bureau of Entomology had discovered a parasite that killed as high as 30 per cent of the sawfly larvae. Dr. QUAINTANCE remarked that this appears to be one of the few cases in which the necessary means for insect control conflict with good agricultural practice, the rotation of clover and wheat being undoubtedly good agricultural practice and also favoring reproduction of the insect. Mr. WALTON took exception to this, stating that forage experts claim that better clover can be grown on plowed land; but planting on stubble is easier and cheaper. Mr. ROHWER stated that sawflies are sluggish fliers and was of the opinion that if in the rotation, fields to be planted to grain were far apart, the infestation would be considerably reduced. Mr. GAHAN thought that the fact that the species is already widely distributed in both mountain and plains regions indicates considerable ability to spread. Winds as a means of spread being suggested, Mr. ROHWER stated it as his experience that sawflies seek shelter in high winds. He also stated that the species is possibly more widely distributed than outlined by Mr. GAHAN, inasmuch as he has a larva from near Parkersburg, West Virginia, that is probably this species.

Notes and Exhibition of Specimens

Mr. Schwarz gave an account of a recent visit which he and several other entomologists had made to the Florida everglades and keys. He described the topography and flora of the region, especially contrasting the character of the everglade keys with the Florida Keys. He spoke of the occurrence in semitropical Florida of the coleopterous genus *Dendrocinus* (family Scolytidae). The type of this genus, *D. globosus* Eichoff, was described in 1868 from two specimens said to have come from "North America," but the correctness of this locality has always been doubted. However, during this visit to Florida Mr. H. S. Barber found an undescribed species of the genus at Marathon (Key Vacas) boring in the solid wood of *Bourreria havaniensis*. This species differs greatly from *D. globosus* and the other species of the genus, and Mr. Schwarz presented a description of it for publication in the proceedings.

Mr. Cushman discussed the larva of the spider parasite, *Polysphineta texana* Cresson, describing its method of maintaining its hold on its host.

Dr. Baker discussed the probable synonymy of *Neotoxoptera violae* Theob. of Egypt with *Rhopalosiphum violae* Pergande of America on the ground that forms similar to the former can be produced in greenhouses in this country. Mr. Rohwer thought that the fact that a form of the American species resembling the African form can be produced in greenhouses was no proof that the American and African forms are the same species. He objected to the synonymizing of the two until further proof of their identity is obtained. In support of his contention he cited the case of the so-called *Cladius pectinicornis*, one of the rose-slugs, stating that the American form, which has heretofore been considered as the same as the European species, is specifically distinct. Mr. Heinrich agreed with Mr. Rohwer, stating that in the Microlepidoptera American species are being rapidly found distinct, so that the European names are taken out of American literature.

323D MEETING

The 323d regular meeting was held at the Cosmos Club on June 5, 1919. President Sasscer presided and there were present twenty-four members and six visitors.

The program offered was as follows:

R. H. Hutchinson: *Experiments with steam disinfection in destroying lice in clothing.* Mr. Hutchinson prefaced his paper with some remarks about the louse, showing lantern slides illustrating sexual characters, eggs, hatching, and the effect of steam on eggs. Further slides were then thrown on the screen showing field laundry units and a large delousing station used at debarkation camps, the speaker explaining in detail all the different processes and apparatus.

Major Harry Plotz, U. S. Army, told of some of his experiences in connection with this work in Bulgaria in the early part of the war. Dr. Baker was interested in the presence, mentioned by Mr. Hutchinson, of the peculiar yellow body in the nymphs of the louse and the fact that it has not been recorded in the literature of the louse. A similar body, he said, always occurs in several groups of Homoptera that he had studied. Its forerunner is present in the egg and is carried to the interior at the time of invagination. In parthenogenetic forms its history is associated with the development of the ovaries. Buckner considered it a commensalistic organ, but this view is not held by all embryologists.

A. N. Caudell: *Notes on Zoraptera.* A discussion of the biology and systematics of this peculiar group of insects. Points of particular interest were the finding of winged forms by Mr. H. S. Barber and the fact that the insects have the habit of dealation.

G. C. Crampton: *Phylogeny of Zoraptera.* Presented by title.

324TH MEETING

The 324th regular meeting of the Society was held October 2, 1919, in the auditorium of the Cosmos Club. Vice-President Gahan presided and there were present twenty-three members and six visitors.

The following program was given:

Harry F. Dietz: *Notes on the insect fauna of Panama.*

This was an account of Mr. Dietz's observations in the canal zone, especially on the scale-insects *Aleurocanthus woglumi* and *Coccus viridis*, and on termites of various species. The talk was copiously illustrated by lantern slides.

In the discussion of this paper Mr. Schwarz spoke of the entomological exploration of the Canal Zone, especially of that by Motschulsky and Leconte and the collaborators of the Biologia Centrali-Americana, as well as the more recent Smithsonian Expedition including Messrs. Schwarz and Busck.

H. F. Wickham: *Two new Carabidae from Alaska.*

In presenting this paper Mr. Schwarz spoke of the knowledge of the Coleoptera of Alaska, dwelling more especially on the collections made by Dr. Eschscholtz and those made under the guidance of Count von Mannerheim. He pointed out that all the early explorations were on the southern coast of Alaska including the islands of the Bering Sea. The two species of *Tachypus* described in Prof. Wickham's papers were collected in the interior, where the fauna is radically different from that of the coast region. Mr. Schwarz also gave a short account of Motschulsky's trip to North America as published by that author in his letters to Ménétriéz.

Dr. Howard introduced Dr. S. I. Kuwana, the famous Japanese entomologist, who addressed the Society briefly in Japanese and in English in appreciation of his trip about the United States in search of entomological methods and ideas.

Notes and Exhibition of Specimens

Dr. Aldrich spoke of the problem in distribution offered by the Ephydrid fly, *Lipochaeta slossonae* Coq. This fly lives along the margin of the Atlantic Ocean from New Jersey southward and along the Gulf coast, reappearing at Long Beach in Southern California. He did not know whether it occurs around the coast of South America or if its distribution is discontinuous.

Dr. HOWARD reported that Mr. Austin H. Clark had taken a specimen of the West Indian moth, *Thysania zenobia*, in Washington on September 29, and that another specimen had been reported on September 22.

325TH MEETING

The 325th meeting of the Society was held in the Lecture Hall of the Cosmos Club on November 6, 1919. President SASSCER presided and there were present thirty-three members and four visitors. New members elected: LESTER L. SPESSARD and HENRY Y. GOULDMAN of the Federal Horticultural Board; CHARLES H. RICHARDSON and ERNEST L. CHAMBERS of the Bureau of Entomology; and RYOICHI TAKAHASHI of the Forest Experiment Station, Meguro, Tokio, Japan.

The regular program was as follows:

L. O. HOWARD: *On entomologists.* This paper was an historical review of the development of entomology from the purely systematic museum work to the intensely scientific biological and economic phases of the science of the present day. Taking as a text "The systematic entomologist must be an all-round entomologist; the economic entomologist must be an all-round entomologist; and both systematic and economic entomologists must be all-round men," Dr. Howard showed the interdependence of all phases of the science, and the fact that the economic entomologists are coming more and more to realize their dependence upon the systematists. The change in the attitude of other branches of science and of the layman toward the entomologist and the factors that have caused the change were also brought out.

Many of the members of the Society expressed their appreciation of Dr. Howard's paper. Dr. QUAINTANCE thought that economic entomology has kept pace with other branches of science. When the experiment stations were established there were no trained entomologists and it was necessary to call on men in other professions who had a general knowledge of biology. In course of time textbooks were published, courses were established in colleges, and entomological papers improved. In more recent years entomologists have contributed some of the best biological papers in any line. As for personal characteristics he thought there was no more wholesome and sociable group of men. Mr. SCHWARZ stated that some of the earliest American entomological publications, even catalogues, contained items on the economic phase of the science.

Dr. HOPKINS commented on the contributions of entomologists to biology and paid a personal tribute to Dr. Howard in the following words: "Dr. Howard has not referred to the entomologist who has done more to command the recognition of the broad aspects of entomological research as related to other sciences and to practice in agriculture and medicine, and who has also done more to command respect for entomology and entomologists by scientists and the public in general than any other. Dr. Howard, through his liberal policy as Chief of the Bureau of Entomology, and his helpful personal interest and counsel, deserves far more credit for the achievements of other entomologists in and out of the Bureau than has been recognized or perhaps ever will be.

He has not only offered unlimited opportunities for the exercise of initiative and the pursuing of original lines of research leading in all directions, and sometimes penetrating deeply into his own fields of investigation, but has given personal advice and made suggestions that have pointed the way to rapid progress in the achievement of results. We are all (especially the older members of the Society) familiar with the very large number of contributions in *Insect Life*, bulletins of the Division and Bureau of Entomology, and his monumental work, systematic and economic, on parasitic Hymenoptera and mosquitoes, and on other insects in their relation to the health of man, which stand as striking examples of the service entomology has rendered to humanity and to the general advancement of biological knowledge. I want to take this opportunity to acknowledge and express my gratitude and appreciation of the opportunities and facilities that have been offered to take up and pursue the lines of work that have been of greatest interest and pleasure to me."

Dr. BAKER called attention to the change in the attitude of medical men brought about by the war and to the function of entomologists in the war in connection with camp sanitation. Mr. ROHWER told of an entomologist of the old school who complained that taxonomy is not what it formerly was. Mr. Rohwer agreed but stated that the taxonomist has progressed and broadened. Mr. HEINRICH feared that the greater recognition of economic entomology would prove disadvantageous to taxonomy and that the taxonomist of the future will have to be very self-sacrificing from a financial standpoint. Dr. HOWARD took exception to this, stating that the economic men appreciate the need of accurate taxonomic work.

The second paper on the program was as follows:

CARL HEINRICH: *A new genus of Oecophorid moths from Japan.*

Notes and Exhibition of Specimens

Mr. HYSLOP called attention to the recent death of Mrs. C. H. Fernald, author of the "Catalogue of the Coccidae of the World."

Mr. HEINRICH exhibited photographs of the camp where Emerson L. Diven, who had been engaged in aeroplane scouting in connection with the work on the pink boll-worm of cotton, and his pilot were killed in an aeroplane accident.

Mr. CAUDELL told of stridulation by the severed legs of the common house centipede and also of the stridulation of a cockroach. The legs of the centipede move very rapidly for a time after being removed from the body, the sound being caused by the rubbing of a spine on the basal joint against the next joint. Dr. HOPKINS and Mr. SCHWARZ spoke of the stridulating organs of the scolytid beetles, some of which have these organs on the sides of the body while others have them on the head. In some species the males have these organs on the head and the females have them at the anal end.

Mr. Schwarz told of a monument erected to the boll weevil in Alabama.

Dr. Baker spoke of finding an aphid on chestnut at Falls Church, Virginia, which was otherwise known to him only from one slide of specimens taken on guava, and that it had since disappeared from chestnut. This reminded Dr. Hopkins of a gnat that was discovered associated with potato-scab that had never been rediscovered.

Dr. Quaintance called attention to the change of habit of the codling moth in attacking walnuts in California. It has become a serious problem and is revolutionizing the industry.

Dr. Hopkins stated that if an insect common to several hosts breeds for a number of generations on one host it will not go to another. This fact is taken advantage of in forest practice against certain scolytids.

Dr. Craighead told of his experiments in transferring cerambycids from one host to another and of the difficulty in inducing them to go back to their normal hosts.

Mr. Heinrich stated that the codling moth belongs to the most plastic group in the microlepidoptera, and cited as an example the eastern *Evetria frustrana*, which if transferred to the western Jack pine develops into *Evetria bushnelli*.

Dr. G. P. Engelhart of the Brooklyn Museum was introduced by the president and addressed the Society briefly concerning his work at that institution.

Mr. Rohwer criticised the lack of short notes by the younger members of the Society. These men, he thought, being largely engaged in field work, should have opportunity to make many observations of interest and should present them at the meetings.

R. A. Cushman, *Recording Secretary*.

SCIENTIFIC NOTES AND NEWS

Ground was broken on April 5 for the new building of the Medical Society of the District of Columbia, to be erected on M Street between Seventeenth Street and Connecticut Avenue.

The Weather Bureau's earthquake summary shows that 87 earthquakes of appreciable intensity occurred in the United States in 1919, as compared with 127 in 1918. As usual, a considerable number of quakes (10) during this year occurred in the Mississippi Valley region. One earthquake occurred near Front Royal, Virginia, but was less intense than the one of 1918 which was central in the same general region and which was felt in the District of Columbia.

During the development of an optical method for studying recording instruments, it has been found at the Bureau of Standards that the photographic records obtained furnished incidentally an excellent means of determining the uniformity of motion of the clockwork used to drive the recording mechanism. A study of this feature has been undertaken using clockwork of foreign and domestic manufacture, and it is believed that the method will prove to be directly applicable to chronographs.

The Bureau of Standards has completed arrangements to test the comparative durability of upper leather made from shark and porpoise skins as compared with that from calfskin and cowhide. The cooperation of the National Boot and Shoe Manufacturers' Association has been secured in the making of the necessary shoes for the tests.

Dr. Lyman J. Briggs, formerly physicist in the Bureau of Plant Industry, U. S. Department of Agriculture, who has been on temporary assignment to the Bureau of Standards for research on aeroplane problems during the war, was transferred permanently to the staff of the Bureau of Standards in January.

Mr. John B. Ferguson, formerly of the Geophysical Laboratory, Carnegie Institution of Washington, and now a member of the research department of the Western Electric Company of New York City, has accepted a position as Associate Professor of Chemical Research at the University of Toronto, Toronto, Canada. He will assume the new position in July.

Mr. L. H. Greathouse, of the U. S. Fixed Nitrogen Research Laboratory, resigned on March 31 to accept a position with the Atmospheric Nitrogen Corporation in New York City. This corporation has been organized by the General Chemical Company and the Semet-Solvay Company.

Dr. P. J. S. Cramer, of Java, known for his studies on the culture of rubber, visited Washington in March.

Mr. H. D. McCaskey resigned from the U. S. Geological Survey in March to assume charge of the Bora Da Orchards at Central Point, Oregon.

Prof. E. B. Matthews, of the National Research Council, and Mr. M. O. Leighton, National Service Representative of Engineering Council, have been authorized by the recently created Board of Surveys and Maps to organize an advisory council to the Board, consisting of representatives of engineering, geographic and other organizations, which shall represent the public and the professions in the presentation and discussion of unofficial demands and needs in connection with the mapping work of the United States.

Dr. M. E. Pennington, formerly chief of the food research laboratory of the Bureau of Chemistry, U. S. Department of Agriculture, has become manager of the research and development division of the American Balsa Company, Inc., at 50 E. 42d Street, New York City.

Dr. H. C. Puckett, of Seattle, Washington, visited the laboratory of the Division of Physical Anthropology, Smithsonian Institution, in March, for the purpose of examining the teeth in skulls of various primitive peoples, and gathering information which will aid in determining the cause of early decay in human teeth. He finds but little indication of decay in the teeth of aborigines, a fact accounted for, he believes, by the coarseness of the food they consumed. White flour, soft foods and insufficient mastication are considered by him to be responsible for the relatively large proportion of defective teeth among highly civilized peoples.

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PHYSICS.—*A simple substitute for a cathetometer.*[1] J. B. FERGUSON, New York City.

A cathetometer is often used, especially by investigators of problems involving gases, when a pressure reading is desired with an accuracy of 0.1 mm. or better. This instrument is, however, very cumbersome and also expensive. It may be replaced to advantage by a "micrometer depth gauge," which is an inexpensive[2] machinists' tool of small size capable of giving readings with an accuracy of 0.01 mm. or 0.0005 inch.

These gauges usually consist of a vertical rod, with a sliding head mounted perpendicular to the rod and provided with a micrometer or a vernier. The head has a polished surface about $^1/_2$ inch (13 mm.) in width, which is sufficient to enable one to make an accurate setting by sighting across it against a mercury meniscus.

To illustrate the possibilities of such an instrument, one was set up in a retort stand with the head opposite the two surfaces of mercury in a partly-filled U-tube, and various observers determined by it the position of one mercury meniscus. Readings were made first with the gauge in front and then behind the U-tube. The results are given in table 1. This instrument was graduated in inches, but instruments graduated in millimeters are also obtainable.

[1] Received April 6, 1920.

[2] A four-inch instrument would cost not over ten dollars.

TABLE 1

Level Readings on Mercury Meniscus, Made by Different Observers

Observer	Reading inches	Position of gauge
A	0.631	In front of tube
	0.6315	In front of tube
B	0.6335	In front of tube
	0.6335	In front of tube
C	0.626	In front of tube
	0.624	In front of tube
A	0.3229	Behind tube
	0.321	Behind tube
B	0.325	Behind tube
	0.324	Behind tube
C	0.3234	Behind tube
D	0.315	Behind tube
	0.315	Behind tube
	0.314	Behind tube
E	0.3209	Behind tube
	0.319	Behind tube
	0.319	Behind tube

The different observers apparently did not all set alike, but each was able to repeat his own measurements with sufficient precision so that each could have measured a pressure difference to ±0.001 inch or about ±0.02 mm.

The above-mentioned use is but one of the many to which such a useful little instrument can be put and no doubt specially shaped heads could be obtained for particular purposes if desired.

BOTANY.—*Revision of the true mahoganies (Swietenia).* S. F. Blake, Bureau of Plant Industry.[1]

The genus *Swietenia*, from which the true mahogany of commerce is derived, was described by Jacquin[2] in 1760. His single species, *Swietenia mahagoni*, was based on a reference to plate 81 of the second volume of Catesby's Natural History of Carolina. This plate is also the basis of Linnaeus' *Cedrela mahagoni*,[3]

[1] Received March 12, 1920.

[2] Enum. Pl. Carib. 4: 1760.

[3] Syst. ed. 10. 940. 1759.

the first binominal name given to the mahogany. Catesby[4] gives a fairly good plate showing the fruit and leaves of the mahogany, with a figure of some withered flowers, and describes its manner of growth in the Bahamas.

About 1836 a second species, *S. humilis*, was added to the genus by Zuccarini,[5] described from specimens collected in Tehuantepec, Oaxaca, by Karwinski. For many years this species has remained comparatively little known. Recently, however, Harms[6] has referred to *S. humilis* a species grown in the Botanic Garden at Victoria, Camerun, West Africa, from seeds collected by Preuss near San Julian, El Salvador, on June 9, 1900. Preuss,[7] in his book on Central and South America, mentions in several places a mahogany which he calls *Swietenia bijuga*, a name never used by any other author (except as cited by Harms from Preuss' book), and not defined by Preuss. Under this name he refers not only to the species from El Salvador, discussed by Harms, but also to a mahogany from Venezuela, which is presumably the species recently described by Pittier[8] as *S. candollei*. Harms describes the species grown in Camerun as having leaflets 10 to 12 cm. long, 4 to 5 cm. wide, thus much larger than those of Zuccarini's original *S. humilis*, but he does not consider the plant botanically distinct. Specimens from Chiapas, collected by Seler (no. 1921), from Guerrero, collected by Langlassé (no. 132), and from Michoacan, collected by Endlich (no. 1335), are also referred to *S. humilis* by Harms. None of this material has been examined by the present writer, but it is clear from Harms' description of the Camerun material that it at least belongs to the species described below as *S. cirrhata*.

A third species, *Swietenia macrophylla*, was described and figured by King[9] in 1886, on the basis of trees grown in the Botanic Garden at Calcutta from seed supposed to be from

[4] Nat. Hist. Carol. **2**: 81. Pl. 81. 1743.
[5] Abh. Akad. Muench. **2**: 355. Pl. 7. 1835–36.
[6] Rep. Sp. Nov. Fedde **12**: 210–211. 1913.
[7] Exped. Centr. u. Suedamer. 112, 432, 433, 440, 442. 1901.
[8] Journ. Wash. Acad. Sci. **10**: 33. 1920.
[9] Hook. Ic. **16**: pl. 1550. 1886.

Honduras. It is now known in the wild state from Tabasco and Campeche to eastern Guatemala and Honduras, and is evidently the only species of the genus on the eastern coast of Central America.

Swietenia candollei, recently described by Pittier,[10] is presumably the only species of *Swietenia* native in Venezuela. It is easily distinguished from *S. mahagoni* by its much longer leaflets and larger flowers, and from *S. macrophylla* by its longer petiolules and obtuse capsules.

A fifth species, not hitherto described, is represented in the National Herbarium by fine flowering material collected in Michoacan by Nelson, and by foliage material collected in Sinaloa and Oaxaca. This species has the subsessile leaflets which distinguish *S. humilis* from all other Swietenias hitherto described, but these are much larger than in that species and are provided with a very long twisted cusp formed by the excurrent midvein. To it evidently belong the specimens mentioned by Harms as grown at the Botanic Garden of Victoria in Camerun, from seeds collected by Preuss in El Salvador.

An interesting account of the history of the three species of mahogany previously recognized has been published by R. A. Rolfe in a recent number of the Kew Bulletin,[11] with references to illustrations and to much of the literature relating to the subject.

The distribution of the five species of Swietenia now known may be summarized as follows: *Swietenia mahagoni* is the only species known from the West Indies, Bermuda, and the Bahamas, as well as the keys of southern Florida. It has been introduced into Trinidad, Venezuela, and the Hawaiian Islands, and is recorded by Casimir DeCandolle from Peru, but the latter record is certainly very questionable. *Swietenia candollei* is a native of Venezuela. *Swietenia macrophylla* is the mahogany of the eastern coast of Central America, from Tabasco to Honduras,

[10] Journ. Wash. Acad. Sci. 10: 33. 1920.

[11] Kew Bull. 1919: 201–207. 1919.

and is also cultivated in botanic gardens at Trinidad, Buitenzorg, and Calcutta. *Swietenia cirrhata* is known in the wild condition from Sinaloa, Michoacan, Oaxaca, and El Salvador, and has been introduced into cultivation in the Botanic Garden at Victoria in Camerun. *Swietenia humilis* is known as a wild species from the coast of Guerrero, Oaxaca, and northwestern Guatemala. The distribution of these species, so far as it is now definitely known, is shown on the accompanying map. It remains to determine the identity of the mahoganies growing between Honduras and Colombia, and also that of the mahogany recorded from Peru as *S. mahagoni* in DeCandolle's monograph, at a time when only two species of the genus were known from America.

Fig. 1.—Map showing range of the species of *Swietenia*. 1, *S. humilis;* 2, *S. cirrhata;* 3, *S. macrophylla;* 4, *S. candollei;* 5, *S. mahagoni.*

(NOTE.—The southernmost locality shown on the map in the range of No. 1, *S. humilis,* belongs properly to No. 2, *S. cirrhata.*)

As is well known, the name mahogany is applied in the trade not only to the wood furnished by various species of Swietenia but also to similar woods derived from a considerable number of other trees, in some cases belonging to widely separated families. In fact, the bulk of the "mahogany" annually brought to market is derived from other trees than Swietenia. Of the true mahoganies, belonging to the genus Swietenia, *S. macrophylla* is probably the one of most importance at the present time. This species grows on the Atlantic coast of Central America from Tabasco to Honduras and for an undetermined distance southward, and is shipped from Belize, Puerto Barrios, and various other points. *S. mahagoni*, of much importance in early days, is probably now marketed in less quantity than *S. macrophylla*. The species of western Mexico, *S. cirrhata* and *S. humilis*, are at present little utilized, and the same is true of the Venezuelan species, *S. candollei*.

Swietenia Jacq. Enum. Pl. Carib. 4. 1760.

Mahagoni Adans. Fam. Pl. **2**: 343. 1763.
"*Roia* Scop. Introd. 226. 1777."
Suitenia Stokes, Bot. Mat. Med. **2**: 436, 479. 1812.

Trees with hard and heavy red wood, glabrous throughout except for the sometimes ciliolate calyx and corolla; leaves alternate, abruptly pinnate, or sometimes odd-pinnate, the leaflets 2 to 6 pairs, opposite or subopposite, elliptic to oval, strongly inequilateral, subsessile or petiolulate; panicles axillary, pedunculate, many-flowered, the flowers whitish or greenish yellow, short-pedicellate; calyx (4 or) 5-lobed for one-third to one-half its length, the lobes semicircular or deltoid, broadly rounded to barely acutish; corolla imbricate in bud, the petals (4 or) 5, oblong-oval or obovate-oval; staminal tube (8 to) 10-toothed at apex, the teeth triangular, acute; anthers borne inside the tube at its apex, alternating with the teeth, subsessile, oval-oblong, obtuse; disk crenulate, about half as long as ovary or less; ovary (4 or) 5-celled, the cells bearing about 12 ovules in two rows of 6 or 7 each; style columnar, about as long as ovary or slightly longer; stigma discoid, thickened, crenulate, about as broad as ovary; capsule ovoid, rounded or umbonate at apex, septicidally dehiscing from the base or apex, with thick woody exocarp and much thinner leathery endocarp, the valves and seeds eventually deciduous leaving the persistent pentagonal narrowly 5-winged receptacle; seeds imbricate, about 12 in each cell, with more or less quadrangular body and much longer slightly broader wing thickened on the chalazal margin; embryo transverse, with broad, flat, oily cotyledons and minute radicle, and scanty albumen.

Type species *Swietenia mahagoni* Jacq.

KEY TO SPECIES

Leaflets subsessile; seeds light brown.

Leaflets 5 to 9 cm. long, 0.8 to 3 cm. wide.........1. *S. humilis.*

Leaflets 8.5 to 14 cm. long, 3 to 5 cm. wide.........2. *S. cirrhata.*

Leaflets distinctly petioluled; seeds dark chestnut-brown.

Petals and sepals ciliolate; leaflets 6 to 18 cm. long; capsule 9 to 15 cm. long; seeds 7.5 to 10 cm. long.

Petiolules 1.5 to 7 mm. long; capsule umbonate at apex 3. *S. macrophylla.*

Petiolules 6 to 12 mm. long; capsule obtuse....4. *S. candollei.*

Petals and sepals not ciliolate; leaflets 3.5 to 7.5 cm. long; capsule 4.5 to 7 cm. long; seeds 2 to 4 cm. long.5. *S. mahagoni.*

1. **Swietenia humilis** Zucc. Abh. Acad. Muench. **2**: 355. Pl. 7. 1835–36.

Tree 7 to 10 meters high, about 6 dm. in diameter, with dense head; branchlets gray; leaves with 2 to 5 pairs of leaflets; petiole 3.5 to 5 cm. long, the rachis 1.5 to 7 cm. long; leaflets 5 to 9 cm. long, 0.8 to 3 cm. wide, elliptic-lanceolate to elliptic-ovate, attenuate at apex and provided with a flattish cusp 3 to 7 mm. long, cuneate to rounded at base, subsessile, prominulous-reticulate both sides, somewhat paler green beneath; panicles pyramidal, 4 to 12.5 cm. long (including the 2.5 to 5.5 cm. long peduncle); pedicels 0.5 to 3 mm. long; calyx 1 mm. long, 5-lobed about to middle, the lobes deltoid, obtuse to acutish, papillose-ciliolate; petals obovate-oval, emarginate at the broadly rounded apex, ciliolate throughout, 5 mm. long, 2.8 mm. wide; staminal tube glabrous, the teeth lance-ovate, acute; disk crenate, papillose, about two-fifths as long as ovary; style shorter and stigma narrower than the ovary; fruit 15 to 20 cm. long, 10 to 12 cm. thick, ovoid, obtusely umbonate at apex; seeds about 10 in each cell, light brown, 6 to 9 cm. long, 2 to 2.5 cm. wide.

TYPE LOCALITY: Dry sunny places near Tehuantepec, Oaxaca, Mexico, altitude about 300 meters. Type collected by Karwinski.

SPECIMENS EXAMINED:

GUERRERO: Acapulco, 1894–95, *Palmer* 405.

OAXACA: Taretan, 1883, *Dugès* (Gray Herb.). Chivela, April 26, 1910, *Orcutt* 3190. Tonameca, altitude 25 meters, November 9, 1917, *Reko* 3549.

CHIAPAS: Between Santa Catarina and Santa Lucia, December, 1906, *Collins* (photog. of leaves and fruit).

GUATEMALA: Near Nenton, Huehuetenango, altitude 915 to 1220 meters, December, 1895, *Nelson* 3533.

The description of the floral details, which differs in some minor features from that of Zuccarini, has been that drawn up from the sheet in the Gray Herbarium collected in Oaxaca by Dugès, which was originally recorded in the Botanical Gazette.[12] Prof. Dugès gives the native name as "cobano." The species is easily distinguished by its comparatively small and attenuate subsessile leaflets.

Solereder[13] has made a careful microscopical examination of seeds of this species purchased of a drug-dealer in the Puebla market, and said to be very poisonous. Solereder finds that what had previously been described as albumen is in reality a part of the cotyledons. He finds, however, that a small amount of true albumen is present in the seeds.

Rose[14] states that the seeds of a Swietenia, referred to this species with some doubt, were sold by Indian peddlers near Acaponeta, Tepic, and were made into a tea which was taken for pains in the chest. The native name was given as "flor de venodillo (venadillo)."

2. **Swietenia cirrhata** Blake, sp. nov.

Tree; branchlets grayish brown, lenticellate; leaves with 3 to 6 pairs of leaflets; petiole 3 to 7.5 cm. long, the rachis 9 to 20 cm. long, terminated by a cusp 2 to 7 mm. long; leaflets 8.5 to 14 cm. long, 3 to 5 cm. wide, subopposite below, opposite above, obliquely ovate or elliptic-ovate, acuminate, tipped by a filiform twisted cusp 3 to 13 mm. long, acute to rounded at base, subsessile, pergamentaceous to subcoriaceous, pale green, glaucescent especially beneath, prominulous-reticulate on both sides, with 9 to 10 pairs of lateral veins; panicle 23 cm. long (including the 8 cm. long peduncle), 15 cm. wide; pedicels 1.5 to 2 mm. long; calyx 0.8 to 1 mm. long, 5-lobed to middle, the lobes broadly deltoid or suborbicular, broadly rounded, ciliolate; petals 5, oval-oblong, rounded, erose-ciliolate throughout, 4.8 mm. long, 2.8 mm. wide; staminal tube glabrous, 3.8 mm. long, the 10 teeth triangular-ovate, acutish; disk crenulate, papillose, half as long as ovary; pistil 4.5 mm. long; style about a quarter longer than ovary; seeds light brown, similar to those of *S. humilis*.

Type in the U. S. National Herbarium, no. 399294, collected at La Salada, Michoacan, Mexico, March 15 to 22, 1903, by E. W. Nelson (no. 6925).

[12] Bot. Gaz. **10**: 430. 1885.

[13] Archiv. Pharm. **229**: 249–258. Pl. 1891.

[14] Contr. U. S. Nat. Herb. **5**: 229. 1899.

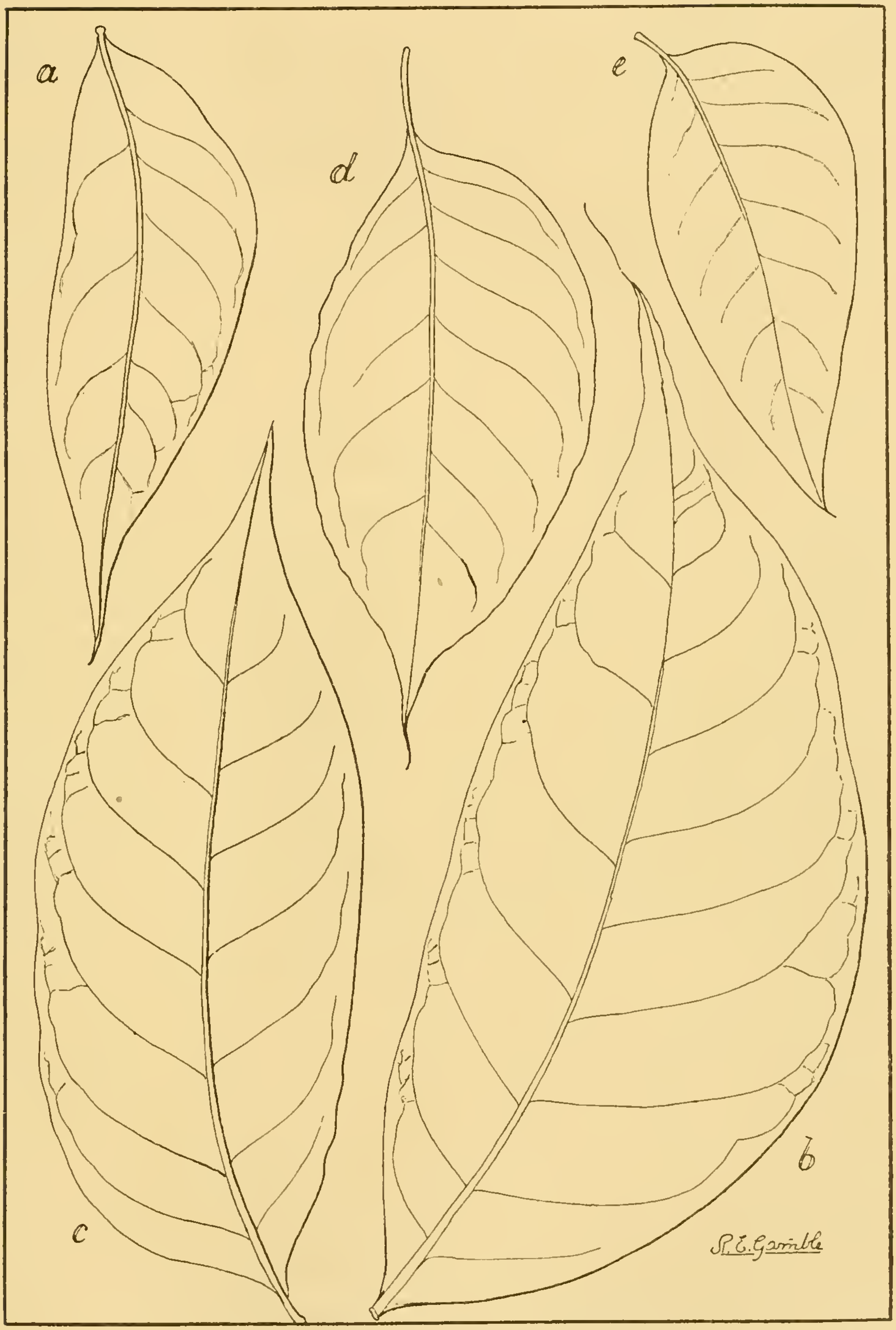

Fig. 2.—*Swietenia* leaflets, natural size. *a*, *S. humilis* Zucc. (drawn from *Reko* 3459); *b*, *S. cirrhata* Blake (*Nelson* 6925); *c*, *S. macrophylla* King (*Blake* 7866); *d*, *S. candollei* Pittier (*Pittier* 5789); *e*, *S. mahagoni* Jacq. (*Ricksecker* 247).

OTHER SPECIMENS EXAMINED:

SINALOA: Lodiego, October, 1891, *Palmer* 1616. On road between Rosario and Colomas, July 13, 1897, *Rose* 3186.

OAXACA: Chicapa, February 17, 1904, *Goldman* 738.

This species, whose range partly overlaps that of *S. humilis*, is most closely related to that species, but may be distinguished by its much larger leaflets which are usually, long cuspidate. Seeds collected by Palmer under his no. 1616 are not distinguishable from those of *S. humilis*, but are too fragmentary to afford any measurements.

3. **Swietenia macrophylla** King, Hook. Ic. **16:** Pl. 1550. 1886. HONDURAS MAHOGANY.

Tree; branchlets grayish or fuscous, lenticellate; leaves with 3 to 5 (or "6") pairs of leaflets, abruptly pinnate or sometimes odd-pinnate; petiole 4 to 8 cm. long, the rachis 4.5 to 15 cm. long; leaflets 6 to 18 cm. long, 2 to 7 cm. wide (the lowest sometimes slightly smaller), elliptic to elliptic-ovate, oblong, or oblong-ovate, short-pointed to acuminate, the terminal cusp 2 mm. long or obscure, cuneate to rounded at base, subcoriaceous, deep green both sides, reticulate, the veinlets impressed or slightly prominulous above, obscure or prominulous beneath; petiolules 1.5 to 4 (rarely 7) mm. long; panicles 13 cm. long (including the 4.5 to 7 cm. long peduncle); pedicels 2 mm. long; calyx sinuately 5-lobed about one-third its length, 0.8 mm. long, the lobes semicircular, broadly rounded, ciliolate; petals oval-oblong, truncate-rounded at apex, finely ciliolate, 4 mm. long, 2.2 mm. wide; staminal tube glabrous, equaling pistil, shorter than corolla, the teeth lance-ovate, acuminate; disk crenulate, about one-half as long as ovary, papillose; style once and a half as long as ovary; stigma crenulate, broader than ovary; fruit 15 cm. long, 7.5 cm. thick, ovoid, subacutely umbonate, rufous-fuscous, tuberculate; seeds deep chestnut-brown, 7.5 to 10 cm. long, 2 cm. wide or more.

TYPE LOCALITY: Cultivated at Botanic Garden, Calcutta, India, from seed supposed to be from Honduras.

SPECIMENS EXAMINED:

TABASCO: Common in the vicinity of Tepetitan, February 14, 1888, *Rovirosa* 181.

CAMPECHE: Apazote, near Yohaltun, December 31, 1900, *Goldman* 571.

GUATEMALA: Santo Tomás, near Puerto Barrios, June 4, 1919, *Blake* 7866. Las Playitas, Dept. Izabal, May 12, 1919, *Whitford & Stadtmiller* 48.

HONDURAS: Clearings, Swan Islands, April 7, 1913, *G. Nelson* 125 (Gray Herb.). Hacienda El Limón, Dept. Copán, May 7, 1919, *Whitford & Stadtmiller* 27.

CULTIVATED: Botanic Garden, Belize, British Honduras, December, 1905, *Kellerman* 5747. Panama Agricultural Experiment Station, *Groth.* Botanic Garden, Port of Spain, Trinidad, December, 1913, *Mell.* Botanic Garden, Buitenzorg, Java, 1903 ("e Calcutta").

The genus Swietenia has generally been described as having abruptly pinnate leaves. Many of the leaves of the writer's no. 7866, however, are odd-pinnate, with the unpaired terminal leaflet smaller and somewhat less asymmetric than the next pair, and borne on a prolongation of the rachis about 2 cm. long. A few of the specimens of *S. mahagoni* show similar leaves.

Specimens with leaves and fragmentary fruits in the Gray Herbarium, collected on low hills in the valley of the Rio Negro, Guaguaqui, Boyacá, Colombia, July 14, 1917, by H. N. Whitford & J. Pinzon (no. 10), and recorded by Macbride[15] as *S. macrophylla*, probably belong to this species but are too incomplete to be satisfactorily determined. The local names are given by Whitford as "cedro caoba" and "cedro mondi." Material in the Kew Herbarium, said to have been collected by Antoine at Cartagena, Colombia, has been referred to this species by Rolfe in his recent paper on the genus.

4. **Swietenia candollei** Pittier, Journ. Wash. Acad. Sci. **10**: 33. 1920. VENEZUELA MAHOGANY.

Tree up to 40 meters high; branchlets gray, lenticellate, those of the year fuscous green, glaucous; leaves with 3 to 5 pairs of leaflets; petiole 6 to 9.5 cm. long, the rachis 5.5 to 20 cm. long; leaflets 6.5 to 13 cm. long, 2.5 to 4.5 cm. wide (the lowest pair sometimes only 5 cm. long), oval or oval-ovate to oblong-elliptic, short-acuminate and usually falcate at apex, with a flat or slightly twisted cusp 3 mm. long or less, cuneate to rounded at base, prominulous-reticulate on both sides, paler green beneath; petiolules slender, 6 to 12 mm. long; panicles axillary, 9 to 18 cm. long (including the 5 to 8 cm. long peduncle), 3 to 6 cm. wide, loose; pedicels 2 to 4 mm. long; calyx 1 mm. long, 5-lobed for about one-third its length, the lobes semicircular, broadly rounded, finely erose-ciliolate; petals yellowish white, 4.5 to "6.5" mm. long, 3.3 mm. wide, oval-oblong, broadly rounded, unequally and broadly cuneate at base, finely erose-ciliolate throughout; staminal tube 3.8 mm. long, glabrous, its teeth triangular-ovate, acuminate; disk crenulate, papillose, nearly half as long as ovary; pistil 3.5 mm. long; ovary 5-celled, the ovules in two rows of 6 or 7 in each cell; style columnar, slightly shorter than ovary; stigma large, barely crenulate, slightly broader than ovary; fruit 9 to 14 cm. long, 6 or 9 cm. thick, ovoid, obtuse, dehiscing usually from the apex; seeds deep chestnut brown to ferruginous, 9 to 9.5 cm. long, 2.5 to 3 cm. wide.

[15] Contr. Gray Herb. N. S. **56**: 54. 1918.

TYPE LOCALITY: La Trinidad de Maracay, Venezuela.
SPECIMENS EXAMINED:
VENEZUELA: La Trinidad de Maracay, altitude 440 meters, State of Aragua, January 31, 1913, *Pittier* 5789 (type).

Distinguished from *S. mahagoni* by its larger leaflets, longer petiolules, larger flowers, and larger fruits and seeds; from *S. macrophylla* by its mostly smaller, paler, and thinner leaflets, and longer and more slender petiolules.

5. **Swietenia mahagoni** Jacq. Enum. Pl. Carib. 20. 1760. WEST INDIAN MAHOGANY.

Cedrela mahagoni L. Syst. ed. 10. 940. 1759.
Cedrus mahogani Mill. Gard. Dict. ed. 8. no. 2. 1768.
Swietenia mahogoni Desr.; Lam. Encycl. **3**: 678. 1791.
"*Swietenia fabrilis* Salisb. Prodr. 317. 1796."
Suitenia acutifolia Stokes, Bot. Mat. Med. **2**: 479. 1812.
Swietenia mahogani C. DC. Mon. Phan. **1**: 730. 1878.

Tree; branchlets gray or fuscous brown, lenticellate; leaves abruptly pinnate, with 2 to 6 pairs of leaflets, or rarely odd-pinnate; petiole 3 to 6.5 cm. long, the rachis 2 to 14 cm. long; leaflets 3.5 to 6 (rarely 7.5) cm. long, 1.3 to 2.5 (rarely 3.3) cm. wide, elliptic to ovate, acute to acuminate, with a terminal cusp 3 mm. long or less, cuneate to rounded at base, papery or chartaceous, prominulous-reticulate on both sides, paler green beneath; petiolules slender, 2 to 7 mm. long; panicles 4 to 8 cm. long (including the 2 to 4 cm. long peduncle); pedicels 2 to 4 mm. long; calyx 0.8 to 1 mm. long, 5-lobed about one-third its length, the lobes semicircular, broadly rounded, erose, glabrous; petals yellowish, 2.5 to 3 mm. long, obovate-oblong, broadly rounded, glabrous; staminal tube glabrous, its teeth deltoid, acutish; disk about one-third as long as ovary; style as long as ovary; stigma narrower than ovary; fruit ovoid, broadly rounded at apex, 4.5 to 7 cm. long, 3 to 5 cm. thick, grayish brown, verrucose, dehiscing from the base or from both ends;[16] seeds 2 to 4 cm. long, 1 to 1.3 cm. wide, deep chestnut-brown.

TYPE LOCALITY: Bahama Islands.
SPECIMENS EXAMINED:
FLORIDA: Lignum Vitae Key, 1877, *Garber;* 1892, *Simpson* 485. Coral soil, Umbrella Key, *Curtiss* 411.
BERMUDA: Flatts Village, 1905, *Harshberger.*
BAHAMA ISLANDS: Crow Hill, Andros Island, 1910, *Small & Carter* 8743. Nassau, Providence Island, 1913.
CUBA: Without locality, *Wright* 1153. Cayo Sabinal, Camagüey, 1909, *Shafer* 1105. La Gloria, Camagüey, 1909, *Shafer* 370. Cayo Coco, Camagüey, 1909, *Shafer* 2723. South of Holguin, Oriente, 1909, *Shafer* 1342.

[16] See ROLFE, Kew Bull. **1919**: 203. 1919.

ISLE OF PINES: Ensenada de Siguanea, 1916, *Britton, Wilson, & Selby* 14529.

JAMAICA: Berwich Hill, altitude 765 meters, 1899, *Harris* 7710. Papine, near Hope, altitude 240 meters, 1909, *Harris* 10821.

SANTO DOMINGO: 1871, *Wright, Parry & Brummel.* Lopez, 1887, *Eggers* 1836. Barahona, 1910, *Fuertes* 223. Azua, 1913, *Rose, Fitch, & Russell* 4082.

ST. THOMAS: 1881, *Eggers.*

ST. CROIX: Bassin yard, 1896, *Ricksecker* 247.

ANTIGUA: 1913, *Rose, Fitch, & Russell* 3313.

MARTINIQUE: 1881, *Duss* 1497.

GRENADA: 1905, *Broadway.*

CULTIVATED: Little River, Florida, *Ricker* 4066, *Tidestrom* 4178. Near Ponce, Porto Rico, 1886, *Sintenis* 4939. Botanical Garden, Port of Spain, Trinidad, 1913, *Mell.* Gamboa, near Caracas, Venezuela, 1918, *Pittier* 7947 (introduced from Santo Domingo). Oahu, Hawaiian Islands, 1911, *Curran* 115.

Although the first binomial given to this species was *Cedrela mahagoni* L., the parenthetical authority cannot be used for the name *Swietenia mahagoni* Jacq., since Jacquin makes no direct reference to the earlier name of Linnaeus.

Descourtilz[17] states that the bark of *S. mahagoni* is used as a tonic and astringent in the West Indies, and that it is often substituted for that of quinine, without, however, possessing the virtues of the latter. He also says: "C'est Lid'Oubouheri des hommes caraïbes, and Liacaïcachi des femmes." Solereder[18] states that a purgative known as "karapatoel" is extracted from the seeds.

Among some fruits of this species collected from a planted tree near Caracas, Venezuela, by Mr. Pittier, is one which has only four valves and four rows of seeds, and which must have come from a tetramerous flower. I have seen no other evidence in the genus of deviation from the pentamerous type. De Candolle,[19] however, describes the flowers as 4-or 5-merous.

[17] Fl. Med. Ant. "2: 125. 1822;" ed. II. 2: 125. Pl. 99. 1833.

[18] Archiv. Pharm. **229**: 256, footnote. 1891.

[19] Prodr. **1**: 625. 1824.

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.

ENTOMOLOGY.—*Note on the European corn borer* (Pyrausta nubilalis *Hübner) and its nearest American allies, with description of larvae, pupae, and one new species.* CARL HEINRICH. Journ. Agric. Res. 18: No. 3. Figs. 35, pls. 5. 1919.

This paper was written to enable positive identity in larval, pupal, and adult stages of the European corn borer, *Pyrausta nubilalis* Hübner to be made. The genus *Pyrausta* is fully characterized. All the generic, family, and larger group characters are given for the adult, larva, and pupa. Full specific descriptions and tables are also given of the larvae, pupae, and adults of *Pyrausta nubilalis* and its two nearest American allies, *P. penitalis* Grote and *P. ainsliei* Heinrich, the latter is here erected as a new species for part of the material hitherto included under the name *penitalis* Grote. The name *penitalis* is restricted to the Nelumbo feeding species; *nelumbialis* Smith remaining a synonym of *penitalis*. Male and female genital characters are used for the first time in separating and defining these species. Five plates containing thirty-five figures of the structural characters illustrate the article.

C. H.

ENTOMOLOGY.—*The ants of the British Solomon Islands.* WILLIAM M. MANN. Bull. Mus. Comp. Zool. No. 7. Pp. 273–391. Figs. 59, pls. 2.

An account of the ants of the islands based on collections made by the author in 1916. The ant fauna of the Solomons had been almost entirely neglected, less than a half dozen species being known from there, so a number of forms among the 144 listed in the present paper are new to science. A new Ponerine genus (Wheeleripone) is described and several new subgenera proposed. Practically the entire list of species belong to Indo-Malayan genera and, in the introduction, the Solomon Islands are considered zoogeographically to be the eastern limits of the Papuasian region.

A curious new exudating habit in the workers of *Rogeria stigmatica* Emery and nesting habits of several species of *Polyrhachis* are noted. In one of the latter, *P. osae* Mann, two females combine and start a colony jointly.

S. A. ROHWER.

CHEMISTRY.—*The determination of cellulose in rubber goods.* S. W. EPSTEIN and R. L. MOORE. Bur. Standards Tech. Paper **154.** Pp. 16. 1920.

After a discussion of the value of a procedure for determining cel lulose in rubber goods and consideration of the literature on the subject, the proposed method is discussed.

Method.—Sample is digested with cresol at 160–185° C. for 4 hours to dissolve the rubber. Filtration is facilitated by addition of 200 cc. of petroleum ether. After washing with benzol, 10 per cent solution of hydrochloric acid, water and acetone, the material is dried and weighed. It is then acetylated by heating for 30 minutes at 75° C. in a mixture of 15 cc. of acetic anhydride and 0.5 cc. of concentrated sulphuric acid. This is filtered on a weighed Gooch, washed with 90 per cent acetic acid and then with acetone and dried and weighed. Loss in weight is recorded as cellulose. S. W. E.

ANALYTICAL CHEMISTRY.—*The analysis of silicate and carbonate rocks.* W. F. HILLEBRAND. U. S. Geol. Survey Bull. **700.** Pp. 285, figs. 23. 1919.

This book, which is the fourth edition of Dr. Hillebrand's treatise, sets forth the modern methods of procedure to be followed or the precautions to be observed in rock analysis. The author advocates that rock analyses should be made as complete as possible, and not stop with determinations of silica, alumina, the oxides of iron, lime, magnesia, the alkalies and water; and suggests that, whenever possible, a thorough microscopic examination of the rock in thin section should precede the chemical analysis. Useful appliances and apparatus are described and illustrated. R. W. STONE.

CHEMISTRY.—*Estimation of nitrates and nitrites in battery acid.* L. B. SEFTON. Bur. Standards Tech. Paper **149.** Pp. 38. 1920.

From among the various methods suggested for the estimation of nitrates and nitrites in small amounts, and admitting of a sulphuric acid medium, three methods for the determination of nitrates—the Diphenylamine, the "Hydrostrychnique," and the Brucine—and three for the determination of nitrites—the Iodide, the Indol and the Dimethylaniline—were selected and studied with reference to their use in testing battery acid.

The Diphenylamine test for nitrates and the Iodide test for nitrites were found to be wholly unreliable. It was found impossible to estimate nitrates in the presence of nitrites; the "Hydrostrychnique" and the Brucine test reacted with nitrites in the same way as with nitrates so that the results of these methods must be expressed in terms of nitrates and nitrites. In the absence of iron, the "Hydrostrychnique" or a modification of the Brucine test is recommended. In the presence of iron, only the original Brucine test may be used.

It was found that nitrites could be estimated in the presence of nitrates and best by the Dimethylaniline method. L. B. S.

PHYSICAL CHEMISTRY.—*Hydrogen ion concentration in dry cells.* H. D. Holler and L. M. Ritchie. Bur. Standards Sci. Paper **364**. Pp. 10, figs. 3. 1920.

The potentials of electrodes consisting of mixtures of Acheson graphite with three different manganese ores and a chemically prepared oxide were measured in ammonium chloride solutions of different hydrogen ion concentrations. The potential of the electrodes containing the ores was found to be a logarithmic function of the hydrogen ion concentration, while the potential of electrodes containing the chemically prepared oxide was found to be independent of hydrogen ion concentration. The potential of the ores was found to decrease in acid solution and to increase in alkaline solutions. The relation found between the potential of the manganese dioxide electrode and hydrogen ion concentration, explains variations in open-circuit voltage of dry cells containing a given ore, and also accounts for a portion, at least, of the polarization of dry cells on discharge. H. D. H.

ENGINEERING.—*The accuracy of commercial electrical measurements.* H. B. Brooks. Advance Paper, Trans. A. I. E. E. 1920. Presented February 20, 1920.

The paper discusses the accuracy required in commercial electrical measurements, and the means of obtaining it, namely, proper choice, installation, use, and maintenance of instruments. The effect of room temperature change is discussed in detail, with special attention to features and methods of design which will minimize this effect. The effect of stray magnetic field is discussed from the same viewpoint.

Considering electrodynamic instruments as reducible to a pair of coils capable of relative motion, it is shown experimentally that the errors introduced by accidental bending of the index will be least if $dM/d\theta$ is constant over the whole range of movement, M being the mutual inductance of the coils and θ the angle by which one is turned with respect to the other.

Features of design which affect the accuracy are briefly discussed. These include permanent magnets, springs, and ratio of the torque of the moving element to its weight.

When a direct-current voltmeter is connected to two points on a network, the reading is in general not a measure of the previous potential difference of the points because the voltmeter takes a current and thus alters conditions in the network. By taking a second reading with the voltmeter shunted by a resistance equal to its own and using a simple formula, this potential difference may be found. Similarly, when a direct-current ammeter is inserted in one branch of a network, the currents in the network are altered by the addition of the resistance of the ammeter. By taking a second reading after adding extra resistance equal to that of the ammeter, the same form of expression will give the current in the branch before inserting the ammeter.

The electrodynamic wattmeter is treated in considerable detail. An equation by Laws is developed into a general correction formula for the effect of both self and mutual inductance, from which the effect of either can be found.

The principal sources of error in electric energy meters and features which should be improved in these and other electrical measuring instruments in the near future are briefly discussed. H. B. B.

GEOLOGY.—*Bibliography of the metals of the platinum group—osmium, platinum, palladium, iridium, rhodium, ruthenium,* 1748–1917. JAS. LEWIS HOWE and H. C. HOLTZ. U. S. Geol. Survey Bull. **694.** Pp. 555.

The first edition of this bibliography, by Dr. Howe, was published in 1897 as a volume of the Smithsonian Miscellaneous Collections and gave a list of the articles on the metals of the platinum group found in scientific literature to the end of 1896. A supplement to this edition, prepared by Dr. H. C. Holtz, of Amsterdam, brought the record down to 1910 but was never published. Dr. Howe received the manuscript of this supplement and has filled its gaps and brought the record down to the end of 1917. The 450 pages of bibliographic references are followed by an author index and a subject index. R. W. STONE.

PHYSICS.—*Preparation and reflective properties of some alloys of aluminum with magnesium and with zinc.* R. G. WALTENBERG and W. W. COBLENTZ. Bur. Standards Sci. Paper **363**. Pp. 5, figs. 1. 1920.

This paper gives the manner of preparation and determination of the spectral reflective properties of alloys of aluminum with magnesium and with zinc.

The reflectivity measurements were made with a spectroradiometer consisting of a mirror spectrometer, a fluorite prism and a vacuum bismuth-silver thermopile. It was found that all of these alloys tarnish in time and hence are not suitable for mirrors where permanency is of prime importance. The compound of aluminum and magnesium, Al_3Mg_4, deteriorates less rapidly than any of the other alloys examined and could be used in apparatus where a highly reflecting mirror is desired for a short time. A reflectivity of 92 per cent at 0.7μ was obtained with this compound.

The zinc-aluminum alloy has a minimum of reflectivity at 0.9μ. An examination of pure zinc disclosed a similar reflectivity minimum at 1.0μ. R. G. W.

TECHNOLOGY.—*Cement for spark plugs.* HOMER F. STALEY. Bur. Standards Tech. Paper **155**. Pp. 10. 1920.

The use of cements for sealing electrodes into spark plug porcelains has been found to be attended by serious difficulties in high temperature engines such as airplanes. Among these are: Promotion of oxidation and destruction of the electrode wires by reactions taking place in the cement and between the cement and electrode wires; breaking of spark plug porcelains caused by difference in coefficients of thermal expansion of electrode wires and porcelain; and cracking of cement, with consequent gas leakage, due to the same cause. A cement composed of silicate of soda and raw kaolin has been found to give little trouble from chemical action. In order to avoid the difficulties attending the use of any form of cement, the use of a mechanical seal at the top of the porcelain has been tried with promising results.

H. F. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

ANNUAL MEETING, 1919

The 825th meeting and 49th annual meeting of the Society was held at the Cosmos Club, December 6, 1919. President HUMPHREYS presided, and 21 members were present. In the absence of the Recording Secretary, the Corresponding Secretary was appointed to act in his stead.

The minutes of the 48th annual meeting were read and approved.

The reports of the Secretaries were read by the Corresponding Secretary. These reports showed that the present active membership is 194, the net gain for the year being 13. Of the active members two died during the year, namely, JAMES M. FLINT and E. C. MCKELVY. 31 new members were elected and qualified, 2 were transferred to the active from the absent list, while 16 were transferred to the absent list, one resigned, and one was dropped.

During the year the Society held 13 meetings for the presentation of papers, in addition to one joint meeting with the Washington Academy of Sciences. At these 13 meetings 27 papers were presented, 4 being by non-members. The average attendance was 53.

It was moved and carried that the reports of the Secretaries be accepted.

The report of the Treasurer, Mr. E. F. MUELLER, was presented, and showed receipts of $1,145.17 from dues ($518.75) and interest ($626.42), while disbursements for current expenses were $833.70, and outstanding bills are estimated at $75. The cash on hand is $393.33, bills receivable amount to $59.25, while securities held amount to $13,000 par value.

The excess of income over expenditures for the year was $312.47.

The report of the auditing committee, W. F. MEGGERS and C. R. DUVALL, was presented by Dr. MEGGERS, and indicated that the report of the Treasurer was correct in all essential respects.

Moved and carried that the reports of the Treasurer and of the auditors be accepted.

The report of the tellers, H. F. STIMSON and R. C. DUNCAN, was presented by Dr. STIMSON. 47 nominating ballots were received.

The Society proceeded to the election of officers, which resulted as follows:

President, ROBERT B. SOSMAN; *Vice-President*, R. L. FARIS; *Corresponding Secretary*, D. L. HAZARD; *Treasurer*, JNO. A. FLEMING; *Members-at-large of General Committee*, WALTER P. WHITE, E. F. MUELLER.

Under the head of discussion of Society policies and recommendations to General Committee, there was considerable discussion involving criticism of the method now used to nominate officers. It was moved by E. F. MUELLER that the General Committee be requested to consider the matter and report its findings to the Society. Motion carried.

Rough minutes of the meeting were read and approved.

At 9.45 the Society adjourned.

E. C. CRITTENDEN, *Corresponding Secretary.*

BIOLOGICAL SOCIETY

604TH MEETING

The 604th regular meeting of the Biological Society of Washington was held in the lecture hall of the Cosmos Club, January 10, 1920. Dr. A. D. HOPKINS, President, called the meeting to order at 8.05 p.m., with 45 persons present. Mr. JACOB KOTINSKY, of the Bureau of Entomology, was elected to membership.

The President announced the appointment of the standing committees as follows: *Publication Committee,* CHAS. W. RICHMOND, J. H. RILEY, NED DEARBORN, ALEXANDER WETMORE. *Committee on Communications,* S. A. ROHWER, CHAS. E. CHAMBLISS, R. E. COKER, FRANCIS HARPER.

Under the heading of *Brief notes and exhibition of specimens,* Dr. WALTER P. TAYLOR stated that in making observations on Mt. Rainier for the Biological Survey during the summer of 1919, he received reports of mammals existing far above timber line and even upon the summit. These reports were verified between August 6 and September 26, in most cases by specimens trapped, as to the Whitefooted Mouse, *Peromyscus maniculatus oreas*; a Chipmunk, *Eutamias amoenus* subsp.; Douglas Squirrel, *Scuirus douglasii;* the Western Bushy-tailed Wood Rat, *Neotoma cinerea occidentalis*; and the Large-footed Field Mouse, *Microtus richardsoni arvicoloides.* These animals seemed to subsist chiefly upon lichens among boulders and snow. All were observed at altitudes of 10,000 feet, and some at the summit, over 14,000 feet in altitude. The altitudes attained by these mammals are not so remarkable in themselves, but the chief interest is in the fact that the trees of Mt. Rainier stop at about 6,500 feet, and that the mammals here mentioned as seen upon Rainier were observed from 3500 to nearly 8000 feet above timber line. More complete notes are given in the *Journal of Mammalogy.*

Dr. T. S. PALMER remarked that 1920 marked the 50th anniversary of the description of fossil birds from America. In 1870 Dr. O. C. MARSH described 7 species, 5 from the Cretaceous of New Jersey. Two years later the toothed birds of Kansas were discovered. It was emphasized that by far the larger number of the birds from the older deposits were described in the early part of this 50-year period. About 125 fossil birds have been discovered since, but most of them from later deposits.

Regular Program

T. E. SNYDER: *An account of the habits of Termites or White Ants.*

Injury caused by termites to buildings, etc., in the United States is often supposed to be caused by species imported from the tropics, but this is not the case. There are 39 species representing 10 genera in the United States, more than the known species of such tropical countries as Japan, Cuba and Hawaii combined, or of Japan, the Republic of Panama and Hawaii combined. Termites occur far north in North America and also at great altitudes.

While Nearctic termites are not as spectacular as the tropical species (they do not construct mounds, but nest in the earth or wood), there are many interesting species with peculiar habits among them.

Many of the habits of the social insects have been attributed to such instincts or feelings as parental feelings of man. Such "anthropomorphisms" are as a rule false. Many of the instincts of insects, such as the care of the brood, queen, etc., can be explained by purely selfish motives, e.g., eagerness for body exudates, while other instinctive behavior is due to odor of body, contact, etc.

There is considerable damage to the woodwork of improperly constructed buildings by termites in the United States; new as well as old buildings are infested. Much of the damage to the woodwork of buildings in the United States by termites (*Reticulitermes* spp.) can be prevented by completely isolating all wood in contact with the ground. When once this source of moisture is shut off, the soft-bodied termites soon disappear.

Instead of one type of "queen" mother there are several types of "queens" or reproductive forms of termites. While studies of termites have been made in many countries for hundreds of years, knowledge of the biology is far from complete.

Mr. Snyder illustrated his paper with lantern slides of several forms of termites and of their work. The paper was discussed by L. O. HOWARD and WM. PALMER.

WILLIAM PALMER: *Some birds of the Chesapeake Bay.*

An account was given concerning the occurrence and habits of some thirty species of birds, mostly water birds, that have been observed during several years along some twenty miles of the Calvert Cliffs of the Western Shore of Maryland. One species, the Shearwater, seen in summer, was a straggler from the ocean; while another, a land species, chuck-will's-widow, was mentioned as a regular summer resident, the northern range of the species being greatly extended. Mention was also made of the regularity of the coloring of the toad, *Bufo fowleri*, occurring along that part of the Coastal Plain, as contrasted with the great diversity of the same species about Washington, D. C. It was also mentioned that some unknown cause had brought about the death of numerous cats in the farmhouses of northern Calvert County;

in one instance eight had died in one house during one week of December, 1919. The principal bird facts of the paper will be published in the *Auk*.

605TH MEETING

The 605th regular meeting was held in the lecture hall of the Cosmos Club on January 24, 1920. President HOPKINS was in the chair and 85 persons were present. On recommendation of the Council the following were elected to membership: J. S. GUTSELL, Bureau of Fisheries; R. W. WILLIAMS, Department of Agriculture; A. H. HARDISTY, Biological Survey.

Under the heading of *Informal communications*, Dr. BARTON W. EVERMANN, former president of the Society and Director of the Museum of the California Academy of Sciences, stated that an aquarium, which had been greatly needed, had been provided for at the Museum, by a gift of $250,000. Several habitat groups had been installed in the Museum, such as that of the Roosevelt Elk and the White Pelican. The White Pelican had an extensive breeding establishment upon Arabo Island, Pyramid Lake, Nevada. Their number is about 10,000. The assumption that these pelicans ate many valuable fish caused considerable destruction of them, but the situation was saved by showing that their food was chiefly suckers and chubs. Dr. Evermann showed a reel of moving pictures illustrating the breeding grounds and the environment of the pelican in Pyramid Lake, the young, their feeding, and the adult. There were also included in the films pictures of California Gulls, Duck Hawks, and Cormorants, which are found at this lake.

Later in the evening Mr. BAILEY discussed the paper and Mr. ERNEST THOMPSON SETON made the observation that in Yellowstone Park a campaign was waged against the pelicans there on the ground that they ate valuable fish. It developed that the pelicans ate only diseased fish, a fact which led to their protection.

Regular Program

ERNEST THOMPSON SETON: *The habitat and home life of the Kangaroo Rats of our Western Desert (illustrated).*

Mr. Seton's studies were made in the Mojave Desert, typical of the western deserts; a level stretch dotted with sage bush with an occasional outstanding yucca and a rim of blue mountains tipped here and there with a store of snow. Although it is the dryest region in the United States, there is an astonishing amount of animal life, not always, however, in evidence. It is at night that from every bush its animal tenant emerges, leaving its trail or other record. Some 30 species were mentioned. Attention was given to the Kangaroo Rat, a large species, rather scattered and rare, yet should the census of the area 100 feet square which was intensively studied, hold for the area over which the Kangaroo Rat lives, there would be 750,000,000 of them.

One burrow was carefully studied; its galleries totaled 75 feet, mostly on a level of about two feet below the surface. Store rooms with but little in them (May 15), a nursery and a relatively large empty room, were found, also compartments for gathering feces, one especially for the young, near the nursery. There were 9 or 10 openings, 2 or 3 of which were vertical shafts used apparently only for ventilation.

The nocturnal habits of the Kangaroo Rat are necessarily hard to follow. They jump 8 to 10 feet regularly, perhaps 15 feet in an emergency. They travel considerable distances, a mile, perhaps, for food such as alfalfa when it is available. They have great ability to find their way home and through their galleries, and a corresponding development of the semicircular canals of the ear as in the homing pigeon and other animals with greatly developed sense of direction. Between the shoulders of both sexes is a gland of considerable size. The supposition that this gland is rubbed on branches or elsewhere for purposes of communication or identification in a manner comparable to that of some ungulates could not be confirmed. They communicate very little by squeaks or other recognizable means. The Kangaroo Rats dig in the open places among the bushes. Search in such places revealed a few insects, mostly beetles. Perhaps this is the only source of fluid, other than that released by oxidation of carbohydrates, for a large part of the year. There is evidence that these animals have games at their gatherings in open places among bushes. In the burrows are some symbionts, mostly beetles, but no rattlesnakes or other large animals.

Mr. Seton's paper was discussed by VERNON BAILEY, E. W. NELSON, H. H. T. JACKSON, L. O. HOWARD, and the Chairman.

The Chairman of the Committee on Communications, S. A. ROHWER, announced that the suggestions which had been laid before the Society relating to the meetings had been taken under consideration, and that the subject of submitting questions for answers was especially discussed with a view of puting the suggestion into effect.

606TH MEETING

The 606th meeting of the Biological Society of Washington was held in the lecture hall of the Cosmos Club at 8 p.m. February 7, 1920, with Dr. A. D. HOPKINS in the chair, and 45 persons present.

Under the heading of *Brief notes*, Dr. W. P. TAYLOR made inquiry regarding the flocking habits of certain species of small birds in the woods of the northwest coast, such as the Western Golden-crowned Kinglet, Chestnut-backed Chickadee, Shufeldt Junco, Red-breasted Nuthatch, and Townsend and Lutescent Warblers. Reasons suggested for these interspecific associations, such as sociability, protection from enemies, and more efficient food getting, may partially account for the flocking but are not fully satisfactory.

Dr. T. S. Palmer commented upon the feeding of quail during the inclement weather then prevailing. He stated that the Metropolitan Police, the Audubon Society, and individuals were actively cooperating in the work in a number of widely scattered places. Advantage is taken of the opportunity to count the number of covies and individuals. In 1918 about 1200 quail were reported; this year, incomplete returns show an increase in several precincts.

Dr. Hugh M. Smith stated that the Alaskan fur seal herd is rapidly increasing under international protection forbidding sealing at sea, and restricting killing upon land. The recent sale of one-fourth of the catch of 1918, consisting of 9,100 skins, yielded $1,282,000.

Dr. R. E. Coker stated that a valuable mussel pearl fishery exists in certain rivers of the United States, especially in the Mississippi River system. The value of the fisheries is several hundred thousand dollars, one-half of which is in the shells. Photographs of peculiar and interesting forms of pearls from mussels were exhibited, and also photographs showing several stages in the metamorphosis of the Acorn Barnacle.

Dr. Paul Bartsch remarked that the feeding of quail calls attention to the value of water. In the city limits birds generally have great difficulty in finding water. Many more birds will visit drinking fountains than feeding troughs.

Regular Program

C. Dwight Marsh: *Some poisonous plants and their effects.* (Illustrated.)

The number of plants which are poisonous, in the usual sense of the word, is greater than commonly supposed. One published list gives 25,000 poisonous species. The Department of Agriculture is gathering data in regard to the effect of such plants on animals. The studies are chiefly in the West, where grazing animals have access to poisonous plants in great numbers, and the losses reach great economic importance. As a means of determining some of the causes and effects of poisonous plants upon stock, there have been established field stations at suitable places where chemist and pharmacologist may have immediate access to fresh cases, and may conduct experiments. It is not probable that animals instinctively avoid poisonous plants, but that they reject them on account of distasteful properties which the plants usually possess. Animals will, however, eat them when pressed by hunger, and sometimes develop a passion for certain of them. The data gathered are definite, but are only preliminary to the real problem, which is to prevent losses from such poisonous plants.

Dr. Marsh exhibited lantern slides showing field stations near Denver and in the Wasatch Mountains, the facilities for handling poisoned animals, and the poisoned animals themselves as affected in characteristic manner by different plants. A long series of poisonous plants, many of them in their habitat, both eastern and western species, were shown with comments.

PAUL BARTSCH: *Our poison gas detector and how it was discovered.* (Illustrated).

Dr. Bartsch first described the nocturnal mating habits of *Limax maximus*, a common garden slug, illustrating the successive acts with photographs taken by flash-light. The slugs, which are bi-sexual, climb trees at night; a pair will twist themselves together, spin a mucous thread, and hang suspended. The genitalia are protruded, and after exchange of products, accompanied by characteristic activities, the pair ascend the thread and retire to their usual retreats where the eggs are deposited.

Some years ago, Dr. Bartsch continued, a number of animals of this species which were under observation in his home, escaped from their box in which they had been confined. Observations on their behavior in the furnace room were recalled when need for a gas detector arose in connection with the great war. A very brief period of experimentation revealed the extraordinary sensitiveness of *Limax maximus* to mustard gas, and in an incredibly short time the information, invaluable for detecting the gas, was in the hands of the Allies and American forces in Europe. The tentacles of *Limax* are sensitive to a dilution of 1 to 10,000,000 of mustard gas, and characteristic responses indicate the degree of dilution. Since man reacts at a dilution of 1 to 4,000,000, *Limax* proves to have ample margin of delicacy. Moreover the species is European, and abundant in the region of the fighting.

Dr. Bartsch pointed out how incidental, even accidental, observations years ago furnished immediate answer to the problem calling for reliable sensitive detectors of certain gases during the war.

The paper was discussed by Dr. H. M. SMITH.

607TH MEETING

The 607th meeting of the Biological Society of Washington was held jointly with the Washington Academy of Sciences in the lecture hall of the Cosmos Club at 8.15 p.m., February 21, 1920. President HOPKINS presided, and 75 persons were present.

Upon recommendation of the Council, Miss DORIS LANGWORTHY, of George Washington University; Mr. K. P. SCHMIDT, of the American Museum of Natural History, and Miss MARION PELLEW, were elected to membership.

The address of the evening was given by Dr. ALFRED G. MAYOR, Director of the Division of Marine Biology, Carnegie Institution of Washington, and Lecturer in Zoology at Princeton University, upon the subject: *The coral reefs of American Samoa.*

The Island of Tutuila in its relation to its marine environment was described, and the distribution of the various reef-forming algae and corals. The island is very old as is shown by geological evidence. The reefs were described, including rate of coral growth, and the conditions prevailing, and the various theories of reef formation were discussed in the light of the observations made at Tutuila. Though none of these theories is wholly satisfactory, it was possible to review the history of the island in its essential features. The lecture was illustrated with numerous maps, diagrams, and photographs of reefs and corals and the more general landscape features. These were supplemented with pictures of natives and their homes.

The paper will appear in the *Proceedings of the American Philosophical Society*. It was discussed by Dr. T. WAYLAND VAUGHAN.

A. A. DOOLITTLE, *Recording Secretary*.

SCIENTIFIC NOTES AND NEWS.

Lectures before the Physics Club of the Bureau of Standards have been delivered as follows since the preceding report in the *Journal:*[1] February 2 and 16, L. J. BRIGGS: *The resistance of the air;* February 9, J. S. AMES: *Einstein's gravitation;* March 1, W. J. HUMPHREYS: *The physics of thunderstorms;* March 15, R. W. WOOD: *Spectroscopic phenomena in very long vacuum tubes;* March 27, SAUL DUSHMAN: *The ionization gage;* March 22 and 29, and April 5, M. D. HERSEY: *Irreversibility in physics, with special reference to elastic lag;* April 12, M. D. HERSEY, J. R. FREEMAN, and others: *Symposium on irreversibility in physics;* April 19, and May 3 and 10, EDGAR BUCKINGHAM: *Elements of theory of dimensions.*

Messrs. W. L. ABBOTT and E. C. LEONARD report from Haiti that a successful collecting trip to Gonave Island has been completed. Rainfall on that island has been very deficient for three years, and the original forest has practically disappeared and been replaced by grass lands.

Dr. JOHN ALFRED BRASHEAR, astronomer and manufacturer of astronomical instruments, and a non-resident member of the ACADEMY, died at his home in Pittsburgh, Pennsylvania, on April 8, 1920, in his eightieth year. Dr. Brashear was born at Brownsville, Pennsylvania, November 24, 1840. He began life as a blacksmith in a Pittsburgh mill, but his interest in research soon led him into the manufacture of astronomical and physical instruments, a vocation which he combined with astronomical research, particularly upon the sun and moon. His work had been recognized by his election to honorary membership in a number of American and foreign astronomical societies. His interest in recent years had been mainly with the advancement of educational facilities. He became a member of the ACADEMY in 1915, and was elected a non-resident vice-president in 1919.

Dr. AUSTIN H. CLARK, assistant curator in the Division of Marine Invertebrates of the National Museum, has been appointed curator of the Division of Echinoderms.

Mr. E. H. FINCH, geologist of the Land Classification Board of the U. S. Geological Survey, resigned at the end of March to accept a position with the California division of the Dutch Shell oil corporation and has left Washington for California.

Mr. GERARD FOWKE, a collaborator of the Bureau of American Ethnology, left St. Louis on April 1 for Honolulu. He will make an archeological reconnaissance of the Hawaiian Islands with a view to future intensive work by the Bureau.

[1] This JOURNAL 10: 115. February 19, 1920.

Mr. D. F. Hewett of the U. S. Geological Survey will make a special examination of certain manganese claims in Cuba for the War Minerals Relief Commission, beginning about April 15.

Mr. Frank Leverett of the U. S. Geological Survey, stationed at Ann Arbor, Michigan, is engaged in an investigation of road materials for the Michigan State Highway Commission.

Dr. W. M. Mann of the Division of Insects, U. S. National Museum, has returned from a two months' trip through Spanish Honduras, where he visited the principal fruit growing districts and made collections of economic insects, especially those attacking fruits.

Messrs. William R. Maxon and Ellsworth P. Killip of the National Museum returned to Washington on April 16, after spending two months in botanical exploration in Jamaica.

Messrs. O. E. Meinzer and J. C. Hoyt of the U. S. Geological Survey returned to Washington from Hawaii in the latter part of April.

Mr. H. D. Miser of the U. S. Geological Survey went to Fayetteville, Arkansas, on May 1, to fill, until the end of the college term, the position left vacant by Professor Drake in the Department of Mining and Geology of the University of Arkansas.

Mr. W. E. Myer of Nashville, Tennessee, has been at work in the library of the Bureau of American Ethnology, putting into form many years' field notes on the mounds and artifacts of Tennessee.

Mr. Cyril S. Taylor resigned from the Bureau of Standards in April to accept a position in the research bureau of the Aluminum Company of America at New Kensington, Pennsylvania. He expects to begin work in the new position in June.

Mr. F. G. Tryon has been appointed Mineral Geographer on the U. S. Geological Survey, and has been assigned to the Fuel section of the Mineral Resources division.

Mr. D. E. Winchester has returned temporarily to the U. S. Geological Survey to finish his manuscript on "Oil shales of the Rocky Mountain region."

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ENTOMOLOGY.—*Description of a new species of Sphenophorus from Florida* (*Coleoptera*). F. H. CHITTENDEN, Bureau of Entomology.[1]

Recently, during studies of the weevils of the genus *Sphenophorus*, an undescribed species collected in Florida by Hubbard and Schwarz has come to my attention. This may be known from the following brief description:

Sphenophorus deficiens Chittenden, sp. nov.

Body more than twice as long as wide. General color black, moderately shining. Head finely, sparsely, punctulate. Rostrum half as long as thorax, feebly arcuate, rather wide, moderately, nearly equally compressed, this compression more pronounced at the base; base much widened but not dilated in front of scrobes, flattened, not sulcate, interocular impression shallow, foveate; apex feebly dilated; surface finely not deeply punctulate, at base moderately punctate, punctures shallow and sparse. Thorax one-fourth longer than wide, posterior half with nearly parallel sides, very little narrower at base, anterior half narrowing toward apex, which is very feebly constricted at sides and scarcely above; surface coarsely irregularly punctate, punctures finest and sparsest just in front of middle where there is a short, nearly smooth, but scarcely elevated space representing the median vitta; a little coarser each side of the middle on the posterior half in what corresponds to the lateral vittae; the surface between these vittae very coarsely irregularly foveate-punctate, some of the punctures contiguous and some confluent; a shallow fossa each side of the vittae there caused by the coarse punctures coalescing at these points. Elytra one-fifth longer than thorax, subovate, at base distinctly margined, at humeri broadly rounded, gradually narrower toward apex; surface uneven, distinctly finely striate, striae interrupted by large, rounded, moderately deep punctures; intervals flat, of unequal width, but not

[1] Received May 3, 1920.

alternate; the third interval widest, the sutural faintly regularly uniseriately, the others very faintly irregularly sparsely, punctulate. Pygidium moderately coarsely, sparsely punctate, strongly narrowed at apex, which is rounded and without visible tufts of hair at sides. Ventral surface very coarsely punctate; on prosternum deeply sparsely punctate at middle, less deeply and more sparsely at sides; on mesosternum very coarsely punctate at middle which is deeply concave, more sparsely at sides, and finely on lateral margins of the concavity, coarsely on first abdominal, less coarsely on last segment, finely and sparsely on middle of second, third and fourth segments. Second abdominal segment connate with first except for a depressed line each side of middle not extending to margin of elytra.

The anterior coxae are more widely separated than is usual in this genus. The anterior tibiae are obliquely truncate, without spur; the middle subtruncate, a little prolonged at apex; the posterior rounded, feebly spurred, and with a small inner tooth. Tarsal joints equal, feebly fimbriate.

Length 9.5 mm.; width 3.8 mm.

Crescent City, Fla. (Hubbard & Schwarz). Also collected in Florida by Prof. W. S. Blatchley.

Type No. 23076, U. S. National Museum.

This species has somewhat the appearance of *Sphenophorus ulkei*, but the resemblance is entirely superficial, as it has characters that distinguish it from any other known in our fauna, as may be seen at a glance. It is to be regretted that the type is somewhat defective, as it lacks the antennal club and the anterior tarsi.

PETROGRAPHY.—*On an iron meteorite found at Yenberrie, Northern Territory of Australia.* JOHN C. H. MINGAYE, Department of Mines, New South Wales. (Communicated by GEO. P. MERRILL, U. S. National Museum.)[1]

The iron meteorite described below was found on July 30, 1918, by Mr. John Hoare, embedded in sandy soil about 20 miles south southeast of Yenberrie. The entire mass weighed about 291 pounds, of which a portion weighing some 28 pounds passed into the hands of Mr. Watkin-Brown of Sydney, by whom it was sent to the United States National Museum, where it was divided among the three museums of Chicago, New York and Washington, in the proportions respectively of 4500, 3760,

[1] Received April 14, 1920.

and 3320 grams. Before being forwarded a portion of the mass was removed for analysis.

Clean turnings from the facing machine, representing the metallic portions only, were analyzed with the results given in table 1.

TABLE 1

COMPOSITION OF METALLIC PORTION OF METEORITE

Fe	92.350
Ni	5.980
Co	1.430
Cu	0.017
P	0.161
S	Trace
C	0.073
Cl	0.003
Pt	Traces[a]
SiO_2	0.140
	100.154

Sp. gr. (average of two determinations), 7.304.

[a] 100 grams of the iron gave 0.00026 gram of platinum. This is the first reported case of platinum in an Australian meteorite. No tin nor gold could be detected. Partial duplicate determinations gave: Ni + Co, 7.46; P, 0.195; C, 0.065.

From a dark nodule in the center of the meteorite were found pieces of metal coated with a black brittle substance which yielded the analysis given in table 2, after the metallic portions had been removed so far as possible.

TABLE 2

COMPOSITION OF BLACK COATING

Fe	65.38
Ni	6.10
Co	0.37
Cu	Trace
P	4.14
S	13.06
C	4.94
Cl	0.08
Ca	0.23
Mg	None
Cr	None
Oxygen	5.70
	100.00

This can be accounted for only as a mixture of sulfide and phosphide, and oxidation products intermingled with carbon.

Small plates including lath shaped pieces, extremely brittle and strongly magnetic, of a brownish color were detected in the process of cutting. These yielded the analysis given in table 3.

TABLE 3

COMPOSITION OF BRITTLE PORTION

Fe	73.22
Ni	6.35
Co	0.25
Cu	0.02
P	5.02
S	None
C	2.51
Cl	Not determined
SiO_2	0.28
Ca	0.20
Mg	0.07
Cr	None
Oxygen	12.08
	100.00

The analysis in table 3 shows that the material is largely schreibersite and magnetite coated with little carbon.

On crystallographic grounds the iron will be classed as a broad, or coarse, octahedrite. The taenite plates are very thin and in the 3320-gram piece retained in Washington, there seems a tendency for both the taenite and schreibersite granules to gather in the outer portion of the iron, leaving the interior nearly free.

RADIOTELEGRAPHY.—*An electron-tube transmitter of completely modulated waves.*[1] LEWIS M. HULL, Bureau of Standards.

In order to utilize a radio-frequency oscillation of given power most effectively in a non-oscillating receiving system, it must be completely modulated, the periodic reduction of the current

[1] Received April 12, 1920. Published by permission of the Director of the Bureau of Standards.

to zero occurring at a suitable audiofrequency. Radio-frequency harmonics, manifested by distortions in the shape of the radiofrequency or carrier wave, limit the total power radiated by a transmitter at a single frequency to which the receiver is tuned. Audio-frequency harmonics, manifested by distortion in the envelope of the radio-frequency oscillations from sinusoidal form, determine the response of any amplifying and rectifying detector.

There are two possible methods of operating an electron-tube generating system so as to furnish a completely modulated output: (1) The use of a direct supply voltage in connection with a mechanical interrupter or "chopper," which periodically breaks the supply circuit, causing the antenna current to be reduced to zero; (2) the use of an alternating audio-frequency supply voltage. If the frequency of the supply voltage be F and the peak value E_b, then the plate is positive with respect to the filament F times per second while the supply voltage rises from 0 to E_b volts, and negative F times per second while the supply voltage falls from 0 to $-E_b$ volts. The antenna current is maintained for a half cycle when the plate is positive and is reduced to zero a greater part of the half cycle when the plate is negative.

The first method requires a source of high direct voltage which may be inconvenient if high power tubes are used. With the second method the whole system can be operated from any audio-frequency generator with suitable transformers for the high-voltage plate and the relatively low-voltage filament. The note produced by telephone receivers actuated by the rectified output from the transmitter corresponds to the frequency F. Consequently a desirable value for F would be 800 cycles per second since most audio-frequency receiving apparatus is designed for best operation at about that frequency. If no 800-cycle generator is available, a 500-cycle machine can be used.

A transmitter of this description has been designed and built at the Bureau of Standards. The set fulfills the following requirements: (1) Use of a single, type "P" pliotron, with 500-cycle, 150-volt alternator; (2) power output exceeding 200 watts in an antenna having 8 to 15 ohms resistance and a natural wave-length below 200 meters; (3) a readily adjustable range of wave-lengths from 500 to 1000 meters; (4) transmission of completely modulated waves, making possible their reception with crystal detectors; (5) sharply tuned waves, in order to avoid excessive interference over long series of tests. The set has been used in fog signaling and direction finding experiments, and in transmission tests carried out as part of an investigation of wave propagation.

In designing the set the average power output in a given antenna was taken as the criterion of its merit as a transmitter of radio waves. The kind and degree of modulation of the waves radiated determine to a large extent what type of receiving circuits should be employed to utilize this power effectively. However, if it be understood that an appropriate receiving circuit is to be used, the effective current output in an antenna of given radiation resistance at a given wave-length determines the merit of any transmitter of modulated or unmodulated waves.

Figure 1 is a diagram of connection of the final form of this transmitter as put into service for radio direction finding and fog signaling.

Owing to the fact that the 500-cycle voltage, when using a 2 kw. alternator, dropped enough to decrease the filament current by as much as 15 per cent when the load was thrown on in the plate circuit, it was found necessary to include in the filament transformer a series compensating winding. This is rendered doubly imperative by the fact that when operating a tube at high plate voltage, the power output changes to a much greater extent with slight changes in emission than when operating at lower plate voltages. The system is always kept adjusted for maximum output at the maximum safe filament current, I, effective = 3.6 amperes, and even a slight decrease in this current decreases the power output considerably, and the current output to a corresponding extent. In order to be able to adjust this transformer to give suitable compensation for the drop in primary voltage, and still be able to use it at different values of generator voltage, when it is found desirable to transmit at reduced power, it is necessary to make the number of turns in the compensating winding adjustable. The compensating winding of the transformer is composed of 100 turns No. 16 d. c. c.

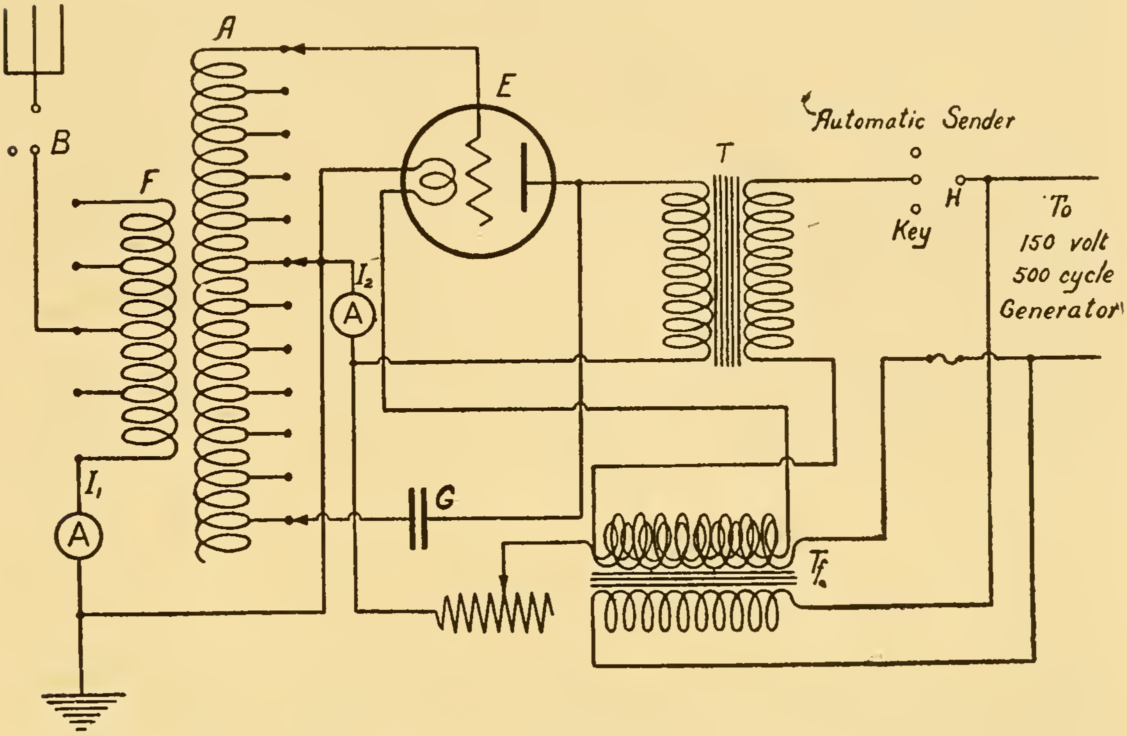

FIG. 1. DIAGRAM OF CONNECTIONS OF MODULATED-WAVE TRANSMITTER.—*A*. Plate and grid coupling coils. Continuous coil wound on fibre tube $5^1/_2''$ in diameter. 80 turns No. 18 solid wire spaced $^1/_8''$ apart; and taps brought out every 5 turns on grid side and every ten turns on plate side of coil. *B*. Antenna switch. *D*. Generator field rheostat. *E*. Electron tube, type P pliotron. *F*. Antenna-coil; 30 turns-litzendraht, wound on fibre tube $6^3/_8''$ in diameter; taps brought out every two turns; mounted so as to slide over coupling coil, in order to vary mutual inductance. *G*. Stopping condenser; mica; C = 0.004 mfd. *H*. Automatic sender, driven by D. C. motor, which is supplied from the field circuit of alternator. I_2. Filament ammeter. I_1. Antenna ammeter. *R*. Filament rheostat. *T*. Supply transformer, 2 kva.; ratio of turns, 40/1; full load voltages, 160/6500. *Tf*. Filament transformer, special construction. The main windings consist of 200 turns No. 16 d. c. c. wire on the primary side, connected across the 180-volt supply, and 120 turns No. 16 d. c. c. wire on secondary side, connected to filament circuit.

wire, with a tap every twelve turns from 30 to 100. The filament rheostat makes it possible to adjust the filament current for any steady value of primary voltage on the transformer; the series compensating winding makes it possible so to adjust the transformer to the supply circuit that the filament current reaches a safe maximum when the load is thrown on. If sufficient power is available from the generator it is advisable to over-compensate the transformer, making it possible to heat the filament at reduced current except when the key is pressed.

The transmitter described in this paper was designed to operate at short wave-lengths. The performance of such a system at short waves is limited by two factors; first, the electrostatic capacity between elements of the electron tube, which may provide a reactive shunt for the oscillatory circuit; second, the approximate linear relation between power output, resistance, and capacity. Consider any short portion of the wave train when the amplitude of the supply voltage may be considered constant so far as the radio frequency oscillations are concerned. It has been shown[2] that the output power is given for any tube by

$$P = \frac{1}{R} \frac{L}{2C} f(P)$$

where R, L and C are the resistance, inductance and capacity of the antenna and f is a function which depends upon the characteristics of the tube and upon the plate and grid coupling. Over a certain range of operation the function f, which involves the oscillating grid voltage as dependent upon the antenna current and coupling is found to be a direct linear function. Then the output power varies inversely with the antenna capacity and with the antenna resistance. Assuming constant L, since a change in L involves a change in the function f, it is evident that if C is made small, as is the case at short wave-lengths, R must be increased, in order to obtain maximum output. It may be impossible to obtain maximum output from a tube in a given antenna of low resistance at short wave-lengths, particularly in view of the fact that the total effective resistance decreases with increasing frequency.

When supplying an antenna having a capacity of approximately 0.004 microfarads and a resistance of 10 ohms, this set

[2] HULL, L. M. *Determination of output characteristics of electron-tube generators.* Bur. Standards Sci. Paper **355**. 1919.

gave a power output in the antenna of 286 watts, at 600 meters wave-length, using an effective value of filament current of 3.5 amperes, and operating at an overall efficiency of 35 per cent, alternator terminals to antenna inclusive. This efficiency takes account of the power expended in the filament supply transformer and in the filament. No data are available on the efficiency of the tube alone, as ordinarily computed in terms of input to the plate and output in the antenna. It was impossible to adjust the coupling so as to obtain maximum output at the shorter wave-lengths.

TRANSMISSION AND RECEPTION TESTS

Signals from this set, which supplied 5 amperes effective current to an antenna approximately 50 feet high in Washington were copied at a distance of 100 miles by using an antenna 60 feet high, with an audibility of 10,000, using an autodyne receiving circuit with a two-step audio-frequency amplifier. Signals from this set working under the same conditions were received through heavy interference by using a six-foot coil aerial and a similar detector and amplifier, at a distance of 225 miles.

It has been found in other tests that waves modulated in this fashion cannot be received with high efficiency with a simple non-oscillating detector. The voltages induced in a receiving antenna by a logarithmically modulated wave will give a response on the output side of the detector greater than that induced by a sinusoidally modulated wave train radiated from antennas in which the effective antenna current is the same, provided always that we confine our attention to short wave-lengths. The truth of this statement has been proven experimentally by direct comparison of two such transmitters. It is beyond the scope of the present paper to discuss quantitatively the effects of sinusoidally and logarithmically modulated wave-trains upon receiving antenna with rectifier and phones. However, a possible reason for such a behavior is suggested by the accompanying diagram, figure 2, upon which are plotted *to the same scale* the envelopes of spark and sinusoidally modulated wave trains emitted by two transmitters operating at 500 cycles and supplying the same antenna with the same effective antenna current. Although the logarithmically modulated wave train persists only about one-twelfth as long as the sinusoidally modulated wave train, yet it rises to a peak value over thirteen times as great. In order to give some idea of their relative number of radio-frequency oscillations per cycle the vertical lines have been so spaced that each one represents a complete radio-frequency cycle.

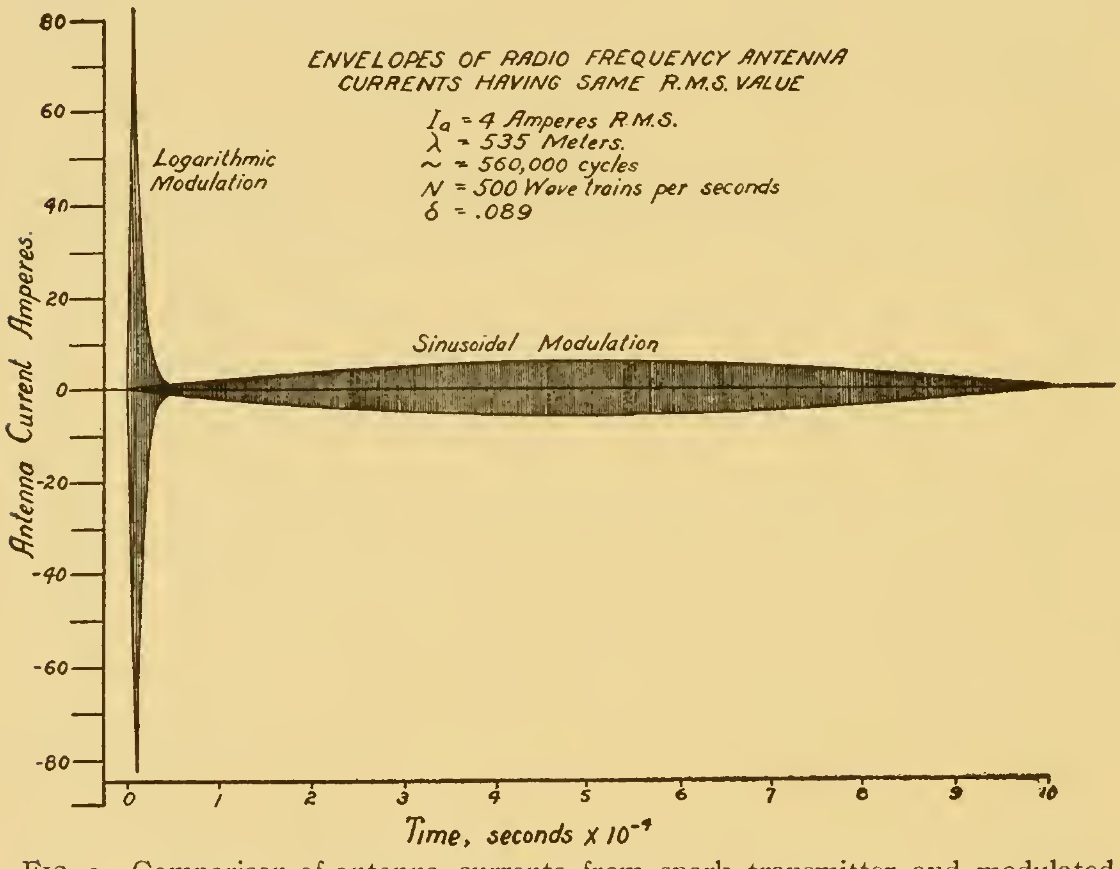

FIG. 2—Comparison of antenna currents from spark transmitter and modulated-wave transmitter.

It is not to be inferred from this diagram that the trains of voltage waves applied to the rectifier in a receiving circuit have an envelope precisely similar to the exponential envelope shown here for the wave train transmitter from the spark set. Nor should the assumption be made that diaphrams of the receiving telephones when acted upon by a strong voltage impulse lasting for one ten-thousandth of a second are distorted a proportionately greater amount than when acted upon by a weak impulse lasting for a thousandth of a second. Undoubtedly, however, the voltage impacts acting upon the telephones are very much the more intense, though lasting for a shorter time, with the wave train of higher peak value, and it is possible that this is the correct explanation of the louder signal furnished by the logarithmically modulated wave train with simple rectifying detector. If the same power be radiated at long wave-lengths it is quite possible for the peak value of the logarithmically modulated wave train to be so reduced in magnitude that the average value of their square (which is the measure of the output voltage of the detector) is equal to or even less than similar values for the sinusoidally modulated waves. It is likely also that if the wave-lengths of transmission be sufficiently increased the same results in receiving the signals with a rectifying detector can be obtained with the tube transmitter as with a similar spark transmitter.

In summarizing the foregoing discussion the following essential points appear: (1) It has been found that an electron-tube transmitter operated wholly from an alternating-current source can be made to compare favorably in operating efficiency with a similar transmitter operated from a direct-current source; (2) it possesses the advantage of not requiring a high-voltage battery or generator; (3) the added advantage over a continuous-wave transmitter is that signals may be received over a limited distance with a non-oscillating detector.

A more complete description of the experiments made in developing this transmitter, and of the theory of its operation will be published at a later date as a Scientific Paper of the Bureau of Standards.

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.—*Ionization and resonance potential for electrons in vapors of lead and calcium.* F. L. MOHLER, PAUL D. FOOTE and H. M. STIMSON. Bur. Standards Sci. Paper **368**. Pp. 14, figs. 2. 1920.

Measurements of electron currents in three electrode vacuum tubes of the type previously described have been made in vapors of lead and calcium.

The lead and calcium were boiled in porcelain tubes at temperatures of about 1000° and 900°, respectively. Current voltage curves in lead showed a resonance potential of 1.26 volts and an ionization potential of 7.93 volts. Applying the quantum relation $Ve = h\nu$ we find that 1.26 volts correspond within experimental error to the frequency of a strong infra-red spectrum line at λ = 10,291Å, giving a theoretical value of the resonance potential 1.198 volts.

In calcium two resonance potentials were found at 1.90 volts and at 2.85 volts of which the first is the most prominent. Ionization occurred at 6.01 volts. The ionization potential corresponds to the limit of the principal series 1.5 S, λ = 2027, Å giving as the theoretical value V = 6.081 volts. The first resonance is determined by the line $1.5S - 2p_2$, λ = 6572.78 Å, V = 1.877 volts. The second resonance corresponds to the line 1.5S − 2 P, λ = 4228.73 Å, V = 2.918 volts.

The spectral relations of the first resonance potential and ionization potential are analogous to the relation found with other metals in this group. Work of other observers shows that both the lines 1.5 S − 2 P and 1.5 S − $2p_2$ appear below the ionization potential in most metals of this group. F. L. M.

PHYSICS.—*A new interferential dilatometer.* IRWIN G. PRIEST. Bur. Standards Sci. Paper **365**. Pp. 10, fig. 1. 1920.

This paper describes new instruments and methods for measuring very small changes in the lengths of samples which are too small to be examined by the Fizeau interferential method. Only a single small pin is required as a sample.

The method of measurement depends upon the change in width of interference fringes instead of their displacement as in the Fizeau method. The outline of the method on this basis is briefly:

1. One of a pair of nearly, but not quite parallel interferometer mirrors is supported at one point by the sample and at two other points by a standard substance of known expansivity, the perpendicular distance from the bearing point of the sample to the line connecting the bearing points of the standards being known.

2. The standard and the sample are so adjusted that the fringes are parallel to the line connecting the bearing points of the standard.

3. Any difference in expansivity of the sample and the standard causes the interference fringes to change their widths with change in temperature. The number of fringes between two fixed reference lines on one of the mirrors is determined at each of the two temperatures in question.

4. From the above data the difference in the expansion of the standard and the sample can be computed.

The new method gives results of the same accuracy as the Fizeau method, while it has marked advantages over the latter. I. G. P.

PHYSICS.—*Contrast sensibility of the eye.* Enoch Karrer and E. P. T. Tyndall. Bur. Standards Sci. Paper **366**. Pp. 14, figs. 10. 1920.

A knowledge of the contrast sensibility of the eye is very essential to the proper understanding of the theory and use of searchlamps and searchlight illumination.

The searchlamp is used at night when the eye is generally adapted to low levels of illumination. If the observer is far removed from the searchlamp the illumination may be simply that from the moon and sky. If he is near the lamp, however, he must look through the diffused light along the beam.

In order to be visible, the target must be illuminated to a degree that will make sufficient contrast in brightness or color between it and this surrounding field. Data are given showing the relationship that exists between the brightness and the size of the target and the brightness of the surrounding field.

In these experiments a large surface painted white was illuminated with an incandescent lamp. The target consisted of a rectangular spot of this surface more brightly illuminated by means of a projection lantern, equipped with a simple bilateral slit. The image of the slit determined the boundaries of the test spot or "target," the length of which could be varied by varying the slit width. Precautions were taken to have the brightness across the image of the slit uniform. The brightness of either the test spot or field could be varied by means of sectored discs, so that any desired contrast between them could be obtained for any given brightness of field.

Curves are given showing the relation between the length of the test spot and the brightness of the field for various contrasts, and also curves showing the relationship between the length of test spot and the contrast between field and spot for various values of the field brightness. E. K.

GEOLOGY.—*The Porcupine Gold Placer District, Alaska.* H. M. Eakin. U. S. Geological Survey Bulletin **699**. Pp. 28, pls. 8. 1919.

The Porcupine gold placer district lies in the headwater region of Chilkat River, near the British Columbia boundary, about 100 miles northwest of Juneau, or 25 miles west of Skagway. Productive mining began here in 1899 and continued so successfully that the district has ranked as one of the most important placer fields in Alaska. This district was visited by Geological Survey parties in 1899, 1903, and 1916, and the present bulletin gives a summary of the knowledge thus obtained. It includes a geologic map and several views of the district. The total output to the end of 1916 is estimated at $1,200,000.

The bed rock consists mainly of limestones, slates, and other sedimentary rock, intruded by diorite of the Coast Range belt. Small diabase dikes also intrude the bedded rocks locally. The placer gold is derived mainly from mineralized belts of sedimentary rock carrying small quartz and calcite veins and in which sulphide minerals are abundant. R. W. Stone.

GEOLOGY.—*Our mineral supplies.* H. D. McCaskey and E. F. Burchard. U. S. Geological Survey Bulletin **666**. Pp. 278, pl. 1. figs. 6. 1919.

This bulletin consists of short papers prepared and published in 1917 on about 30 minerals to meet a demand from the public and from other Government bureaus for information and advice concerning these minerals. Each separate chapter discusses the source of supply of the mineral, its uses both in peace and war, and the normal demand.

The papers are here assembled and to them is added a bibliography of Survey publications on the minerals considered in the volume.

R. W. STONE.

PALEONTOLOGY.—*Pliocene and pleistocene fossils from the Arctic coast of Alaska and the auriferous beaches of Nome, Norton Sound, Alaska.* WILLIAM HEALEY DALL. U. S. Geological Survey Prof. Paper **125-C.** Pp. 23–37, pls. 2.

Describes briefly the Tertiary geology and indications of changes in elevation and climate. The intercommunication of Atlantic and Pacific faunas in Pliocene time and the routes of migration of faunas are considered.

The author concludes that neither the Aleutian chain nor Bering Strait has offered a bridge between continents since Miocene time and it is evident that postulated land bridges must have existed in some other place or the assumed migration must have taken place over the ice of the strait when frozen. The Pliocene fauna indicates a more temperate sea than at present and there is evidence that a freer connection probably existed in Pliocene time between the North Atlantic and the Bering Sea regions.

Species collected on the Northern Alaska coast are listed and new species described.

R. W. STONE.

PALEONTOLOGY.—*Some American Jurassic ammonites of the genera* quenstedticerds, cardioceras, *and* amoeboceras, *family* cardioceratidae. JNO. B. REESIDE, JR. U. S. Geol. Survey Prof. Paper **118.** Pp. 38, pls. 24, fig. 1. 1919.

Gives systematic descriptions of several new species of ammonites obtained mostly from the Sundance formation of Wyoming. The numerous plates are exceptionally fine illustrations of the material described, faithfully reproducing the minute details of structure and form.

R. W. STONE.

PALEONTOLOGY.—*Reptilian faunas of the Torrejon, Puerco, and underlying upper Cretaceous formations of San Juan County, New Mexico.* CHAS. W. GILMORE. U. S. Geol. Survey Prof. Paper **119.** Pp. 68, pls. 26, figs. 33. 1919.

This paper is based on the best single collection of fossil turtles that has ever been made in the southwestern United States. The recovery of nearly perfect individuals forms a distinct contribution to our knowledge of the skeletal anatomy of these extinct turtles. The faunas of the various formations are discussed, following which there is a systematic description of the specimens, including sixteen new species. The illustrations are excellent reproductions from photographs of the turtle shells. R. W. Stone.

PALEONTOLOGY.—*An Eocene flora from Trans-Pecos, Texas.* Edward Wilber Berry. U. S. Geol. Survey Prof. Paper **125-A.** Pp. 9 (1–9), pls. 3, figs. 2. 1919.

Six forms of fossil plants, two of them palms, are described. They point to warm temperate climatic conditions with abundant precipitation and plentiful ground water. They enable the assignment of a definite age to the beginning of the igneous activity of the region and establish correlations between the floras of the Mississippi embayment and the Rocky Mountain region. It is concluded that the basal tuffs in the Barilla Mountains, in which this flora occurs, are post-Cretaceous and pre-Wilcox in age, and that they and the volcanic activity which they represent were probably contemporaneous with the floras and similar volcanic activity reflected in Raton and Denver formations and elsewhere in the Rocky Mountain region. R. W. Stone.

TECHNOLOGY.—*The properties of American bond clays and their use in graphite crucibles and glass pots.* A. V. Bleininger. Bur. Standards Tech. Paper **144.** Pp. 52, pl. 1, figs. 23. 1920.

The properties of American bond clays are described in detail and expressed through characteristic numerical values with special reference to their burning behavior. It is shown that materials equal in quality to those formerly imported from Germany are available and that by suitable blending any desired combination of properties can be readily produced. The characteristics of natural and artificial graphite are described and means suggested for the control of crucible mixtures. The fact is brought out that the main advantage in the use of German glass-pot clay consists in its low fire shrinkage and suggestions are made for obtaining similar conditions with the use of domestic materials and with increased resistance to corrosion. The compositions and the preparation of semi-porcelain and porcelain glass pots are given. The method of casting glass pots as practiced at the Pittsburgh laboratory of the Bureau of Standards is also described. A. V. B.

TECHNOLOGY.—*Location of flaws in rifle-barrel steel by magnetic analysis.* R. L. SANFORD and WM. B. KOUWENHOVEN. Bur. Standards Sci. Paper **343.** Pp. 21, pls. 3, figs. 13. 1919.

This paper describes an investigation which was undertaken for the purpose of determining whether an application of magnetic analysis was practicable for the detection of flaws in rifle-barrel steel. By means of apparatus especially constructed for the purpose a large number of bars were explored for magnetic uniformity along their length. In spite of the fact that these bars were taken from material which had previously been rejected as the result of drilling tests, not one was found which contained a pipe. The results obtained, however, demonstrated that the method is amply sensitive to detect and locate flaws. Further study is necessary to determine to what degree the sensitivity of the apparatus should be reduced in order not to cause the rejection of material which is satisfactory for all practical purposes and also to determine the type and magnitude of the effect which will be produced by a pipe. For this reason the work is being continued by the Winchester Repeating Arms Company who cooperated in the investigation and at whose plant the apparatus has been installed. R. L. S.

CERAMICS.—*The cooling of optical glass melts.* HOWARD S. ROBERTS. Journ. Amer. Ceram. Soc. **2**: 543–563. July, 1919. (Geophysical Lab. Papers on Optical Glass, No. 14.)

The conditions to be attained when a melt of optical glass is cooled in the pot are: (1) that neither ream nor bubbles shall be introduced during the cooling, nor carried into the middle of the melt; (2) that the glass shall not become inhomogeneous through the precipitation of a crystalline phase; (3) that the bulk of the cooled melt shall be found cracked into large, reasonably rectangular blocks, having smooth, flat surfaces; and (4) that these blocks shall be sufficiently free from strain to cleave readily with a smooth fracture.

The appearance of ream in the middle of the melt, vacuum bubbles, or a crystalline phase, can be discouraged by rapid cooling, preferably from the bottom of the pot, while the glass is still soft; and by insulating its top surface as soon as the melt is set out of the melting-furnace.

The cold melt shows cracks of two types: "spherical cracks" and "plane cracks." The presence of either type of crack in the melt reduces the tendency for the other type of crack to form. As the fracture due to spherical cracks is rough and the pieces formed are irregular, while that due to plane cracks is entirely satisfactory, it is desirable to maintain the temperature gradient at a low value by slow cooling, and to prevent its decreasing much below its maximum until after the formation of plane cracks has begun. This can be accomplished by increasing the cooling rate at the proper time.

The cooling rate can be reduced (1) by heating the surroundings of the melt, *i. e.*, placing it in a heated kiln; and (2) by surrounding it with an envelope of some such insulating material as sand or kieselguhr. Variations of these two methods are described and time-temperature data given. H. S. R.

CERAMICS.—*Thermocouple installation in annealing kilns for optical glass.* E. D. WILLIAMSON and H. S. ROBERTS. Bull. Amer. Inst. Min. Met. Eng. 1445–1453. Aug., 1919. (Geophysical Lab. Papers on Optical Glass, No. 15.)

During the war-time rush to prepare the glass necessary for the needs of the Army and Navy, the problem of the temperature control of the annealing kilns became most serious. This paper gives a short account of the system evolved by the members of the Laboratory staff who were cooperating with the Pittsburgh Plate Glass Company at its Charleroi plant. The points which are most specifically treated are: (1) The advantages of the thermocouple over other devices for this type of work. (2) Choice of material for thermocouples. (3) Choice of measuring instrument. (4) Arrangement of leads and other apparatus. (5) The general problem of annealing optical glass. E. D. W.

CERAMICS.—*The volatilization of lead oxide from lead silicate melts.* OLAF ANDERSEN. Journ. Amer. Ceram. Soc. 2: 784–789. Oct., 1919. (Geophysical Lab. Papers on Optical Glass, No. 19.)

Experiments were made on the amount of PbO volatilized from the surface of lead silicate glasses at temperatures from 900° to 1400° C. It was found that the volatilization from an unstirred glass in 15 minutes took place at practically the same rate as from a stirred glass heated for a longer period. The rate of volatilization falls off considerably during a long heating if the glass is not stirred, as a film considerably lower in PbO forms on the surface of the melt, into which PbO must diffuse from below before it can escape. The rate of volatilization of PbO at the temperatures usually employed in optical glass manufacture would seem from these experiments to be small enough so that variations in refractive index due to volatilization are not to be expected if the procedure is reasonably constant from melt to melt, but large enough to cause considerable variations in index if the melting schedule is changed. O. A.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

137TH MEETING

The 137th meeting of the ACADEMY was held at the Cosmos Club at 8.15 p.m. on Tuesday, May 27, 1919. Major A. O. LEUSCHNER, Acting Chairman of the Division of Physical Sciences, National Research Council, and professor of astronomy in the University of California, delivered an address, illustrated with lantern slides, on *The determination of the orbits of comets and planets.*

(Proceedings of the 138th and 139th meetings have already been published in the JOURNAL.)

140TH MEETING

The 140th meeting was held jointly with the Geological Society of Washington at the Cosmos Club at 8.15 p.m., Thursday, February 19, 1920. President C. L. ALSBERG presided.

ALFRED H. BROOKS, of the U. S. Geological Survey, formerly lieutenant colonel and geologist on the General Staff, American Expeditionary Forces in France, delivered an address, illustrated with maps and diagrams, on *The application of geology to war.*

Geology finds application to war both in the rear areas and in the theatre of operations. The work in rear areas relates to water supply, drainage conditions, road metal, etc., at mobilization and training camps, and in connection with various other military projects. Above all it involves the determination of sources of minerals which the exigencies of war have made specially important. This field will be of equal and may be of greater importance than that of the more purely military application of geology in the theatre of operations. The latter use of geology was first developed during the late war and is the subject of this address.

It will be shown that there are many military applications of geology. The usefulness of the science was recognized by nearly all the great powers before the close of the war by the organizing of geologic staffs. Modern scientific warfare compels an army to seek every possible advantage by making full use of all sources of information about the physical conditions within the theatre of operations. Of two opposing armies the one having the most complete knowledge of the terrain will have an advantage and at times a decisive advantage. Such a complete knowledge is, however, only possible by use of geology.

Geology finds its principal direct application to war in forecasting the physical conditions that will be met with in the execution of certain military projects, such as fortifications, maneuvering of troops, erection of engineering structures, etc., and in determining the sources of water, road metal, etc. It will be evident that as both strategy and tactics must take account of the physical features of the terrain all great military leaders have made at least a subconscious use of geologic facts. Most of them have, however, failed to recognize that geology makes it possible to predict, often with a high degree of accuracy, the physical conditions that influence and often control certain military operations.

Any engineering project involving excavation must take account of the underground physical conditions, or, in other words, of the geology. This is specially true of fortifications, for protection against modern high-power artillery cannot be obtained by surface structures no matter how strongly built. Adequate cover demands deep works protected by virgin ground. The deeper the excavation the greater the geologic control. Even the construction of the relatively shallow trenches, however, is to a great extent controlled by geology. In these the depth to hard rock, the permeability of the soil, and the stability of the slopes are important and often decisive factors. There are many examples during the late war where positions have been lost and lives sacrificed because of the ignorance of commanding officers of the fact that entrenchment was impossible at the selected site within the time and with the equipment available. Again, many dugouts have been built only to be useless because of flooding by underground water. In most cases such blunders could have been avoided with only an elementary knowledge of local geology. Military mining is usually impossible where geologic conditions are unfavorable, yet no mention of this fact is made in the many manuals devoted to this subject.

Geologic facts, together with those relating to seasonal precipitation, also serve in the classification of the terrain with reference to the physical conditions of surface, which determine its passableness for infantry, artillery and tanks. A land surface that would have been no obstacle in former wars, with their relatively small number of troops and light equipment, might prove almost impassable to the great concentration of men and heavy artillery and tanks demanded by present tactics.

The supplying of the huge modern armies with water is one of the largest tasks of the military engineer. The great utility of geology in this field needs no argument. Geology also finds an important use in helping to locate sources of road metal and other structural materials. The principal subjects in which geology may be of military service are summarized as follows:

I. Field works. (Trenches, dugouts, and mines.)

1. Siting of field works. Location will take advantage of favorable geologic conditions as far as tactical situation permits.

2. Trenches. Physical character of material to be excavated; depth to hard rock; stability of slopes; surface drainage; underground water.

3. Dugouts and mines. Lithology and structure of rocks; ground water; water-bearing strata.

II. Maneuvering. (Infantry, artillery, and tanks.)

Physical character of surface formation, including seasonal variations; river crossings; interpretation of maps.

III. Water resources.

Distribution of springs; underground water; volumes of streams with seasonal fluctuations.

IV. Transportation.

Road metal; railroad ballast; depth to hard rock; stability of slopes; river crossings.

V. Construction.

Material for concrete; building stone; stability of slopes; character of foundations.

VI. Mineral resources.

Mineral fuels in theatre of operations; location of centers of enemy mining industry; mineral resources of enemy.

VII. Earth telegraphy and listening-in devices.

Determination of localities of favorable geologic conditions.

VIII. Camps, cantonments, aero fields. Munition and engineer dumps.

Drainage and character of soil and subsoil, as well as water supply.

IX. Areas of possible artificial inundation.

In part based on geology.

As in all other fields of applied geology the first essential for its military use is a geologic map. A geologic map once made with necessary structural sections and tables of sequence can be interpreted for the various military uses above referred to. Should warfare continue to develop on the scale and with the scientific refinement witnessed by the last five years, geologic maps will in time be considered almost as essential to offensive and defensive operations as are topographic maps.

It is evident that the use of geology must be considered a part of the preparations for war. Such preparation will take account of the following propositions:

1. The general principles of geology and their application to war must be made a part of military education.

2. Peace-time preparation should include the collection and coordination of geologic data relating to all possible theatres of operation.

3. A staff of geologic engineer reserve officers should be organized. It should be selected from experienced professional geologists and should receive a special peace-time training necessary to develop its full usefulness when called into active service.

ANTHROPOLOGICAL SOCIETY

538TH AND 539TH MEETINGS

The 538th meeting of the Anthropological Society of Washington was held in room 42–43 of the National Museum, at 4.45 p.m. on Tuesday, October 21, 1919. The meeting was devoted to discussion of *Field experiences* and the results of the anthropological work of the past year. The discussion was continued at the 539th meeting, held at the same place and hour, on Tuesday, November 4, 1919.

540TH MEETING

The 540th meeting was held in room 42–43 of the National Museum, at 4.45 p.m. on Tuesday, December 9, 1919. Program:

PHILIP AINSWORTH MEANS: *The Department of Piura, Peru.* (Illustrated with lantern slides.)

541ST MEETING

The 541st meeting was held in room 42–43 of the National Museum, at 4.45 p.m. on Tuesday, January 6, 1920. Program:

J. WALTER FEWKES, Chief of the Bureau of American Ethnology, *The genesis of the cliff dwellings.* (Illustrated.)

The speaker pointed out the characteristic architectural features of the highest type of cliff dwellings as illustrated by Square Tower House, a ruin situated in the Mesa Verde National Park in Colorado, excavated and repaired last summer in continuation of the development of the educational research of the Park by the Smithsonian Institution and Department of the Interior. This ruin belongs to what is called the pure type of pueblo, which differs from other types in our Southwest and from other cliff dwellings in the world in the style of construction of the sacred room or kiva, which is prehistoric and now extinct. The differences of this type from others were shown by views of a model made for that purpose. In no other ruins in the Mesa Verde is the vaulted roof of a kiva of this kind so well preserved as in Square Tower House.

The speaker said we need not look outside the area characterized by this type of kiva for a record of its evolution, and that it developed in the same geographic area in which it occurs, before it became extinct. The earlier stages in its evolution, previously unknown in the Mesa Verde National Park, were discovered last summer among the cedars at the head of the trail to Square Tower House. These buildings, the speaker claimed, may be regarded as prototypes of the unit type kivas of the cliff dwellings having likewise affinities with habitations of non-pueblo peoples from which the cliff dwellers were descended. One of these, called Earth Lodge A, a view of which was shown, was thoroughly excavated. Its essential difference from earth lodges of non-pueblos is the existence of stone bins made of slabs of stone on edge. Between Earth Lodge A with its rude vertical stone slabs and Square Tower House with its regular horizontal masonry and multiple unit type kivas is a series of buildings awaiting investigation and illustrating the evolution of cliff dwellings.

Dr. Fewkes considers that the stone cysts of the basket makers of Utah and the slab-house people of the same locality are products of a people of similar archaic culture, preceding those who constructed the horizontal kiva masonry, but not the work of peoples of a distinct culture that disappeared. These house builders employed adobe or rude mud walls with brush and logs in the construction of their dwellings and introduced cysts made of vertically placed stones for storage, burial or other purposes. They were not replaced by another people but gradually improved in their craft, passing step by step into structures of cut stone with regular horizontal masonry characteristic of the excellent work of the cliff dwellers. *Pari passu* they made synchronous advances in the excellence of their pottery and other artifacts, although certain weapons like the "throw-stick" were replaced by the bow and arrow.

The earliest stage in the genesis of the Mesa Verde cliff dwelling was an earth lodge constructed of adobe walls accompanied by cysts made of vertical stone slabs; the last member of the evolution series being the pure pueblo with unit type kivas situated in caves or on the plateau.

The culmination of the series flourished and disappeared before the advent of European historians. It illustrates a middle phase of pueblo development, but, although now extinct, degenerate forms of the unit type kiva characteristic of the Mesa Verde cliff dwellings still survive in the sacred buildings of the modern pueblos, where the type is modified by mixture with other architectura' features.

542ND MEETING

The 542nd meeting was held in room 42–43 of the National Museum, at 4.45 p.m., on Tuesday, January 20, 1920. Program:

GERARD FOWKE: *Explorations in caves in the Ozark region of Missouri.*

In the hilly portions of Missouri south of the Missouri River, especially in the Gasconade limestone formation, are thousands of caverns. Most of them are small, or at least have small entrances; others are large, extending beyond the point to which any visitors have ventured. Many of them have the front portion much expanded, with an opening which admits ample light; and these were often resorted to by aborigines for shelter. Owing to various causes not many of them were suited for permanent occupation; the floors may be rough or uneven; water may drip from the roof or flow along the bottom; the entrance may not be easily accessible; no stream or spring may be near; or other reasons may make them undesirable as places of abode. Occasionally one of them offers exceptional advantages for residence; and in such cases the primitive dwellers in the region availed themselves of the opportunity to secure a good home without labor.

The most noteworthy habitations of this character are along the lower portions of the Osage and Gasconade Rivers and their tributaries, especially in Phelps and Pulaski Counties. Some of these have been carefully explored recently, with interesting results. It is evident that they were continuously occupied for a long period. In one, the ashes from campfires were fully eight feet in depth; in another, the ashes over an area of 50 by 100 feet had an average thickness of $4^1/_2$ feet, and in all this mass there was not a barrow load of earth; the entire deposit was of pure ashes. In others, masses of talus at the entrance contained from top to bottom refuse thrown out by the inmates. The objects of artificial origin comprised mortars, pestles, hatchets, flint implements of various forms and sizes, bone and antler tools of diverse shapes, quantities of animal bones and mussel shells, and a large amount of broken pottery. Articles of a decorative or ornamental character were almost entirely lacking. Human remains were, in every case examined, buried in different positions but never at any considerable depth, seldom as much as 3 feet. The skulls indicated a low order of intellect; this, with the absence of ornaments, and some evidences of cannibalism, shows a very low grade of culture.

Specimens found, at whatever depth, were uniform in character. Though the amount of material would require centuries for its accumulation, there was no trace of advancement or improvement during the entire period.

When the remains ceased, they ceased absolutely and at once; below a certain level nothing whatever occurred.

F. Neumann, *Secretary*

SCIENTIFIC NOTES AND NEWS

THE AMERICAN GEOPHYSICAL UNION

The first annual meeting of the American Geophysical Union was held on April 23, 1920, at the offices of the National Research Council. At this meeting the permanent organization of this body was completed, amendments to its statutes were adopted, by-laws were enacted, and officers of the Union were elected. Brief reports were submitted by the American officers of the sections of the International Geodetic and Geophysical Union describing the progress made in the organization of the international sections.

A brief exposition was given of the status and functions of the American Geophysical Union, on the one hand in relation to the parent bodies, *e. g.*, the International Research Council, the National Research Council and the International Geodetic and Geophysical Union, and on the other in relation to the branches of science embraced under the term "geophysics" and specifically included in the sections of the Union.

For each of the Sections brief addresses were made by the chairmen, setting forth in outline various problems of interest to the Sections. These addresses constituted brief surveys of the research needs of the various branches of geophysics. They will be prepared for publication and issued at a later date.

Officers were elected to serve from July 1, 1920, as follows: American Geophysical Union—*Chairman*, William Bowie, for two years; *Vice-Chairman*, L. A. Bauer, for two years; *Secretary*, H. O. Wood, for three years.

Sections: (*a*) Geodesy: *Chairman*, William Bowie; *Vice-Chairman*, J. F. Hayford; *Secretary*, H. O. Wood. (*b*) Seismology: *Chairman*, H. F. Reid; *Vice-Chairman*, J. C. Branner; *Secretary*, H. O. Wood. (*c*) Meteorology: *Chairman*, C. F. Marvin; *Vice-Chairman*, W. J. Humphreys; *Secretary*, A. J. Henry. (*d*) Terrestrial Magnetism and Electricity: *Chairman*, L. A. Bauer; *Vice-Chairman*, W. F. G. Swann; *Secretary*, J. A. Fleming. (*e*) Physical Oceanography: *Chairman*, G. W. Littlehales; *Secretary*, J. T. Watkins. (*f*) Volcanology: *Chairman*, H. S. Washington; *Vice-Chairman*, R. A. Daly; *Secretary*, H. O. Wood.

The Union authorized the formation of a new section, (*g*) Geophysical-chemistry, covering researches in physics and chemistry as related to the problems of the earth. H. O. W.

NOTES

The National Academy of Sciences has purchased the block bounded by Twentieth, Twenty-first, B and C Streets, opposite the Lincoln Memorial in Potomac Park, and will erect a building on the site as a home for the Academy and the National Research Council. Plans for the building were made public on April 26, at the annual meeting of the Academy, by Dr. JAMES R. ANGELL, Chairman of the Council.

The National Academy of Sciences, at its meeting at the National Museum on April 26–28, elected the following new members: J. R. ANGELL, psychologist, Chairman National Research Council; H. P. ARMSBY, agricultural chemist, State College, Pennsylvania; W. D. BANCROFT, chemist, Cornell University; M. F. BLICHFELDT, mathematician, Leland Stanford, Jr., University; A. J. CARLSON, physiologist, University of Chicago; WILLIAM DUANE, physicist, Harvard University; L. R. JONES, plant pathologist, University of Wisconsin; E. P. KOHLER, chemist, Harvard University; C. K. LEITH, geologist, University of Wisconsin; C. E. McCLUNG, zoologist, National Research Council; E. V. McCOLLUM, biological chemist, Johns Hopkins University; G. W. PIERCE, physicist, Harvard University; H. J. RYAN, electrical engineer, Leland Stanford, Jr., University; JOEL STEBBINS, astronomer, University of Illinois; BAILEY WILLIS, geologist, Leland Stanford, Jr., University.

The following foreign associates were elected: F. D. ADAMS, geologist, McGill University; CAMILLE JORDAN, mathematician, College de France; FRANCOIS LACROIX, mineralogist, Musée d'Histoire Naturelle, Paris; H. KAMMERLINGH ONNES, physicist, University of Leyden; Sir DAVID PRAIN, botanist, Royal Botanic Gardens, Kew, Surrey; SANTIAGO RAMON Y CAJAL, histologist, University of Madrid.

The thirteenth Annual Conference of Weights and Measures Officials was held at the Bureau of Standards on May 24–27.

The sixty-eighth annual meeting of the American Pharmaceutical Association was held in Washington on May 5–10. The National Association of Boards of Pharmacy and the American Conference of Pharmaceutical Faculties, organizations affiliated with the Association, also met.

The United States Pharmacopoeial Convention met on May 11 for the tenth decennial revision of the *United States Pharmacopoeia* under the presidency of Dr. REID HUNT. The first convention met in Washington in 1820. The ninth met in 1910, and its work was embodied in the *Pharmacopoeia* which became the official standard on September 1, 1916.

The second annual convention of the Association of Scientific Apparatus Makers of the United States of America was held in Washington on April 22 and 23, under the chairmanship of C. S. STOELTING. Calibration of apparatus, standardization of designs for glassware, guaranteed chemical reagents, and pyrometer materials were among the subjects discussed. The Association elected the following officers: *President*, M. E. LEEDS; *Vice-President*, H. N. OTT; *Secretary-Treasurer*, J. M. ROBERTS.

A new exhibit has been arranged in the department of geology of the National Museum, consisting of portraits of early American geologists and copies of the first editions of their works, arranged to show the history of the progress of mineralogical and geological science in America.

A shipment of over 12,000 publications, the largest single consignment ever forwarded through the International Exchange Service of the Smithsonian Institution, went forward to Belgium in April, to aid in the restoration of Belgian libraries.

A complete working model showing the mining and preparation of the commercial forms of salt, made and presented by the Worcester Salt Company of New York, has been set up in the division of mineral technology of the National Museum.

Dr. James R. Angell, Chairman of the National Research Council, and professor of psychology in the University of Chicago, has been elected president of the Carnegie Corporation of New York. This corporation, to which the late Andrew Carnegie gave the greater part of his property, is chartered "For the purpose of receiving and maintaining a fund or funds and applying the income thereof to promote the advancement and diffusion of knowledge and understanding among the people of the United States, by aiding technical schools, institutions of higher learning, libraries, scientific research, hero funds, useful publications, and by such other agencies and means as shall from time to time be found appropriate therefor." Its present assets are about $130,000,000.

Dr. N. L. Bowen, formerly of the Geophysical Laboratory, Carnegie Institution of Washington, and recently professor of mineralogy at Queen's University, Kingston, Ontario, rejoined the staff of the Laboratory on May 1.

Mr. Spencer A. Colville, formerly with the New Amsterdam Gas Company, has been appointed associate gas engineer at the Bureau of Standards. He will assist in investigations leading toward a national gas safety code, which have been arranged for with the cooperation of the American Gas Association and the American Engineering Standards Committee.

The nomination of Dr. F. G. Cottrell, assistant director of the Bureau of Mines, to succeed Dr. Van H. Manning, resigned as director of the Bureau, has been sent to the Senate by the President.

A new record in precise leveling was made on March 9 by a Coast and Geodetic Survey party in California in charge of C. A. Egner. In eight hours of actual leveling the party ran 25.7 miles of single line.

Mr. Neil M. Judd, Curator of American Archeology, U. S. National Museum, left Washington on May 1 for the purpose of continuing his archeological investigations of the region north and west from the

Rio Colorado. The present reconnaissance will be conducted chiefly in northwestern Arizona. At the request of the National Geographic Society, the Secretary of the Smithsonian Institution has granted permission for Mr. Judd to direct the Society's archeological reconnaissance of Chaco Canyon, New Mexico, during the present summer.

Dr. Van H. Manning, Director of the Bureau of Mines, has presented his resignation, to be in effect June 1, and will become director of research in the American Petroleum Institute. Dr. Manning has been with the Department of the Interior since 1886, and became director of the Bureau of Mines after the death of Dr. J. A. Holmes, in 1915.

Mr. T. Matsumoto, of the Imperial Geological Institute, Tokyo, Japan, visited Washington in April.

Mr. O. E. Meinzer, of the Water Resources Branch, U. S. Geological Survey, recently addressed the Southern California members of the American Society of Civil Engineers, at Los Angeles, and also the section of the Society at San Francisco, on "An outline and glossary of ground-water hydrology."

Mr. G. W. Morey, of the Geophysical Laboratory, Carnegie Institution of Washington, who has been on leave of absence and in charge of the optical glass plant of the Spencer Lens Company of Buffalo, New York, since November, 1918, returned on May 1, 1920, to resume his research work at the Laboratory.

Dr. W. C. Phalen, formerly geologist in the U. S. Geological Survey and mineral technologist in the Bureau of Mines, has been engaged as geologist by the Solvay Process Company with headquarters at Syracuse, New York.

Mr. R. Luther Reed, who aided Secretary S. P. Langley in his work on aerodromes, died on April 26, 1920, after forty years of service with the Smithsonian Institution.

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SCIENTIFIC RESEARCH.—*The economic importance of the scientific work of the Government.*[1] E. B. ROSA, Bureau of Standards.

SCIENCE IN THE WAR

1. The Great War was based very largely on science and engineering. During the twenty-five years preceding the outbreak of the war the enemy had developed science and the practical applications of science in a wonderful way. He had fostered the industries, developed shipping and foreign trade, and promoted scientific research and education until the German nation stood in the forefront of the nations of the earth. With a complete misunderstanding of race psychology and an utter lack of appreciation of moral values, the enemy had prepared for a sudden attack with crushing force when a favorable occasion should arise. When the blow fell the allied nations were unprepared, not only for lack of armies and munitions but for lack of industrial equipment, transportation facilities and scientific development. Holding the enemy at bay under fearful odds while they built up their armies and their industries, the allied and associated powers utilized all the resources of science and engineering and a vast amount of accumulated treasure to make good their initial deficiencies and gain strength enough to wear out and overcome the enemy. In this titanic struggle scientists, engineers and captains of industry were mobilized by

[1] A lecture given before the Washington Academy of Sciences on May 20, 1920.

the tens of thousands, and men and women in the industries by the tens of millions, in order that the soldiers and sailors in the armies and the fleets might be adequately supplied with food, munitions and equipment. The wonderful achievements of science under the pressure of necessity demonstrated the economic possibilities of scientific research. This demonstration was not altogether new, but the war brought it home more forcefully, and at its close one felt that never again would anybody question the importance and economic value of scientific investigation.

NECESSITY FOR INCREASED PRODUCTION

2. The war was conducted on such a gigantic scale that the world's supply of raw and manufactured materials was largely exhausted. The increased demand thus caused for labor and commodities, together with the inflation of currency and credit, and in many cases the reduced efficiency of labor have raised prices beyond all precedent. Hardship and suffering have come to hundreds of millions of people throughout the world and political and economic confusion generally has resulted.

The cost of living during the war increased considerably, but wages were so high that many classes of workers were more prosperous than ever. The government directed the channels of trade and controlled the supplies of materials with much success, and prices in most cases were kept within bounds. With the end of the war came an end of governmental control, and also, with many, an end of economy and thrift, and for these and other reasons, prices have been mounting steadily ever since. Increased costs led to industrial unrest, strikes, high wages and further rise in prices. Profiteering has been denounced in the press and sought out by the government, but the average of prices continues to rise. It is generally agreed that in order to bring down prices it will be necessary (1) to contract currency and credit, (2) to economize in the use of necessities and luxuries, and (3) to utilize raw materials and labor more effectively and expand the production of commodities. The first remedy must be worked out by financiers and economists. The second might be accomplished by a nation-wide campaign for thrift and economy; and the third would be greatly aided by cooperative study and scientific and technical research on a comprehensive scale.

THE GOVERNMENT AND INCREASED EFFICIENCY

3. There is a shortage of labor in the country, and a tendency to shorten rather than to lengthen the hours of labor. If, therefore, production is to be increased without increased labor, it is necessary to increase the productivity of labor. To economize in the use of staple commodities and luxuries, to reduce the waste of raw materials, to make use of cheaper materials, to increase the efficiency of men, of machines and of processes, on a nation-wide scale and at an early date will call for intelligent and energetic effort, comparable in difficulty and importance with the task before the country in 1917 when we entered the World War. It is not merely in order to reduce the cost of living to those millions whose incomes have not increased in proportion to the rise in prices, and who in many cases are suffering hardship and distress; but it is to allay industrial discontent and forestall economic and political disturbance or even disaster. The confusion and inequity that have resulted from the rise of prices threaten the stability of society. The governments of the world are face to face with the problem of improving conditions and allaying discontent. To hold that governments cannot or should not deal constructively with the most serious problems of society, but that such matters should be left to chance, without organized effort or leadership, is not a satisfactory position to take after the successful experience with government leadership in the war. The old idea that the less government we have the better, no longer applies, if it ever did. Society is made up in part of a multitude of groups, some of which are highly organized, and many are seeking the advantage of the group rather than of society as a whole. The government represents the interests of society as a whole, and its problems and responsibilities have increased enormously in recent years.

THREE KINDS OF GOVERNMENTAL FUNCTIONS

4. Henry C. Adams, in his treatise on the Science of Finance, classifies governmental functions into three groups, namely, (*a*) The protective functions of government, (*b*) the commercial functions of government, and (*c*) the developmental functions of government.

(*a*) The protective functions of government are divided into three principal classes: (1) Protection against invasion or encroachment from without is provided by the army and navy, and this has always been an important and relatively expensive department of a national government. (2) Protection of life, property and reputation, which is accomplished through police, fire departments and the courts. (3) Protection against the spread of disease, either physical or social. As crime is looked upon as a phase of social disease, this will include prisons, asylums, sanitary provision, public charities, etc.

(*b*) The commercial functions of government include those which render a service for which payment is made by the individuals served, and are in general self-supporting. They address themselves primarily to the personal needs of the citizen rather than to the social needs of the state, and are performed by the state because it can render the service better or cheaper than private agencies. Examples are the post office, and in some cases railways, canals, telegraphs and other public utilities, patents and insurance.

(*c*) The developmental functions of government "are such as spring from a desire on the part of society to attain higher forms of social life." Society is not merely a collection of individuals, but is a conscious organism and the interests of society require collective action in developing itself. This includes: (1) Public education, (2) public recreation, (3) providing those legal and administrative conditions in which private business will be conducted in a just and equitable manner, (4) public investigation and control of public utilities, (5) developing the resources and wealth of the state, which includes scientific and industrial research.

DEVELOPMENTAL FUNCTIONS OF THE FEDERAL GOVERNMENT

5. These three classes of functions are exercised to some extent by municipal and state governments as well as the federal government. The powers of the federal government were delegated to it by the states, and were intended to be those required for the exercise of sovereignty by the nation in its relation with other nations, the maintenance of a national army and navy, the provision of a national currency, a common postal system, a uniform system of weights and measures (although this was not carried out as intended), the regulation of interstate commerce, etc.

In the early years of our history, society was relatively simple, communication and travel were infrequent, and each community was comparatively independent. Hence local governments were, in many respects, more important than national. With the developments in transportation and communication which have resulted from steam and electricity, the forty-eight states have come very close together, commerce and industry have much in common everywhere, uniformity of practice and uniformly good practice are generally desired, and it has been a problem how to avoid confusion of administration and industrial practice when there were so many legislatures and administrative bodies acting independently of each other. This has been partly accomplished by the cooperation of federal agencies with state bodies, leaving the legal authority with the states.

Many protective and developmental functions have long been exercised by the federal government because they were of common interest to all the people, and they could be performed more effectively and more economically by the federal government than by the several states, and there was no practicable way of getting all the states to work in harmony on a common program. The people who support the federal government are the same people who support the forty-eight state governments, and hence the plan of acting together through the federal government in performing functions of interest to all is not only economical and efficient but logical and just.

SCIENTIFIC RESEARCH A LUXURY OR A NECESSITY?

6. For many years the revenues of the federal government were ample and easily obtained. Taxation was indirect and not felt and many of the developmental functions of the government were exercised with little question or objection. The Great War involved enormous expenditures and increased the fixed charges due to the public debt and other war obligations to several times the former budget. The result is that expenditures for education, scientific research and development work are severely scrutinized, and the question is raised as to whether we can afford to carry on such work on a generous scale. It is, of course, proper that every item in the national budget be closely scrutinized, and that nothing be passed which cannot justify itself. It is desirable, therefore, to inquire whether scientific research as carried on by the federal government is a luxury or a necessity; whether it is something to be enjoyed when taxes are light and curtailed when taxes are heavy; or whether it is creative and wealth-producing, and therefore to be increased and developed when expenses are abnormally large and a heavy debt must be liquidated. The question is, in short, whether scientific and industrial research and education are like good seed and fertilizer to a farmer, which are essential to the best success; or whether they are as luxuries to the rich which consume but do not produce, and which should be curtailed when necessary expenses increase.

THE NATIONAL BUDGET

7. In order to discuss the question concretely and with reference to actual conditions, let us examine the national budget as it stands for the current fiscal year, with appropriations amounting to a total of $5,686,005,706, as given in the regular supply bills and three deficiency bills prior to May 1, 1920. For convenience, we may divide it into six parts as follows:

Group I.	Obligations arising from recent and previous wars, including interest on the public debt, pensions, war risk insurance, rehabilitation and care of soldiers, deficit in the operation of railways, expenditures of the Shipping Board, European food relief and the bonus to government employees to partially cover the increased cost of living due to the war, a total of......	$3,855,482,586
Group II.	War and Navy Departments, expenses somewhat above a permanent peacetime basis........................	1,424,138,677
Group III.	Primary governmental functions, including Congress, President and White House staff, courts and penal establishments, departments of Justice, State, Treasury, Interior, Commerce, Labor, Interstate Commerce and other commissions, one-half the District of Columbia, including all the necessary functions of government other than defense, except the commercial activities of Group V and the research, education and developmental work of Group VI........................	181,087,225
Group IV.	Public works, including rivers and harbors, public buildings, reclamation service, post roads, national parks and railway in Alaska...................	168,203,557
Group V.	Commercial or self-supporting activities, including the Post Office, Patent Office, Land Office, Panama Canal, and Housing Corporation, which taken together earn their expenses....	
Group VI.	Research, educational and developmental, including the wide range of work of the Agricultural Department, Geological Survey, Bureau of Mines, Coast and Geodetic Survey, Bureau of Standards, Bureau of Fisheries, Bureau of Foreign and Domestic Commerce, Bureau of Labor Statistics, Women's and Children's Bureaus, Vocational Education, Colleges for Agriculture and Mechanic Arts, Library of Congress, Smithsonian Institution and the Public Health Service..	57,093,661
	Total.........................	$5,686,005,706

ONE PER CENT FOR RESEARCH, EDUCATION AND DEVELOPMENTAL WORK[1]

8. The first two groups together amount to 92.8 per cent of the total; public works amount to 3 per cent, primary govern-

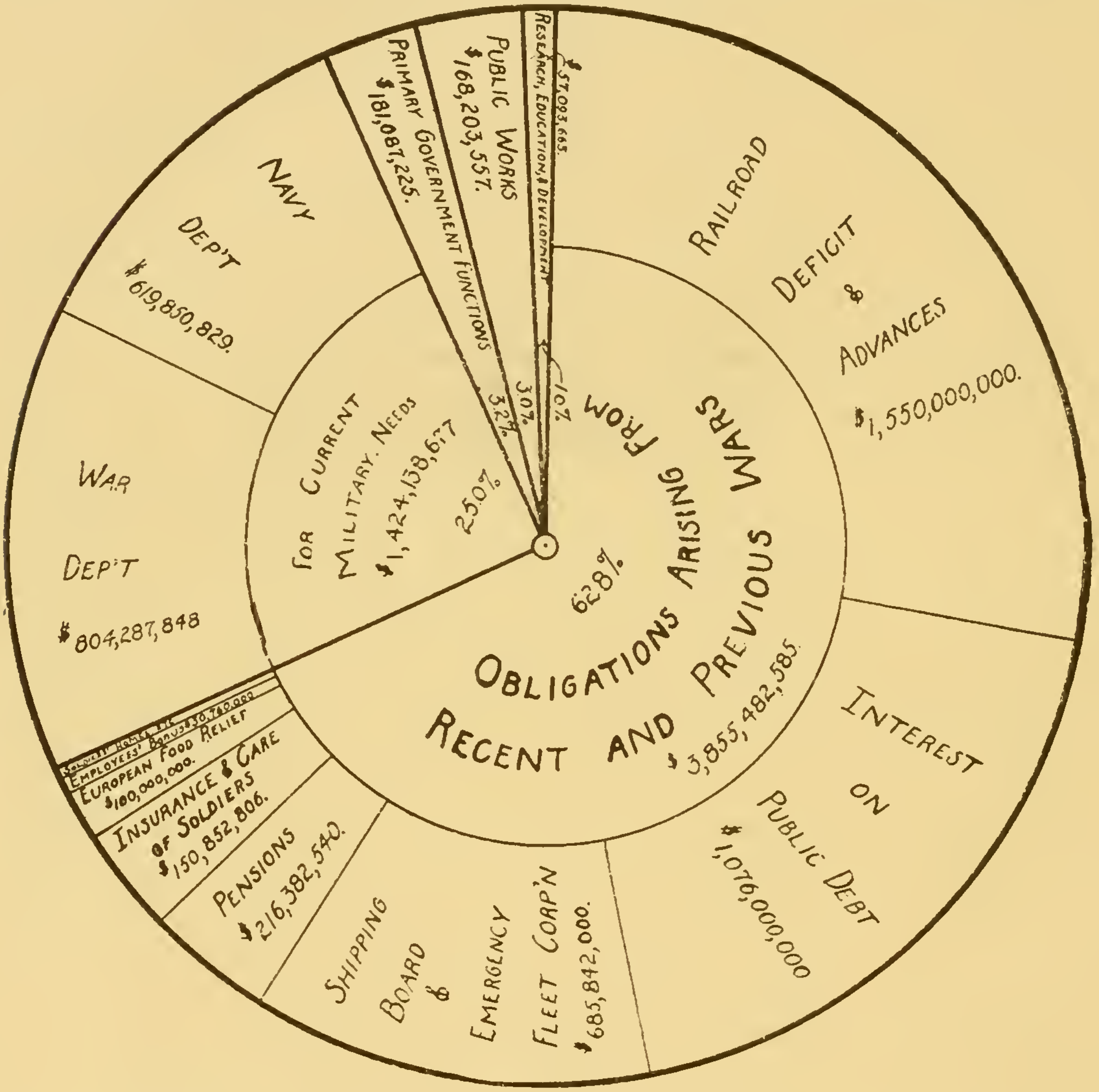

Fig. 1.—Distribution of government appropriations for the fiscal year 1920 (July 1, 1919 to June 30, 1920, inclusive). See table on page 380 and summary on page 382.

[1] For the next fiscal year, the appropriations needed for the railroads and Shipping Board, and for the Army and Navy, will be very much less than for the current fiscal year. The Treasury Department, therefore, expects to be able to make a very substantial reduction in the floating debt, now amounting to nearly three billions of dollars. The appropriations for Group VI for the next fiscal year are substantially the same as for this year. The ratio of Group VI to the total will, therefore, be substantially the same as at present (namely, one per cent), if we include, as we should, the payments on the floating debt and sinking fund in Group I, and if the total revenues for next year are approximately the same as for this year.

mental functions 3.2 per cent, and research, education and developmental work 1 per cent. The population of the country being about 110,000,000, the total budget is about fifty dollars per year per capita, of which fifty cents per year per capita is expended for the wide range of research, education and development work included in Group VI. That is, of the fifty dollars per year per capita collected for all purposes, a dollar and a half per year per capita is spent for what is here called the primary functions of government; nearly as much more is put into public works, and fifty cents per year is put back into research, educational and developmental work, to promote scientific research, to increase production and efficiency, to develop wealth, to promote the public health, and to conserve our natural resources. This is a very small part of the total, hardly enough to be regarded as a burden on the nation. Indeed, one is led to wonder whether the total burden of taxation would not be lighter if the expenditure for scientific and developmental work were increased; if, for example, it were one dollar per year per capita instead of fifty cents. In other words, if $110,000,000 were expended annually for this creative and productive work, would it not be easier to collect the five and a half billions for other purposes? To answer this question intelligently, it will be well to look a little closer into how the fifty cents per capita is expended and what is accomplished thereby.

WORK OF THE AGRICULTURAL DEPARTMENT

9. Nearly two-thirds of all the expenditures made under Group VI are for the work of the Agricultural Department. Agriculture is the most important industry of the nation. Agricultural and animal products amount possibly to twenty-five billions of dollars per year. Food has risen in price in recent years along with other products, partly because of higher wages and higher cost of machinery and supplies used by farmers, but largely because the urban population has increased faster than the rural and the demand for food products has increased faster than the supply. It is of prime importance to city dwellers that food products be produced in greater quantity, and this requires

an increased efficiency or an increased rural population, or both. The Agricultural Department carries on a wide range of educa-

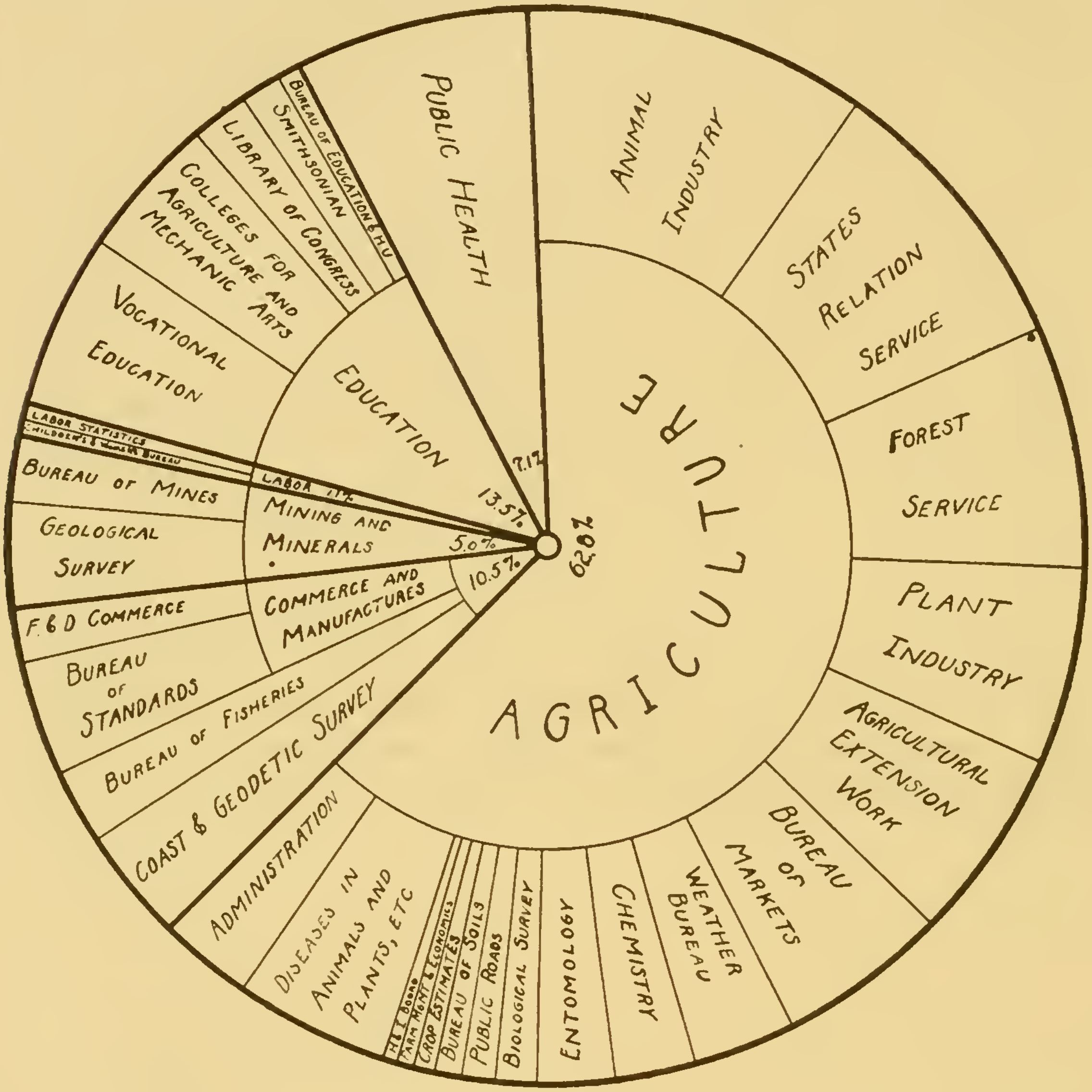

Fig. 2.—Distribution of appropriations for research, education and development, Group VI. See summary on page 381.

tional and experimental work in order to increase the production of farm products and to promote the interest of the farmer in his work, as well as to make life on the farm and in rural communities more attractive. This not only benefits the farmer but tends to keep food prices within reason for city dwellers. It is therefore serving all the people, and its work was never so much needed as at the present time. It is spending about \$1.50 for every $1,000 of value of agricultural and animal products, and without doubt the results achieved pay many times the cost of the work. The work of the Forest Service is nearly self-supporting, and might have been put into Group V. This year, owing to unusual forest fires, its deficit is larger than usual. Ultimately it will be more than self-supporting. The work of the various bureaus is of great importance and absorbing interest, but time does not permit even a brief description.

THE GEOLOGICAL SURVEY AND THE BUREAU OF MINES

10. The Geological Survey and the Bureau of Mines are concerned with the mineral industries of the country: coal, iron, copper and the other industrial and precious metals, oil, gas and the water supply and the topography of the land. Our country is rich in these natural resources and we are spending them in prodigal fashion. It is the business of these two bureaus to survey and map the distribution of metals and minerals; to look for new sources of supply; to gather statistics and to increase safety and efficiency in the mining and metallurgical industries; and to consider what can be done to conserve these natural resources which, unlike the products of agriculture, are not reproduced in annual cycles, but when once used can never be replaced. In addition, topographic and water power surveys are made and mapped. The products of the mineral industries of the country amount possibly to six billions of dollars per year. They are indispensable to our manufactures, and a most important part of our national wealth. If these two bureaus were to spend in this important work of research and development, an amount equal to one dollar in a thousand of the annual value of mineral products, it would amount possibly to six millions of dollars per year, which is more than double present expenditures. Can there be any doubt that such a sum expended in the interest of the public that pays the entire cost, and must bear the burdens of any inefficiency that exists in the industries, would be amply repaid? For example, millions of dollars are worse than wasted every year in accidents that could be prevented. Mining is one of the most hazardous of industries. The Bureau of Mines

has done a great deal of valuable work, both in research and education, to make mining safer; but there is need for a great deal more than it has been able to do. The results of such work are available in all the states where mining is carried on. It can generally be done better, and far more economically, than if done by the states unaided by the federal government. These two bureaus are doing a work of great economic importance at a cost to the people of this country of three cents per capita per year. If it were doubled the burden would be only slightly increased, but the service rendered in the increased efficiency of production and fewer accidents and more intelligent use of our natural resources would be very considerable. This is a splendid example of the economic and social value of cooperation of all the people through the agency of the federal government in doing efficiently what is needed by all.

THE BUREAUS OF STANDARDS AND OF FOREIGN AND DOMESTIC COMMERCE

11. The Bureau of Standards develops and maintains the standards of length, mass, volume, temperature, electrical and optical measurements, prepares standard chemicals and does many other kinds of fundamental work; it does testing for the government and the public, and it carries out scientific and industrial researches to develop the industries. A very large amount of work is done for the army, navy and other departments and for state institutions, so that not more than one-half of its total expenditures can properly be considered as done for the development of the industries. Excluding food products, tobacco and liquors, the annual value of manufactured products in this country, over and above the value of the raw materials entering into them, is possibly $12,000,000,000. The Bureau of Standards spends this year a sum not more than 15 cents per $1,000 of manufactured products in all its work, and as stated above, not more than one-half of it is for the purpose of developing these manufactures. If this sum could be considerably increased, it would enable a much larger amount of work to be done and the work could be carried on more efficiently. I shall give examples

presently of such work, and you may judge whether it would be profitable.

While the Bureau of Standards maintains and makes available the standards of measurement, of quality, of performance, and of practice, for commerce and the industries, and engages in research to develop the industries, the Bureau of Foreign and Domestic Commerce is concerned with the development of commerce and our export trade. The importance of foreign trade to a great nation, and the opportunity and duty of the government in fostering that trade in all legitimate ways, need no emphasis on this occasion. In view of the position of America as a world power, and in view of the general desire that our foreign commerce may be not only profitably but creditably conducted, it would seem that this function of the government would be developed and strengthened.

THE COAST SURVEY AND THE BUREAU OF FISHERIES

12. The Coast and Geodetic Survey is one of the oldest branches of the government doing scientific and technical work, and until the establishment of the Bureau of Standards, kept the standards and did the testing of weights and measures. It is charged with the survey of the coasts and rivers to the head of ship navigation, and the publication of charts, giving the results of base measurements, triangulation, topographic and hydrographic surveys, deep sea soundings, temperature, magnetic observations, gravity research, determination of heights, latitude, longitude, and reference points for state surveys. The work is very fundamental and important and has been done with a high order of precision and thoroughness, and with marked credit to the government.

The object of the Bureau of Fisheries is the stimulation of the production and consumption of fish as an important source of food. To stimulate production, scientific research on the habits and propagation of fish is carried on. The breeding of fish and their distribution into lakes and streams is done on a large scale. In all of this work, but particularly in connection with the propagation of fish and the protection of fish against lawlessness, the Bureau cooperates with the various states. The responsibility of the government for work of this kind is obvious, and there can be no doubt as to its being profitable.

THE BUREAU OF LABOR STATISTICS, THE WOMAN IN INDUSTRY SERVICE AND THE CHILDREN'S BUREAU

13. The Bureau of Labor Statistics gathers the statistics of wages in the various industries and the cost of living, and publishes much valuable material of interest to labor and capital. The prosperity and happiness of all the people depend to a considerable extent upon industrial peace and freedom from strikes and disorder. Industrial peace and contentment require justice and fair dealing between employers and employed. In order that both may know what is just and fair, statistical information as to wages and changes in prices and the cost of living is essential. It is probable that the greatest obstacle to a good understanding between employers and employed is lack of information. Suspicion and prejudice often give way to sympathy and understanding when full information, including information about what others are doing, is made available. The good results achieved by generous treatment of labor should be put before all employers, and if the government would spend more on research and education in this important field, might it not save much that is now spent in other directions? And might not the public be saved much both in expense and inconvenience that results from industrial warfare? This subject is of such tremendous and far-reaching importance that one is led to ask whether the government is doing as much as it should in this connection.

The work of the Children's Bureau and the Woman in Industry service is relatively new, but of great importance. Women are employed in the industries more than ever before, and the high wages and shortage of labor increases the pressure for the work of children. In the interest of the state, apart from considerations of humanity, women and children should be protected in the industries; and the work of these two bureaus is therefore of fundamental importance. It seems likely that it will grow rapidly in magnitude and occupy a larger place in the public's thought.

EDUCATIONAL WORK

14. The Bureau of Education collects and disseminates information concerning educational matters. The federal government has never taken a very active part in the educational work of the country. Whereas cities spend an average of $6 per year per capita for education and the states and private agencies about $3 per year per capita, the federal government spends only 6 cents per capita per year, including the sums expended in vocational education and assistance granted to colleges of agriculture and mechanic arts. Common schools and high schools are maintained by towns and municipalities, with some aid from the state. Normal and secondary schools, colleges and universities are maintained by the states and private agencies. Indeed private schools and privately endowed colleges and universities constitute a very important part of our educational system. The federal government, on the other hand, has no national university, and spends no money in the District of Columbia on higher education, except for Howard University for colored students. The Bureau of Education has for many years been doing a valuable work in keeping a record of the educational work of the country. Its support might well be greatly augmented, its scope broadened, and its activities and responsibilities correspondingly increased. We believe thoroughly in this country in popular education. We believe that the welfare of the state demands an intelligent electorate, and that material prosperity goes with education. The war revealed an unsuspected percentage of illiteracy in the men examined for military service. A million men in the draft could not read and write. The federal government might well take greater responsibility in matters of education and cooperate more actively with the states, setting standards for educational work and giving direction and encouragement where they are needed. A Department of Education with a cabinet member at the head, has more than once been proposed, and is even now being discussed.

Better facilities for higher education in the District of Columbia would be of great value to thousands of federal employees, as well as to other residents of Washington. The desire of federal employees for educational advancement should be encouraged and the needed facilities supplied, partly for their own sake and partly because they would thereby be enabled to render better service to the government. Washington is the proud capital of the richest nation on earth, and yet there are few cities in America and few capitals anywhere in the world where so little is done for higher education.

Recently, the Federal Board for Vocational Education has been established, and a substantial sum placed at its disposal. The need for vocational training was emphasized by the results of tests made in the army. Of men claiming expert knowledge of the skilled trades, only six in a hundred were found to be really expert. The Board assists the states financially and otherwise in developing and maintaining a system of vocational training. Such work is greatly needed as industry itself fails to supply the training necessary.

For many years the government has been cooperating with the states by paying a certain sum of money each year to one college in each state for the teaching of agriculture and mechanic arts. This was provided for under the Morrill act, and these payments now amount to $2,500,000 per year. In most cases these sums are a very substantial help to the institutions receiving them, and undoubtedly do a very great deal of good in the aggregate.

An English journal, commenting on the increased sums allotted in the English budget for next year to scientific and industrial research, has this to say: "Education and the financing of that education are important subjects. Indeed, we do not hesitate to say that upon the right method of instruction being followed depends very largely the future prosperity of the nation."

THE LIBRARY OF CONGRESS AND THE SMITHSONIAN INSTITUTION

15. The Library of Congress is a great national institution, corresponding to the British Museum and the Bibliotheque Nationale. It is properly grouped with the educational institutions of the government, and it is an institution of which all

Americans are proud. It is a great library, housed in a beautiful building, useful to thousands, enjoyed by hundreds of thousands. The country approves a generous policy toward this activity of the government, devoted as it is to art and education.

The Smithsonian Institution and the National Museum are national institutions devoted to science, art, and natural history. The Smithsonian Institution has a private endowment, but the greater portion of its funds comes from the government. It carries out scientific researches in the physical and natural sciences and has extremely valuable collections in its museums and art galleries. The government has not done as much in promoting art and collecting works of art as have many other governments, and it is to be hoped that much may be done in the future to compensate for past neglect of these matters.

THE PUBLIC HEALTH SERVICE

16. The Public Health Service is one of the most important of the agencies doing work of research and education. It maintains supervision over incoming vessels to prevent the introduction of diseases; to prevent the spread of diseases between the states it makes inspections and cooperates with the state departments of health; statistics of diseases are collected and interpreted, and scientific research is carried out to develop methods of preventing the spread of disease.

The Service has recently formulated a comprehensive health program to be carried out on a nation-wide scale by the active cooperation of federal, state, and local authorities and voluntary organizations. That these needs are urgent is shown by the fact that more than one-third of all men examined under the draft during the war were rejected for physical defects and diseases. The Surgeon General states that in large measure these defects and diseases could have been prevented had proper attention been given to them, especially in childhood. This unsatisfactory condition of the public health shows the need of greater attention on the part of the federal government, and more systematic cooperation between local and national agencies.

This systematic cooperation is obtained by the federal aid extension principle, as in the construction of good roads, and agricultural education.

A large amount of most valuable medical, statistical, and research work is carried on by the Public Health Service, which has been greatly developed in recent years. The opportunities presented in this work for growth and increased usefulness are almost boundless. In addition to its work in connection with the public health, a large amount of work is done in the care and rehabilitation of sick and wounded soldiers.

The foregoing brief outline of the activities of the various government agencies included in Group VI gives a very incomplete statement of the research and educational work done by the government. It is, however, intended to convey some idea of the wide range and important character of this work, and its great possibilities for development if more adequate provision could be made for its support. A portion of the work of the Bureau of Chemistry, the Bureau of Standards, the Coast and Geodetic Survey and other bureaus of Group VI would have been included in Group III if the work of the bureaus had been split up and the classification had been more detailed and exact. On the other hand, a portion of the work of the Naval Observatory, the Bureau of the Census, and other bureaus in other groups is scientific and educational. It is not possible to make a simple classification that is perfectly exact, but it is believed that the one given is sufficiently exact for the purpose. The Public Works group has value in economic development, but it is not research and educational, and is quite different from most of Group VI. It is now proposed to speak more in detail of one important kind of scientific research, namely, that designed to develop the industries of the country. This work is done primarily in the public interest, although it is generally helpful and beneficial to the individual owners.

COOPERATION BY THE GOVERNMENT IN INDUSTRIAL RESEARCH AND STANDARDIZATION

17. The success of industrial research work by the government

has been amply demonstrated. That government laboratories have done scientific and technical work of the highest quality, and done it efficiently and acceptably to the public, is generally admitted. Their efficiency will not suffer in comparison with that of commercial organizations. It is doubtful if any commercial organization could approach the performance of government laboratories if the board of directors had maintained an inflexible and inadequate salary scale for all the more responsible technical and administrative positions as the government has done.

Scientists and engineers in the service of the government appreciate the opportunity of carrying on researches and constructing public works in the public interest, and of being able to make investigations and publish results unfettered by commercial considerations. In consideration of these advantages, many are willing to remain in the government service at less salary than could be earned elsewhere. Until recently the government has been able to retain its able men on the average nearly as well as the colleges and the industries. During the past few years, however, circumstances in this respect have changed. While the cost of living has nearly or quite doubled, and salaries in the industries and in many of the colleges have been considerably increased, government salaries have increased very little and in the higher grades not at all. The result is that in many cases men cannot support their families, and are obliged to seek employment (or accept employment offered or urged upon them) at a living salary. In many cases men who are making a splendid success and have regarded the government service as their career, leave their positions from necessity and with the greatest reluctance. Often these positions cannot be filled and the work suffers or ceases altogether. It is believed, however, that this condition will not continue indefinitely. A readjustment of the salary scale must be made if the government is to have the services of a competent and permanent staff to conduct its scientific and administrative work. In view of the splendid success achieved in the past, it does not seem possible that this essential part of an effective government will be allowed to disintegrate and go to pieces. Industrial research conducted by the government with the active cooperation of the industries, and in some cases of the states, may be made even more important and successful in the future than in the past; for it is needed now more than ever, and is appreciated as never before.

In order to give a more concrete idea of the practical usefulness and economic importance of research and standardization, a number of special cases will be cited in the field of the Bureau of Standards. These cases are chosen partly because I am especially familiar with the work of this Bureau, and partly because there appears to be at this time especial need of the kind of constructive scientific research in the manufacturing industries which it is one of the functions of this Bureau to carry on. Equally striking examples could be cited in Agriculture or Mines or other lines of government research.

STANDARDIZATION AND RESEARCH IN THE BUILDING INDUSTRIES

18. For several years recently the building of homes has been almost suspended, and now there is a scarcity of houses in many cities. Meantime the cost of building has increased enormously, due to the greatly increased cost of labor and materials. In consequence real estate and rents have risen beyond all precedent. There never was a time when it was so necessary to use building materials intelligently, to reduce waste, to simplify design and construction, to standardize dimensions and methods, to make parts interchangeable and fit together readily, so as to economize labor and reduce costs. If standard specifications could be prepared and agreed upon in a much larger number of cases than has yet been done it would greatly facilitate the work of architects and builders; and if building methods and the requirements of city building codes could be thoroughly studied and revised this also would aid in reducing building costs. It seems probable that hundreds of millions of dollars could be saved within a few years if a comprehensive and intelligent study were made of all phases of building, including fire prevention and the plumbing, heating, lighting and hardware equipment of buildings. It would also reduce the cost of repairs and

maintenance of these buildings; partly because deterioration would be slower and failures would be less frequent, and partly because repairs would be easier and cheaper to make. The government would do only a portion of this work of research and standardization, as many engineering societies, industrial organizations and manufacturers would cooperate. But the government should take the lead, and do an important part of the research work, and nothing which the government could do would be more useful and constructive, or would be more appreciated by the building industries and the public. Standardization work of the kind suggested has great educational value to architects, to builders, to manufacturers, to jobbers, to building owners. Is there any good reason why such a constructive program of cooperative study should not be undertaken? Can the people of this country afford to go on without it under present conditions?

STANDARDIZATION AND TESTING OF AUTOMOBILES

19. The automobile industry is one of the most important of our industries, and motor vehicles of all kinds play a most important part in the business and social life of the people. Several billions of dollars are expended each year in the purchase and maintenance of motor vehicles. Great improvements have been made in recent years in their design and construction; on the other hand, the quality of materials and workmanship has in many cases gone backward. Much progress has been made toward the standardization of the materials and parts of motor vehicles, and great credit is due to the automobile industry therefor. But there is great need for further systematic study and the preparation of specifications and tests, and the encouragement of testing so that purchasers may know better what they are buying and selling agents may describe their machines more precisely. The interests at stake are so enormous, and the possibilities of service to the public are so great, that it seems imperative that more should be done by the government to assist the industry in its great task.

GASOLINE AND MANUFACTURED GAS

20. Gasoline is getting scarcer and dearer every year, and yet not enough is being done in a systematic way to show how to economize in the use of gasoline. A thorough investigation of carburetors and fuels, and certified tests of the performance of all makes of automobiles, would be of great value in economizing in the use of gasoline, and giving the public as much service as possible for a given expenditure. The Bureau of Mines and the Bureau of Standards have studied different phases of this question, but neither has been able to do as much as should be done. With millions of automobiles in daily use, and gasoline constantly rising in price and deteriorating in quality, can the public afford to have the government fall short in a matter of so great economic importance, and of serious personal concern to so many?

Manufactured gas is used for cooking and lighting by many millions of people and by the industries for scores of uses. A large part of this gas is made by the use of petroleum oil to enrich blue water gas of low heating value. Recently this gas oil has become scarcer and dearer, and it threatens to become still more expensive and perhaps impossible to get in sufficient quantity. That will necessitate the use of lower grades of oil, or the production of lower grades of gas, or a change of manufacturing equipment at enormous expense. Individual gas companies cannot study so fundamental a question comprehensively; individual cities or states cannot assume the responsibility of solving the problem for the entire country. The proper agency to take up this question is the federal government, with the cooperation of the gas companies and the oil companies and the state and municipal authorities. Such a comprehensive and constructive study would be of great value and would have the sympathy and support of all the important interests. It should include the matter of raw materials, manufacturing methods, and the relative usefulness of the various grades of gas that can be produced.

PUBLIC UTILITIES

21. The government should cooperate actively with gas and electric and railway and telephone companies in the study of the many engineering questions involved in rendering good service to the public. The changed economic conditions of recent years have made it impossible for many public utility companies to meet expenses. In some cases they have gone into the hands of receivers, in many other cases they escape by putting up rates. But advancing the rates beyond a certain point reduces the sales and does not give a proportionate benefit. The public in the end must pay all the cost, and the public is vitally concerned in having efficient and economical management of these utilities. If the government could help the companies to help themselves, it would often be better than an increase in rates. The government could render a service of immense usefulness and importance by studying the problems of the public utilities and helping the companies to secure more efficient operation and a better understanding by the public of their difficulties and their needs. The utilities are a special kind of partnership between their owners and the public, in which the owners agree to furnish the plant and the service and the public grants a monopoly privilege and agrees to accept the service rendered and to pay the cost. If the company's credit is impaired or it fails altogether the community, as well as the company, suffers. It is evident, therefore, that the public should take a keen and intelligent interest in public utility problems, and especially in the situation which has resulted from the rising cost of labor and commodities, for which the companies are not responsible. The government has been rendering important service of this kind, enough to demonstrate its value and to show that cooperation in this work is practicable. But it could render a service of vastly greater importance to the utilities and to the public, by an expenditure, say, of one million dollars per year for research and education on utility problems. That would be only one cent per year per capita of the country's population, whereas the

value of the service that would be rendered to the public would possibly be fifty or a hundred times the cost.

STANDARDIZATION OF ELECTRICAL BATTERIES

22. One of the most productive lines of research at the Bureau of Standards recently has been a study of electrical batteries, primary and secondary. They are used in great numbers for starting and lighting automobiles, for tractors and other electric vehicles, for electrical power stations, for telephone exchanges, railway signals, door bells, flash lights and a hundred other purposes. No adequate specifications or methods of test had ever been generally agreed upon when the Bureau took up the work. They were sold without guarantee or adequate statement of performance, and the purchaser had no way of ascertaining just what he was getting. The manufacturers have cooperated cordially and intelligently in the study that has been in progress, and in time it is expected that a complete set of specifications and methods of tests will be developed. In the meantime the manufacturers have derived important benefit from the investigation and the public is getting a better product. Possibly a hundred million dollars worth of these batteries are made and sold each year, and if this work could be carried on more adequately and as thoroughly in all lines as it has already been in some lines, it seems a safe statement to make that the public would be benefited not less than five per cent on the entire product. This would amount to five million dollars per year, which is several times the cost of all the work of the Bureau of Standards, and more than a hundred times what the battery work would cost. This kind of research and educational work is like seed that falls on good ground and springs up and bears fruit, some thirty, some sixty, and some a hundred fold.

TESTING OF GOVERNMENT SUPPLIES

23. For many years electric lamps purchased by the government have been systematically inspected at the factory and samples selected for life test in the laboratory. The information so obtained is utilized in the preparation and periodical revision

of standard specifications which are used in the purchase and testing of lamps. Formerly lamps were bought by each department or government establishment separately, without specifications or tests. The prices were relatively high and the quality of the lamps often uncertain or poor. Electric lamps are made by highly specialized technical processes. It is very easy to make lamps that will give light, but difficult to make lamps of high quality. Since government purchases of lamps have been consolidated into large contracts and lamps have been tested according to proper specifications, the prices have been the lowest and the quality of the lamps the highest that the market affords. The ordering of lamps by each department is now a simple routine operation, whereas formerly the separate purchasing of lamps involved dealing with agents of various manufacturers and guessing as to who offered the best values. The systematic testing of lamps by the government not only protects the government in its purchases, but it protects the public in large measure, for the testing tends to keep up the quality of the entire product, and so benefits the public. The value of this work, which puts the purchase of lamps by the government on a business basis, and protects the manufacturer of a high-grade product as well as the user, is many times the cost of the work. The influence of the government, instead of being hurtful as it formerly was, is thus stimulating and helpful to the industry, tending to raise the quality of the product and to improve business methods.

The testing of paper for the government is another example of constructive work which puts the government's purchases on a business basis and tends to help the industry instead of degrade it. Formerly the government bought paper in great quantities on incomplete specifications with inadequate tests. Manufacturers knew that they could supply something different from what was specified, and one who was willing to do so had the advantage over one who supplied what was called for. This was an intolerable situation which was corrected when the specifications were made adequate and tests were complete and systematic.

The value of such work is incomparably greater than its cost, and it would be well if all government purchases were as intelligently and systematically handled as lamps and paper and certain other products now are. It is proposed to establish a central purchasing bureau and to have supplies purchased and delivered in wholesale quantities and tested as to quality, instead of ordering small lots separately that cannot be inspected or tested systematically. This would be a long step forward in putting the business of the government on a business basis.

TEXTILES

24. The textile industry is one of the largest and most important of our industries and one which concerns every man, woman and child in the country. If textiles were standardized, so that they could be bought and sold on adequate and intelligent specifications, and consumers as well as wholesale and retail dealers could know what they are buying and could get what they pay for, it would be of enormous benefit to all. Suppose the brand or name of every textile product was defined in such a way as to convey precise information, and the same name always meant the same quality. And suppose that dyes were tested and certified, and one could depend on the mark as to their permanence, and were told what conditions they would stand or would not stand. Would it not be worth hundreds of millions of dollars every year to the public to have such information? And would it not be a boon to honest dealers, both wholesale and retail? The only class to be injured by such a situation would be those who thrive by misrepresentation or by selling inferior goods on their appearance without representation. It seems almost certain that money intelligently spent in research and education along the lines indicated would yield results of very great value, and while it would involve some expense and trouble, it would be constructive and wealth-producing and would raise the standards of business. It seems certain that it would be as useful as the grading of lumber, or cattle, or wheat.

THE CHEMICAL INDUSTRIES

25. Rubber, leather, paints and the chemical industries generally, include a vast number of products which should be standardized and described in intelligent specifications. In many cases the product can be materially improved with little or no expense, if available information is utilized. Often it is the difficulty in securing information and not reluctance to use it that explains the poor quality. There are great numbers of small manufacturers who would avail themselves, if they could, of information to improve their product, but who cannot afford to engage in expensive research to get the information. The government could supply thousands of small manufacturers with information on hundreds of subjects if an adequate staff were made available to do the work, and this would be of direct benefit to the public which pays the cost. This is cooperative work of the most practical sort, and it has been done already in enough cases to demonstrate how productive of good results it is.

SCIENTIFIC INSTRUMENTS

26. The manufacture of scientific instruments has recently come to be an important industry in this country. This is partly owing to the greater use than formerly of scientific instruments in the industries, and partly to the war which has largely reduced the importation of scientific apparatus from abroad. An increased protective tariff is proposed to encourage and protect American manufacturers of such apparatus, but if there are no standards of excellence set up and no adequate specifications or guarantees, the purchaser will often be uncertain of what he is getting when he buys such apparatus. The government would do well to cooperate actively with the manufacturers and with scientific and engineering societies in standardizing and describing scientific apparatus, so that the manufacturer will know better the properties and capabilities of his own output of apparatus, and the purchaser will know how to select apparatus and whether he gets what he orders. In other words scientific apparatus should be scientifically described and intelligently used, and the govern-

ment could render an invaluable service in aiding to bring this about. The manufacturers of this apparatus are eager for information, and will do their part in such work. They are calling for greater service from the Bureau of Standards in instrument testing than it is able to render because of lack of men to do the work.

SAFETY RESEARCH AND THE PREPARATION OF SAFETY CODES

27. One of the most valuable opportunities for cooperative work by the government is in safety research and education; that is to say, in studying methods of reducing accidents in the industries and in every-day life, in formulating sets of safety rules or codes, and in assisting the state industrial commissions in adopting them and manufacturers in complying with them. More than 3,000,000 industrial accidents occur every year, of which 25,000 are fatal. Many millions of dollars are expended annually by employers for accident compensation, and many millions more are lost by injured employees in wages not compensated. Nearly every state has an accident commission which supervises the collection of compensation for accidents, but many of them do very little to reduce accidents. A few states have provided their commissions with generous sums to enable them to prepare safety rules and put them into effect, and valuable results have been secured by such efforts. Recently a comprehensive program of safety work has been prepared in which many agencies will cooperate. This work includes the preparation of nearly a hundred different safety codes, covering the hazards of manufacturing in many different industries, transportation, mining, and the use of electricity, gas, machinery, and explosives by the general public. These safety codes are more than mere sets of safety rules, often amounting to a standardization of engineering practice in many aspects of an industry, and being of great value in promoting efficiency and good practice as well as safety. They are prepared by the active cooperation of all the interests concerned, including engineering societies, industrial and insurance associations, state accident boards,

manufacturers of machinery and appliances, and the federal government. The work of preparing the codes involves study and discussion, a comparison of experience and a consideration of the best operating methods. Efficiency and good service are considered as prominently as safety. Some of the more important examples of these codes are the Steam Boiler Code of the American Society of Mechanical Engineers, the Electrical Fire Code of the National Fire Protection Association, the National Electrical Safety Code of the Bureau of Standards. A national elevator code, codes for steel mills, blast furnaces, foundries, machine shops, textile mills, saw mills, and dozens of other industrial establishments are being prepared or are under consideration. The government is rendering a valuable service in this work, but the work suffers for lack of funds. The industries, the engineering societies, and the state commissions are doing their share of the work. The government's share is important and should be well done. The cost of the work is trifling in comparison with its value, and it does not seem possible that this work will be allowed to lag or cease for want of funds if the general public could but understand its immense importance and usefulness. Aside from questions of humanity and the economic value of human life, the losses in wages and the damages paid in compensation amount to so many millions annually that the small amounts required for the government's share of the work are insignificant in comparison. Probably no work of the government is more useful or more productive in proportion to its cost, and none is more needed by the country at large. The states and the industries are waiting to put these safety codes into effect, and the great advantage of national uniformity will result if they are prepared so well that they can come into general use. The work should be strengthened and enlarged at an early day, as a measure of efficiency and economy as well as of humanity and good government.

METALLURGY, CERAMICS, AERONAUTICS, ETC.

28. Many other examples of the economic importance of scientific research and standardization could be cited, if time

permitted. The metallurgical industries have been greatly developed in recent years through scientific research, and there is now greater activity than ever in this field. The metallurgical division of the Bureau of Standards works in close cooperation with the engineering societies and manufacturers, and is doing work of very great industrial importance. The manufacture of glass, porcelain, tile, and other clay products has been greatly stimulated during the war by the cooperation of scientific laboratories, and vast benefit would be derived by these industries if this cooperation could be continued and even increased. The measurement of temperatures and especially high temperatures is a problem of continually increasing importance in the industries, and many scientific investigations are continually arising in this connection. The intelligent and efficient development of aeronautics depends on the possession of full and reliable information as to the properties of materials, the accurate measurement of the performance of machines, experimental researches in mechanics and aerodynamics, and the most intelligent utilization of existing and newly developed information. Considering the amount of money that is being expended in the development of aeronautics it would seem that a very considerable amount should go into scientific research. The measurement of color and of illumination and of the optical properties of materials and the development of optical methods and instruments form together a field of investigation of great scientific and economic value. It is impossible even to mention all the subjects of importance in this connection, but enough has been said to show how vast the field and how practical the results that are obtained whenever science is appealed to in answering the problems arising in the industries.

RESEARCH BY LARGE CORPORATIONS

29. The Standard Oil Company has attained a wonderful reputation for its technical and commercial success in deriving valuable products from petroleum, a result which could never have been reached without extensive scientific research.

The General Electric Company has achieved notable success in the development of electrical instruments and machinery, electric lamps, steam turbines, the applications of electricity to ship propulsion, etc., and a very large part of this success may be credited to its scientific and development work. Its research laboratories have turned out many valuable contributions to science, in addition to the results of direct application in their business. The American Telephone and Telegraph Company, and its subsidiary, the Western Electric Company, have achieved a world-wide reputation for their development of long distance telephony, multiplex telephony and telegraphy and radio telephony as well as for the development of many of the engineering features of telephone practice of the present day.

These and other great corporations carry on research work on a generous scale and derive great commercial advantage therefrom. But thousands of smaller companies cannot do what they do. The smaller companies are, however, rendering the public a service that is very essential, and the public will serve itself by helping them to improve this service. This does not mean that they will have their burdens carried for them by the government, but rather that the government as the agent of the public should participate in research and standardization work (in cooperation with manufacturers' associations and engineering societies) in order that the public may be better served and in order that the public may judge more intelligently of the quality of the product or the service rendered. It is the open door method of doing business as opposed to the method of keeping the government and the public in partial ignorance. The burden of this work when borne by over a hundred million people is very light; the benefits far outweigh the cost. The American Telephone and Telegraph Company's research laboratories employ more research workers in their single field of investigation than the Bureau of Standards does for all its many lines of work for all the industries of the country. The results obtained justify the large expense for research in the telephone field. The splendid results obtained are not due merely to the fact that work is well managed and is done by a great corporation; but rather to the fact that abundant resources (provided of course by the public) are made available and an adequate scale of salaries is paid. Government laboratories could do as well if they had an equal or nearly equal chance; but they cannot work miracles.

THE ECONOMIC VALUE OF STANDARDIZATION

30. The American Engineering Standards Committee has recently been formed to promote engineering and industrial standardization. Five engineering societies and three departments of the government were represented initially in its membership. Several additional member societies have just been added and others will be added from time to time. The Committee is already actively at work in selecting sponsor societies for standardization work and approving standards. The government is rendering a valuable service to the industries, and thus to the people, by cooperating actively in this constructive and useful work. Manufacturers have not cooperated with one another in the past in standardizing designs as much as they could have done if there had been some practicable way of cooperating. They have resented government dictation and control, but they welcome government cooperation in constructive work that benefits both them and the public. In many cases the designs and sizes of machines and materials manufactured by different concerns are different because development has been independent. In other cases it is in order to have something upon which to base a claim of superiority. In either case, too many sizes and designs and lack of interchangeability increase the cost to the manufacturer, to the distributor and to the user. Nothing promotes economy and efficiency in the use of raw materials and finished products more than intelligent standardization. It reduces the varieties and sizes of materials that must be supplied by the manufacturer, lessens the stocks that must be carried by the distributor, makes the cost of the finished product less and reduces the trouble and expense to the user in caring for and keeping in repair machinery and equipment of all kinds. The high cost of the services of the plumber have been proverbial for years. Standardization in plumbing fixtures and fittings,

and interchangeability of parts could be carried further than it has been. This would greatly reduce the charges for time and material in making repairs as well as in the original installation. The enormous and confusing variety of lighting fixtures, and the bad design of many, are due to utter lack of standardization or cooperation of the manufacturers with one another. Inefficient and dangerous gas appliances have been sold to the public for years, and many are still in use. The manufacturers cannot be blamed, for they cannot separately engage in expensive research to arrive at correct designs. The only practicable way is for all to cooperate and for the government to take an active part, helping the manufacturers to study these problems of design and standardization intelligently and thoroughly.

THE DUTY AND OPPORTUNITY OF THE GOVERNMENT

31. Such work is constructive and wealth-producing, and yields returns a hundred-fold upon the investment. The benefit is almost immediate and not only are there material returns in decreased costs and improved service, but such cooperation between the government and the industries raises the standards of business and is helpful both to the government and to the industries. It emphasizes good quality and good performance and good service, and reduces misrepresentation and exaggeration in selling. Is it not the duty of the government to cooperate more actively in this constructive way with the industries? No other agency can perform this important function. The government would do only a part of the work, but that part is of great importance. Engineering societies, manufacturers' organizations, and individual manufacturing companies will do their part, and in many cases the greater part. But if the government refuses to do its part on the ground that it would increase taxation, the public will not be satisfied with the reason given when it knows that at the present time out of $50.00 per capita per annum collected by the government for all purposes, *scarcely more than one cent per capita per annum is expended by the government for this important work, and five cents per year per*

capita would accomplish wonders. The matter is of so fundamental importance, and promises results of so great economic and social value, that it is to be hoped that some more adequate effort along this line may be made. It seems impossible that such effort would not succeed at least in part, and even a partial success would more than repay the cost.

The English journal previously quoted says this of the government's part in scientific research: "*The endowment of research and the financing of scientific investigation are essential in any progressive nation, and if the money is well spent no amount allocated to these branches can be too great at the present stage in our country's history.*"

In Great Britain the Engineering Standards Association is largely financed by the government, while the Department of Scientific and Industrial Research is a government body financed entirely by the government. The American Engineering Standards Committee and the National Research Council (of America) are financed entirely without government aid. This is an additional reason why government research institutions in America should be so well supported that they can do their full duty in cooperation with privately supported scientific and industrial institutions which are doing work in the interest of the public.

GOVERNMENT LABORATORIES AND THEIR TRAINED PERSONNEL AVAILABLE FOR WAR

32. The war called for scientific research in connection with the standardization and making of munitions, finding and using substitute materials, locating enemy guns by sound and flash ranging, locating submarines, building and equipping ships and submarines, building and equipping airplanes, dirigibles and balloons, and many other major subjects as well as countless minor ones. This called for well-equipped scientific laboratories and the trained personnel of research workers and assistants. The government laboratories were utilized to the limit of their capacity, and all kinds of makeshift facilities were pressed into service. If preparations had been begun several years before,

it is needless to say results would have been obtained sooner and the war appreciably shortened. In view of this experience, and the probability that science and technology will be no less important in the future than in the past, the question naturally arises whether the government is making adequate preparation for scientific research as a part of its program of military preparedness? In time of war the civil branches of the government will be called upon immediately, and they will be able to render invaluable service if they are adequately equipped and manned. In the meantime, pending the arrival of the war, which we hope will never come, they will be able to render useful service in civil problems and so be more than self-supporting. This kind of preparation for war, which adds nothing to the military budget if the civil departments are adequately supported, should appeal to all as practicable and desirable.

SUMMARY OF THE ARGUMENT

33. The federal government, having emerged from participation in the World War, finds itself with a large debt and heavy annual charges caused by the war. These together with the current cost of the army and navy amount for the present fiscal year to 92.8 per cent of the total budget. The cost of public works and the necessary administrative cost of the federal government amounts to 6.2 per cent of the total. There remains one per cent for a large number of governmental activities classed as research, educational and developmental. The question arises whether in the interest of economy and efficiency the one per cent shall be decreased; or because this work is constructive and of great economic value it shall be increased, possibly doubled. The arguments in favor of increasing it may be summarized as follows:

(1) The government should be constructive and helpful to the people and to business wherever possible. It should carry on scientific research, promote education, develop the industries, assist in improving commercial and industrial methods, and furnish technical information to manufacturers and others, as

well as develop agriculture and the public domain. Such service by the government tends to establish good relations with business, to elevate business methods, to increase efficiency and to educate the public. The many services thus rendered cost very little in the aggregate as compared with the total expense of the government, but they are of great practical value and are appreciated by the people. *One per cent of the total expenses of the government spent in this constructive way seems a very small proportion in view of the wide range and the economic value of such work.*

(2) But a part of this one per cent is incurred in behalf of the government itself, to enable the government to purchase its supplies intelligently and to do business in a businesslike way. Without this research and testing work the government would waste more in buying than it would save by eliminating the research and testing. Making purchases without full technical information is embarrassing to public officials and unsatisfactory to business; whereas by always using intelligently drawn specifications and making adequate tests, the government can save money, elevate its own service and improve business methods. Much but not enough of this kind of work is now done. It is the duty of the government to set a good example before the business world of efficient and intelligent methods and fair dealing; neither accepting goods below the specified quality nor demanding more than is specified. *The government would spend less for its purchases if it spent more in standardizing the products purchased and in testing deliveries systematically.*

(3) But apart from the service the government can render its citizens, and the benefit to the state resulting from scientific, educational, and developmental work, and apart from the benefit to the government of having the results of such work in constructing buildings and other public works, and carrying on its business, this kind of work develops wealth, and the increased wealth can be taxed, and hence there is a third reason for increasing such work. The war has made it necessary to raise many times the revenue formerly required, and the taxation is now an important issue. Economizing in the use of raw materials, using

cheaper materials, reducing waste, developing the public domain, increasing manufacturing efficiency, reducing distribution costs, all tend to create wealth and to make it easier for the government to raise the needed revenue. Therefore, if there were no other reason, this consideration should appeal to legislators and business men alike; *namely, that research and development work by the government develop wealth, and the burden of taxation is thereby lightened.*

(4) But there is another powerful economic reason for increasing the productive developmental work of the government. The rising cost of living not only leads to hardship and distress, but to industrial unrest, strikes, disorders and great economic losses to the nation. In order to check rising prices, and if possible bring down prices, it will be necessary to increase production. To do this it is necessary to reduce waste and increase efficiency. This requires greater intelligence and fuller knowledge, and calls for education, the results of scientific investigation and of intelligent and extensive industrial research. The government could not and should not do it all. But neither should it refuse to do its part, and its part often is to take the lead in a constructive and statesmanlike way. It is stupid and blind to think that because taxes are heavy we cannot afford to do things intelligently. If a farmer's barn burns down, he would not sell half his supply of seed and fertilizer to buy lumber, and then plant only half a crop. He would, if necessary, borrow money to buy more seed and plant a larger crop than usual, in order to increase his income and pay for the new barn more easily. *Intelligent research by the government, in cooperation with the industries, is like seed and fertilizer to a farmer. It stimulates production and increases wealth, and pays for itself many-fold. It is as productive and profitable in peace as in war.*

(5) Finally, if the reasons already adduced are not sufficient, there remains the military reason. The development of our intellectual, moral, and material resources is the best preparation for war. Food and manufacturing facilities, and adequate supplies of raw materials and transportation systems and scientific attainments and the equipment and trained personnel

available for military research, these together with an intelligent citizenry and a just cause are the best preparation for war. A standing army and fleets of battleships are necessary but not a sufficient preparation, even if the army is armed to the teeth and the battleships are the heaviest or the swiftest in the world. The Great War demonstrated that modern wars are not of armies but of peoples, and their resources and their intellectual and industrial resourcefulness are more important than the initial equipment of armies and fleets. Therefore, a government that pays much attention to education and research and industrial developmental work is making the best preparation for possible wars of the future. *This fortunately produces good results if war never comes. By increasing the power and prestige of the nation, such preparation tends to prevent war, and so pays for itself twice over.*

CONCLUSION

34. Probably everyone will grant the principle that a government should do something to educate the people, and to develop the industries and the natural resources of the country. It is only a question of the scope and extent of such work. The government has already done much, but in comparison with the needs and the opportunity it is inadequate. Cooperation of all the people in developing themselves and improving their condition and securing protection against the selfish and unfair efforts of individuals or corporations or groups, is more necessary in the modern state than formerly. And when the state contains a hundred million people and covers a continent, effective cooperation in many cases can be attained only by government assistance and leadership. Friendly governmental cooperation and constructive assistance in the industries are more welcome than regulation and repression. We must have the latter in some cases, and that is an additional reason why we should have a generous measure of the former. How far we should go experience alone can determine. But we should have the courage to face the facts, to analyze them correctly and, both in the government and in the nation, *to do as well as we know how.* We should

strive for a higher and truer efficiency, for efficiency in the government, efficiency in labor, efficiency in business; and the government should not fail to do its part, which in many cases is to take the lead. If the government will cooperate with the industries in peace as earnestly and effectively as the industries cooperated with the government in war, it would be of vast benefit to the public, which pays all the costs.

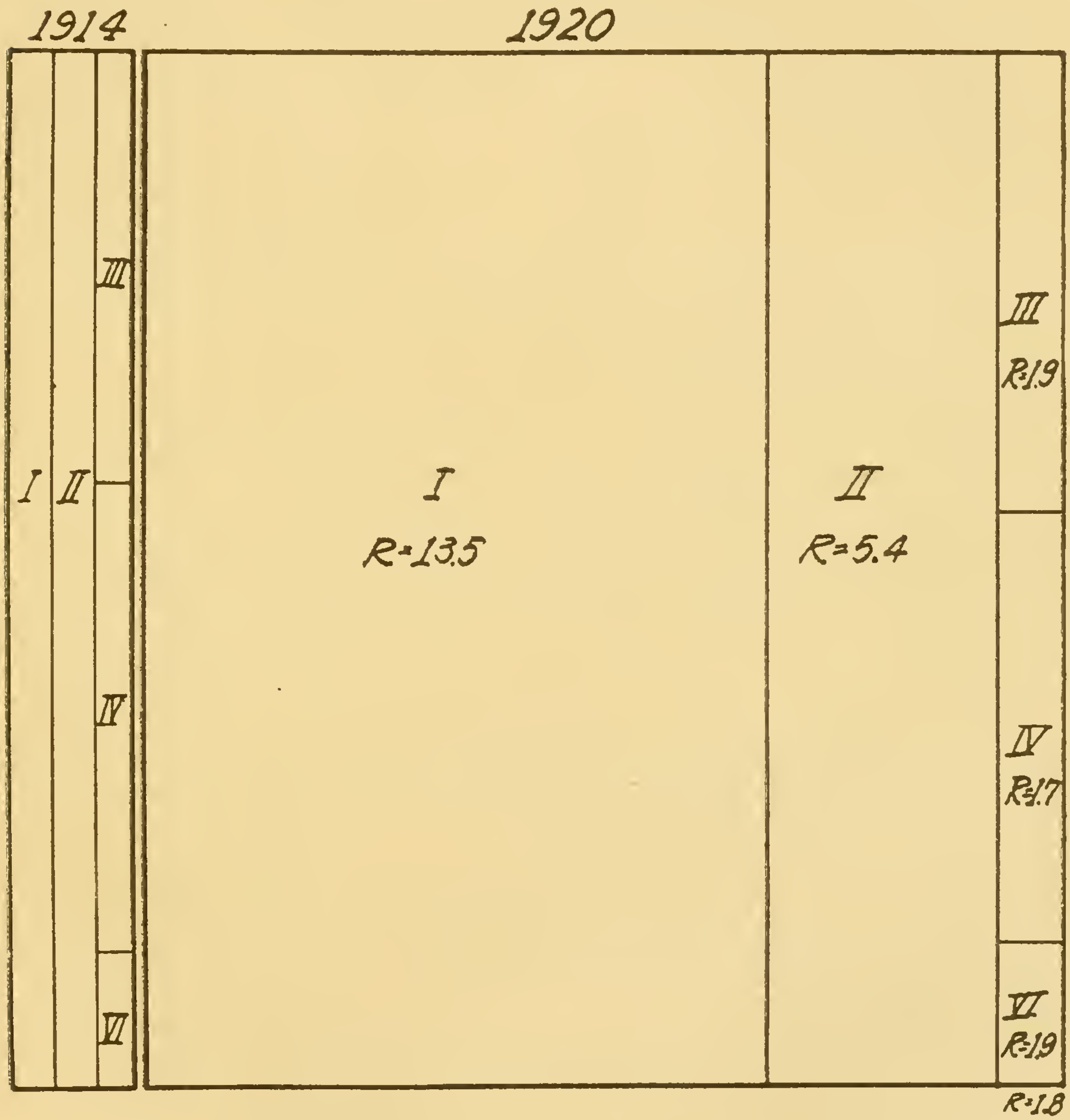

Fig. 3.—Diagrammatic comparison by groups of appropriations for the fiscal years 1914 and 1920.

APPROPRIATIONS FOR FISCAL YEAR ENDING JUNE 30, 1920

(As given in the regular supply bills and three deficiency bills prior to May 1, 1920.)

Group I.—Expenditures Arising from Recent and Previous Wars:

Interest on the Public Debt[a]	$1,076,637,000.00
Pensions	216,382,540.00
War Risk Insurance (estimated expenses above receipts $102,000,000)	120,852,806.00
Federal Board for Vocational Education (rehabilitation)	30,000,000.00
Public Health Service (care of soldiers, etc.)	25,901,517.14
Soldiers' and Sailors' Homes, Cemeteries, etc.	14,639,010.00
Federal Control of Transportation (deficit and advances)[b]	1,550,000,000.00
United States Shipping Board (estimated expenses, including funds reappropriated)	685,842,000.00
European Food Relief	100,000,000.00
Other Expenditures due to Recent War	4,467,712.46
Bonus to Government Employees	30,760,000.00
67.81%	$3,855,482,585.60

[a] Disbursements for interest on public debt for the fiscal year 1920 will be somewhat less than appropriations.

[b] Appropriations to Railroads include $300,000,000 loan, but do not include the deficit from March 1 to June 30, 1920.

Group II.—War and Navy Departments (somewhat above permanent peace-time expenditures):[a]

War Department—Military	$797,913,898.95	
Civilian	6,373,949.12	
		$ 804,287,848.07
Navy Department—Military	617,621,353.56	
Civilian	2,229,474.94	
		619,850,828.50
	25.02%	$1,424,138,676.57

[a] Disbursements for fiscal year 1920 will exceed by about one billion of dollars the above appropriations for the War and Navy Departments because of balance of appropriations carried over from 1919.

Group III.—Primary Governmental Functions:

Legislative		$ 10,837,936.47
Executive (President and White House Staff)		224,080.00
Judicial (federal courts, penal establishments, etc.)		12,124,884.24
Department of Justice		4,483,671.70
State Department		12,331,371.97
Treasury Department:		
General, including Collection of Customs	$ 29,065,653.22	
Internal Revenue Service	29,751,170.00	
Coast Guard	8,880,523.33	
Bureau of Engraving and Printing	7,010,425.00	
		74,707,771.55

Department of Interior:			
General, including Alaskan Expenditures	$ 1,940,684.92		
Indian Office and Indian Service........	11,437,187.00		
		$	13,377,871.92
Department of Commerce:			
General, including Bureau of Navigation	920,725.52		
Bureau of Lighthouses................	8,411,030.00		
Steamboat Inspection Service..........	995,890.00		
Bureau of Census.....................	17,550,000.00		
			27,877,645.52
Department of Agriculture:			
Meat Inspection Service..............................			3,000,000.00
Department of Labor—Immigration, Naturalization, Employees' Compensation, Conciliation, etc.................			5,464,337.32
Interestate Commerce Commission......................			5,313,086.90
Federal Trade Commission.............................			1,205,000.00
Civil Service Commission.............................			543,700.00
Joint Commission on Reclassification of Salaries............			50,000.00
U. S. Tariff Commission..............................			300,000.00
Bureau of Efficiency.................................			145,000.00
One-half District of Columbia, Hospitals, etc..............			9,100,867.82
	3.19%,	$	181,087,225.41
Group IV.—Public Works:			
War Department—Rivers and Harbors....................		$	43,456,653.15
Treasury Department—Public Buildings (equipment and construction)................................			10,319,076.11
Repairs and Maintenance of Public Buildings in D. C.......			1,139,633.20
U. S. Reclamation Service.............................			7,511,000.00
Department of Agriculture—Rural Post Roads.............			99,000,000.00
National Park Service................................			777,195.00
Construction of Railroad in Alaska........................			6,000,000.00
	2.97%,	$	168,203,557.46
Group V.—Commercial or Self-Supporting Government Activities:			
Post Office Department, surplus, 1919.....	$ 2,342,851.96		
Department of Interior:			
Patent Office, surplus, 1919............	106,654.10		
General Land Office, estimated surplus, 1920..............................	1,500,000.00		
U. S. Housing Corporation, estimated operating surplus, 1920....................	1,012,973.00		
Panama Canal, estimated deficit, 1920....	3,297,337.00		
Group VI.—Research, Educational and Developmental:			
Department of Agriculture:			
Forest Service—Less Receipts of $4,750,000.00............................	$ 4,191,869.00		
Bureau of Animal Industry............	5,783,231.00		
States Relations Service...............	4,905,820.00		

Bureau of Plant Industry	$ 3,379,638.00	
Cooperative Agricultural Extension Work	3,080,000.00	
Bureau of Markets	2,811,365.00	
Weather Bureau	1,880,210.00	
Bureau of Entomology	1,371,360.00	
Bureau of Chemistry	1,391,571.00	
Bureau of Biological Survey	742,170.00	
Bureau of Public Roads	594,320.00	
Bureau of Soils	491,235.00	
Bureau of Crop Estimates	372,484.56	
Bureau of Farm Management and Farm Economics	302,590.00	
Horticultural and Insecticide Board	252,940.00	
Miscellaneous Investigations	2,589,400.00	
General Administration	1,715,626.58	
		$ 35,855,830.14
Department of the Interior:		
Geological Survey	1,661,353.50	
Bureau of Mines	1,216,897.00	
Bureau of Education	241,960.00	
Howard University	121,937.75	
		3,242,148.25
Department of Commerce:		
Coast and Geodetic Survey	1,925,370.03	
Bureau of Standards	1,892,260.00	
Bureau of Fisheries	1,274,490.00	
Bureau of Foreign and Domestic Commerce	912,510.00	
		6,004,630.00
Department of Labor:		
Bureau of Labor Statistics	321,690.00	
Children's and Women's Bureaus	320,140.00	
		641,830.00
Treasury Department—Public Health Service		4,025,440.00
Federal Board for Vocational Education		3,182,000.00
Colleges for Agricultural and Mechanic Arts		2,500,000.00
Library of Congress		925,825.00
Smithsonian Institution		715,957.51
	1.01%,	$ 57,093,660.93

SUMMARY

Group I.	Expenditures arising from Recent and Previous Wars	$3,855,482,585.60	67.81%
Group II.	War and Navy Departments	1,424,138,676.57	25.02%
Group III.	Primary Government Functions	181,087,225.41	3.19%
Group IV.	Public Works	168,203,557.46	2.97%
Group VI.	Research, Educational and Developmental	57,093,660.93	1.01%
	Total	$5,686,005,705.97	100.00%

SCIENTIFIC NOTES AND NEWS

THE MEYER MEMORIAL MEDAL

FRANK N. MEYER was an agricultural explorer in the Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, U. S. Department of Agriculture. For thirteen years he searched through China, Turkestan and other parts of Asia, for plants which might be valued additions to American agriculture and horticulture. When he lost his life on the Yangtze River in 1918,[1] he left a bequest of a thousand dollars to the staff of the Washington Office. The individuals of the Office have put the bequest into a permanent tribute to his memory, in the shape of a medal, designed by Theodore Spicer-Simson, which is to be awarded for distinctive service in plant introduction. The awards are to be made by the Council of the American Genetic Association.

The first award was made on May 3, 1920, when the medal was presented to Mr. BARBOUR LATHROP. Dr. DAVID FAIRCHILD, in behalf of the Council, presented the medal. Mr. Lathrop had a large part in the founding of the Office of Foreign Seed and Plant Introduction, and has been intimately connected with it since. He and Dr. Fairchild comprised one of the first exploration expeditions, and visited the West Indies, South America, Europe, Egypt, India, Ceylon and the East Indies. Many introductions now growing in this country were secured on this and subsequent trips which Mr. Lathrop conducted and financed. The first seed of the Egyptian cotton, the culture of which now amounts to $20,000,000 a year in Arizona, was brought in by them. The tropical mangos, now an industry in Florida; the Persian Gulf dates, peculiarly successful in the Imperial Valley; Sumatra wrapper tobacco, now famous in Connecticut; the first large collection of Japanese flowering cherries; Rhodes grass, which has been called the timothy of the South; and varieties of soy beans and the oriental timber and edible bamboos of Japan, which are now represented by groves in various parts of the South, were also secured.

NOTES

With a view to determining the exact routes followed by migratory birds, their speed of travel, the causes of unusual movements by such birds, and many other questions of interest to naturalists as well as to the public, the Bureau of Biological Survey, U. S. Department of Agriculture, has taken over the work heretofore carried on by the American Bird Banding Association, which has headquarters at the American Museum of Natural History, New York City. This work includes the trapping of birds and the placing of identification bands on their legs, after which the birds are released. Subsequent discovery of these bands on trapped or dead birds is reported by the finders to those in charge of the work. The Biological Survey asks the coopera-

[1] See This JOURNAL, **8**: 463. 1918. **9**: 559. 1919.

tion of all former members of the Bird Banding Association and the public in general, particularly persons in a position to establish trapping stations. Arrangements are being made to supply volunteer cooperators with numbered aluminum bands.

Dr. N. E. Dorsey, physicist in charge of investigations of radioactive substances at the Bureau of Standards, resigned from the Bureau in April. He expects to complete his work at the Bureau by the end of June, and will then go into private consulting and testing work. He will give especial attention to those physical problems that are of interest to members of the medical profession.

Mr. E. D. Gordon of the Weights and Measures Division, Bureau of Standards, resigned on May 31 to accept a position as sales engineer with the General Automatic Scale Company of St. Louis.

Mr. C. H. Kidwell, Chief of the Water Resources Laboratory, U. S. Geological Survey, resigned in May to accept a position with the Solvay Process Company at Syracuse, New York.

Dr. F. Kölpin Ravn, of Denmark, visited the Bureau of Plant Industry in May. He was in the United States in the interests of Danish potato growers, as considerable quantities of potatoes are being shipped from Denmark and have to pass certain inspection regulations before being permitted to enter the country. Dr. Ravn, when in the United States in 1915 as a guest of the Department of Agriculture, discovered the stripe rust of wheat in Arizona and later in other western States.[1]

Mr. Cephas Hempstone Sinclair, hydrographic and geodetic engineer in the U. S. Coast and Geodetic Survey, died on May 16, 1920, in his seventy-third year. Mr. Sinclair was born at Charlottesville, Virginia, December 4, 1847. After graduating from the University of Virginia he entered the Coast and Geodetic Survey as an aid in 1873, and had been in the service since that date. For a number of years, ending in 1913, he was in charge of a party engaged in the survey of the boundary between the United States and Canada. He was a member of the Academy, the Philosophical Society, and the Society of Engineers.

Dr. Alexander Wetmore of the Biological Survey, U. S. Department of Agriculture, has gone to Buenos Aires in connection with an investigation into the status of certain of our migratory birds that pass a part of the year in southern South America. Extended field observations to determine local conditions affecting these birds, covering approximately a year, will be made in Argentina and adjacent countries.

[1] After this item went to press word was received that Dr. Ravn died on May 24, at East Orange, New Jersey.

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GEOCHEMISTRY.—*Analysis of a brine from the Ligonier well in Pennsylvania.* C. H. KIDWELL, Water Laboratory, U. S. Geological Survey. (Communicated by C. E. Van Orstrand.)[1]

By the courtesy of Mr. J. B. Tonkin, Vice President of the Peoples Natural Gas Company, of Pittsburgh, Pennsylvania, a sample of a brine obtained at a depth of 6,184 feet in the Ligonier well was furnished to the U. S. Geological Survey for analysis. The Ligonier well, the Peoples Natural Gas Company's well No. 1588, is located less than one mile northwest of Longbridge, Pa., in Westmoreland County, between Loyalhanna Creek and the Lincoln Highway. It is the fifth deepest well in the world at this time and drilling is to be continued. With one exception, which will be considered later, no other analyses of ground water from this depth are available. Collection of the sample was made February 20, 1920. A half million cubic-foot flow of gas was encountered in the well at a depth of 6,822 feet. Results of an analysis of the water are given in table 1.

Reference to the table of reacting values (table 2), in which the values of the radicals are arranged in order of descending magnitude, shows that practically all the constituents of the brine are present in the form of chlorides, and although the fallacies of hypothetical combinations of the constituents of a water containing several different acidic radicles are too well established to warrant making hypothetical combinations as a general rule, in this case it happens that if the chloride were distributed among

[1] Published by permission of the Director, U. S. Geological Survey. Received May 8, 1920.

the basic radicles as they are arranged in the table of reacting values, the approximate percentages of the principal salts could be easily calculated because the chloride represents practically all the acidic radicles.

TABLE I

CHEMICAL ANALYSIS OF WATER FROM LIGONIER WELL

		Grams per liter
Silica	(SiO_2)	0.008
Iron	(Fe)	0.084
Aluminum	(Al)	0.057
Titanium	(Ti)	None
Manganese	(Mn)	0.014
Calcium	(Ca)	8.68
Strontium	(Sr)	0.68
Barium	(Ba)	0.13
Magnesium	(Mg)	1.42
Lead	(Pb)	None
Bismuth	(Bi)	None
Sodium	(Na)	30.13
Potassium	(K)	0.63
Carbonate radicle	(CO_3)	None
Bicarbonate radicle	(HCO_3)	None
Phosphate radicle	(PO_4)	None
Chloride radicle	(Cl)	67.14
Sulphate radicle	(SO_4)	0.033
Nitrate radicle	(NO_3)	Trace
Bromide radicle	(Br)	None
Iodide radicle	(I)	0.022
Radium[a]	(Ra)	No appreciable quantity detected by gold-leaf electroscope
Sum		109.028

T[illegible] lids, converting Al to Al_2O_3 and Fe to Fe_2O_3.... 109.114

Speci[illegible] gravity at 23.4° C. 1.0777

Temperature of water at point of entrance into well, 67.3° C.[b]

The brine was slightly acid to methyl red and possessed a "stale" odor.

[a] Determined by Dr. L. I. SHAW, Bureau of Mines, Washington, D. C.

[b] Estimated for 6,184 feet from a series of temperature measurements made from depths of 100 to 6,000 feet by Mr. C. E. VAN ORSTRAND, U. S. Geological Survey.

A comparison of the analysis of the brine with that of an average analysis of sea water[2] shows that this brine is over three

[2] CLARKE, F. W. *The data of geochemistry*, U. S. Geol. Survey Bull. **695**: 123. 1920.

times as highly mineralized as ocean water. It is remarkable in its content of iodide in the absence of bromide, and to a lesser extent in its content of barium, manganese, and strontium.

According to Dr. Charles Butts,[3] Geologist, U. S. Geological Survey, the brine probably issued from shales representing the top or middle of the Hamilton formation of the Middle Devonian.

TABLE 2

Reacting Values in Milligram Equivalents per Liter[a]

Na	1307.61	Cl	1893.35
Ca	433.13	SO_4	0.6864
Mg	116.58	I	0.1733
K	16.109		
Sr	15.517		
Ba	1.898		
Mn	0.5096		
Total basic radicles[b]	1891.3836	Total acidic radicles	1894.2097

[a] The reacting value of an element or radicle is obtained by dividing its valence by its molecular weight and multiplying the resultant quotient by the number of milligrams of the element or radicle obtained analytically. It may be defined as its equivalence in capacity for chemical reaction to 1.008 milligrams of hydrogen or 8.000 milligrams of oxygen.

[b] Fe and Al are considered to be present as Fe_2O_3 and Al_2O_3 and therefore do not enter into the sum of reacting values.

Many hypotheses have been proposed to explain the origin of deep-seated brines. Several investigators have assumed that they represent entrapped ancient sea waters the composition of which has been altered by such agencies as precipitation, reactions from contact with basic magmas, evaporation, and leaching of sedimentary beds by percolating ground waters.

Such hypotheses are inadequate for the explanation of differences in the chemical character of deep-well brines and the ocean as it exists at the present time or as it existed in the past. The chemical composition of the Devonian sea is conjectural. It may have contained either more or less calcium and magnesium than the present ocean and the predominance of magnesium over calcium that now obtains in the ocean may have been reversed

[3] Personal communication.

in the ancient sea on account of a lesser number of calcium-secreting organisms, or the fact that they had not been active for a sufficient period of time to decrease the calcium content of the old ocean comparable to that of the modern sea. It is difficult to believe, moreover, that organisms could exist in a brine as concentrated as the one here described.

In order to explain satisfactorily the reversal of the calcium-magnesium ratio in brines of this nature as compared with sea water, the greater concentration of salts in the brines, the higher ratio of calcium to chloride in the brines, and the fact that mere concentration of water such as now constitutes the ocean will not form brines similar to those obtained from supposed fossilized oceans, it must be assumed that extensive alterations of the old ocean waters have occurred since the time of their inclusion. This has been discussed in a most excellent paper by R. Van A. Mills and Roger C. Wells[4] who advance the hypothesis that deep-seated brines are derived in part from waters of sedimentation, often described as "connate waters," and in part from meteoric waters the mixture of which in the lapse of geologic time has suffered vast changes through such geophysical and geochemical changes as concentration, evaporation, leaching of sediments, reduction of some constituents by organic matter, heat, pressure, incursion of petroleum, rock movements, and cementation. Concentration and evaporation have been materially assisted by the expansion or movement of gases through underground passages which have absorbed some of the water as moisture during their contact with it.

Several possible explanations are offered by Mills and Wells for the predominance of calcium over magnesium in deep-seated brines. At moderate temperatures hydrolysis may occur and the magnesium be precipitated as hydroxide, basic carbonate or carbonate. According to Hunt,[5] magnesium silicates and calcium chloride are formed when magnesium chloride reacts with calcium

[4] Mills, R. Van A., and Wells, Roger C. *The evaporation and concentration of waters associated with petroleum and natural gas.* U. S. Geol. Survey Bull. 693. 1919.

[5] Hunt, T. S. *Chemical and geological essays,* p. 122. 1878.

silicates. Magnesium may have been separated from solution by this process.

Only one other analysis of a brine from a depth comparable to that from which this brine was obtained has been made, as far as is known. It was made by George Steiger[6] and represents a brine that is similar in chemical composition to the one reported here. The principal points of dissimilitude are that Steiger reported no silica, aluminum, or manganese, and only a trace of barium, all of which were obtained in small quantities in this analysis; he found bromide to be predominant over iodide, while in this brine iodide occurs to the exclusion of bromide; and he determined the total solids to be 263.64 grams in 1,000 grams.

ENTOMOLOGY.—*A new species of Phyllotreta.*[1] F. H. CHITTENDEN, Bureau of Entomology. (Communicated by L. O. Howard.)

In studying the injurious genus *Phyllotreta* accumulated in the U. S. National Museum and Bureau of Entomology, a species is found which is new to science. Like others of the genus, it attacks and undoubtedly breeds on cruciferous plants and is at least a potential pest. The description follows:

Phyllotreta utana Chittenden, sp. nov.

Elongate oval, moderately convex, shining black except last ventral segment which is opaque; thorax and elytra variably black or aeneous; elytral vittae very narrow, pale yellowish. Antennae less than half as long as body, joints 2 to 5 usually honey yellow, 1 and 6 either black or partly pale, remainder piceous. Each elytron with a very narrow vitta, moderately sinuate, curvature scarcely reaching beyond middle of elytron either at base or apex; each vitta with a short broad post-humeral branch. Tibiae piceous, tarsi fuscous.

FIG. 1.—Phyllotreta utana

Male: Last ventral segment large, concave, nearly as long as segments 2–4 combined, moderately impressed at apex with a short median impressed line at base. Antennal joints 2–3–4

[6] CLARKE, F. W. *Water analyses from the laboratory of the United States Geological Survey.* U. S. Geol. Survey Water-Supply Paper **364**: 9. 1914.

[1] Received June 8, 1920.

subequal in length; 3 and 4 subtriangular; 3 distinctly wider; 4 much wider; 5 depressed, wider than 4, about one-half longer than wide, anterior ace shorter than posterior, nearly straight; 6 short, basal part generally pale and apical piceous.

Female: Last ventral segment simple and shorter. Antennae as in *zimmermanni* and *vittata*.

Length, 2.5–3.0 mm.; width, 1.4–1.5 mm.

Logan, Utah (type locality), July 9–12, 1906; June 20, 1904; Alta, Utah, June 29 (E. D. Ball and E. G. Titus); Park City, Utah, June 17, (Hubbard & Schwarz); Elko, Nev.; Corvallis, Ore. (C. F. Moznette.)

Type No. 23114, U. S. National Museum.

A good series of specimens shows considerable variation. One individual has all antennal joints piceous and another has bluish elytral humeri. The general appearance and punctation are similar to *zimmermanni*. In addition to the distinctive characters of the antennae (the fifth joint is flat, not bowed) and last ventral segment of the male, the elytral vittae are quite different from other species, approaching *zimmermanni*, but pale, not distinctly yellow as in that species. It is also larger than the latter, which measures only 2–2.5 mm.

This species was observed by Prof. E. G. Titus and Dr. E. D. Ball at Logan, Utah, in June, 1904, attacking sugar beet. It was abundant in a beet field overgrown with hedge mustard, on which it was also taken.

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.—*Germination of barley pollen.* STEPHEN ANTHONY and HARRY V. HARLAN. Journ. Agric. Res. **18**: 525–536. 1920.

The paper reports the first artificial germination of barley pollen and gives in detail the methods by which this was accomplished. It was found that barley pollen was extremely sensitive to moisture, so sensitive that it could be killed by blowing one's breath upon it. It was equally sensitive to dryness, shrinking perceptibly in two minutes when exposed to free air. A few minutes of such exposure resulted in death. All attempts to germinate the pollen in solutions or upon media or membranes, resulted in failure. Germination was finally accomplished by exposing the pollen to an atmosphere in which the humidity gradually increased. Growth of lengthy tubes occurred in five minutes. H. V. H.

BOTANY.—*The genera of grasses in the United States with special reference to the economic species.* A. S. HITCHCOCK. U. S. Dept. Agric. Bull. **772**. Pp. 307, pls. 20, figs. 174. 1920.

This paper contains an introduction on the scope and plan of the work, including an economic classification of grasses based on uses; a description of the grass family; descriptions of the subfamilies with keys to the tribes, and under each tribe, keys to the genera and descriptions of the genera. The arrangement of the tribes differs from the usual presentation in that the more primitive are placed first, thus: Bamboseae, Festuceae, Hordeae, Aveneae, Agrostideae, Nazieae, Chlorideae, Phalarideae, Oryzeae, Zizanieae, Melinideae, Paniceae, Andropogoneae, Tripsaceae. Under each genus is given a technical description, with synonymy. The type of each genus is selected whether the names are valid or cited in synonymy, and the reasons for the selection are given in all cases. Following this under each genus is given information on all species that are likely to have attracted the attention of agriculturists. Each genus is illustrated by one figure and the larger genera by more than one. There are 144 genera described.

A. S. H.

BOTANY.—*Effect of the relative length of day and night and other factors of the environment on growth and reproduction in plants.* W. W. GARNER and H. A. ALLARD. Journ. Agric. Res. **18**: 553–606. 1920.

It is found that the relative length of the day to which the plant is exposed is in many species a factor of great importance in growth and development, especially as regards sexual reproduction. While early, medium, late and very late maturing varieties of soybeans required at Washington about 26, 62, 73 and 110 days, respectively, to attain the flowering stage when exposed to the full seasonal length of day of the summer, all of these varieties flowered within 28 days when the daily light exposure was reduced to 12 hours or less. Certain varieties of tobacco, aster, ragweed, etc., behaved similarly. On the other hand, certain plants, as Raphanus, Hibiscus, and Mikania, flowered only under a relatively long daily light exposure. By suitable control of the daily light exposure certain annuals were forced to complete two cycles of alternate vegetative and reproductive activity in a single season. It was found, also, that flowering may be delayed more or less indefinitely when the length of the exposure is unfavorable, and this may result in a corresponding prolongation in the period of growth. By use of tungsten filament electric lamps to increase the illumination period of the short winter days the results obtained with several species were similar to those obtained during the natural long days of summer, *i. e.*, the vegetative or the reproductive phases of development were initiated or inhibited, depending on the specific requirements of the plants used. With an illumination period favorable both to vegetative and reproductive activity there was a marked tendency in several species toward the "ever-blooming" or "ever-bearing" habit. In all species studied the rate of growth (increase in height) was proportional to the length of the daily period of illumination. Although the length of the daily illumination period may exercise a controlling influence on the attainment of the reproductive stage, it appears from experiments detailed in this paper that differences in light intensity ranging from full normal sunlight to less than a fourth of the normal do not greatly affect this phase of plant development. Hence it is concluded that, within the range indicated, the total quantity of solar radiation received by the plant daily during the summer season is of little importance directly as regards attainment of the flowering stage. The term *photoperiodism* is suggested to indicate the response of the organism to the relative length of day and night. W. W. G.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

141ST MEETING

The 141st meeting of the ACADEMY was held jointly with the Biological Society of Washington at the Cosmos Club, at 8.15 p.m. on Saturday, February 21 1920. ALFRED G MAYOR, Director of the Department of Marine Biology of the Carnegie Institution of Washington, delivered an address, illustrated with lantern slides, on *The coral reefs of American Samoa.* A brief abstract of the address has been published in the proceedings of the Biological Society (see this JOURNAL, **10**: 309. May 19, 1920).

142D MEETING

The 142d meeting was held jointly with the Anthropological Society of Washington in the auditorium of the National Museum, at 8.15 p.m. on Saturday, March 6, 1920. President G. M. KOBER of the Anthropological Society presided. W. H. R. RIVERS, of St. John's College, Cambridge, England, delivered an address on *Ethnology: its aims and needs.*

143D MEETING

The 143d meeting was held at the Cosmos Club at 8.15 p.m. on Thursday, March 18, 1920. President C. L ALSBERG presided. J. WALTER FEWKES, Chief of the Bureau of American Ethnology, Smithsonian Institution, delivered an address, illustrated with lantern slides, on *American archaeology: its history and technique.*

144TH MEETING

The 144th meeting was held jointly with the Chemical Society of Washington (the local section of the American Chemical Society) at the Cosmos Club, at 8.15 p.m. on Thursday, March 25, 1920. President C. O. JOHNS of the Chemical Society presided. E. T. WHERRY, of the Bureau of Chemistry, U. S. Department of Agriculture, delivered an address, illustrated with lantern slides and experiments, on *Soil reaction and plant distribution.*

The methods used in testing soils, and a proposed method of statement of acidity and alkalinity, have already been published in the JOURNAL,[1] and a paper on the subject for one of the botanical journals is in preparation.

[1] This JOURNAL, **9**: 305–309. 1919. **10**: 217–223. April 19, 1920.

145TH MEETING

The 145th meeting of the ACADEMY was held jointly with the Medical Society of the District of Columbia and the Anthropological Society of Washington on Wednesday March 31, 1920. The meeting was called to order at 8.20 p.m. in the assembly hall of the Carnegie Institution of Washington by President F. R. HAGNER of the Medical Society. Sir ARTHUR NEWSHOLME K.C.B., formerly Chief Medical Officer of Health of the Local Government Board of England, and during the past season Professor of Hygiene in the School of Public Health of Johns Hopkins University, Baltimore, Maryland, delivered an address on *The national importance of child welfare work.* The address was illustrated with lantern slides.

The lecturer sketched briefly the history of the development of child welfare work in England. It arose out of the gradual awakening of the people to the risks of unhygienic environment, emphasized by the ravages of the great plagues such as cholera and typhus fever. The growth of industrialism and the increasing population of the cities are really at the bottom of this awakening. The health reforms of the past seventy years are a part of the attack made on the problems raised by these two conditions.

The study of these problems and their remedies has increasingly emphasized the fact that the death rate in childhood is unnecessarily high. The study of the death rate of children carries us still farther back and shows that the care of the mother immediately before and after the birth of the child is as necessary as the care of the children themselves.

To reduce this needless loss of mothers and children, which is comparable in magnitude with the loss of life in the Great War, the following conditions must be ameliorated: (1) Careless, shiftless, or immoral motherhood or fatherhood. (2) Ignorance, especially of civic duties, of the most desirable ideals of family life, and of the elementary methods of proper housekeeping and cooking. The ignorance of the poor is more serious than the ignorance of the rich, since the ignorance of the rich can be made up for from without. (3) The lack of the essentials of life and health such as proper food and clothing and expert assistance at critical periods. (4) Ignorance of the public and its leaders as to the actual conditions in the community, which can be remedied either by surveys in specialized fields, or, better, by competent statistics which are in reality a continuous survey. It is in this feature particularly that the public health movement in the United States is hitherto lacking. The statistics of birth and puerperal diseases are most strikingly inadequate in the United States, and no solid progress can be made until the data by which such progress can be measured are made more complete and dependable.

Nutrition is the be-all and end-all of a child's life up to the age of seven, and all other things must be subsidiary. The agencies to be considered and improved are play, sleep, cleanliness, exercise, food, and shelter. The lecturer exhibited a series of tables, curves, and columnar diagrams illustrating the statistics that have been obtained on these subjects in England, and the decrease in infant and child mortality that has followed improvements in the conditions. An item of particular interest in this series of data dealt with the effect of diminished infant mortality on the death rate of the community as a whole. It has been urged by many that the saving of infant lives works directly against that process of natural selection which is assumed under the conditions of civilized life to continue to weed out unfit individuals early in life. If this were the case it is to be expected that communities having a high infant mortality should show a decreased mortality in part or all of the subsequent age periods. The statistics show that exactly the contrary is the case. Individuals in a community with high infant mortality have a smaller expectation of life throughout their entire period of life than do individuals in a community with low infant mortality. In other words, any action of natural selection that continues is so small a factor under present conditions that it does not appear on the curves. The same preponderant effect of evil environmental circumstances persists in the successive years of life as was evidenced in infancy.

The lecturer then showed a series of diagrams illustrating the various agencies that have been developed in England to remedy the conditions described.

The discussion was participated in by Drs. Wall, J. A. Foote, G. M. Kober, Livingston Farrand, and T. A. Williams.

Robert B. Sosman, *Corresponding Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 826th meeting was held at the Cosmos Club, Dec. 20, 1919, with President Sosman presiding and 34 persons present. The minutes of of the 823rd and 824th meetings were read in abstract and approved.

The first paper was by Mr. J. Warren Smith on *Predicting minimum temperatures*,[1] and was illustrated by lantern slides.

This paper was a mathematical discussion of the relation between the relative humidity in the late afternoon and the variation of the minimum temperature during the coming night from the afternoon dewpoint temperature, when radiation conditions prevail. The study shows that there is a well defined relation which can be expressed by the curve for a parabola. This curve can be constructed by the "star point" method of curve fitting instead of by the more tedious well known least square method.

The equation used is written $v = x + by + cz$ in which v is the variation of the minimum temperature from the evening dewpoint; b is the evening relative humidity, and c is the square of the relative humidity. x, y, and z are the three unknowns, which are evaluated

[1] Full publication in Monthly Weather Review Supplement, No. 16, pp. 6–19. 1920.

from three normal equations which are readily written by the star point method after the data have been properly charted. The results are remarkably accurate. The studies show that the minimum temperature can be closely predicted n the orchard at a considerable distance from the observing station; that the hygrometric observations made at noon may be used quite as well in some instances as those made in the evening, and that the equation will sometimes apply as well to cloudy as to clear nights.

By using the depression of the dewpoint instead of the relative humidity in correlating with the variation of the minimum temperature from the dewpoint there is, in some instances, an even closer relation shown. In this case a straight line from the equation $v = x + yd$ fits the data fully 83 per cent of the time. In this equation d is the depression of the dewpoint, v is the variation of the minimum from the dewpoint, and x and y the two unknowns.

Discussion: Mr. ABBOT exhibited a slide indicating a relation between solar-constant variations and minimum temperatures.

Mr. BROOKS spoke of the effect of snow cover in lowering the minimum temperatures.

Replying to question by Mr. SOSMAN, Mr. SMITH stated that the protection afforded to orchards by the use of heating pots was not due to the smudge produced but to an actual increase of from 4 to 8 degrees in the temperature of the air.

Mr. HUMPHREYS showed that the artificially heated air in an orchard does not rise far on account of a marked temperature inversion.

The second paper was by Mr. CHARLES F. BROOKS on *Clouds and their significance*,[2] and was also illustrated by lantern slides.

When closely observed, clouds are remarkable indices of atmospheric processes and movements. Their forms and motions may be used not only directly in determining what general winds and turbulence exist at different levels, but also in surmising the vertical distribution of temperature and humidity. Here without the expense of apparatus are the means for discerning what is happening in he atmosphere up to great heights, and, therefore, the means for determining the causes of certain features of our weather, and for forecasting local changes. Also, the effect of cloudiness on the temperature and humidity of the lower air is not to be overlooked.

The cloud transformations and movements during the passage of a strong low-pressure area in winter give a fairly clear picture of the internal dynamics of such a storm. As the low approaches, a relatively warm southerly wind enters like a sideways-moving wedge over the cold surface air, and under the westerly upper wind. The lower surface of contact is frequently marked by stratus clouds formed by mixture, and the upper by alto-cumulus clouds formed by thermal convection due to the warmth of the southerly wind relative to that above. Later, the warm wind reaches the earth's surface. The lines of appreciable

[2] This paper was published in the Monthly Weather Review, **48**: 26–28, Jan., 1920.

wind convergence are marked by nimbus and more or less continuous rainfall. Where such nimbus is formed the forced ascent of the air may go to great heights and thus supply the fast upper winds with the material for the drawn-out cirrus and cirro-stratus clouds that go far in advance of the storm and later for the heavy alto-stratus. As the center of lowest pressure goes by, perhaps not far to the north, an underrunning wedge of cold air may, by raising the warm moist southwesterly current above, bring on a few more hours of rainfall. This cold wind carries strato-cumulus clouds, formed by the turbulence and thermal convection, for perhaps a day, while the last of the long SW.-NE. lines of alto-stratus and cirro-stratus clouds, forming by the underthrust of the lower wind which lifts the higher moist layers, gradually pass over the eastern horizon.

It is evident from studies of the appearance and transformations of cloud forms that the different types of clouds are very closely interrelated and pass from one form to another without any recognizable dividing line.

Since our weather is largely the result of the interaction of over- and underrunning winds, clouds as indices of such are valuable in showing what is going on and what is to be expected. Cloud observations are finely complementary to pilot-balloon observations, for which there must be clear air and a lack of even intermittently intervening clouds. The whole domain of meteorology has no easier, more interesting, or more promising aspect for observations and study than clouds.

Discussion: In response to a question by Mr. FENNER, Mr. BROOKS stated that the cloud sequence during the progress of a cyclone was different for different parts of the country. Mr. HUMPHREYS called attention to the unsatisfactory nature, from the scientific point of view, of cloud nomenclature.

The meeting adjourned at 10.03 p.m.

S. J. MAUCHLY, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

The bill for a tariff on scientific instruments, etc. (H. R. 7785)[2] was brought up on the Senate calendar on April 5, but was passed over. On April 28, Mr. Knox offered an amendment providing for the exemption from import duty of "guaranteed disks, ten inches or more in diameter, for astronomical telescopes."

The Second Deficiency bill for 1920 (H. R. 12046) passed the House on February 5, and the Senate on February 20. After two conferences the House and Senate agreed to final passage on March 2 and 3, and the bill became Public Law 155 on March 8. A proposed appropriation of $100,000 to enable the Bureau of Mines to investigate gases in vehicular tunnels,[3] in anticipation of the construction of such a tunnel under the Hudson River, was thrown out by the Senate on a point of order.

The widely differing viewpoints of members of Congress regarding research were brought out in discussions of certain paragraphs of this bill and other appropriation bills. Three principles that are more or less obvious to workers in scientific subjects are far from being universally accepted in Congress, namely: (1) that a successful research institution is a result of years of growth, and continuity is essential to its success; (2) that any nation which expects to keep to the front in world competition must encourage research; and (3) that, when accounting is made in terms of decades rather than years, research is the best paying business in the world. Mr. Mann, for example, in objecting to certain appropriations, says on February 2: "The Coast and Geodetic Survey is a good service. It is mainly scientific. They do good work, but a good deal of it is useless. Very little of it is absolutely necessary to-morrow. . . . . . If we are ever to have economy we have got to commence on these things which are not essential." Mr. McLaughlin of Michigan, on the other hand, discussing an item for chemical research, says on February 11: "In regard to this, as in regard to other highly scientific and investigational matters, it is difficult for the Committee to determine whether or not the money is needed or whether or not the work done by the expenditure of the money is satisfactory. We all know that wonderful results have followed experiments and scientific investigations. . . . . . Splendid results have been found in the most unpromising field, and when scientific gentlemen in whom we have confidence come before us and ask for appropriations to enable them to carry on work, we are loath to refuse them as we hesitate to criticize the work they are doing."

[1] Preceding report: this Journal, **10**: 243. 1920.

[2] This Journal, **9**: 454. 1919.

[3] See this Journal, **10**: 54. 1920.

The appropriations in the Second Deficiency Act include: $75,000 for continuation of the investigation of the mineral resources of Alaska, to be available also during 1921; and $47,100 for the continuation of magnetic and geodetic work by the Coast and Geodetic Survey.

The legislative, executive, and judicial appropriation bill (H. R. 12610), carrying appropriations for the Bureau of Standards, passed the House on March 4, and the Senate on April 1. After agreement to the conference reports the bill was sent to the President, carrying an amendment introduced by Mr. SMOOT on April 1 to the effect that no government journal, magazine, or periodical should be printed, issued, or discontinued without the approval of the Joint Committee on Printing. On account of the inclusion of this amendment the President vetoed the bill on May 13. The objectionable paragraph was eliminated and the bill repassed and signed as Public Law No. 231.

The act includes $432,360 for salaries at the Bureau of Standards, together with many special research items of which the following are examples: fire-resisting properties of building materials, $25,000; development of color standards, $10,000; optical glass, $25,000; metallurgical research, $25,000; sugars and sugar-testing apparatus, $30,000; high temperature measurement and control, $10,000. Total for the Bureau, $1,217,360.

Hearings on the Jones-Reavis bill (S. 2232)[4] for a Federal Department of Public Works were held before the Senate Committee on Public Lands on February 11. The bill was supported by M. O. LEIGHTON, Chairman, and C. T. CHENERY, Secretary, of the National Public Works Department Association; J. PARKE CHANNING, Chairman of Engineering Council; G. F. SWAIN, of Harvard University; F. L. CRANFORD, President of the General Contractors' Association; Colonel F. M. GUNBY; C. W. BAKER, Consulting Editor, *Engineering News-Record;* FRANCIS BLOSSOM, of the War Department; C. W. WHITAKER, Editor, *Journal American Institute of Architects;* W. F. WILLOUGHBY, Director, Institute for Government Research; and P. N. MOORE, mining engineer.

A joint resolution looking toward an even more comprehensive reorganization of the executive departments than that contained in the Jones-Reavis bill was introduced as H. J. Res. 353 on May 7 by Mr. MADDEN. The resolution provides for a Joint Committee on Reorganization consisting of three members each from House and Senate. Referred to the Committee on Rules.

Another reorganization and consolidation measure is S. 4369, introduced by Mr. HENDERSON on May 12: "To create a Division of Mines and Geology in the Department of the Interior." The proposed Division would be under the direction of an Assistant Secretary of the Interior, "technically qualified by experience and education," at a salary of $10,000. The powers and duties of the present Geological Survey and Bureau of Mines, and any powers and duties of other

[4] This JOURNAL, **9**: 422. 1919.

federal agencies relating to mining, metallurgy, mineral technology, geological surveying, land classification, or mineral resources, would be transferred to the new Division. The bill was referred to the Committee on Mines and Mining.

The recommendations of the Reclassification Commission were embodied in a bill (S. 4106) introduced in the Senate by Mr. JONES of New Mexico on March 22. A very thorough review of this legislation was given in the Senate by Mr. HENDERSON on April 29.

More liberal provisions regarding inventions by members of the Government bureaus than are provided by existing law are contained in H. R. 9932 and S. 3223: "Authorizing the Federal Trade Commission to accept and administer for the benefit of the public and the encouragement of industry, inventions, patents, and patent rights, and for other purposes."[5] The Senate bill, after reference from the Committee on Patents, was debated on March 22, and was amended by the insertion of a provision that the Commissioner of Patents should grant patents of the type described in the bill without the payment of any fee. The bill passed the Senate on March 22 and was referred to the House Committee on Patents, from which it was favorably reported on May 12.

One of the periodical attempts to reform the calendar is contained in H. R. 13574, introduced by Mr. SCHALL on April 12: "To provide for a modification of the time calendar now in general use in the United States, the modified form to be known as the Liberty Calendar." The modified calendar divides the year into 13 months of 28 days each, with a New Year Day which is not included within any month, and likewise a Leap Year Day in every fourth year, both of which are legal holidays. The bill was referred to the Committee on the Judiciary.

A special research of a geological character is planned for in S. 3829 (Mr. PHIPPS, February 2): "Making an appropriation for the investigation of underground currents, particularly shallow underground waters, and artesian wells in eastern Colorado." Referred to the Committee on Public Lands.

NOTES

A joint conference of national, state and regional engineering societies met at the Cosmos Club June 3–4, for the purpose of organizing to carry into effect the plans of development committees of the national societies. About 140 delegates, representing about 70 engineering organizations throughout the country, were present. The conference resulted in the formation of the "Federated American Engineering Societies," under the management of a representative body to be known as the "American Engineering Council." The principal discussion was on the resolution: "That it is the sense of the Conference that the

[5] For an analysis of the bill see Science, **51**: 421–427. 1920

proper organization should be an organization of societies and affiliations and not of individuals." This was opposed principally by representatives of the American Association of Engineers, but was finally unanimously adopted.

The fifteenth annual meeting of the American Association of Museums was held at the Natural History Building of the National Museum on May 17–19. Announcement was made of the incorporation of the Association.

A scientific congress has been organized to meet at Honolulu August 2–20. Its object is to outline scientific problems of the Pacific Ocean region, suggest methods for their solution, make an inventory of existing knowledge, and devise plans for future work. The program is in charge of the Committee on Pacific Exploration of the National Research Council. Among those in attendance from Washington will be: PAUL BARTSCH, of the National Museum; WILLIAM BOWIE, of the Coast and Geodetic Survey; T. WAYLAND VAUGHAN, of the U. S. Geological Survey; H. S. WASHINGTON, of the Geophysical Laboratory, Carnegie Institution of Washington; and H. O. WOOD, of the Research Council.

A laboratory for research on dyestuffs and explosives has been established at George Washington University. The laboratory, which is under the general supervision of Professor H. C. MCNEIL, will be in charge of Mr. G. W. PHILLIPS, formerly of the Chemical Warfare Service. Dr. C. E. MUNROE, of the National Research Council, will be consulting chemist of the laboratory.

The Bureau of Mines has completed arrangements for a cooperative research on the carbonization of lignite. $200,000 is to be supplied by private parties for the erection of a plant at New Salem, North Dakota. The Bureau will be in charge of the technical and experimental side of the investigation.

A new solar constant observing station is being established on the Haqua Hala Mountains near Wenden, Arizona, which will be equipped with apparatus now in use at Mt. Wilson, California. At the same time the Calama, Chile, station is being removed to the summit of a mountain about ten miles south of Calama, where it will be about 10,000 feet above sea level and free from interference due to the dust and smoke from the town and mine.

Messrs. CARLETON R. BALL, A. S. HITCHCOCK, and R. A. OAKLEY, of the Bureau of Plant Industry, received the honorary degree of Doctor of Science from Iowa State College in June.

Dr. HARVEY BASSLER, formerly paleontologist with the U. S. Geological Survey, is now engaged in exploratory work for the Standard Oil Company in South America.

Prof. Marston Taylor Bogert, of Columbia University, has been given a recess appointment by the President as a member of the U. S. Tariff Commission. Doubt has been raised as to the legality of the appointment, based on the fact that this and other appointments had been submitted to the Senate but no action was taken before adjournment.

Mr. Eugene Sewell Bruce, special inspector for the U. S. Forest Service, died on June 8, 1920, in his sixty-first year. He had been with the Service since 1900, having previously been connected with several large lumber companies. He was a member of the Society of American Foresters.

Prof. H. A. Bumstead, professor of physics and director of the Sloane Physical Laboratory, Yale University, has been elected Chairman of the National Research Council for the year ending July 1, 1921.

Dr. H. D. Curtis, of the Lick Observatory, has been appointed director of the Allegheny Observatory at Pittsburgh, Pennsylvania. Dr. Keivin Burns, recently of the Bureau of Standards, will be associated with Dr. Curtis in the work of the Observatory.

Mr. B. S. Butler has resigned his position as geologist on the U. S. Geological Survey to take up private work, and has been associated since July 1 with L. C. Graton in making surveys of copper properties in Michigan.

Mr. S. H. Cathcart is resuming his work in Alaska for the U. S. Geological Survey.

Mr. C. F. Choate, Jr., has been made a regent of the Smithsonian Institution by Public Resolution No. 37, passed by the Senate on March 3 and the House on April 5.

Mr. William Churchill, Associate in Primitive Philology, Carnegie Institution of Washington, died on June 9, 1920, in his sixty-first year. Mr. Churchill was born at Brooklyn, New York, October 5, 1859. He had been consul-general in Samoa and Tonga, and had been a member of the editorial staff of the *New York Sun* for 13 years, before joining the Carnegie Institution in 1915. During the war he was in charge of the division of foreign language publications of the Committee on Public Information.

The Willard Gibbs medal of the Chicago Section of the American Chemical Society "in recognition and encouragement of eminent research in theoretical and applied chemistry" was presented to Dr. F. G. Cottrell, of the Bureau of Mines, on May 21.

Dr. J. Walter Fewkes, chief of the Division of American Ethnology, left Washington in June to continue his archeological work on the ruins in Mesa Verde National Park. Unusual storms in the Rockies rendered roads in the Park inaccessible during the spring.

Dr. Gordon S. Fulcher, of the Research Information Service, National Research Council, resigned on June 1 to join the research staff of the Corning Glass Works at Corning, New York.

Mr. J. M. Hill, geologist of the U. S. Geological Survey, was transferred on July 1 to the Survey's office in San Francisco, in order to be more directly in touch with western metalliferous mines.

Mr. E. A. Holbrook, formerly superintendent of the Pittsburgh branch of the Bureau of Mines, has been transferred to Washington as assistant to the Director, Dr. F. G. Cottrell, whose nomination has been confirmed by the Senate.

Mr. Charles M. Hoy, who is collecting for the Smithsonian Institution in Australia, reports that within the past few years many of the characteristic mammals of Australia have been rendered extinct or nearly so as a result of the introduction and rapid multiplication of foxes and cats.

The University of Arizona has conferred the honorary degree of Doctor of Laws on Dr. T. H. Kearney, of the Bureau of Plant Industry, in recognition of his work on the breeding of Egyptian long-staple cotton in Arizona.

Prof. Vernon Kellogg, professor of entomology at Leland Stanford, Jr., University, has been elected secretary of the National Research Council for the year ending July 1, 1921.

Mr. W. S. W. Kew, of the U. S. Geological Survey, is studying the oil conditions of northwestern Mexico for private parties while on furlough from the Government service.

Dr. F. Lamson-Scribner, of the Department of Agriculture, has received the degree of Doctor of Philosophy from the University of Maine.

Prof. John Campbell Merriam, professor of vertebrate paleontology at the University of California, and recently acting chairman of the National Research Council, was elected president of the Carnegie Institution of Washington on May 25, to succeed Dr. R. S. Woodward, who retires at his own request after sixteen years of service in the presidency. Dr. Merriam will assume office January 1, 1921.

Dr. John R. Mohler, chief of the Bureau of Animal Industry, U. S. Department of Agriculture, received the degree of Doctor of Science from Iowa State College on June 9.

Mr. R. M. Overbeck has returned from Bolivia and will resume his work in Alaska for the U. S. Geological Survey.

Dr. C. L. Parsons was appointed as delegate from the National Research Council to the meeting of the International Chemical Union, held in Rome during the last week of June. Dr. Parsons went to Europe in April on private business, expecting to remain until after the meeting in Rome.

Prof. H. Postma, of Feist, Holland, visited Washington in May and examined materials in the Division of Physical Anthropology of the National Museum.

Mr. M. J. Proffitt, formerly of the Great Western Sugar Company, Denver, Colorado, has been put in charge of sugar technology at the Bureau of Standards.

Dr. Brayton H. Ransom, of the Bureau of Animal Industry, has been elected a corresponding member of the Société de Pathologie Exotique of Paris.

Mr. Edward Sampson, of Princeton University, has been appointed assistant geologist in the metalliferous section of the U. S. Geological Survey.

Mr. Eugene Stebinger, geologist in charge of the Foreign Section of the Mineral Resources Branch, U. S. Geological Survey, has been granted furlough from June 1, in order to go to South America for an American oil company. He is accompanied by Harvey Bassler and J. B. Mertie of the Survey.

Mr. Henry Earl Surface, formerly chemist in the U. S. Forest Service, and recently transferred to the Treasury Department, was killed in a railway accident near Schenectady, New York, on June 9, 1920. Mr. Surface joined the Forest Service in 1907, after graduation from Ohio State University. He went to Madison, Wisconsin, in June, 1910, when the Forest Products Laboratory was transferred to that place. In 1919 he was transferred to the Bureau of Internal Revenue in connection with the valuation of forest lands. He was a member of the Chemical Society.

Dr. W. van Bemmelen, director of the magnetic and meteorological observatory at Batavia, Java, spent several weeks in Washington in June, visiting the laboratories of the city.

Secretary Charles D. Walcott, of the Smithsonian Institution, left Washington on June 19 to spend the summer in geological field work in the Canadian Rockies.

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ETHNOLOGY.—*International and interclass misunderstandings.* JOHN R. SWANTON, Bureau of American Ethnology.[1]

Both individually and in the mass man tends to see in the world about him, animate and inanimate, what he feels within himself. If "God made man in His own image," it is equally true that man has ever since insisted in making over God into his. Not only so but, until the most recent times—and even now more than we are willing to admit—man has made over nature. In scientific terminology he has "anthropomorphized" it. The student of primitive mythology is familiar with this process, and the student of the child knows how natural it is to an immature mind. But while those of us who esteem ourselves "civilized" no longer see human personalities in the animals, plants, and natural phenomena, and refrain from worrying ourselves about hatreds or friendships on their part which are nothing more than reflections of our own psychological processes, we are far from having conquered the same tendency as it is applied to our fellow man. Of course our fellow man does have mental processes similar to ours, and it is therefore possible for us to interpret them to our mutual advantage. We do this daily. What I have reference to is the tendency that each evinces to interpret the thoughts and actions of another, not in terms of human mental processes in the broad sense, but in terms of his own individual processes. We are familiar in daily life with the man who suspects everyone of insincerity or dishonesty because he is insincere or dishonest himself, and to a somewhat less degree with the man who is easily cheated because

[1] Received June 14, 1920.

double-dealing has no abiding place in his thoughts. The problem of rendering justice to the intentions of our immediate neighbors and associates is, however, a matter of individual ethics and must be considered by each as his personal problem. What I wish to call attention to here is a similar attribution of motive as between groups of people, races, nations, classes, because in it is to be found the source of endless misunderstandings and the seed-bed for a large part of the controversies and wars which have afflicted mankind.

Every human group assumes that its peculiar views and customs are the normal, sane views and customs which everyone should hold, and that the deviations which are observed among its neighbors are departures from that norm which prove them to be inferior creatures, to be tolerated, if necessary, and suppressed, if possible. The home people being normal and the foreign people abnormal, one should expect in the latter not merely abnormal ideas and actions but even abnormal physical characteristics. Hence those persistent reports of cannibals, Amazons, centaurs, men with eyes in their breasts, and so on. Within the memory of the writer a book of African travel published by Harper Bros. was advertised to contain arguments for the existence of "tailed men" in Africa. It is only in recent years that the world has been obliged to content itself with pygmies and give up all of the other abnormal races for which it had been eagerly looking. In abandoning its mythic race with physical tails, however, the world has been unable or unwilling to give up its men with mental tails, *i.e.*, mental abnormalities. Even neighboring, cultured peoples are called "queer," or "funny," simply because they are different, and there is nothing that the average civilized human being is unwilling to believe regarding the more primitive peoples of the earth. This view was unintentionally encouraged by some early anthropologists who in their heroic efforts to divest themselves of preconceived ideas regarding the lower races almost removed the latter from the human category. They deceived themselves and their readers alike, by assuming that to be most primitive which was most diverse from that to which they and their own particular branch of civilized humanity were accustomed. Tattooing, head-flattening, labret-wearing, scarification, marriage by capture, "totemism," apparently meaningless taboos, sanguinary rites—if such could be found—although these did not occur in one and the same tribe and frequently not in those most primitive, were dragged from their natural connections and mercilessly heaped upon a theoretical "primitive man" who never had any objective existence. The origin of each of these peculiar customs was then made the subject of voluminous studies and accounted for in ways no less peculiar, all tending to mystify the already over-stimulated public in a very much greater degree.

That all of these things may be accounted for by referring them to common human instincts acting under diverse conditions is more and more clearly apparent the farther ethnological studies are pursued. We have only the same mind expressing itself diversely, the divergencies being added to and acquiring the sanctity of custom and law, generation after generation, until they present themselves to other races as bizarre and unnatural.

While all such collective beliefs and customs are not of equal value and some are of no value at all, it must be remembered that this applies to peoples alike. Civilized man, having had the benefit of a greater accumulation of experience, longer in time and drawn from a wider area, naturally has more well-grounded ideas and better tested customs, or perhaps one ought to say fewer ill-grounded ideas and badly established customs, than his savage brother, but he must remember that his advantage is only one of degree. He and his *do not* constitute a norm from which all other races and peoples are to be judged. Just as the Copernican and evolutionary theories disillusioned him regarding his physical immutability, so he must disillusion himself regarding his psychical immutability. There is no more singularity in having a black skin and frizzly hair or a yellow skin and straight black hair than in having a fair skin and wavy hair. It is no more odd to pierce the nose and deform the head than to pierce the ears and deform the waist. To acquire one's name from one's mother's family is even less unnatural than to take it from the father's kin. Paint as a personal adornment is common to both savage and civilized society, and the "full dress" of a primitive belle is often more ample than that of her civilized counterpart. It is no more depraved to abandon the aged and infirm to die—especially when other members of the band may have difficulty in keeping alive themselves—than it is to allow thousands of one's fellows to be born into the slums found in some of our great cities and drag out there the miserable existence to which they are condemned. The savage sometimes fasts and scarifies himself in the hope of obtaining help from imaginary beings and becoming thereby rich and successful, but this infliction is temporary and rarely results in permanent injury to the devotee, while civilized men in pursuit of fortune throw over their health and everything else that would make the fortune worth having. The savage sometimes resorts to human sacrifice, generally of men from other tribes, but for his own self-advancement; the white man too frequently permits a slow sacrifice of other members of his own nation.

Aside from misunderstanding the nature of savage customs and beliefs in themselves and an accompanying obliquity regarding the customs and beliefs of his own people, civilized man constantly does injustice to his primitive brother by interpreting customs as exhibitions of wilful moral depravity. The immobility often displayed by Indians on meeting after a long period of separation is attributed to coldness of disposition. The great numbers of tasks which savage women perform are thought to be arbitrarily imposed upon them. The indignities heaped upon captives or persons cast away among primitive people by accident are cited as proofs of a brutal and bloodthirsty disposition. And the ease with which such peoples credit the pronouncements of their medicine-men is, of course, a clear demonstration of an innately "superstitious" temperament. All of these things are held up as so many evidences of "naturally" depraved minds. One writer, observing that the Indians among whom he was traveling applied the terms "father" and "mother" to a number of different people, inferred that the relationship was in doubt and that their morals must be of the loosest character, being entirely ignorant of the fact that these terms were extended as "etiquette terms" over a great number of persons of the same clans as those to which the true father and mother belonged. Depravity there is among primitive people as among civilized races, and, as with us, too much has from time to time become embodied into custom and law. However, it would certainly not be just to assume that any people are depraved merely because they conform to the customs and laws in which they have been brought up. Particularly, it would not be fair to interpret customs and laws which are the expressions of one interpretation of morality in terms of customs and laws representing different interpretations.

Unfortunately this lack of appreciation of primitive mentality has resulted in an ignorant impulse on the part of representatives of so-called higher races to take such esteemed backward peoples under surveillance with the idea of making them over into at least outward conformity with civilized views of what is right and proper. They must be given civilized dress, taught to live in civilized houses—however unsuited to their climate—made to marry and rear families in accordance with the paternal customs and ideas of the higher race, and proselytized into the religion or religions dominant among the latter. Particularly they must be kept in "tutelage" until they are "fitted for self-government"—which can only mean a government after the pattern of one of the more developed states, with all its uses and abuses—for, until the white race came in upon them, there was not a single people that did not ordinarily govern itself.

"Tutelage" of a primitive people has just this meaning and just this justification, that, since the peculiar civilization of western Europe has in the last four centuries spread so rapidly that it is invading all corners of the earth, between their past isolation and their future adaptation to this culture the backward peoples must experience a transition period which may be one of "tutelage" or not, but should at any rate be one of sympathetic appreciation on the part of the culture-bearing powers, not the product of a desire to profit by the ignorance and helplessness of the peoples whose well being is professedly desired.

Unfortunately for this wished-for consummation the first information that an American or European gets regarding the backward peoples is apt to be sensational reports of their most peculiar customs, sweeping condemnations of their physical and moral condition, and usually lurid accounts of barbarities inflicted upon representatives of civilized races who may have chanced to stray among them. This distorted publicity is due partly to the willingness of newspapers and journals in Europe and America to cater to the love of the marvelous—their expectation, as goes the Spanish proverb, of "distant countries, big tales"—and partly to the desire of commercial interests to force an intervention which will render available to them the natural riches of a virgin but helpless land.

Inability or unwillingness to understand the other man's point of view has a second, and perhaps more dangerous, development here in our midst. It is the failure to understand the thoughts and actions of men of a different class or social stratum. This has some slight excuse when it concerns the representatives of distinct races living among us, but it is also maintained toward individuals of different classes whether foreign or not. Upper, middle, and lower classes attribute to each other vices of which they profess to be free themselves, and look upon actions which tend to run counter to the views or curtail the comfort of themselves, as evidences of wilful evil intent. Opinions of this kind are particularly dangerous because most people associate familiarly with only a restricted class, and when one hears the same stock accusations repeated over and over he comes to assume their absolute truth without giving himself the trouble to inquire further. Responsibility for this state of affairs rests upon all classes alike, but by far the greater measure must be shouldered by those most abundantly endowed with wealth, power, and intelligence because they also have better opportunities for ascertaining actual conditions. Too much reading and too many exchanges of opinion are for the purpose of re-enforcing prejudices rather than establishing truth and rendering justice, and in this connection I cannot refrain from expressing the opinion that the public press in America is altogether too ready to cater to the partisan demand. What we find in the news columns is frequently rather a garbling of events than a record of events, the whole thrown purposely out of perspective in order to cater to the "policy of the paper," the prejudices of the community which it serves, or the known attitude of the financial interests supporting it or represented in its advertising columns. And such misrepresentation of the facts is still further exaggerated by the choice and placing of the heads and sub-heads, and by the editorial utterances.

I have spoken of willingness to entertain and promote misrepresentation as "dangerous." It is dangerous because misunderstanding and misrepresentation destroy sympathy between peoples of different nations, and where persisted in within the borders of any one nation tend to weaken the ties which bind classes together and, more than any other single thing—except palpable and wide-spread injustice—pave the way for those disturbances which may lead to civil war and revolution.

MINERALOGY.—*Optical properties of anthophyllite.* N. L. BOWEN, Geophysical Laboratory, Carnegie Institution of Washington.[1]

In minerals of variable composition (solid solutions) a knowledge of the corresponding variation of optical properties is often of great importance, particularly since it renders possible the determination of chemical composition by optical measurement alone in cases where no other means may be available. In attempting to check the optical properties of the pure artificial magnesian amphibole, kupfferite, against those of natural anthophyllites the writer encountered a discrepancy in the data for the natural mineral from Franklin, North Carolina. Penfield, in his description of the Franklin crystals, gives two different values for β as determined by different methods.[2] The attention of Professor Ford was called to this matter and he kindly sent me the original Penfield material, including oriented plates and wedge. The wedge, which was made by polishing natural prism faces, suffices for the measurement of two refractive in-

[1] Received June 19, 1920.

[2] Amer. Journ. Sci. **40**: 396. 1890.

dices by the method of minimum deviation, and by this method the writer obtained exactly the same values as Penfield: γ = 1.6404, β = 1.6301. The method is so thoroughly dependable that there is no reason for doubting the value of β so obtained. The other value of β given by Penfield was calculated from measurements of the optic axial angle on oriented plates in an immersion medium. The relation between the angles so observed and the true angle is given by the equations

$$\sin H_a = \frac{\beta}{n_H} \sin V$$

and

$$\sin H_o = \frac{\beta}{n_H} \sin (90 - V)$$

whence by dividing one obtains the relation

$$\frac{\sin H_a}{\sin H_o} = \tan V.$$

Therefore, by measuring both the obtuse and the acute optic axial angle in an immersion medium one can calculate the true angle without any knowledge of the index of the immersion medium. The method is very accurate and there is no reason for questioning the value of 2 V so obtained. On the other hand, if one wishes to calculate β from such measurements, an accurate knowledge of the refractive index of the immersion medium is required. The liquid used by Penfield was potassium mercuric iodide solution, and though he gives the index of his solution, the assumption that this was in error, since it may change so readily by evaporation, is the most reasonable method of accounting for the great discrepancy between the value of β so calculated (1.6353) and that measured by minimum deviation (1.6301). Penfield evidently placed greater dependence upon the former value (1.6353), for he used it in calculating α, obtaining the result 1.6288. On the other hand, if the latter value of β (1.6301) is used, the calculated value of α is 1.6195. The whole question can best be decided by direct measurement of α. This was done in immersion liquids with Na light on a rather thick cleavage plate ||010, under which conditions the method is very sensitive. The first trial, with a liquid of index 1.622, showed that α was distinctly lower and on making up a liquid of index slightly less than 1.620, no difference in refraction of liquid and mineral was observed. The determination therefore checks with the calculated value $\alpha = 1.6195$. A rough determination

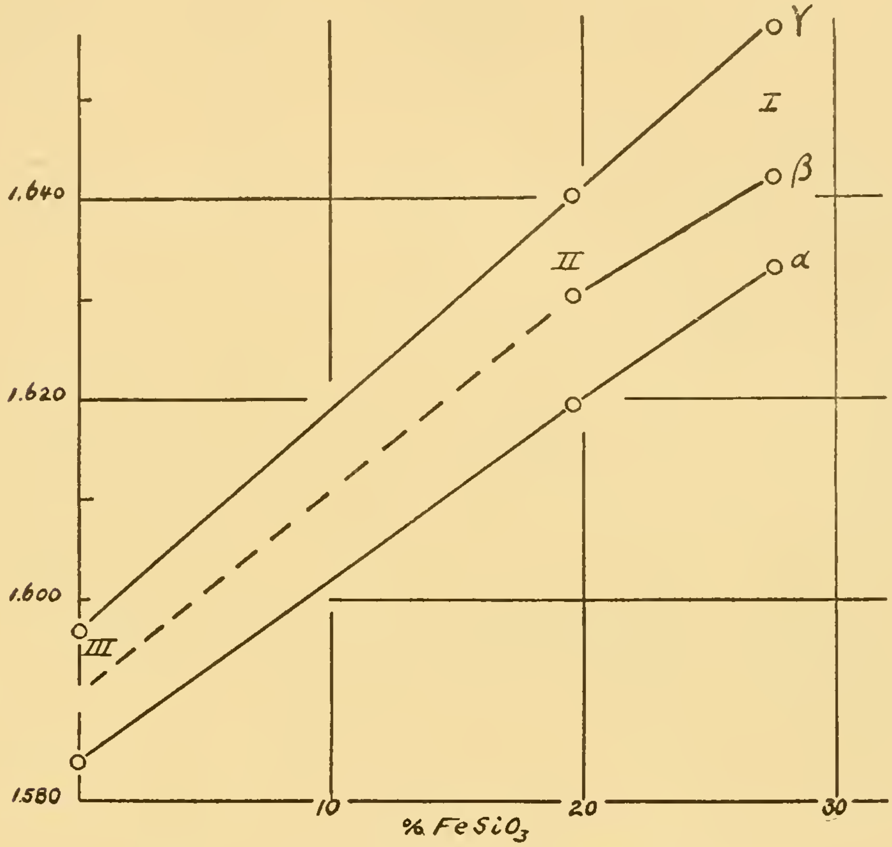

Fig. 1. Reflection indices of anthophyllite.

of the birefringence of the plate which gave the value 0.021 is also in accord with this lower value of α. From these determinations it may be stated, then, that the indices of anthophyllite from Franklin, North Carolina, are

$$\gamma = 1.6404, \ \beta = 1.6301, \ \alpha = 1.6195.$$

The optic axial angle is 88° 46′ and the birefringence $\gamma - \alpha = 0.0209$. In the text-books the erroneous value $\alpha = 1.6288$ is given as well as the correspondingly erroneous value of the birefringence $\gamma - \alpha = 0.0116$. The new values of the indices as given above are in accord with those observed in the pure artificial mineral and in another natural anthophyllite whose Al_2O_3 content is low enough to admit comparison. The relation between refractive indices and $FeSiO_3$ content is shown in table 1 and graphically in figure 1.

TABLE 1.—CHEMICAL COMPOSITION AND OPTICAL PROPERTIES OF ANTHOPHYLLITE.

	I. Kongsberg[a]	II. Franklin	III. Artificial
SiO_2	55.16	57.98	60.00
Al_2O_3	2.65	0.63	...
FeO + MnO	15.04	10.70	...
MgO	23.19	28.69	40.00
γ	1.657	1.6404	1.597
β	1.642	1.6301	...
α	1.633	1.6195	1.584

[a] MICHEL-LEVY and LACROIX, *Les Mineraux des Roches*, p. 150.

The indices given for the artificial kupfferite are redetermined values and are slightly higher than those given in an early paper from this Laboratory.[3] The artificial material is not very satisfactory for index determination, but the above values are observed when grains are used that are free from the dusty effect produced by contamination with excess silica.[4]

[3] ALLEN, WRIGHT and CLEMENT. Amer. Journ. Sci. **22**: 410. 1906.

[4] BOWEN and ANDERSEN. Amer. Journ. Sci. **37**: 492. 1914.

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.

ANALYTICAL CHEMISTRY.—*Application of the interferometer to gas analysis.* JUNIUS D. EDWARDS. Bur. Standards Techn. Paper **131**. Pp. 19. 1919.

One of the most useful of the physical methods applicable to gas analysis is that of gas interferometry. By the application of a new method of calibration, previously described in Scientific Paper 316, the use of the gas interferometer has been simplified and extended. The relation between the refractivities of the gases and the indications of the interferometer is discussed for various typical cases and illustrative calculations given. The determination of helium in a mixture of gases is one case of interest which is discussed. It is of importance because of the scarcity of analytical methods for determining helium. Other cases discussed are the effects of variations in the composition of air where it is a component of mixtures under test, the analysis of flue gases, the relative sensitivity of the interferometer for different gases and points about the operation of the interferometer. J. D. E.

BIOCHEMISTRY.—*Biochemical studies of the saliva in pellagra.* M. X. SULLIVAN and K. K. JONES. Public Health Reports **24**: 1068. No. 20, May 16, 1919.

In pellagra the condition of the mouth, and especially of the tongue, is of considerable importance in establishing a correct diagnosis. The true pellagrous tongue is vividly red and more or less swollen. The literature also speaks of salivation as a symptom of pellagra. In careful quantitative studies at the pellagra hospital, Spartanburg, South Carolina, it was found that, though there were cases of increased salivary flow, the salivation spoken of by the patients was often apparent rather than real and was seemingly due to some inhibition of swallowing combined with a peculiar ropy change in the saliva or high content of mucus which made the presence of saliva in the mouth more obvious. Occasionally also the flow was very slow, but in general it was within normal limits, which vary considerably. The specific gravity of the saliva of the pellagra patients tended to be higher than that of the controls. The total solids, ash, organic matter and mucin of the saliva was greater for the pellagrins than for the controls, but bore no relation to the mouth symptoms. The diastatic power of the saliva of pellagrins varied within the limits established by the controls. The sulfocyanate content was much less marked in the saliva of pellagra patients than in that of normal people. The reaction of the saliva in pellagra was found to be somewhat more alkaline than that of normal saliva. M. X. S.

METALLOGRAPHY.—*Constitution and metallography of aluminum and its light alloys with copper and magnesium.* P. D. MERICA, R. G. WALTENBERG and J. R. FREEMAN, JR. Bur. Standards Sci. Paper **337**. Pp. 14, pls. 8, figs. 19. 1919.

The temperature-solubility curves of $CuAl_2$ and of Mg_4Al_3 in aluminum were determined by the method of annealing and microscopic examination. Aluminum dissolves about 4.2 per cent of copper as $CuAl_2$ at 525° C. and about 12.5 per cent of magnesium as Mg_4Al_3 at 450° C. The solubility of both compounds decreases with decreasing temperature. At 300° C. aluminum dissolves only 1 per cent of copper as $CuAl_2$ and slightly less than 5.9 per cent of magnesium as Mg_4Al_3.

The structural identification of the various constituents, $FeAl_3$, $CuAl_2$, Mg_4Al_3, found in alloys with magnesium and with copper, is described, and a constituent is noted in all light aluminum alloys containing magnesium which is believed to be Mg_2Si. The solubility of iron as $FeAl_3$ in aluminum is at all temperatures less than 0.15 per cent. Small amounts of silicon up to 0.12–0.20 per cent are dissolved by aluminum at the eutectic temperature but are reprecipitated upon cooling, corresponding to the diminished solubility for silicon of aluminum at lower temperatures. Silicon in the usual commercial amounts is probably present as a compound of iron and silicon, together with some aluminum. The composition of this compound is not known but it separates out with aluminum and $FeAl_3$ at an invariant point at 610° C. R. G. W.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

BOARD OF MANAGERS

At the 238th meeting of the Board, held on March 8, 1920, changes in the free list of the JOURNAL were considered. Mr. F. V. COVILLE was appointed as the ACADEMY'S representative at the inaugural meeting of the Board of Surveys and Maps. Nominations to membership were considered at the 239th, 240th and 241st meetings, held on March 22, April 5, and April 26. Reports from the committee on preservation of the Shaw lily-ponds were presented at the 242d meeting, on May 24, and it was voted that these reports be brought to the attention of the Engineer Commissioner with the endorsement of the officers of the ACADEMY and of other affiliated societies that might be interested. At the 243d meeting on June 28, Dr. S. F. BLAKE, of the Bureau of Plant Industry, was appointed editor of the JOURNAL to fill the unexpired term of Dr. ALEXANDER WETMORE, who had resigned on account of expected absence from Washington for a year.

The following persons have become members of the ACADEMY since the last report in the JOURNAL (May 4, 1920, p. 275):

Dr. ELLIOT Q. ADAMS, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Mr. S. HENRY AYERS, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C.

Dr. NORMAN L. BOWEN, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C.

Dr. FAY CLUFF BROWN, Bureau of Standards, Washington, D. C.

Dr. NATHAN AUGUSTUS COBB, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. W. D. COLLINS, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Mr. LEON DOMINIAN, Department of State, Washington, D. C.

Dr. W. E. FORSYTHE, Nela Research Laboratory, National Lamp Works of the General Electric Company, Nela Park, Cleveland, Ohio.

Mr. WILLIS RAY GREGG, Weather Bureau, Washington, D. C.

Dr. RALPH EDWIN HALL, Firestone Tire and Rubber Company, Akron, Ohio.

Dr. DAVID BREESE JONES, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Dr. GEORGE W. McCOY, Hygienic Laboratory, Public Health Service, Washington, D. C.

Mr. CURTIS C. McDONNELL, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Dr. Edward Browning Meigs, Dairy Division, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C.

Dr. John R. Mohler, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C.

Dr. Clarence Aurelius Skinner, Bureau of Standards, Washington, D. C.

Dr. Thomas Elliott Snyder, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Mr. Louis Bryant Tuckerman, Bureau of Standards, Washington, D. C.

Robert B. Sosman, *Corresponding Secretary.*

ANTHROPOLOGICAL SOCIETY

543D MEETING

The 543d meeting of the Anthropological Society of Washington was held in room 42–43 of the National Museum, at 4.45 on Tuesday, February 3, 1920. Program:

Sylvanus Griswold Morley, Associate of the Carnegie Institution of Washington: *The foremost civilization of Central America.* Mr. Morley traced the rise and fall of the Maya empire and by means of charcoal drawings explained the calendar systems of the ancient Yucatecans.

544TH MEETING

The 544th meeting was held jointly with the Washington Academy of Sciences in the auditorium of the National Museum, at 8.15 p.m. on Saturday, March 6, 1920. Program:

W. H. R. Rivers: *Ethnology, its aims and needs.*

545TH MEETING

The 545th meeting was held jointly with the Washington Academy of Sciences and the Medical Society of the District of Columbia in the assembly hall of the Carnegie Institution of Washington, at 8.15 p.m. on Wednesday, March 31, 1920. Program:

Sir Arthur Newsholme: *The national importance of child welfare work.* (See proceedings of the Academy for an abstract of the lecture[1].)

546TH MEETING

The 546th meeting was held at the National Museum at 4.45 p.m. on Tuesday, April 6, 1920. Program:

J. A. Jeancon: *Antiquities of the Jemez Plateau, New Mexico.*

Among all of the areas of the Southwest which offer material for the study of American archaeology, there is not one which presents to the man engaged in research of that kind a finer and more responsive field than the Jemez Plateau of New Mexico. Some work has been

[1] This Journal, **10**: 394. 1920.

done, but there remains such a vast field that many men could engage in the work for a long period, and still there would be room for more.

We are satisfied that the dwellings in the cliffs and mountain fastnesses were occupied by some of the ancestors of the people who now dwell in the Rio Grande valley, and the contiguous country. Ample legendary information is at hand; the similarity of artifacts found, and those still in use in the villages, go to prove their relationship. Inter-marriage with other peoples, and Spanish influences, have produced differences which are very apparent, but granting all of these, the pre-Columbian people did not differ a great deal from the present-day Pueblo.

There are three distinct types of dwellings on the Plateau: (1) the cavate lodge, (2) the large communal house, and (3) the small structures of only a few rooms which are supposed to have been the earliest habitations.

The pottery found in the ruins presents a great variety of form and design, but it is unlike that of other areas. Occasionally we find outside influences creeping in and occurring in a local product, but, as a rule, the pottery is pronounced and distinct.

There is every reason to say that the old peoples originally came into the Rio Grande country from the north, possibly from the Mesa Verde region of southwestern Colorado. The knowledge of place names in the Montezuma Valley by the Tewa Indians is only one of the indications that the Rio Grande people came from the north. There are many other reasons. (Author's abstract.)

547TH MEETING

The 547th regular meeting (41st annual meeting) of the Anthropological Society of Washington was held at the National Museum at 4.45 p.m. on Wednesday, April 28, 1920. The meeting was devoted to reports and election of officers.

The Secretary reported that while during the year 1918 the greater part of the lectures had dealt with the races of the Near and Far East, the program for 1919 was entirely devoted to papers dealing with anthropology and prehistoric archaeology. An innovation was provided in the first three meetings, which were devoted to field experiences of those members of the Society who had been on active field work during the preceding year. The Society lost no members by resignation or death and four new members were elected.

Officers for the season 1920–21 were elected as follows: *President*, C. HART MERRIAM; *Vice-President*, NEIL M. JUDD; *Secretary*, J. P. HARRINGTON; *Treasurer*, J. N. B. HEWITT.

FELIX NEUMANN, *Secretary*.

BOTANICAL SOCIETY

141ST MEETING

The 141st regular meeting of the Botanical Society of Washington was held at the Cosmos Club at 8 p.m. Tuesday, February 3, 1920. Seventy members and six guests were present. Messrs. R. P. Marshall, E. W. Brandes, Henry F. Bain, S. D. Gray, E. G. Arzberger, Geo. M. Reed, and O. F. Berger, of the U. S. Department of Agriculture, and Prof. Richard E. Schuh, of Washington, were elected to membership.

As the retiring President for 1918, Mr. Walter T. Swingle gave an address on *Chinese botany and Chinese botanists.* It was illustrated with lantern slides and by an exhibit of books. The speaker sketched the study of Chinese botany and the study of European plants and outlined plans for a more effective study of the Chinese flora.

As the retiring President for 1919, Dr. Karl F. Kellerman gave an address on *The effects of salts of boron upon the distribution of desert vegetation.* He stated that it appears that the portions of the deserts completely devoid of vegetation are in many cases contaminated with borax deposits. It also seems clear that the salts of boron must be regarded as of fundamental importance in considering ecological relationships of native plants, and also in considering the agricultural use of land or water in regions containing natural deposits of these salts.

142D MEETING

The 142nd regular meeting of the Botanical Society of Washington was held at the Cosmos Club at 8 p.m. Tuesday, March 2, 1920. Ninety-seven members and ten guests were present. Dr. F. E. Kempton, of the U. S. Department of Agriculture, was elected to membership.

Brief notes and reviews of literature

Mr. M. B. Waite exhibited a number of panicles of *Paulownia tomentosa*, commonly planted as an ornamental tree in Washington, D. C., and often escaping from cultivation. This tree, a native of Central China, not Japan, as often stated, is remarkable in that the flowering panicles, often a foot in length, fully formed in summer with large naked buds, go through the winter with no protection except the wool on the calyx. The statement of Mr. W. T. Swingle at a previous meeting that this tree was an immigrant from the tropics into the temperate regions of China, might explain the origin of the peculiar naked panicles. This Paulownia has evidently been able to make the necessary physiological adjustments to become cold-resistant, standing temperatures of 0° to possibly −15° F., but has not made the usual morphological adjustments of temperate-zone trees by covering its cluster-buds or individual flower buds with protective bud scales.

Mr. C. V. Piper exhibited specimens of bastard toad-flax (*Comandra pallida* A. DC.) which has recently been found parasitic on the roots of apple trees in orchards at Wenatchee, Washington, where it has occasioned alarm. This species occurs over the region from Minnesota to the State of Washington, south to New Mexico, but not in California. No data concerning its natural host plants are available in the literature, but herbarium labels record Quercus and Cercocarpus positively, and with some doubt Pinus and Populus. Doubtless the hosts are numerous. The eastern analogue, *C. umbellata*, has never been recorded as attacking cultivated plants. It is of interest that the nuts of *C. pallida* are edible. Palmer, in 1878, states that the Pah-ute Indians eat the fruits, and Piper, in 1901, records that they are eaten in Washington by children as well as by swine.

Dr. David Griffiths reviewed the first volume of *The Cactaceae* by N. L. Britton and J. N. Rose (Carnegie Institution, Publication No. 248). He referred to the treatment of *Opuntia lindheimeri* as characteristic: "Certain forms have been described which in cultivation we have been able to recognize as possibly distinct; but in the field they seem to intergrade with other forms. In fact, all the plants described as species which are cited above in the synonomy grow within a relatively small distributional area." This small distributional area extends from the Coast to the highlands of the Lower Pecos, and from the alluvial saline delta of the Rio Grande to the cretaceous of the Edwards Plateau, and a similar distance in the other direction to Tampico. The species, according to the monograph, extends over close to 75,000 square miles of territory. It was the conclusion of the late lamented Professor Bernard Mackensen, that each change of soil produced a different cactus flora in southern Texas. But Professor Mackensen, after making his field studies, grew the plants in his garden, a practice which the authors appear to think is likely to lead the systematist into error. The type locality of *O. lindheimeri* is the detritus at the base of the Edwards Plateau. Two colored illustrations are given. They are both from the delta of the Rio Grande, 260 miles distant.

O. leptocarpa, of Mackensen, is considered by the authors to be a hybrid between *O. lindheimeri* and *O. macrorrhiza*—a hybrid which the reviewer had not been able to produce artificially. The reasons given for the supposed hybridity are two in number. (1) The three species are often found growing together and (2) the supposed hybrid is intermediate in stature between the other two. The so-called hybrid reproduces true from seed. The parent plants of the synonomy of *O. lindheimeri* are reproduced with remarkable fidelity from seed. Cross-pollinations on *O. lindheimeri* have produced nothing but maternal inheritance thus far.

Dr. Griffiths also exhibited a few colored illustrations of the species included in *O. lindheimeri*. The eleven plates that were displayed constitute about one-third of the illustrated evidence available on this remarkable species. Two colored plates illustrating *O. basillaris* also were shown. The authors have decided that one of these is an anomalous form of the other.

Regular Program

Mr. Ivar Tidestrom read an illustrated paper on the *Flora of Utah and Nevada*. He said that no region within the limits of the United States is marked by a more diversified flora than that of the Great Basin. Its plains and desert areas are found at an elevation of 600 to 1,500 meters above sea-level while its numerous mountain ranges rise in some instances above 3,900 meters altitude. Within this region we find the northern boundary between the flora of Mexico and that of western North America. This line coincides with the upper limit of *Covillea glutinosa*, *Yucca mohavensis* and *Cleistoyucca arborescens*.

In the West-American Dominion there are several characteristic belts, the lowest of which is dominated by *Artemisia tridentata*. The latter has a wide range as it ascends to 3,000 meters elevation or more on exposed slopes. At 1,500 meters above sea-level, the pinon and its associated Juniperus species becomes the dominant element. Above the pinon, especially on the plateau, *Pinus scopulorum* rules. This species forms forests in New Mexico and Arizona. Adjoining the pinon and ascending higher (2,700 meters or more) the aspen becomes the dominant element. In central Nevada *Cercocarpus ledifolius* replaces to a large extent the aspen. At 2,700 meters above sea-level *Picea engelmanni* and associated Abies species forms the spruce-belt. The belt is succeeded by the alpine flora of which many species are circumpolar.

Dr. P. J. S. Cramer, Chief of the Division of Plant Breeding, Department of Agriculture, Java, spoke on *Problems in tropical plant breeding*. He confined his remarks principally to breeding with the rubber plant *Hevea brasiliensis*, giving a brief description of the cultural methods employed. He stated that good strains may be developed from seedlings but more success may be expected from budded plants if buds are used from the highest yielders. Budded rubber plants sometimes show a tendency to low branching, but proper selection of buds will prevent this. If the top of the branch is used as a scion the graft will not develop a stem, but if the top of the stem or leader is used, a normal tree is obtained.

Chas. E. Chambliss, *Recording Secretary*.

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

The Agricultural Appropriation Bill for 1920–21 (H. R. 12,272) passed the House on February 14, and passed the Senate, with amendments, on March 26. Three conferences were necessary before the final agreement was reached on May 29. The bill was approved on May 31 as Public Law No. 234.

The Department of Agriculture, which receives, according to Dr. Rosa's figures recently published in this JOURNAL,[2] 63 per cent of the Federal Government's appropriations for "research, education and development," is granted $31,475,368 by this Act. The bureaus which are devoted entirely or in part to scientific work receive the following appropriations, stated in round numbers:

Weather Bureau	1.9 million
Bureau of Animal Industry	5.5 million
Bureau of Plant Industry	2.8 million
Forest Service	5.9 million
Bureau of Chemistry	1.3 million
Bureau of Soils	0.5 million
Bureau of Entomology	1.1 million
Bureau of Biological Survey	0.8 million
States Relations Service	4.9 million
Bureau of Public Roads	0.5 million
Bureau of Markets	2.5 million

The Sundry Civil Bill for 1920–21 (H. R. 13,870) passed the House on May 11, and the Senate on May 26 (with amendments); the conference report was agreed to on June 2 and the bill became Public Law No. 246, on June 5. This Act includes appropriations for the Public Health Service, National Advisory Committee for Aeronautics, Smithsonian Institution, Geological Survey, Bureau of Mines, Reclamation Service, Coast and Geodetic Survey, Bureau of Fisheries, and Bureau of Standards.

The Public Health Service receives approximately 8.6 million, including 0.3 million for "investigations of diseases of man and conditions influencing the propagation and spread thereof," and $45,000 for the maintenance of the Hygienic Laboratory.

The National Advisory Committee for Aeronautics receives 0.2 million for research in the field of aeronautics.

The Smithsonian Institution receives approximately 0.75 million, including $44,000 for ethnological researches, $13,000 for the Astrophysical Observatory, and $80,000 for additional land for the National Zoological Park.

[1] Continued from page 400.

[2] This JOURNAL, **10**: 350. 1920.

The Geological Survey receives approximately 1.7 million, including $125,000 for investigation of the so-called "super-power project" for a comprehensive system of electrical power generation and distribution in the Boston-Washington industrial district.

The Bureau of Mines receives approximately 1.3 million, including about 0.4 million for investigations of the causes of mine explosions and the study of methods of mining.

The Reclamation Service receives approximately 8.5 million for its engineering work.

The Coast and Geodetic Survey receives approximately 2.0 million, including about 0.4 million for surveys and resurveys of coasts, and about 0.1 million for geodetic and magnetic work. The title of "superintendent" of the Survey is changed to "director."

The Bureau of Fisheries receives approximately 1.2 million, including $45,000 for "inquiry into the causes of the decrease of food fishes in the waters of the United States," and a reappropriation of unexpended balance for cooperative work with the Bureau of Standards on "new aquatic sources of supply of leather."

The greater part of the Bureau of Standards' appropriations are carried in the Legislative, Executive and Judicial Act,[3] but the present Act carries additional items of $40,000 for the testing of large scales and $47,272 for the purchase of additional land; it also directs the Bureau to investigate the quality and cost of gas in the District and make a report thereon in December, 1920.

The salaries of commissioned officers of the Coast and Geodetic Survey are increased through Public Law No. 210, "An Act to increase the efficiency of the commissioned and enlisted personnel of the Army, Navy, Marine Corps, Coast Guard, Coast and Geodetic Survey, and Public Health Service," which provides that commissioned officers of the Survey "shall receive the same pay and allowances as now are or hereafter may be prescribed for officers of the Navy with whom they hold relative rank." The director of the Survey holds the rank of captain in the Navy. The Comptroller of the Treasury has ruled that the change of status takes effect from the passage of the Act, but the pay increases are in effect from January 1, 1920.

The Army Reorganization Bill[4] (H. R. 12,775) passed the Senate on April 20, and after two conferences, was agreed to on May 29 and became Public Law No. 242 on June 4. The Act establishes the Chemical Warfare Service as a separate service in the Army, under the direction of a Chief with the rank of Brigadier General, and with 100 officers and 1,200 enlisted men. The Service is "charged with the investigation, development, manufacture, or procurement and supply to the Army of all smoke and incendiary materials, all toxic gases, and all gas-defense appliances; the research, design, and experimentation connected with chemical warfare and its material; and chemical pro-

[3] This Journal, **10**: 399. 1920.

[4] This Journal, **10**: 244. 1920.

jectile filling plants and proving grounds; the supervision of the training of the Army in chemical warfare, . . . ; the organization, equipment, training, and operation of special gas troops. . . ."

H. R. 9,781, to permit the transmission of poisons through the mails by physicians and chemists, by amending Section 217 of the Criminal Code, Act of March 4, 1909, passed the House on April 5, and the Senate on May 3; the conference report was agreed to on May 18, and the bill became Public Law No. 216 on May 25.

The Nolan bill (H. R. 11,984) to increase the force and salaries in the Patent Office[5] passed the Senate on June 4, with S. 3,223 (authorizing the Federal Trade Commission to accept and administer inventions and patents for the public)[6] added as an amendment. The bill as thus amended met with opposition from industrial chemical interests on the ground that it would give undue advantage to Government inventors. At the request of Mr. NOLAN, a committee consisting of Messrs. F. G. COTTRELL, C. L. ALSBERG and ANDREW STEWART, have undertaken to draft further amendments.

The general subject of the nitrogen fixation plants was made the subject of an investigation by a select committee of the House, which rendered a report in May.[7] The committee divided in its report and recommendations on strictly political lines.

A hearing was held on May 21 on S. Res. 165 concerning the Botanic Garden.[8] Dr. N. L. BRITTON, director of the New York Botanical Garden, and a number of Washington botanists, attended. Removal of the Garden to Mt. Hamilton, in the northeastern part of the District, was strongly recommended by members of the Fine Arts Commission. On the occasion of the 100th anniversary of the Garden in June, Representative NELSON, of Missouri, secured leave to print in the *Congressional Record* a speech opposing the removal of the Garden from its present site.

The Second Session of the Fifty-Sixth Congress adjourned *sine die* on June 5. The next regular session will begin on December 6, 1920.

NOTES

The name of the Maryland State College of Agriculture, at College Park, near Washington, was changed on July 1 to "The University of Maryland." The institution was merged with the older University of Maryland, which had medical and law schools in Baltimore. The Board of Trustees of the State College becomes the Board of Regents of the University, and the headquarters of the University will be at College Park.

[5] This JOURNAL **10**: 243. 1920.

[6] This JOURNAL **10**: 400. 1920.

[7] See This JOURNAL **9**: 646. 1919; **10**: 244. 1920. A thorough summary of the report was published in Chem. Met. Eng. **22**: 993–996. May 26, 1920.

[8] This JOURNAL **9**: 563. 1919.

A party of twenty Czecho-Slovak professors and teachers, officers of Czecho-Slovak troops on their way back to Europe, visited Washington on July 3 to study the educational institutions and museums of the city.

Mr. H. S. BAILEY, formerly of the Bureau of Chemistry, U. S. Department of Agriculture, resigned his position with E. I. du Pont de Nemours and Company on July 1, to take charge of research for the Southern Cotton Oil Company at Savannah, Georgia.

Dr. ELMER D. BALL, of the Iowa Agricultural College, has been appointed Assistant Secretary of Agriculture, and assumed office on June 12.

The degree of Master of Science was conferred on Major EDWARD HALL BOWIE, forecaster of the U. S. Weather Bureau, at the Commencement of St. John's College, Annapolis, Maryland, on June 11.

Dr. ALFRED H. BROOKS, of the U. S. Geological Survey, received in June the honorary degree of Doctor of Science from Colgate University.

Dr. ARTHUR F. BUDDINGTON, of the Geophysical Laboratory, Carnegie Institution of Washington, has accepted the position of assistant professor of geology at Princeton University.

Mr. EARL P. CLARK, assistant in chemistry at the Rockefeller Institute for Medical Research, New York City, has joined the chemical staff of the Bureau of Standards.

Mr. W. D. COLLINS, of the Bureau of Chemistry, U. S. Department of Agriculture, has been appointed chief of the quality-of-water division of the U. S. Geological Survey.

Dr. F. G. COTTRELL, of the Bureau of Mines, was elected chairman of the Division of Chemistry and Chemical Technology of the National Research Council for the year ending July 1, 1921, at the annual meeting of the Division held on May 7.

Dr. N. E. DORSEY, who recently resigned as chief of the radium and X-ray section of the Bureau of Standards, in order to take up private consulting and testing work, has been retained by the Bureau in the capacity of consulting physicist, while continuing his private work.

Mr. W. F. FOSHAG, of the division of mineralogy, U. S. National Museum, spent May and June in collecting minerals in California.

Mr. ANDRE GOELDI, of Para, Brazil, has presented to the grass herbarium of the National Museum an exceptionally complete and well-prepared collection of grasses from Brazil, consisting of 299 specimens.

Major General WILLIAM CRAWFORD GORGAS, U. S. A. (Retired), formerly surgeon general of the United States Army, and a resident member of the ACADEMY, died in London, England, on July 4, 1920, in his sixty-sixth year. General Gorgas was born at Mobile, Alabama, October 3, 1854, and was appointed a surgeon in the United States

Army in 1880. He became widely known by his work in eradicating yellow fever from Havana after the war with Spain, and malaria and yellow fever from the Canal Zone during the construction work on the Panama Canal. He reorganized the Medical Corps for the war with Germany, and in 1919, after retirement from the Army, became director of the International Health Board of the Rockefeller Foundation.

Dr. FRANKLIN L. HUNT, physicist in the aeronautic instruments section of the Bureau of Standards, who has been detailed to Paris, France, for a period of twelve months, to serve as the Bureau's representative in relations with the scientific and aviation authorities of England, France, Italy, Belgium and Holland, is expected to return about the first of October. The exchange of technical information in connection with aviation matters has been greatly facilitated through courtesy of the Commercial Attaché Service of the Department of Commerce.

Dr. H. R. KRAYBILL, assistant physiologist in the Bureau of Plant Industry, U. S. Department of Agriculture, has resigned to accept the position of professor of agricultural chemistry and head of the department of chemistry at the Experiment Station of New Hampshire State College, Durham, New Hampshire.

Col. ARTHUR B. LAMB, director of the U. S. Fixed Nitrogen Research Laboratory, American University, will return to Harvard University as professor of chemistry, on September 1. Major R. C. TOLMAN, at present associate director, will at that time become director of the Laboratory.

Mr. O. C. MERRILL, formerly chief engineer of the Forest Service, has been appointed executive secretary of the newly-established Federal Power Commission, which will administer the Water Power Act passed in June by Congress. The members of the Commission are the Secretaries of War, Interior, and Agriculture.

Dr. E. W. NELSON, chief of the Bureau of Biological Survey, U. S. Department of Agriculture, received the honorary degree of Master of Arts from Yale University in June.

Mr. HELGE OHLSSON, of the Royal Hydrographic Service of Sweden, visited the United States in June for the purpose of studying the hydrographic, geodetic, and magnetic work of the U. S. Coast and Geodetic Survey.

Dr. HARRISON E. PATTEN has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, to accept a position as chief chemist with the Provident Chemical Company of St. Louis, Missouri. Dr. Patten will also do consulting work in food chemistry and chemical engineering.

Mr. WALDEMAR T. SCHALLER, who has been engaged in work for the Great Southern Sulphur Company, at Orla, Texas, for the past few months, has severed his connection with that company and has resumed his work in Washington.

Dr. GEORGE OTIS SMITH, director of the U. S. Geological Survey, received the honorary degree of Doctor of Laws from Colby College in June.

Professor AUGUSTUS TROWBRIDGE, professor of physics at Princeton University, has been elected chairman of the Division of Physical Sciences of the National Research Council for the year ending July 1, 1921.

Dr. RODNEY H. TRUE, of the Bureau of Plant Industry, U. S. Department of Agriculture, resigned in July to accept the position of professor of botany at the University of Pennsylvania.

Correction: The JOURNAL was in error in an item on p. 402 of the preceding issue, in stating that there was doubt as to the legality of the recess appointment of Professor M. T. BOGERT to the Tariff Commission. We are informed that this appointment had not been before the Senate, and there could therefore be no question of its implied rejection through lack of action by that body before adjournment. Professor Bogert has decided not to accept the appointment.

JOURNAL

OF THE

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PHYSICS.—*Methods of increasing the precision of thermostats.* Walter P. White, Geophysical Laboratory, Carnegie Institution of Washington. (Communicated by Robert B. Sosman.)[1]

In the July number of the *Physical Review* I published the abstract of a paper on the performance of mercury-contact thermostat regulators. Further work has brought out additional facts which are of considerable importance where a practical application is desired. It therefore, seems best to present at once briefly the subject as modified by these facts, without waiting for the final publication.

The only phenomenon peculiar to the thermostat is the backlash of the mercury contact; the mercury, descending, clings to the wire and then drops away, so that the temperature of the make is higher than that of the break. The thing of direct importance is the corresponding bulb temperature difference, ΔU_B, the temperature change required to move the mercury meniscus from the break to the make position. Since the effect upon this ΔU_B of a change in the backlash can be completely offset by a corresponding change in the length of the bulb, a knowledge of the magnitude of the backlash is not important in a brief discussion, though desirable for efficient designing. The backlash can probably be kept as small as 10μ, and the largest probable value is only 6 times as great as that.

The lag also has a profound influence on the constancy of the thermostat temperature. Sligh[2] has given a formula which,

[1] Received July 17, 1920.

[2] T. S. Sligh, Jr. *Some characteristics of the Gouy thermoregulator.* Journ. Amer. Chem. Soc. **42**: 66. 1920.

simplified, is as follows:

$$\Delta\theta_P = \Delta\theta_B + VL,$$

where $\Delta\theta_p$ is the periodic oscillation performed by the bath as the heat goes off and on; L is the lag; V is the rate of temperature change due to the interrupted, or regulated, part of the heating. $\Delta\theta_P$ is ordinarily the largest variation or error in the bath temperature. This equation, therefore, measures the efficiency of the thermostat. It reveals one fact which is true even where the equation does not apply, namely, that the rate of heating, V, is quite as important as the lag, L.

My other paper presented a formula, more rigorous but more complicated that Sligh's, which often gives results very different from his.

It was further pointed out, however, that where the two formulas disagree seriously, neither one applies, as a rule. The reason is that both treat the lag as a single quantity, which is equivalent to assuming that the fluid in the bulb is always at a practically uniform temperature. But for rapid alternations of bath temperature the temperature change travels into the bulb as a damped wave, and the middle portions of the fluid may take no appreciable part whatever in the periodic oscillation. It is evidently proper to use a formula based on the damped wave; a sufficient approximation, probably, is the well-known formula for plane waves due to harmonic oscillations:

$$\theta = \theta_0 e^{-\alpha x} \sin\left(\frac{2\pi}{T} t - \alpha x\right) \tag{1}$$

where $2\theta_0$ is the temperature range at the margin; T the period; x distance measured into the body; $\alpha = \sqrt{\frac{\pi}{h^2 T}}$, with h^2 the diffusivity. A very probable value of V is 0.01° per minute; with it a temperature fluctuation of 0.001° may correspond to an oscillation of 24 seconds period. The effective penetration of such an oscillation into gasoline or toluol is of the order of 0.5 mm., and the dimensions of the bulb must be chosen accordingly. In mercury the penetration is 5 times as great, and the resulting expansion, therefore, about the same per unit of surface. The interior portions of bulb fluid are largely inert, but the detrimental effect of bulb wall expansion, if that is present, increases with the volume of the bulb.

There are, however, two further considerations not treated hitherto. One is the fact that the effective or integrated temperature of the bulb fluid is zero only one-eighth of a period before the maximum temperature is reached at the surface. Hence if the bath lags only 3 seconds behind the heater, the bulb, no matter how sensitive it is, cannot possibly function normally and regularly for a constancy of 0.001° with a rate, V, of 0.01° per minute, and similarly for other lags.

A second consideration is the damping and delay of the wave as it goes through the bulb wall,[3] which still further cuts down the efficiency, more with mercury than with gasoline, and much more with glass than metal for the bulb wall.

If the rate, V, is made smaller, which can be done by diminishing the room-temperature fluctuations, then the period for any given precision becomes longer, and the effect of all lags, in the heater, in stirring, and in the bulb, may become very much less. Thus, if the bath is put in a large packing box, or in a space inclosed by curtains, and the air temperature in this space is controlled by another simple regulator, V can often be made over fifty times as small. This means that a precision of 0.001° can be reached with the heat going on or off only once in 10 minutes or so. The lag effect, which is LV, is now far smaller than before even with the lag somewhat larger, hence large and, therefore, sensitive bulbs can be employed, and a precision beyond 0.001° can be thought of. Another advantage peculiar to this method is the diminution of differences between one part of the bath and another. Inclosure, however, is often inconvenient.

This *cascade* thermostat is one means of securing high precision. A second, giving practically no short-period temperature oscillations at all, is the Gouy, or oscillating-wire,

[3] The mathematical problem presented by this additional complication has been seldom, if ever, treated in the literature. Prof. L. B. Tuckerman has worked out for me a number of solutions for different cases, an account of which will belong in a more complete publication.

thermostat, for which Sligh has given an equation. From this equation it follows that the length of stroke usually employed, 20 or more times the backlash, makes the variation from day to day much greater than in the previously discussed type. It also follows, however, that the error can be diminished by shortening the stroke, by using an excess of heating power, and by enlarging the bulb. How far these expedients can be carried without introducing irregularity of action has not yet been worked out.

A third means for increasing precision is to put the heater very near the regulator bulb. This is like the Gouy regulator in making the oscillations of the heating current so rapid and small that the oscillations of the bath become negligible. It is well known, and is often hailed as a complete solution of the problem of temperature regulation. What is not nearly so well known is that this method is also like the Gouy in giving relatively large variations from day to day. This is because the bulb is intermittently bathed in water considerably warmer than the rest of the bath. Hence as the amount of heat required varies, the relative temperature of bulb and bath, and therefore, the absolute temperature of the bath, varies also.

BOTANY.—*A new genus of Leguminosae.* C. V. PIPER, Bureau of Plant Industry.[1]

In a study of the genus *Canavalia*, to which the cultivated jack bean and sword bean belong, it has become evident that the generic characters will need some revision. Among the specimens referred to this genus in the U. S. National Herbarium was found the new species herewith described, diverging so much from any other as to necessitate the proposal of a new genus for its reception. Superficially, it has much resemblance to *Canavalia*, but the floral characters indicate that its relationship is much closer to *Dolichos*.

Monoplegma, gen. nov.

Leaves palmately trifoliolate; leaflets entire, 3-nerved from the base the two lateral nerves nearly as large as the midrib; flowers in racemes,

[1] Received July 21, 1920.

each pedicel with prominent glands at the base; calyx campanulate, 2-lipped, the upper lip broad, emarginate, as long as the tube, the lower lip with 3 broad ovate lobes nearly as long as the upper lip, the median lobe smallest; standard orbicular, emarginate, biauriculate at base, short-unguiculate, a narrow thick gland near the middle of the petal; wings spatulate, unguiculate, obtuse and hooded at apex, without median auricle; keel geniculate, unguiculate, blunt at apex, as long as but broader than the wings; stamens diadephous, the vexillar one free; anthers small; style hairy on the inner side; stigma lanceoloid, terminal; pod large, woody, 1- or 2-seeded, a small longitudinal ridge on each valve very near the ventral suture, the inner layer of the pod not separating at maturity; seed globose, the narrow linear hilum covered with spongy tissue and extending three-fifth of the circumference.

In the Englerian classification this plant would fall in the group Papilionatae-Phaseoleae-Phaseolinae.

Monoplegma sphaerospermum Piper, sp. nov.

Probably a tall climbing vine; stems woody, terete, thinly strigillose when young; stipules persisting, oblong, acutish, strongly and prominently 5–7 nerved, 3–4 mm. long; petioles terete, shorter than the leaflets, sparsely pilose, especially at base; stipels like the stipules but longer and narrower, curved; petiolules fleshy, sparsely pubescent; leaflets very thin, narrowly ovate, conspicuously acuminate, but the acumination often blunt, rounded at base, 3-nerved from the base, reticulate-venose, very sparsely strigillose on both surfaces, 6–10 cm. long; peduncles densely puberulent; racemes 15–30 cm. long in fruit, apparently 10–20-flowered; pedicel as long as the calyx; calyx ciliolate; upper calyx lip emarginate, 7 mm. long; lower lip with 3 broadly ovate, obtuse lobes, the lateral ones slightly larger and nearly as long as the upper calyx-lip; corolla (not fully open) 10 mm. long; standard orbicular, notched at apex, short-clawed at base between two narrow basal auricles, a narrow thick swelling near the middle; wings spatulate, obtuse, hooded at apex, without a lobe in the middle; keel as long as the wings, blunt at apex, sharply genticulate in the middle; mature pods oblong, woody, each valve with a single longitudinal ridge very close to the ventral suture, the dorsal suture prominent and acute, glabrous but at first strigillose, 5–9 cm. long, 3–4 cm. broad, tipped with a straight beak, 6 mm. long; seeds usually 2 in each pod, nearly spherical, black, somewhat shiny, the longest diameter 2 cm.; hilum narrowly linear, white, somewhat spongy, extending three-fifths of the circumference.

Type in the U. S. National Herbarium, no. 577,636, collected in thickets at Las Vueltas, Tucurrique, Costa Rica, November, 1898 (flowers), and April, 1899 (fruit), by A. Tonduz (no. 12,743).

Other Specimens Examined:

Costa Rica: Baru, Pacific slope, January 28, 1898, *Pittier* 11,958.

ENTOMOLOGY.—*Descriptions of two new species of butterflies from tropical America.*[1] W. SCHAUS, U. S. National Museum.

Recently the National Museum has received two new butterflies, from the tropics of the new world, which are of more than usual interest. It is desirable that names for these be made available and for this reason the following descriptions are presented.

Anaea suprema Schaus, sp. nov.

Fore wings arched and falcate, the outer margin deeply incurved. Hind wings with the outer margin rounded, the anal angle slightly produced.

Male.—Palpi and head reddish brown irrorated with white. Collar and thorax olive-brown. Wings black faintly tinged with deep blue. Fore wings: a scarlet fascia from base, filling the basal fourth of costa and the basal third of inner margin, narrowing towards apex, its anterior edge following below subcostal to near termen, its hind edge somewhat dentate, especially between veins 5 and 8; the apex and terminal line reddish brown; a black streak on discocellular. Hind wings with the outer margin rather broadly reddish brown. Wings below dark reddish brown glossed with iridescent lilacine and mottled with yellowish striae. Fore wings: a transverse dark shade in cell, and a similar smaller shade on discocellular; a postmedial fuscous shade, vertical to vein 5, outcurved to vein 3, vertical to vein 2 and inbent to inner margin; an ochreous line from apex joining the postmedial at vein 4 and edging it to inner margin; an oblique dark shade on costa beyond postmedial. Hind wings: a dark transverse shade in cell; a dark median streak below costa, and a fine line on discocellular; an irregular postmedial fuscous line; a fuscous line from costa before apex to inner margin just above anal angle.

Female.—Wings black. Fore wings with the fascia broader and shorter, orange-red, crossed by a thick black line on discocellular, ending somewhat beyond, followed by a large irregular and elongated deep yellow spot between veins 5 and 7; a similar upright spot from vein 2 to above vein 3, and a streak above submedian; marginal triangular orange-red spots, their base resting on a terminal reddish brown line. Hind wings with large postmedial deep yellow spots not reaching inner margin, the black beyond them forming triangular spots, their apices touching black marginal spots and enclosing large subterminal brownish yellow diamond-shaped spots; a terminal reddish brown line. Wings below to postmedial line maroon striated with yellow, beyond postmedial ochreous-yellow striated with maroon; the spots and lines as in male, but better defined; fore wings with a darker triangular space before apex; an incurved subterminal maroon shade from

[1] Received July 21, 1920.

apex to submedian; hind wings with a subterminal maroon line shaded with fuscous. The gloss on underside more of a steel color.

Expanse: male 65 mm.; female 74 mm.

Habitat: Serra da Mantiqueira, Brazil.

Type.—Cat. no. 23,349, U. S. National Museum.

Unlike any described species.

Actinote calderoni Schaus, sp. nov.

Male.—Head, collar and thorax black, some white scaling on vertex; a silvery shade on tegulae. Body whitish. Wings thinly scaled, grayish white, the veins fuscous brown. Fore wings with short terminal gray streaks on interspaces, longer above vein 5 and 6; the interspaces between veins 8 and 11 suffused with gray. Hind wings with gray streaks on interspaces from near cell to termen; a short streak in cell before discocellular. Wings below similar; a small ochreous spot at base of hind wing.

Expanse: 43 mm.

Habitat: Ateos, Salvador.

Type.—Cat. no. 23,348, U. S. National Museum.

Received from Mr. Calderon, head of the Agricultural Laboratory in Salvador, in whose honor I take great pleasure in naming this species.

THERMOCHEMISTRY.—*The thermochemistry of ionization of vapors of certain compounds.*[1] PAUL D. FOOTE and F. L. MOHLER, Bureau of Standards.

Two general types of ionization of compound molecules in the gaseous phase are known. In one mode of ionization the molecule preserves its general structure, simply losing a negative charge and becoming a positive ion. It seems probable that materials capable of ionizing in this manner should possess a characteristic spectrum, as for example, carbon monoxide.

In the second type of ionization the molecule is dissociated into a positive and a negative ion. Materials which are ionized in this manner probably do not possess characteristic spectra in the ordinary sense. Radiation of a single frequency, usually in the extreme ultraviolet, *may be* emitted, however, when the two ions recombine to form the neutral molecule. We have found evidence that hydrogen chloride exhibits this form of ionization,[2] being without doubt dissociated on electronic impact of 14.0 volts into a hydrogen nucleus and a negative chlorine ion.

[1] Published by permission of the Director Bureau of Standards. Received Aug. 21, 1920.

[2] FOOTE and MOHLER. Journ. Amer. Chem. Soc. September, 1920.

Alkali halides.—Compounds of the alkali metals and the halogens probably show a similar behavior, the ionization of the vapor consisting in the production of positively charged metal ions and negatively charged halogen ions. Thus the ionization of NaCl into Na^+ and Cl^- would give rise to no spectra characteristic of NaCl (except possibly the single frequency above mentioned), but rather to the spectrum of sodium produced by recombination of the sodium ions and free electrons. If positive salt ions were formed, on recombination with electrons spectra of the salt would appear. No emission spectra characteristic of the alkali halides have been observed.[3] Furthermore, the flame emission spectrum characteristic of the metals is suppressed by the presence of an excess of the halogen in the flame. Kaiser and Runge[4] concluded from this that an undiscovered spectrum of the salt must exist, but the theory that NaCl ionizes into Na^+ and Cl^- and hence has no spectrum except a single line is a more probable explanation. The presence of an excess of halogen gas in the flame simply reduces the proportion of free sodium ions, which combine with chlorine ions instead of electrons. The sodium spectrum is accordingly suppressed.

This type of ionization of the vapor is precisely that obtained in the electrolytic dissociation of the fused salt, thus suggesting that there may be a much closer relation between electrolytic conduction and gaseous conduction than is ordinarily supposed.

If a material in the vapor state ionizes by dissociation it is sometimes possible to compute from chemical and physical data the value of the ionization potential. As an example, we shall illustrate the method of computing the work necessary to ionize a gram mol of sodium chloride vapor.

Let

[ ] denote solid phase or crystalline state.

( ) denote gaseous phase.

D = heat of dissociation of $^1/_2$ gram mol halogen gas into monatomic gas.

[3] Kaiser and Runge. Handbuch der Spektroskopie.

[4] *Loc. cit.* 6: 127.

S = heat of sublimation at absolute zero of 1 gram atom metal or gram molecule of salt.
Q = heat of formation of the salt.
J = work necessary to ionize 1 gram mol salt or 1 gram atom metal.
E = electron affinity referred to 1 gram atom halogen gas.

The following thermochemical relations may be written:

$$\begin{aligned}
[\mathrm{NaCl}] + Q_{\mathrm{NaCl}} &= [\mathrm{Na}] + (^1/_2\mathrm{Cl}_2) \\
(^1/_2\mathrm{Cl}_2) + D_{\mathrm{Cl}} &= (\mathrm{Cl}) \\
[\mathrm{Na}] + S_{\mathrm{Na}} &= (\mathrm{Na}) \\
(\mathrm{NaCl}) - S_{\mathrm{NaCl}} &= [\mathrm{NaCl}] \\
(\mathrm{Na}) + J_{\mathrm{Na}} &= (\mathrm{Na})^+ \\
(\mathrm{Cl}) - E_{\mathrm{Cl}} &= (\mathrm{Cl})^-
\end{aligned}$$

Adding:

$$(\mathrm{NaCl}) + Q_{\mathrm{NaCl}} + D_{\mathrm{Cl}} + S_{\mathrm{Na}} + J_{\mathrm{Na}} - E_{\mathrm{Cl}} - S_{\mathrm{NaCl}} = (\mathrm{Na})^+ + (\mathrm{Cl})^- \qquad (1)$$

Equation (1) accordingly gives the amount of energy J_{NaCl} required to ionize 1 gram mol of sodium chloride vapor. Whence:

$$J_{(\mathrm{NaCl})} = Q_{\mathrm{NaCl}} + D_{\mathrm{Cl}} + S_{\mathrm{Na}} + J_{\mathrm{Na}} - E_{\mathrm{Cl}} - S_{\mathrm{NaCl}} \qquad (2)$$

A similar relation holds for any salt of compositions R X where R is an alkali metal and X a halogen. For the greater portion of these salts, all the terms on the right of equation (2), with the exception of the heat of sublimation of the salt are known. Hence a determination of the heat of sublimation would permit the computation of the ionization potential of the vapor of the salt.

On the assumption that, in addition to the ordinary Coulomb force of repulsion or attraction between the charges on the ions forming the crystal structure of these salts, there exists between two ions a repulsive force, the potential of which is inversely proportional to the ninth power of the distance apart, Born[5] has computed the grating energy of the crystal, *i. e.*, the work U necessary to convert 1 mol of the crystal into free positive and negative ions—a purely electrostatic problem. The physical significance of the quantity U is apparent. It may be con-

[5] BORN. Verh. d. Phys. Ges. **21**: 16. 1919.

sidered as representing the work required to first sublime a mol of crystal and then ionize each molecule by dissociation. Or, in terms of thermochemical data, it represents the heat of formation of a mol of the salt, plus the heat of dissociation of one-half mol of halogen gas, plus the heat of sublimation of a mol of metal, plus the work of ionization of a mol of metal, minus the work represented in the electron affinity of a gram atom of halogen gas; the end products of either transition being identical.

Accordingly equation (2) may be expressed in the following general form:

$$U_{[RX]} = J_{(RX)} + S_{[RX]} = Q_{[RX]} + S_{[R]} + D_{(X)} - E_{(X)} + J_{(R)} \quad (3)$$

Table 1 gives the values of the grating energies computed by Born, from which the ionization potentials may be obtained directly if the heat of sublimation of the salt were known:

TABLE 1

Born's Values of Grating Energies

Vapor	$J_{(RF)} + S_{[RF]}$	Vapor	$J_{(RCl)} + S_{[RCl]}$	Vapor	$J_{(RBr)} + S_{[RBr]}$	V por	$J_{(RI)} + S_{[RI]}$
LiF	231	LiCl	179	LiBr	167	LiI	153
NaF	220	NaCl	182	NaBr	168	NaI	158
KF	210	KCl	163	KBr	155	KI	144
RbF	...	RbCl	144	RbBr	140	RbI	138
CsF	...	CsCl	156	CsBr	150	CsI	141

The numbers in this table are expressed in kilogram calories per mol. Equation (4) gives the relation between kilogram calories per mol and potential in volts.

$$\text{kilogram calories per mol} = 23.1 \times \text{volts} \quad (4)$$

Halides of the second group.—The ionization of vapors of these halides may be very much more complicated than those of the alkali halides because of the higher valence of the metal. The grating energies of the salts have not been determined. As a particular example of the possible conditions to be expected, we shall consider the ionization of mercuric and mercurous chlorides.

The mercuric chloride molecule consists of a doubly positively charged mercury atom and two negatively charged chlorine atoms. Ionization may result in the following immediate conditions:

(1) A positively charged molecule $(Hg\ Cl_2)^+$

(2) A positively charged molecule of mercurous chloride and a negatively charged chlorine atom $(Hg\ Cl)^+ + (Cl)^-$

(3) A doubly positively charged mercury atom and two negatively charged chlorine atoms $(Hg)^{++} + (Cl)^- + (Cl)^-$

Since the chlorine is undoubtedly bound to the mercury as atoms rather than as a molecule there would not be an immediate production of molecular chlorine. If molecular chlorine were produced it would require a secondary reaction of two chlorine atoms, quite apart from the phenomenon of ionization. The ionization by method (3) would appear improbable in low voltage arcs. The two chlorine atoms are probably joined to opposite sides of the mercury atom. Hence in order that the impacting electron may eject both chlorine ions, it must first collide with the molecule and eject one chlorine ion, then pass through the mercury atom before its electric field may exert an appreciable influence on the second chlorine ion. But to pass through the mercury atom would require a velocity approaching that of a beta particle. Hence while this type of ionization might exist in cathode ray phenomena it would not appear possible at one collision in ordinary arcs.

The production of a doubly charged mercury atom, however, might be developed by successive collision or by absorption of radiation followed immediately by collision in an arc of high current density. The process occurs in two steps. A collision with an impacting electron of suitable velocity or the absorption of radiation of the proper frequency may cause the ejection of one chlorine ion resulting in ionization by method (2). Before the positively charged *mercurous* chloride thereby produced, recombines, it may collide with a second electron and lose the second chlorine ion. Hence even if ionization finally resulted in a doubly charged mercury ion and two chlorine ions, measurements of ionization potential of mercuric chloride would show two inelastic collisions, the first giving the energy required for the step $(HgCl_2) \longrightarrow (HgCl)^+ + (Cl)^-$ and the second for the step $(HgCl)^+ \longrightarrow (Hg)^{++} + (Cl)^-$.

In general, since this latter step is a secondary process which in order to occur at all must *immediately* follow the first step, it is a very improbable condition in low voltage arcs. Ionization resulting in the production of a positively charged mercuric chloride ion is considered later.

It would appear that a very probable type of ionization of mercuric chloride results in the production of a positively charged mercurous chloride ion and a negatively charged chlorine ion.

The ionization of mercurous chloride may result in the following immediate conditions:

(1) A positively charged molecule $(HgCl)^+$

(2) A positively charged mercury atom and a negatively charged chlorine atom $(Hg)^+ + (Cl)^-$

We would expect to find both types of ionization present. That the first type may occur is reasonable since positively charged mercurous chloride ions may be produced in the ionization of mercuric chloride. The second type of ionization is in direct analogy to that of the alkali halides.

The thermochemical relations may be written for the above modes of ionization.

Let J'_{HgCl} represent ionization of type $(Hg)^+ + (Cl)^-$
J_{HgCl} represent ionization of type $(HgCl)^+$
J'_{HgCl_2} represent ionization of type $(Hg)^{++} + 2(Cl)^-$
J_{HgCl_2} represent ionization of type $(HgCl)^+ + (Cl)^-$
J'_{Hg} represent ionization of type $(Hg)^{++}$
J_{Hg} represent ionization of type $(Hg)^+$

[ ] denotes solid phase, ( ) gaseous phase, and no sign, liquid phase.

L = latent heat of fusion per mol.

Accordingly we have for the ionization of $(HgCl_2)$ into $(Hg)^{++}$ and $2(Cl)^-$:

$$
\begin{aligned}
[HgCl_2] &+ Q_{HgCl_2} &&= Hg + (Cl_2) \\
Hg &- L_{Hg} &&= [Hg] \\
[Hg] &+ S_{Hg} &&= (Hg) \\
(Hg) &+ J'_{Hg} &&= (Hg)^{++} \\
(Cl_2) &+ 2D_{Cl} &&= 2(Cl) \\
2(Cl) &- 2E_{Cl} &&= 2(Cl)^- \\
(HgCl_2) &- S_{HgCl_2} &&= [HgCl_2]
\end{aligned}
$$

Adding:

$$(HgCl_2) + Q_{HgCl_2} - L_{Hg} + S_{Hg} + J'_{Hg} + 2D_{Cl} - 2E_{Cl} - S_{HgCl_2} = (Hg)^{++} + 2(Cl)^- \quad (5)$$

For the ionization of $(HgCl_2)$ into $(HgCl)^+$ and $(Cl)^-$ we obtain:

$$\begin{aligned}
[HgCl_2] + Q_{HgCl_2} &= Hg + (Cl_2) \\
Hg + {}^1/_2(Cl_2) - Q_{HgCl} &= [HgCl] \\
(HgCl_2) - S_{HgCl_2} &= [HgCl_2] \\
[HgCl] + S_{HgCl} &= (HgCl) \\
(HgCl) + J_{HgCl} &= (HgCl)^+ \\
{}^1/_2(Cl_2) + D_{Cl} &= (Cl) \\
(Cl) - E_{Cl} &= (Cl)^-
\end{aligned}$$

Adding:

$$(HgCl_2) + Q_{HgCl_2} - Q_{HgCl} - S_{HgCl_2} + S_{HgCl} + J_{HgCl} + D_{Cl} - E_{Cl} = (HgCl)^+ + (Cl)^- \quad (6)$$

For the ionization of (HgCl) into $(Hg)^+$ and $(Cl)^-$ we obtain:

$$\begin{aligned}
[HgCl] + Q_{HgCl} &= Hg + {}^1/_2(Cl_2) \\
Hg - L_{Hg} &= [Hg] \\
[Hg] + S_{Hg} &= (Hg) \\
{}^1/_2(Cl_2) + D_{Cl} &= (Cl) \\
(Cl) - E_{Cl} &= (Cl)^- \\
(Hg) + J_{Hg} &= (Hg)^+ \\
(HgCl) - S_{HgCl} &= [HgCl]
\end{aligned}$$

Adding:

$$(HgCl) + Q_{HgCl} - L_{Hg} + S_{Hg} + J_{Hg} + D_{Cl} - E_{Cl} - S_{HgCl} = (Hg)^+ + (Cl)^- \quad (7)$$

The works of ionization in the manner indicated are given by equations (5), (6) and (7). Accordingly

$$J'_{HgCl_2} = Q_{HgCl_2} - L_{Hg} + S_{Hg} + J'_{Hg} + 2D_{Cl} - 2E_{Cl} - S_{HgCl_2} \quad (8)$$

$$J_{HgCl_2} = Q_{HgCl_2} - Q_{HgCl} - S_{HgCl_2} + S_{HgCl} + J_{HgCl} + D_{Cl} - E_{Cl} \quad (9)$$

$$J'_{HgCl} = Q_{HgCl} - L_{Hg} + S_{Hg} + J_{Hg} + D_{Cl} - E_{Cl} - S_{HgCl} \quad (10)$$

The heats of sublimation may be derived from the vapor pressure data by means of the formula[6]:

$$p\sqrt{T} = Ce^{-S/RT}, \text{ where } R = 1.985 \text{ g. cal.}$$

[6] STERN. Phys. Zeit. **14**: 629. 1913.

These data, plotted logarithmically, give a straight line, the slope of which determines S. The following values expressed in kg. cal. were used in the above computations.

$Q_{HgCl} = 31$ Landolt-Börnstein-Meyerhoffer Tab.
$S_{Hg} = 15$ From data in Kaye and Laby
$D_{Cl} = 56$ Pier
$J_{Hg} = 240$ Mohler and Foote, *et al.*
$E_{Cl} = 119$ Born (confirmed experimentally by Foote and Mohler)
$S_{HgCl} = 19$ From data of Stelzner and Niederschulte
$S_{HgCl_2} = 20$ From data of Stelzner and Niederschulte
$Q_{HgCl_2} = 53$ Landolt-Börnstein-Meyerhoffer Tab.
$L_{Hg} = 1$ Kaye and Laby, actually 0.6

On substituting these data in equations (8), (9) and (10) we obtain:

$$J'_{HgCl} = 203 \text{ kg. cal.} \simeq 8.8 \text{ volts} \quad (11)$$
$$J_{HgCl_2} = J_{HgCl} - 42 \simeq (J_{HgCl} - 1.8) \text{ volts} \quad (12)$$
$$J'_{HgCl_2} = J'_{Hg} - 79 \simeq (12345\nu . 10^{-8} + 7.0) \text{ volts} \quad (13)$$

where

$\nu = 1.5\mathfrak{S}$, since $J'_{Hg} = J_{Hg} + 12345\nu . 10^{-8}$.

The value of the spectral frequency $\nu = 1.5\mathfrak{S}$ for mercury does not appear in the literature, although Sommerfeld[7] has determined this frequency for zinc as 159000. It represents the frequency of the quantum involved in the removal of the second electron from the metal ion.

It would therefore appear that mercurous chloride may be ionized by dissociation into $(Hg)^+$ and $(Cl)^-$ at 8.8 volts. A second type of ionization, J_{HgCl}, into $(HgCl)^+$ may occur, but the value cannot be computed by the methods outlined. This would require a knowledge of spectral series of HgCl, which at present is not available.

The ionization of mercuric chloride into $(Hg)^{++}$ and $2(Cl)^-$ requires an amount of work eV where $V = (12345\nu . 10^{-8} + 7.0)$ volts and $\nu = 1.5\mathfrak{S}$, but this type of ionization could not exist, in ordinary arc phenomena, except by a two-stage process, and then but rarely. A far more probable type of ionization is

[7] Referred to by BORN. Zeit. f. Physik **1**: 252. 1920.

by dissociation into $(HgCl)^+$ and $(Cl)^-$. The ionization potential corresponding to this type of inelastic collision differs by 1.8 volts from the ionization potential (without dissociation) of mercurous chloride. An ionization potential may exist corresponding to the removal of the second chlorine ion from the mercurous chloride *ion*, but this type of ionization is statistically improbable in low voltage arcs. This potential would have a value equal to the difference of the complete and partial ionizations, *viz.*, $J'_{HgCl_2} - J_{HgCl_2} = (12345\nu . 10^{-8} + 8.8 - J_{HgCl})$ volts. Finally, an ionization potential may exist corresponding to the formation of a mercuric chloride ion. Evidence for this would be the existence of spectra characteristic of $HgCl_2$ as distinguished from HgCl, but no spectral relations of this type are established.

Relations analogous to those described for mercuric chloride probably hold for the other chlorides of this group and the halogen compounds. Even though such compounds as ZnCl are incapable of existing to any stable degree there is no apparent reason why they may not exist momentarily as a product of decomposition, and especially so as positive ions. In fact, the existence of $ZnCl^+$ is recognized in electrolytic dissociation of $ZnCl_2$.

Lohmeyer[8] has studied in some detail the emission spectra of the mercuric halides. Each shows a characteristic complicated band structure. This gives further evidence that ionization of HgX_2 into Hg^{++} and $2X^-$ is at least *not* predominant, for then, as with the alkali halides, we would expect to find no spectrum characteristic of the salt. Whether the observed spectra rise from the ions $(HgX)^{\pm}$ or $(HgX_2)^+$ remains an open question.

Hydrogen-chloride, -bromide and -iodide.—The ionization of these gases has been considered by Born, Fajans, and others.[9] The thermochemical relations are as follows:

$$(HCl) + Q_{HCl} = {}^1/_2(H_2) + {}^1/_2(Cl_2)$$
$${}^1/_2(H_2) + D_H = (H)$$

[8] Diss. Bonn, 1906. Zeit. Wiss. Phot. **4**: 367. 1906.

[9] Series of papers in Verh. d. Phys. Ges. 1919–20. See also Foote and Mohler. Journ. Amer. Chem. Soc. September, 1920.

$$\begin{aligned} {}^1/_2(Cl_2) + D_{Cl} &= (Cl) \\ (H) + J_H &= (H)^+ \\ (Cl) - E_{Cl} &= (Cl)^- \end{aligned}$$

Adding:

$$(HCl) = Q_{HCl} + D_H + D_{Cl} + J_H - E_{Cl} = (H)^+ + (Cl)^-$$

$$\begin{aligned} J_{HCl} &= Q_{HCl} + D_H + D_{Cl} + J_H - E_{Cl} \qquad (14) \\ &= 22 + 45 + 56 + 312 - 119 \\ &= 316 \text{ kg. cal.} \approx 13.7 \text{ volts} \end{aligned}$$

Value observed by Foote and Mohler[10] = 14.0 volts.

Similarly

$$\begin{aligned} J_{HBr} &= Q_{HBr} + D_H + D_{Br} + J_H - E_{Br} \qquad (15) \\ &= 12 + 45 + 23 + 312 - 84 \\ &= 308 \text{ kg. cal.} \approx 13.3 \text{ volts} \end{aligned}$$

Similarly

$$\begin{aligned} J_{HI} &= Q_{HI} + D_H + D_I + J_H - E_I \qquad (16) \\ &= 1 + 45 + 18 + 312 - 77 \\ &= 299 \text{ kg. cal.} \approx 12.9 \text{ volts} \end{aligned}$$

Hydrogen Sulphide.—On the assumption that hydrogen sulphide may be ionized by dissociation, Born and Bornmann[11] have computed the ionization potential to be about 31 volts. The thermochemical relations are as follows:

$$\begin{aligned} (H_2S) + Q_{(H_2S)} &= (H_2) + [S] \\ (H_2) + 2D_H &= 2(H) \\ 2(H) + 2J_H &= 2(H)^+ \\ [S] + S_S &= (S) \\ (S) - E_S &= (S)^{--} \end{aligned}$$

Adding:

$$(H_2S) + Q_{H_2S} + 2D_H + 2J_H + S_S - E_S = 2(H)^+ + (S)^{--}$$

$$\begin{aligned} J_{H_2S} &= Q_{H_2S} + 2D_H + 2J_H + S_S - E_S \\ &= 5 + 90 + 624 + 59 - 50 \\ &= 728 \text{ kg. cal.} \approx 31.5 \text{ volts} \end{aligned}$$

The above examples suffice to show that an investigation of the ionization potential of vapors of various compounds is of exceedingly great interest from the thermochemical standpoint.

[10] *Loc. cit.*

[11] Zeit. f. Physik **1**: 250. 1920.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY OF WASHINGTON.

326TH MEETING.

The 326th regular meeting was held at the Cosmos Club, Dec. 4, 1919, with Pres. Sasscer in the chair, and 31 members and 5 visitors present.

Officers elected for 1920: *President*, W. R. WALTON; *First Vice-President*, A. B. GAHAN; *Second Vice-President*, A. G. BÖVING; *Recording Secretary*, R. A. CUSHMAN; *Editor*, A. C. BAKER; *Corresponding Secretary-Treasurer*, S. A. ROHWER; *Members at Large of Executive Committee*, A. N. CAUDELL, A. L. QUAINTANCE, and E. R. SASSCER. S. A. ROHWER was nominated as a vice-preident of Washington Academy of Sciences.

PROGRAM.

WM. SCHAUS, *Collecting in the American Tropics.*

Mr. Schaus told in a most interesting way of his experiences during his many years of collecting in South and Central America. He described most vividly the plant and animal life of the tropical forest, his description of night in the jungle being most impressive.

In the discussion on this paper, Mr. CAUDELL spoke of insects as food, especially of the grasshoppers and caterpillars used by the American Indians. He also told of a mantid that is found in Texas and Brazil but has not been found at points between. Dr. ALDRICH spoke of the stenoxenid fly, *Stenoxenus johnsoni* Coq., described from the Delaware Water Gap, that has since been found only in Costa Rica. Mr. SCHWARZ stated that there are only two spots in the United States where tropical species occur, southern Florida and Brownsville, Texas; and told of some of his experiences collecting in those localities and in the tropics, comparing the faunas of the regions. Dr. HOWARD commended Dr. Schaus highly on his paper.

Under the heading of Notes and Exhibition of Specimens, Dr. HOPKINS exhibited a sweet potato mined by a scolytid beetle, *Platypus compositus* Say, which ordinarily breeds in hardwoods. The galleries in the specimen already contained a growth of the ambrosia fungus. Another and undescribed species of barkbeetle, he stated, had also been found attacking sweet potato.

Retiring president SASSCER then presented to President-elect WALTON a gavel made of two pieces of wood beautifully engraved by the bark-beetle *Leprosinus aculeatus* Say. This had been made by Mr. H. W. Clark and presented by him to Dr. HOWARD, who in turn presented it to the Society. President WALTON then took the chair.

Mr. MIDDLETON spoke of finding on certain sawfly larvae two oval slits on the abdominal segments and inquired of Dr. McIndoo if these might be olfactory pores. Dr. McINDOO stated that he could not speak with certainty but thought they might well be of that nature.

R. A. CUSHMAN, *Recording Secretary.*

327TH MEETING.

The 327th regular meeting of the Society was held at the Cosmos Club Jan. 15, 1920, with Pres. WALTON in the chair, and 33 members and 5 visitors present.

The recording secretary, Mr. CUSHMAN, presented his annual report on the activities of the Society for 1919. Embodied in this report were statistics concerning attendance at meetings, programs presented, and members taking part in discussion, and altogether it was shown that 1919 had been a profitable year. The report was accepted with the thanks of the Society.

Mr. BUSCK, for the auditing committee, reported the books of the Treasurer correct and complimented the Treasurer on the neatness and system of his accounts.

The Corresponding Secretary-Treasurer, Mr. ROHWER, submitted his report for 1919, showing that for the first time in several years the Society has no outstanding indebtedness, all expenses of publication of the Proceedings being paid up, including the indices to Vols. 18–21. He also stated that the expense of publication of the proceedings would show an increase in 1920 of about 13 per cent and reported a change in policy adopted by the Executive Committee whereby the entire expense of separates will be borne by authors. The report was accepted with the thanks of the Society.

In the absence of the Editor, Dr. BAKER, Mr. Rowher reported the Proceedings up to date.

New members elected: F. B. HERBERT, Forest Insect Laboratory, Los Gatos, Calif.; and J. C. EVENDEN, Ashland, Oregon.

PROGRAM.

E. R. SASSCER, *A Brief Résumé of the Family Coccidae.* (Presidential address.)

Mr. Sasscer discussed briefly the history of the study of the Coccidae; distribution and number of species; economic loss caused by these insects; useful products such as shellac, cochineal and other dyes, wax, and ground pearls, the last the empty shells of the genus *Margarodes;* habits in relation to oviposition, part of plant attacked, and gall-making; methods of distribution; natural enemies; and works on the family. Of special interest was the suggestion that *Cryplophyllaspis liquidambaris*, which forms galls on the leaves of sweet gum, may be a form of *Aspidiotus ancylus*, which is always found on the twigs of trees bearing galled leaves.

A discussion of the *Periodical Cicada* followed under the following headings:

R. A. St. George, *Notes from Virginia.*—Mr. St. George opened the discussion with notes made at Falls Church, Va., and vicinity, supplemented by further observations secured by Mr. Snyder. The first adult cicada was observed on May 14th, and the first appearance in numbers was on May 22nd. Mating and oviposition were observed on May 31st, and oviposition has ceased by June 12th. By June 20th adults were practically all gone and the last one heard was on July 1st. From caged material the first egg hatched between July 16th and 20th and hatching continued until Aug. 12th. Numerous records were taken associating the phenological events in plants and the cicada to serve as an index as to when the various stages of the cicada should appear in later generations. Observations were also made on the relation of temperature to the cicada song. These observations show that the cicada began to sing when the temperature ranged from 60° to 66° F., at no time below 60°. During two nights, when the temperature ranged from 62° to 74°, it is believed that they sang all night. On one occasion a concert that lasted 5 minutes was started by causing a captive cicada to sing.

R. E. Snodgrass, *Biological and anatomical notes.*

Mr. Snodgrass continued the discussion by recounting some observations made at Somerset, Md., on the habits and the anatomy of the cicada, the latter being illustrated by many beautiful drawings for which Mr. Snodgrass is noted. He also exhibited plaster casts of the chambers that the cicadas form when they come up near the surface in the spring. The longest of these measured 6 inches. Mr. Snodgrass was able to distinguish four songs of the larger form and discussed the entirely different song of the smaller form. Oviposition of the adult and emergence of the pupae and shedding of the pupal skin were discussed briefly corroborating earlier observations. The young cicadas hatch in a membrane with pouches for the appendages and the speaker commented on the resemblance of the shedding of this membrane to a true molt. The functional mouth of the adult is reduced to a narrow median tube between the closely appressed epipharynx and hypopharynx. The setae arise from pouches behind the lateral wings of the hypopharynx, and therefore neither pair can represent the mandibles as commonly supposed. Mr. Snodgrass was inclined to believe both pairs maxillary. The abdomen in both sexes is almost filled by a large air-sac, crowding the viscera into very narrow spaces around the periphery. What appears to be the intestine from its position at the end of the stomach is really a long coiled tube that returns and rejoins the stomach at a point near the opposite end, while the true intestine originates at the anterior end of the stomach near the oesophagus.

Mr. Middleton suggested the purpose of the air-sac to be for breaking the pupal shell, but Mr. Snodgrass thought not, because of its absence in the pupa. Dr. Böving agreed with and emphasized the interpretation of the mouthparts as given by Mr. Snodgrass.

Mr. W. T. Davis, of Staten Island, N. Y., the well known specialist on cicades, told of the feeding of adults of the periodical cicada; he had observed their preference for white birch and sweet gum. The transparent cicada, *C. heiroglyphicus*, feeds on pine. He had received a specimen of the small form of the periodical cicada from Missouri as late as the latter part of October.

Dr. Hopkins told of records of emergence of the cicada kept by members of one family in West Virginia for 119 years, and commented on the small variation in the dates of emergence shown by these records. He also described the song of the cicada.

Dr. Vernon Kellogg addressed the Society briefly, expressing gratification at being able to get in touch with entomology once more and his hope of again taking up his work in the science.

R. A. Cushman, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

According to a ruling of the Comptroller of the Treasury, the newly established Federal Power Commission is without authority to build up its own organization, and is dependent for its personnel upon such help as may be loaned by the War, Agriculture, and Interior Departments. No provision for the employment of personal services, with the exception of the salary of the Executive Secretary, was made in the act appropriating funds for the Commission.

A projection of the whole sphere on an equivalent, or equal-area system, devised by Aitoff, has been issued by the U. S. Coast and Geodetic Survey. The sphere is represented within an ellipse with major axis twice the minor axis. The network is obtained by the orthogonal, or perpendicular projection of a Lambert meridional equal-area hemisphere upon a plane making an angle of 60° to the plane of the original. As used for a map of the world, this projection is well adapted to replace the Mercator projection in atlases of physical geography or for statistical purposes, and has the advantage over Mollweide's in that its representation of the shape of countries far east and west of the central meridian is not so distorted, because meridians and parallels are not so oblique to one another.

Through the Chamberlain bequest the Department of Geology of the U. S. National Museum has been able to purchase a beautiful series of cut stones and crystals which have for several years been on deposit in the gem and mineral collection.

At the request of the National Park Commission, tests are being made at the Bureau of Standards to determine the best surface treatment for sandstone to prevent its disintegration by weathering, with special reference to the preservation of ancient inscriptions on a mesa near El Morro, New Mexico.

The section of photography of the National Museum has received apparatus used by Edward Maybridge, "the grandfather of motion pictures," in his experiments in 1872.

Simultaneous nightly tests by 50 radio stations on the fading of radio signals were conducted from June 1 to July 17 by cooperative arrangement between the Bureau of Standards, the Naval Air Service, the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, and the American Radio Relay League. Further tests will be run in October, January, and April.

Recent appointments to the geologic force in the U. S. Geological Survey have been made as follows: Chester R. Longwell and Gail F. Moulton, assistant geologists; Harold S. Cave, Waldo

Glock, Robert Webb, Preston James, and William Russell, geologic aids.

Messrs. J. B. Baylor, J. B. Boutwell, and E. F. Dickins, officers of the U. S. Coast and Geodetic Survey, have been placed on retired status under the Retirement Act.

Dr. William Mansfield Clark, physical and biological chemist at the Dairy Division, Bureau of Animal Industry, U. S. Department of Agriculture, was appointed Professor of Chemistry and head of the chemical division of the Hygienic Laboratory on July 1.

Mr. T. Nelson Dale, geologist of the U. S. Geological Survey, has retired from active service, under the provisions of the Retirement Act.

Mr. J. S. Diller, of the U. S. Geological Survey, who was taken seriously ill while on field work in Arizona, has recovered after an operation and is in New England recuperating his strength.

Mr. Arthur Jackson Ellis, geologist in the Water Resources Branch of the U. S. Geological Survey, died on July 22, 1920, after undergoing an operation for acute appendicitis. Mr. Ellis was born January 6, 1885, in Sedgwick County, Kansas. After completing his work at the University of Illinois and Northwestern University, he entered the Geological Survey in 1911 and devoted himself to the economic geology of ground water, chiefly in Arizona, California, Connecticut, and Montana. During the war he was acting chief of the Division of Ground Waters, in the absence of Mr. O. E. Meinzer, and made numerous reports on water supplies for the Army and Navy. He was a member of the Academy, the Geological Society, and the Society of Engineers.

Dr. Walter Faxon, until recently curator in charge of mollusca and crustacea at the Museum of Comparative Zoology, Harvard University, and a non-resident member of the Academy, died on August 10, 1920, in his seventy-third year. Dr. Faxon was born at Roxbury, Massachusetts, February 4, 1848. He had been associated with the University since his graduation therefrom in 1871, having been instructor and assistant professor of Zoology as well as curator in the Museum. He was a member of the Biological Society of Washington as well as of the Academy.

Sr. J. de Sampaio Ferraz, director of the Brazilian Meteorological Service, Rio Janeiro, visited the scientific institutions and laboratories of Washington in June.

Mr. Hoyt S. Gale, who recently returned from a six months' trip in Bolivia, resigned from the U. S. Geological Survey on August 3, to take up private work.

Mr. A. M. Heinzelmann, specialist in inks and varnishes at the Bureau of Standards, has resigned to enter private employment.

Mr. Frank L. Hess has returned from South America, and resumed his work at the U. S. Geological Survey early in August.

Mr. B. L. Johnson, geologist, has been appointed acting chief of the Foreign Section of the Mineral Resources Branch of the U. S. Geological Survey, in the absence of Mr. Eugene Stebinger.

The Division of Birds of the National Museum has recently received 496 bird skins from Mr. C. Boden Kloss, from his recent explorations in Siam, Cochin China, and Southern Annam. Mr. Kloss's explorations were partially financed by Dr. W. L. Abbott.

Messrs. M. O. Leighton, C. T. Chenery, and A. C. Oliphant have formed a co-partnership under the name of M. O. Leighton & Company, with offices at 700 Tenth Street, for the purpose of engaging in general engineering practice and industrial representation before the departments of the Federal Government.

Mr. E. C. Leonard, of the Division of Plants, U. S. National Museum, who accompanied Dr. W. L. Abbott to Haiti in February for botanical explorations, returned to Washington on July 30.

Messrs. R. B. Moore and Dorsey A. Lyon, of the Bureau of Mines, made an inspection trip through the southern States in July, with the purpose of selecting a site for the new non-metallic mineral station of the Bureau.

Mr. Sylvanus G. Morley, of the Carnegie Institution, returned to Washington in July, after several months spent in archeological research in Central American countries.

Mr. James T. Newton, Commissioner of Patents, resigned on July 19, after thirty years of service in the Patent Office.

Mr. R. M. Overbeck, geologist, has resigned from the U. S. Geological Survey to accept a position with an oil company.

Mr. David J. Price, engineer in charge of grain dust explosion investigations at the Bureau of Chemistry, U. S. Department of Agriculture, has been appointed chief of the newly organized "development section" of the Bureau.

Prof. Joseph F. Rock, formerly professor of botany in the College of Hawaii, Honolulu, spent several days in July at the National Herbarium, prior to leaving upon an extended trip of agricultural exploration in eastern Asia for the Office of Foreign Seed and Plant Introduction, U. S. Department of Agriculture, with which he has recently become connected.

While in charge of a Coast and Geodetic Survey subparty working in New Mexico, Mr. R. L. Schoppe was struck by lightning and seriously burned, but is recovering.

Dr. Johs Schmidt, director of the Carlsberg Laboratory, Copenhagen, visited the Division of Fishes of the U. S. National Museum in July.

Mr. Edward Schramm, formerly on the chemical staff of the Bureau of Standards, has left the research laboratory of the Bridgeport Brass Company, to take charge of research for the Onondaga Pottery Company of Syracuse, New York.

Mr. A. H. Taylor, of the photometer section of the Bureau of Standards, has resigned to accept a position at the Nela Research Laboratory of the General Electric Company, at Cleveland, Ohio.

Mr. W. T. Thom, Jr., of the U. S. Geological Survey, has returned from Austria, where he was engaged in relief work.

Mr. F. H. Tucker, associate chemist at the Bureau of Standards, has resigned to take up research work at the New York laboratories of the Chile Exploration Company.

Mr. R. G. Waltenberg, member of the physical staff at the Bureau of Standards, has been appointed an industrial fellow of the International Nickel Company, and will continue his researches at the Bureau on the properties of nickel and monel metal.

Dr. L. F. Witmer, formerly associate chemist at the Bureau of Standards, has been appointed professor of chemistry at Lafayette College, Easton, Pennsylvania.

JOURNAL

OF THE

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Vol. 10 October 4, 1920 No. 16

BOTANY.—*New or noteworthy plants from northwestern Ontario. I.*[1] O. E. Jennings, Carnegie Museum. (Communicated by A. Wetmore.)

During the past few years the writer has worked over and named several thousands of specimens from among the collections which were made by Mrs. O. E. Jennings and himself during five summers spent botanizing in Ontario to the north and northwest of Lake Superior.

Among the plants named are several which are believed to be undescribed and a few others which are particularly noteworthy for one reason or another. Rather than wait indefinitely for the final completion of the work of studying and naming the rest of the collections, it is thought best to publish some of the more important items at this time.

Lysias orbiculata var. **pauciflora** Jennings, var. nov.

Leaves broadly elliptic, 6–7 cm. wide and about 14 cm. long, the apex shortly acute; flowers few, about 6, the lip about 14–15 mm. long, and the spur about 2.5 cm. long.

Type collected in spruce-birch woods along the inlet at Magenet Point, near the tip of Black Bay Peninsula, northwest Lake Superior, Ontario, O. E. & G. K. Jennings, No. 4130, August 14, 1913. Herbarium of the Carnegie Museum.

Lysias orbiculata is quite variable as to the size and shape of the leaves and the length of the spur. The common form, which we take to be the typical form of the species, has large round leaves, and the spurs of the flowers are not much longer than the combined length of the pedicel and the ovary. The form here described as var. *pauciflora* presents a combination of differences from the typical form which might easily characterize a species, but because of the occasional occurrence of forms of intermediate character it is thought best to regard it, for the present at least, as a variety.

[1] Published by permission of the Director of the Carnegie Museum. Received May 27, 1920.

Kneiffia depauperata Jennings, sp. nov.

Stems wiry, flexuous, decumbent to ascending or almost erect, 1–1.5 dm. long, moderately appressed-pubescent with fine white hairs, brown, sublustrous, rarely with a few branches; leaves finely appressed-puberulent; rosette leaves 2–3 cm. long, 6–9 mm. wide, spatulate-oblong, rounded at apex, gradually narrowed to a margined petiole; stem leaves mostly bunched in about the middle third of the stem, linear-oblong, about 1.5–2.4 cm. long, 4–6 mm. wide, entire or slightly undulate, rounded to bluntly acute, tapering below into a short margined petiole, light green above, paler below, often strongly tinged with rose-purple; upper part of stem with few or no leaves below the flowers; flowers 1–4 on stem and 1–2 on branches, the floral bracts, if present, similar to leaves, but smaller, usually shorter than the capsule; capsule 5–6 mm. long, oblong-club-shaped, winged on the angles, sparsely glandular-puberulent, tapering below into a pedicel 4–8 mm. long; seeds brown, dull, narrowly ovoid, about 1 mm. long, minutely pitted.

Type growing in matted brownish and partially decayed leaf-remains along the shore of a boulder-strewn bay of the lake northeast of Sioux Lookout, northwestern Ontario, O. E. & G. K. Jennings, Sept. 7, 1914, No. 7,501. Carnegie Museum Herbarium.

This species resembles a weak sprawling specimen of *Kneiffia pumila*, but the leaves are rather strongly appressed-pubescent with fine rather stiff hairs, and the capsules are usually exceeded in length by their pedicels. From *K. linearis* it differs in having the capsules glandular-puberulent and the pedicels longer, the plant having the pubescence distinctly appressed on stem and leaves. *K. depauperata* is perhaps most nearly related to the decumbent plant of the sands of eastern Long Island, *K. Alleni* (Britton) Small, (*Oenothera fruticosa* var. *humifusa* Allen), but the minute pitting on the seeds of the Ontario plant appears not to be in distinct rows, and in shape of capsule also there appears to be a difference.

Pyrola uliginosa var. **gracilis** Jennings, var. nov.

Differing from the typical *Pyrola uliginosa* Torrey in its more slender form, the pedicels longer than the bracts, the veinlets towards the margins of the leaves excurrent into the crenulate teeth.

The leaf blades are about 2.5–3.5 cm. long by 2.1–2.4 cm. wide, varying from emarginate to slightly acute at the apex, rather stiffly membraneous, sub-lustrous to dull, marginally crenulate, at the base gradually tapering into margined petioles which are slender and 3–5 cm. long; scape 2.5–3 cm. high, bearing 5–8 scattered flowers on slender pedicels about 8 mm. long, in the axils of lanceolate acuminate bracts about 5 mm. long; calyx-lobes acute, ovate-lanceolate, about 2.5 mm. long by 1.5 mm. wide just above the base; petals obovate-oblong, obtuse, about 7–8 mm. long, spreading rather widely; anthers about 2.5 mm. long, distally mucronate, the pores terminating short curved tubes, the filaments dilated below; style slender, declined, curved, about 8 mm. long, the apical collar narrower than the length of the stigma.

Growing in sphagnum moss in a bog near the Indian Mission, south of Fort William, Ontario, O. E. & Grace K. Jennings, No. 1493, July 30, 1912; type consisting of four specimens on one sheet in the Carnegie Museum Herbarium.

Pyrola compacta Jennings, sp. nov.

Perennial with a stiff woody rootstock about 1.5 mm. in diameter, often forking at the apex; leaves forming a rather dense rosette, 5–12 mm. long, leaf-blades broadly oval-elliptic or obovate, abruptly rounded at the base into and acutely tapering into the margined petiole, blades up to 4 mm. long by 3.2 mm. wide, rounded and often apiculate at apex, thin but stiff and sub-lustrous above, the marginal veinlets ending in very fine crenulate teeth; veins fairly prominent, often light colored above and purplish beneath; scape with inflorescence 6–11 cm. high, with usually one bract, stiff, strongly angled; flowers usually six to eight, drooping, borne on pedicels about 2.5–3 mm. long, shorter than the subtending bracts; flowers 12–15 mm. wide; calyx-lobes about 2 mm. long, triangular-ovate, acuminate or acute, a little narrower than long, widest just above the base; petals thick, somewhat concave but widely spreading, veiny, often apiculate, about 7–9 mm. long; filaments dilated below, the anthers usually erect or almost so, with a short curved tube at the proximal end and a slender purplish mucro at the distal end, 6–8 mm. long, often forked; style stiff, declined and curved, the expanded collar usually wider than the length of the stigma; fruit not seen.

A compact rosette plant in a low boggy pasture near Six-mile Lake (Louise Lake), Thunder Cape, northwestern Lake Superior, Ontario, O. E. & Grace K. Jennings, August 20, 1912. Type specimens in Carnegie Museum Herbarium.

This species is unique in its compact form, partly apiculate petals, and long mucronate anthers. Its flowers are very fragrant and in their dried condition indicate that they were probably purplish or rose color. The species resembles most closely *Pyrola elliptica* Nuttall and *P. uliginosa* Torrey.

Pyrola chlorantha var. **revoluta** Jennings, var. nov.

Perennial, with a slender sparsely branching rootstock, the stem above ground short or none, usually caespitose and with rather numerous (5–11) densely clustered leaves; petioles 5–12 mm. long, channeled; leaf-blades rounded-ovate, 1–2.5 cm. long, coriaceous, dull and grayish green above, much paler beneath, glabrous throughout, margins minutely crenulate and closely revolute, veins not prominent, apex obtuse to acute, base rather abruptly narrowed to the petiole; scape with inflorescence 1.2–1.8 dm. high, stiff, usually reddish below, 3–8 flowered, naked or with one bract; pedicels and their bracts about 3–5 mm. long; flowers drooping, about 1.2 cm. wide, light-colored, drying light yellow; calyx 4.5–5.0 mm. wide, the lobes ovate-triangular, rather obtuse about 1.2 mm wide and long; petals oblong to narrowly obovate, obtuse, 6–7 mm. long, rather widely spreading; filaments dilated below; anthers about 3 mm. long, distally mucronate, light yellow, the tubes nearly 1 mm. long, curved, orange-colored and obliquely porous; style stiff, strongly declined and curved, about 7–8 mm. long, dilated above into a ring wider than the length of the stigma. Fruit not seen.

Growing among huckleberry bushes on the sand of open Banksian pine woods (barrens) at Slate River Station, Canadian Northern Ry., about ten miles west of Fort William, Ontario, O. E. & G. K. Jennings, July 4, 1913, No. 3378. Type consists of three specimens on one sheet in the Carnegie Museum Herbarium.

At first glance the inflorescence suggests *Pyrola chlorantha*, but in the character of the leaves, more or less acute to both ends, the resemblance is rather with the plants known as *P. picta* Smith and *P. dentata* Smith, lacking however, the mottling of the former, and not conspicuously wider above the middle as in the latter. *P. chlorantha* var. *saximontana* Fernald (Rhodora **22**: 49–53, March, 1920) is closely related but appears from a study of a specimen from Leigh's Lake, Wyoming (*Merrill & Wilcox*, No. 1120), to have thicker, more broadly rounded calyx lobes and more deeply colored petals than in var. *revoluta*. The leaves of var. *revoluta* superficially resemble quite closely those of *Pyrola secunda* var. *obtusata* Turcz.

Ledum grœnlandicum Oeder.

Throughout almost the whole region covered in our investigations this plant shows considerable variation, yet the limits of this variation scarcely permit one to subdivide the species even into well-defined varieties. The rather concise description of the North American species of Ledum in Small's treatment in the *North American Flora* (Vol. XXIX, 1919, pp. 36–38) apparently draws the limits of *L. grœnlandicum* too close. Instead of acute or acutish sepals the material from northwestern Ontario has rounded sepals, as indeed has also the material of this species in the Herbarium of the Carnegie Museum from a number of localities from northeastern North America, so that apparently this does not constitute a difference between *L. grœnlandicum* and *L. pacificum* Small. The number of stamens per flower varies indefinitely from 5 to 9, and the capsules vary in the same manner from oval or ovoid to oblong-cylindric, from subacute to obtuse, and from 4.5 to 6.5 mm. long. These limits of variation show a distinct trend in one direction towards *L. pacificum* Small, reported from Sitka and Japan, and a slight trend towards *L. decumbens* (Aiton) Loddiges of more distinctively arctic regions, but there seems to be little indication of any well-defined form or variety in the material thus far studied.

Scutellaria lateriflora Linnæus.

Falls of the English River, Jarvis Lake, Hunt, C. G. Ry., Ontario, O. E. & G. K. Jennings, No. 15,272, August 26, 1917; Black ash swamp at upper end of Pelican Lake, Sioux Lookout, O. E. & G. K. Jennings, No. 7,436, Sept. 5, 1914. Specimens in Carnegie Museum Herbarium.

General Distribution: Newfoundland to British Columbia and south to Florida, New Mexico, and Oregon. Northwards Macoun notes that it reaches Lake Athabasca.

Scutellaria lateriflora var. **axillaris** Jennings, var. nov.

Similar to *Scutellaria lateriflora* Linnæus except that the flowers are single, and in the axils of the large stem leaves, and of the leaves on the slender branches, these latter leaves being ovate and longer than the flowers even at the tips of the branches.

Found in but one locality, a black ash swamp at the upper end of Pelican Lake, Sioux Lookout, Ontario, O. E. & G. K. Jennings, Aug. 18, 1916, No. 11,022. Type in Herbarium Carnegie Museum. Typical *lateriflora* had been found in the same swamp in 1914 and from these the specimens collected in 1916 differ quite markedly in being somewhat larger, much more branched, the leaves of the branches being mainly large like the stem leaves with single flowers in their axils, the ovate leaves being longer than the flowers even towards the tips of the branches.

Stachys palustris Linnæus.

The writer has not seen from North America what he would regard as the typical form of this species, but it seems to be well shown by a specimen studied from Bex, Canton Vaud, Switzerland, Aug. 15, 1887 (Herbier Mouillefarine). In this form the stem is more or less completely covered by a fine and decidedly appressed pubescence, mixed on the angles of the stem with longer stiff and spreading or reflexed hairs. None of the plants found in northwestern Ontario agrees in these characters with the typical form, and there seem to be further differences in the characters of the leaves and flowers also. The *tenuifolia-aspera* type, such as comprises most of the *Stachys* specimens seen from Western Pennsylvania, appears not to be present in the region north and west of Lake Superior, but in that latter region the plants seem best to be regarded as varieties of one widely distributed and variable species, and are perhaps best grouped with the forms described by Rydberg and by Greene (*S. ampla* Rydberg, *S. teucriformis* Rydberg, and *S. scopulorum* Greene) from the western plains and Rocky Mountains of the United States and Canada. The accompanying key will serve to differentiate the three forms found in northwestern Ontario:

Key to *Stachys* in northwestern Ontario.

Bright green; leaves rather sharply acute to acuminate, the larger ones bright green about 8 cm. long by 2 cm. wide, appressed-pubescent above........................*S. palustris* var. *puberula*.

Bright or light green; often decumbent, stem smooth on lower part; leaves obtuse to bluntly acute, smooth above, on flowering stem not over about 6 cm. long by 1.6 cm. wide..*S. palustris* var. *macrocalyx*.

Whole plant ashy-green; the fine whitish pubescence, more or less glandular-puberulent above; leaves obtuse to bluntly acute, rather finely crenate-serrate, not over 7 cm. long by 2 cm. wide..............................*S. palustris* var. *nipigonensis*.

Stachys palustris var. **puberula** Jennings, var. nov.

Angles of the stem with stiff hairs as in *S. palustris* but with the minute pubescence of the sides of the stem loose and spreading and often partly glandular-puberulent.

Perennial, stoloniferous, the stems erect, simple or branched, usually 4–6 dm. high; leaves of the main stem lance-oblong or lance-ovate, the largest in about the middle of the stem reaching a length of about 8–9 cm. and a width of 2–2.5 cm., crenate-dentate, acute at the apex, narrowed to a rounded or obscurely subcordate base, the upper practically sessile, the lower and median with flat petioles from 1–4 mm. long; leaves bright green above, lighter beneath, and with scattering stiff appressed hairs above and spreading hairs at least on the veins beneath; branches often numerous, sometimes arising from the axils of practically every leaf up to the inflorescence about two-thirds of the way up the stem; these branches slender, bearing flowers towards the apex, but especially noteworthy in that the basal and median leaves of these branches are often somewhat oblanceolate and narrowed below to a more slender petiole; inflorescence an interrupted spike up to 2–3 dm. in length having usually 5–6 flowers at each node, the foliose bracts of the lower nodes far surpassing the flowers, the upper lance-ovate and but little if any longer than the calyx; calyx 6–8.5 mm. long, usually densely finely puberulent and with some gland-tipped hairs in addition to the coarser stiffer hairs on the nerves, practically sessile, strongly nerved, the teeth usually purplish, strongly bristly and spinose-tipped and about the same length as the tube and almost erect in fruit; corolla 12–16 mm. long, widely gaping, the upper side and usually the medium portion of the lower lip more or less puberulent outside; the middle lobe of the lower lip about twice larger and longer than the lateral lobes, and considerably exceeding the upper lip; seeds dark brown, obovoid, about 2 mm. long and 1.5 mm. thick, dull.

Type in Carnegie Museum Herbarium, two sheets of specimens collected along the marshy shore of Jarvis Lake, Hunt, Ontario, Can. Gov. Ry., Aug. 19, 1917, O. E. & G. K. Jennings, No. 15052.

The common form of *Stachys palustris* in the black-ash swamps, marshy borders of lakes, and other wet but apparently not boggy (sphagnous) habitats in western Ontario differs considerably from the typical form of the species, in which the stem is more or less completely covered with a fine appressed pubescence, together with which there are on the angles of the stem longer, stiff, spreading or reflexed flowers.

Stachys palustris var. **macrocalyx** Jennings, var. nov.

Erect or decumbent, the base of the stem leafless and more or less swollen, glabrous, sending up erect branches; the upper, or in the decumbent stems, the erect portion of the stem 2–2.5 dm. long, rather weak, smoothish below, above furnished with a fine loose and more or less glandular puberulence mixed on the angles of the stem with sparse, spreading, hispid hairs; leaves oblong-lanceolate, the median 3–5.5 cm. long by 1–1.5 cm. wide, glabrous above, marginally ciliate and with a few spreading hairs on the veins beneath, thin, shallowly crenate-serrate, bluntly acute, rounded or truncate below into a flattened petiole 1–2 mm. long; leaves on shoots arising from the decumbent or lower part of stem often larger, very thin, sometimes oblanceolate, and more gradually narrowed at the base into a longer (1–4 mm.) and more slender petiole; inflorescence consisting of 5–11 whorls, about 1–1.3 dm. long, lax, the lowest whorls situated in the axils of the upper leaves; calyx more or less black-dotted, campanulate, 7–9 mm. long, sparsely glandular-puberulent and sparsely longer-hispid on the nerves and teeth, the teeth moderately spreading and with somewhat spinose tips; corolla widely gaping, the tube often a little shorter than the calyx teeth, puberulent on upper side, slightly so below, about 13–15 mm. long, the rounded terminal lobe of the lower lip at least twice longer and twice wider than the lateral lobes.

Collected in two places in a black-ash swamp at the east end of Pelican Lake, Sioux Lookout, Ontario, O. E. & G. K. Jennings, Aug. 18, 1914, Nos. 11,031 (type) and 11,015. Carnegie Museum Herbarium.

In four of the five specimens collected, the short erect portion of the stem arose from a somewhat swollen prostrate stem from 3–5 dm. long rooted only at the lower end but presenting the appearance of having wintered under water, and sending up during the following season the terminal flowering shoot and also the axillary larger-leaved shoots from along the stem itself.

Stachys palustris var. **nipigonensis** Jennings, var. nov.

Ashy green in color, with a whitish pubescence; but lower part of stem, axis of inflorescence, and the calices usually more or less purple; stem 3–7 dm. high, simple or rarely branched above, rather slender, covered especially above with a more or less glandular whitish puberulence mixed on the angles of the stem with slender but stiff, jointed, spreading hairs; basal leaves small, linear-oblong to oblong-oval, the median leaves 4–7 cm. long by 0.8–2 cm. wide, narrowly oblong to oval-oblong or oblong-obovate, abruptly rounded to a subcordate base with a short (1–3 mm.) petiole, strongly margined and often with one or two pairs of lateral veins, running independently down to the stem; leaves thin, shallowly crenate-serrate, finely appressed-hispidulous above, below with spreading hairs on the veins, the apex of the lower leaves obtuse, the middle and upper leaves bluntly acute; inflorescence sometimes short, but usually later elongated occasionally reaching a length of 14 cm., widely interrupted below, denser and spicate above, the lowest whorls often in the axils of the comparatively large uppermost leaves; the floral bracts mainly about the same length as the calyx, lanceolate and often reflexed; calyx practically sessile, about 7 mm. long, narrowly campanulate, more or less glandular-puberulent and with stiffer hairs on the nerves and teeth; teeth spreading, two-thirds to three-fourths the length of the tube, narrowly triangular, moderately spinous-tipped; corolla 12–15 mm. long, more or less puberulent and glandular-puberulent on the upper side and somewhat so beneath, widely gaping, the lower lip spotted, the lateral lobes about one-third as wide and one-third as long as the middle, rounded lobe.

Inhabiting the boulder-strewn or sandy, but low and marshy shores at points along Ombabika and Orient bays, Lake Nipigon, Ont. The type is our No. 6,944, from the marsh at the head of Ombabika Bay, north end of Lake Nipigon, Ontario, O. E. & G. K. Jennings, Aug. 15, 1914; other collections are 6,633 and 6,636, O. E. & G. K. Jennings, Aug. 6, 1914, and No. 7,001, O. E. & G. K. Jennings, north shore of Ombabika Bay, Aug. 16, 1914. Specimens in Carnegie Museum Herbarium.

ICHTHYOLOGY.—*The fish fauna of the Cordillera of Bogota.*[1] CARL H. EIGENMANN.

The Cordillera de Bogota (or Oriental of Colombia) extends from the equator northeastward to about the seventh degree of north latitude. It is continued northward as the Sierra de Perija to the Sierra Nevada de Santa Marta and northeastward as the Cordillera de Merida to Barquisimeta. The Maracaibo basin lies between the Cordilleras de Perija and Merida. It rises to a height of over 10,000 feet and forms an effective barrier to the intermigration of lowland forms for its entire length from near the equator to the Cordilleras of Perija and Merida. The Cordillera of Perija is the chief barrier between the Maracaibo basin and the Magdalena and the Cordillera of Merida between the Maracaibo and the Orinoco. It contains a series of highland plateaus or parks, of which the Plain of Bogota near its center, with an elevation of about 9,000 feet, is the best known. Its fresh-water fish fauna consists mostly of various species of Astroblepus and Pygidium, three species of Pseudancistrus, a Chaetostomus, and two species of Hemibrycon, all of which are mountain genera, the latter most frequently dipping into the lowland. Two genera, Grundulus and Eremophilus, are peculiar to the highland plateaus. Very few lowland genera and species ascend some distance on the slopes of these Cordilleras. *Farlowella acus* causes some surprise on the eastern slope at 4,500 feet. It is usually found much lower. *Creagrutus magdalenae* and Argopleura cause greater surprise at Alban, at over 7,000 feet. These genera are usually found in much lower altitudes. The greatest surprise is furnished by *Creagrutus beni* at San Gil.

[1] Contribution from the Zoological Laboratory of Indiana University, No. 178. Received July 26, 1920.

It belongs to the eastern slopes of the Andes from the Rio Beni to Central Colombia at least. San Gil at 3628 feet in the Magdalena basin is its only record west of the Cordilleras. No lowland genera or species are found on the heights. So many of the lowland genera and species of the Magdalena to the west of it are identical with those of the Orinoco to the east of it, that it seems very probable that the formation of these young Cordilleras has cut a former continuous fauna in two. Is it possible that the presence of *Creagrutus beni* at San Gil indicates a late route of migration?

Our knowledge of the fauna of the Cordillera de Bogota is based on:

1. The observations of Humboldt during a stay at Bogota.

2. Collections received by the British Museum from different collectors.

3. Collections made by Mr. Manuel Gonzales, my servant during my ichthyological reconnaissance of Colombia in 1912. He collected for me in the Cordillera de Bogota within a radius of a few days riding from Bogota. He gathered specimens in the quebradas along the route from Facatativa on the Plain of Bogota northwestward to Honda on the Magdalena, the western base of the Cordillera. Also along the route northward from Bogota, from Suescum north through Susa, Chiquinquira, Quebrada, Ropero, Guadalupe, Mogotes, San Gil, and Capitanejo in the territory embraced by the Rio Sagomoso and the Rio Suarez and finally southeastward from Bogota along the route from Bogota to Villavicencio.[2]

4. Very valuable collections made for Hermano Apolinar Maria, Director of the Museum of the Instituto de la Salle, on the Plains of Bogota and at the eastern base of the Cordillera of Bogota, at Cumaral and Carneceria. I have received a series of these fishes. Most of the species at Villavicencio, Cumaral and Carneceria more properly belong to the fauna of the Llanos of Colombia and Venezuela than to that of the Cordilleras.

5. Extensive collections were made by myself near Bogota.

[2] Mr. Gonzales also collected at Barrigon on the Meta but this locality is beyond the mountains. Other collections made by Gonzales were unfortunately lost by the carriers after reaching New York.

I. LIST OF ALL SPECIES RECORDED FROM THE CORDILLERA DE BOGOTA

ASTROBLEPIDAE

A family of catfishes of one genus, found exclusively in the Cordilleras from southern Panama and Merida south to Lake Titicaca, from the highest elevation down in places to 300 feet. It has not been recorded from the Plain of Bogota but in all directions from it. The species have a large sucker mouth and a peculiar adaptation to take in water at the dorsal end of the gill slit to pass it out below while they hold fast to rocks with their mouths. The ventrals are freely movable backward and forward, enabling them to hunch forward. They are able to climb vertical and even overhanging walls.

Astroblepus Humboldt.

A. unifasciatus Eigenmann. North and west of Bogota, up to 7,258 feet; also on the Pacific slope in the Rio Dagua.

A. santanderensis E. North of Bogota up to 5,600 feet. Santander.

A. frenatus E. Known from a single specimen. North of Bogota, 6,534 feet. Santander.

A. micrescens E. Principally north of Bogota, sparingly west and east of it. 8,471 feet. It is the principal species of Santander.

A. chotae (Regan). North and west of Bogota. 7,400 feet. South to Ecuador.

A. longifilis (Steindachner). North and south of Bogota. Abundant from Peru to Panama.

A. homodon (Regan). West of Bogota. 7,258 feet. It is the characteristic species between Facatativa and Honda.

A. grixalvii Humboldt. Sparingly west of Bogota. Widely distributed in southern Colombia and Ecuador. The present identification may be questioned.

A. latidens E. Characteristic of the eastern slope east of Bogota between 1,500 and 5,300 feet.

PYGIDIIDAE

A family of South American catfishes with about a hundred species of very divergent habits.

Pygidium Meyen.

Found in all mountain streams of South America from the highest elevations to sea level. Short eel shaped. Bunches of erectile spines on its opercles enable it to maintain itself in the swiftest currents or to hunch itself forward between rocks or to burrow in sand, gravel, or mud.

P. bogotense E. Plains of Bogota to the Santa Marta mountains.

P. venulosum Steindachner. Paramo de Cruz Verde at the eastern edge of the Plain of Bogota. 10,000 feet.

P. stellatum E. Western slope of the Cordillera de Bogota.

P. striatum Meek and Hildebrand. North and west of Bogota. Southern Panama and Rio Dagua on the Pacific slope of Colombia.

P. straminium E. North of Bogota. Santander.

P. nigromaculatum (Boulenger). North of Bogota, to Santa Marta.

P. vanneaui E. Near Honda, west of Bogota.

P. latistriatum E. North of Bogota. Santander.

P. dorsostriatum E. East of Bogota at Villavicencio.

Eremophilus Humboldt.

E. mutisii H. "El Capitan," the only food fish of the plain of Bogota. The genus and species is all but confined to the plain of Bogota. It differs from Pygidium in having no ventral fins. It burrows in the banks and bottom in ponds and rivers.

LORICARIIDAE

A South American family of armored catfishes, principally of the lowlands, a few species ascending to 7,000 feet or more.

Pseudancistrus Bleeker.

Snout granular, with a large sucker mouth and bundles of spines on the interoperculum, both adjustments to torrential conditions.

Ps. setosus (Boulenger). North and west of Bogota up to 7,400 feet. On western slopes only.

Ps. daguae E. East of Bogota and in the extreme west of Colombia. Both slopes of the Andes.

Ps. pediculatus E. East of Bogota. Eastern slopes.

Chaetostomus Tschudi.

Snout naked. A large sucker mouth and interopercular bristles.

Chaetostomus thomsoni Regan. West and north of Bogota up to 7,258 feet.

Farlowella Eigenmann and Eigenmann.

Long slender fishes with no suggestion of adaptations to mountains.

F. acus (Kner). East of Bogota up to 4,500 feet.

CHARACIDAE

A very large family with the widest possible adaptations.

Hemibrycon Günther.

From sea level to 7,000 feet. No particular structural adaptation to high elevations.

H. colombianus E. North and west of Bogota, 4,620 feet. Santander.

H. tolimae E. North of Bogota and widely in the west of Colombia to 7,000 feet.

Creagrutus Günther.

In swift brooks, widely distributed.
C. magdalenae E. West of Bogota. Chiefly in swift lowland brooks.
C. beni E. East and north of Bogota, to 3,628 feet. On both slopes.

Argopleura Eigenmann.

Colombia west of the Cordillera de Bogota.
A. diquensis E. West of Bogota, lowland to 7,258 feet.

POECILIIDAE

Rivulus Poey.

Marine brackish and fresh water. South America to Buenos Aires.
R. magdalenae E. & H. West of Bogota, to 3,372 feet.

II. THE FISHES OF THE PLAIN OF BOGOTA

The Plains of Bogota are drained by the Rio Funza or Bogota which leaves the plateau by the Tequendama falls, 418 feet high. It empties into the Magdalena near Girardot.

The Plains of Bogota (locality No. *1*), at about 9,000 feet elevation, harbor but few species. *Eremophilus mutisii*, "El Capitan," which has elsewhere been recorded only from Chiquinquira, just north of the Plain; *Pygidium bogotense*, which is not distinguished by the local fishermen from the young of *E. mutisii*, extends north to the Santa Marta mountains; and *Grundulus bogotensis*, the "Guapuche" elsewhere taken only in the Quebrada Zuaita, wherever that may be. These three species were found in abundance everywhere I was able to fish.

"El Capitan" is found in the lakes as well as in the streams and the fishwomen in the markets point out lake forms from river forms. There was evidently considerable variation but whether this was correlated with localities I can't say. Three specimens were sent me recently, one of them white, one of them blind, and the third piebald. The specimens suggest that there is a white blind species which at times hybridizes with the normal form.

In addition to the three very common species Gonzales got *Hemibrycon tolimae* at Suescum at the extreme northern edge of the basin of the Rio Funza or Rio Bogota. Steindachner has recorded *Pygidium venulosum* from the Paramo de Cruz Verde at about 10,000 feet. This Paramo lies along the crest southeast of Bogota. I do not know in which direction, east or west, the stream flows from which it was taken, and I am giving it the benefit of the doubt and am placing it in both lists.

III. THE DISTRIBUTION OF THE FISHES ALONG THE LINE BETWEEN THE RIO SECO NEAR HONDA AND THE PLAIN OF BOGOTA, NEAR FACATATIVA

Specimens were reported from the localities listed below. The longitude is from Bogota. The numbers refer to the species listed below. *1*. Plains of Bogota. See Part II. *2*. Sargento, 4,000 feet, 1, 2, 4, 5, 6, 8. *3*. Guadual, Rio. 1, 2, 4, 5, 6, 8, 9. *4*. Guaduas. Between 0° and 0° 14′ W., 5° 7′ and 6° N., 3168 feet. 1, 2, 5, 6, 7, 12. *5*. Guamal, 1, 2, 4, 5. *6*. Villeta. 0° 24′ 30″ W., 4° 56′ 30″ N., 2,760 feet. 1, 8, 12. *7*. Chimbe. Near Alban. 2, 4. *8*. Alban, 7,258 feet. Formerly Aqua Larga. 1, 3, 4, 6, 8, 10, 11. *9*. Chamisal. Exact locality not known. 4, 6, 9, 12. *10*. Pacho. 0° 5′ W., 5° 2′ 25″ N., 5,893 feet.

The last named locality is not in line with the rest, being northeast of Alban. As far as I am able to locate the localities they run in the order given from Sargento to Alban. There are crests between Sargento and Guaduas and between Guaduas and Villeta. The entire territory drains into the Rio Negro and through it into the Magdalena.

SPECIES TAKEN BETWEEN HONDA AND FACATATIVA

The numbers following the names refer to the localities enumerated above.

1. *Astroblepus homodon, 2, 3, 4, 5, 6, 8.* 2. *A. unifasciatus, 2, 3, 4, 5, 7.* 3. *A. micrescens, 8.* 4. *A. chotae, 2, 3, 4, 5, 7, 8, 9.* 5. *Pygidium selelatum, 2, 3, 4, 5.* 6. *P. striatum, 2, 3, 4, 6, 8, 9.* 7. *Pseudancistrus setosus, 4.* 8. *Chaetostomus thomsoni, 2, 3, 6, 8.* 9. *Hemibrycon colombianus, 3, 9.* 10. *Creagrutus magdalenae, 8.*[3] 11. *Argopleura diquensis, 8.*[3] 12. *Rivulus magdalenae, 4, 6, 9.*

IV. THE FISHES OF THE HIGHLANDS OF SANTANDER

Most of the localities in this area, all of them draining into the Suarez and thence into the Rio Magdalena, are small quebradas not given on any maps available.

[3] I have no reason to doubt these localities, especially as the two species were not taken elsewhere by Gonzales. But it is certainly remarkable that they should be found at Alban at over 7,000 feet and not between Alban and Honda.

The first eighteen, Nos. 11–28, are "Astroblepus brooks," probably very swift, from which Astroblepus can easily be caught from under rocks with a dip-net. In these brooks Pygidium has rarely been taken either because it is rare or absent, or because Pygidium is not so readily taken in such streams.

The next eight are preeminently "Pygidium brooks," possibly with pools that could be seined. Pygidium can readily be taken in pools in which Astroblepus would not be found.

Zuaita of this group is notable as containing Grundulus, otherwise only found in the Plain of Bogota.

The most interesting place is San Gil, containing *Creagrutus beni*, otherwise not found west of the crest of the Cordillera of Bogota.

Localities and their location north of the Plain of Bogota, mostly in the Province of Santander

The longitude is measured from Bogota. The numbers following the names of the localities refer to the list of species below.

11. Ducho, Rio, 1, 4, 5. *12*. Labaja, Quebrada, 1. *13*. Callejona, Q., 2. *14*. Charala, Q., near Ocamonte, 2, 8. *15*. Guadalupe, 0° 20′ 42″ E., 6° 2′ 30″ N., 5,400 feet, 2. *16*. Guapota, 0° 25′ 10″ E., 6° 7′ 45″ N., 3,300 feet, 2, 5. *17*. Mogotes, 6° 16′ N., 0° 42′ 42″ E., 5,626 feet, 2, 6. *18*. Pava, Q., 2, 5. *19*. Pelada, Q., 2, 4, 5. *20*. Varriri, Q., 2, 5. *21*. Cabarachi, Q., 4. *22*. San Joaquin. Near San Gil, 6,534 feet, 3, 4. *23*. Densino, Q., 4. 7. *24*. Potrero, Q., 4. *25*. Siachia, Q., 4. *26*. Susa, 0° 4′ 45″ E., 5° 54′ 35″ N., 8,471 feet, 4. *27*. Arguello, Q., 5. *28*. Baipe, Rio Boyaca, 7,400 feet, 5, 14. *29*. Pinchote, 0° 33′ 45″ E., 6° 19′ 25″ N., 4,150 feet, 5, 11. *30*. Ocamonte, 6° 9′ 45″ N., 0° 35′ 35″ E., 4,620 feet, 7, 19. *31*. Honda, Q., 7, 10. *32*. Mango, Q., 7. *33*. Zuaita, Q., 7, 16. *34*. Piedras, R., 8, 19. *35*. Capitanejo, 6° 18′ 40″ N., 1° 0′ E., 3,867 feet, 9. *36*. Raya, Q., 9. *37*. Hato.[4] Between 0° and 1° E., and 4° and 5° N., 4,300 feet, 12. *38*. Ropero, Q., about 5° 43′ N., 12, 15. *39*. San Gil, 3,628 feet, 12, 14, 15, 16, 19. *40*. Suescum, 5° 2′ 25″ N., 0° 11′ E., 7,073 feet, 16, 18. *41*. Chiquinquira, 1° 56′ 45″ E., 5° 32′ 20″ N., 8,626 feet.

It will be noted that only San Gil is credited with more than three species. 13 (Eremophilus) otherwise only in the Rio Funza basin.

[4] There is another Hato near San Gil.

List of the species along the heights north of Bogota with their specific localities by number.

ASTROBLEPIDAE

1. *Astroblepus unifasciatus, 11, 12.* 2. *A. santanderensis, 13, 14, 15, 16, 17, 18, 19, 20.* 3. *A. frenatus, 22.* 4. *A. micrescens, 11, 19, 21, 22, 23, 24, 25, 26.* 5. *A. chotae, 11, 16, 18, 19, 20, 27, 28, 29.* 6. *A. longifilis, 17.*

PYGIDIIDAE

7. *Pygidium straminium, 23, 30, 31, 32, 33.* 8. *P. bogotense, 14, 34.* 9. *P. nigromaculatum, 21, 35, 36.* 10. *P. banneaui, 31.* 11. *P. latistriatum, 29.* 12. *P. striatum, 37, 38, 39.* 13. *Eremophilus mutisii, 41.*

LORICARIIDAE

14. *Pseudancistrus setosus, 28, 39.* 15. *Chaetostomus thomsoni, 38, 39.*

CHARACIDAE

16. *Grundulus bogotensis, 33, 40.* 17. *Creagrutus beni, 39.* 18. *Hemibrycon tolimae, 40.* 19. *H. colombianus, 30, 34, 39.*

V. THE FISHES AND THEIR DISTRIBUTION ON THE EASTERN SLOPE BETWEEN CHOACHI AND VILLAVICENCIO

Localities and their location. The longitude is east from Bogota.

42. Paramo de Cruz Verde.[5] *43.* Choachi, 0° 9′ 40″ E., 4° 32′ 55″ N., 6,200 feet, 1. *44.* Caqueza, 0° 7′ 40″ E., 4° 25′ 15″ N., 5,300 feet, 3, 4, *45.* Fosca, 0° 9′ 15″ E., 4° 20′ 35″ N., 4,500 feet, 2, 3, 4, 7, 9. *46.* Naranjito, 4. *47.* Marcetita, 3 and 4. *48.* Perdices, 4. *49.* Chirajara, 4. *50.* Susumuco, 4 and 8. *51.* Piperel, 4. *52.* Villavicencio, 0° 30′ E., 2° 15′ 10″ N., 1496 feet, 2, 4, 6, 8, 9, 10. *53.* Carneceria, 1, 3, 7. *54.* Rio Rontador, 4, 10. *55.* Tengavita, 4, 8.

The species with their specific localities on the eastern slope are:

1. *Astroblepus grixalvii, 43, 53.* 2. *A. micrescens, 45, 52.* 3. *A. longifilis, 44, 45, 47, 53.* 4. *A. latidens, 44, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55.* 5. *Pygidium venulosum, 42.* 6. *P. dorsostriatum, 52.* 7. *Pseudancistrus daguae, 45, 53.* 8. *P. pediculatus, 50, 52, 55.* 9. *Farlowella acus, 45, 52.* 10. *Creagrutus beni, 52, 54.*

This list gives a glimpse of the fauna of the upper slopes of the eastern face of the Cordillera of Bogota.

Of the localities I have not been able to place the Rio Rontador. The fact that *Creagrutus beni* is found there, places it probably

[5] As stated elsewhere, I am not sure whether this drains to the east or the west. It lies between Bogota and Chipaque on the road to Villavicencio.

near Villavicencio. Tengavita is more uncertain. The fact that it contains *Ps. pediculatus* probably places it near Susumuco and Villavicencio. I have taken Marcetita of the maps to be Marutiba as made out from the labels. Carneceria is a day's journey north of Villavicencio. Villavicencio is given as 150 kilometers from Bogota or about 90 miles. Choachi is directly east of Bogota at a distance of 30 kilometers or 18 miles. Caqueza is 24 miles southeast of Bogota. Fosca is south of Caqueza. The line between Choachi, Caqueza and Fosca is nearly meridional. Naranjito or Naranjal, Marcetita, Perdices, etc., follow each other in order on the trail from Quetame, which is a few miles east of Fosca to Villavicencio.

All of the localities are drained into the Rio Meta and through it into the Orinoco.

There are other species of Pygidium (*metae, kneri*), at Barrigon, at the head of navigation on the Meta and others probably occur in the localities listed.

Of the species taken, *Astrobelpus grixalvii, micrescens* and *longifilis, Pseudancistrus daguae* and *Creagrutus beni* also occur west of the crest.

A. grixalvii is found in streams of southern Colombia to northern Peru. *A. micrescens* in Santander. *A. longifilis* occurs all the way from Panama to Peru.

Pseudancistrus daguae is abundant in the Rio Dagua on the Pacific slope and *Creagrutus beni* is recorded in this paper from Santander.

The one species characterizing the slope is *Astroblepus latidens*, which is known only from this slope, and everywhere on the slope except at Carneceria.

I suspect that the recorded absence of Pygidium from the higher slopes of the eastern side is due to incomplete collecting.

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.

APPARATUS.—*A new form of vibration galvanometer.* P. G. AGNEW. Bur. Standards Sci. Paper **370.** Pp. 8 (37–44). 1920.

Vibration galvanometers are very useful in a. c. null measurements, but have not been much used in industrial laboratories on account of their being sensitive to external vibrations and requiring delicate adjustments. The present instrument, which has a sensitivity higher than other forms of the moving-iron type, but less than that of the most sensitive forms of the moving-coil type, has the advantages of sturdiness, quick responsiveness, and freedom from the effects of external vibration. It consists essentially of a fine steel wire mounted on one pole of a permanent magnet and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which flows the current to be detected. The motion of the wire is observed with a microscope.

The "resonance range" is about one per cent; that is, if the frequency of the current is one per cent. above or below the frequency of resonance, the amplitude of vibration will be half as great as at resonance. The sensitivity is such that with a 1-ohm winding an e. m. f. of 3 microvolts may be detected, and with a 270-ohm winding a current of 0.05 microampere can readily be detected. P. G. A.

ELECTRICAL ENGINEERING.—*Leakage resistance of street railway roadbeds and its relation to electrolysis of underground structures.* E. R. SHEPARD. Bur. Standards Tech. Paper **127.** Pp. 39, pl. 1, figs. 9. 1919.

Electrolytic damage to underground piping systems is caused by the escape of current from the rails of electric lines and the resistance of the roadbed is an important factor in the amount of current which may escape.

Short sections of fourteen common types of roadbeds were constructed on the grounds of the Bureau of Standards and resistance measurements under varying weather conditions were carried on for a period of three years. Some measurements were also made on a number of city lines in and about Washington, both open track and several types of roadbed in paved streets being investigated. Through the co-operation of the United States Forest Products Laboratory at Madison, Wisconsin, measurements were also made on several sections of test track on the Chicago, Milwaukee and St. Paul Railway where railroad ties subjected to several different kinds of preservatives were employed. The results of these measurements are given in tabular and graphical form. E. R. S.

GEODESY.—*A study of map projection in general.* OSCAR S. ADAMS. Special Publication **60**. U. S. Coast and Geodetic Survey Serial **113**. Pp. 24, figs. 15. 1919.

A study of some of the general properties of map projections is attempted in this short publication. The intention is to illustrate in simple form both the difficulties to be met with and the way in which certain properties are attained at the sacrifice of other desirable features. Of necessity there is always a compromise in any given method of mapping, for the spherical surface of the earth cannot be truly represented upon a plane surface. Throughout the whole paper the aim has been to present the considerations in the simplest possible terms, so that the subject matter may be readily intelligible to any reader without the necessity of following intricate mathematical developments or, in other words, the purpose has been to present things in a popular style so that he who runs may read with full understanding. The relatively large number of illustrations should serve as aids in making clear the statements of the text. O. S. A.

GEOLOGY.—*Deposits of manganese ore in Southeastern California.* EDWARD L. JONES, Jr. U. S. Geol. Survey Bull. **710-E**. Pp. 24 (185–208), pl. 1. 1919.

This bulletin describes the manganese deposits in the desert region west of Colorado River, which in 1917 and 1918 yielded over 6,000 tons of high-grade ore and in which at least 30,000 tons is available. The costs of mining, transportation to the railroads, and shipment to furnaces east of Mississippi River are high, and when high-grade foreign ores are available these deposits can probably not be worked at a profit, unless a nearer market can be found.

The manganese deposits occur in veins and brecciated zones in sedimentary and igneous rocks ranging in age from pre-Cambrian to probably Quaternary.

The manganese ore consists of the oxides, of which psilomelane, pyrolusite, and manganite have been determined. Psilomelane is the dominant oxide in all these deposits. It occurs in many forms but most commonly in laminae deposited along the walls of fissures. Psilomelane is more abundant in the surficial ores of the deposits; with increasing depth the softer oxides, pyrolusite and manganite, become increasingly abundant. Associated with the manganese oxides are calcite and subordinately, iron oxides. Calcite is universally present in the ores, though it varies largely in quantity. Quartz was nowhere observed as a primary constituent of the manganese deposits, although the ore generally carries a small quantity of silica from the inclusion of fragments of siliceous wall rock. No manganese mineral other than oxides was recognized in any of these deposits, but none of the workings had passed through the oxidized zone.

The manganese deposits of southeastern California examined in this reconnaissance are similar in type and mineralogy to the deposits in southwestern Arizona, but in each locality the source of the manganese oxides is obscure. However, it seems probable that the manganese oxides are the decomposition product of manganiferous calcite deposited by rising hot solutions in the fissures, or that they were deposited with calcite in the fissures by meteoric waters which obtained the oxides from the decomposition of manganiferous minerals of the surrounding rocks. The evidence for either hypothesis is not conclusive, and definite proof can probably not be obtained until the deposits are explored below the zone of oxidation. R. W. Stone.

GEOLOGY.—*Surface formations and agricultural conditions in the south half of Minnesota.* Frank Leverett and F. W. Sardeson. With a chapter on climatic conditions by U. G. Purssell. Minnesota Geol. Survey Bull. **14**: 8–148, map, pls., figs. July, 1919.

This is the third of a series of three bulletins which treat of the surface geology of Minnesota. The first (Bull. 12) deals with the northwest quarter of the State, and the second (Bull. 13) with the northeast quarter. Although published by the State of Minnesota, these bulletins represent results of a cooperative survey between the United States and the Minnesota Geological Surveys.

Each of the bulletins contains a discussion of the physical features and climatic conditions of the entire State. In bulletin 14 a chapter is given to an outline of the extent and character of each of the drift sheets, the loess, and the alluvium. The detailed descriptions then follow, county by county, and under each county appear tables showing the percentages of each class of land, and farm and crop data, the latter being taken from the reports of the Federal Census of 1910. The percentage of improved land ranges from about 7 per cent in Pine and Crow Wing Counties to over 80 per cent in each of a dozen counties in the south end of the State. The relatively stony red drift of the northeastern part of this area, with its cover of forest and brush, is less attractive to the farmer than the more clayey gray drift of the remainder of the area which is largely in prairie or oak openings. Consequently the red drift has correspondingly slight development. The extent of swamp land is shown for each county, and is found to be much greater in the forested than in the prairie counties. A small map is included to show the distribution of forest and prairie. F. L.

GEOLOGY.—*Nickel deposits in the lower Copper River Valley, Alaska.* R. M. OVERBECK. U. S. Geol. Survey Bull. **712**-C. Pp. 8 (91–98). 1919.

Nickel deposits have been found in the valley of Canyon Creek, a small stream that enters Copper River 6 miles below the mouth of Chitina River. The country rock is light-gray limy and quartzose schist, into which peridotite has been intruded. The peridotite is rather strongly mineralized in places with sulfides, with which the nickel is associated. The peridotite is highly altered and coarse grained. 16 nickel claims have been located, but very little development work has been done. At present, the known nickel deposits of Alaska probably could not compete on the basis of nickel content alone, with the deposits of Sudbury, Canada. R. W. STONE.

GEOLOGY AND HYDROLOGY.—*Ground water in the San Jacinto and Temecula Basins, California.* GERALD A. WARING. U. S. Geol. Survey Water-Supply Paper **429.** Pp. 113, pls. 14, figs. 15. 1919.

Observations on the ground-water level during 1904–1916 are given, with mention of the relation of the changes in level to rainfall and to irrigation development. Areas of flowing artesian wells are outlined, and the possibility of obtaining flows in other localities discussed. Analyses of well waters are given, with a discussion of their use and adaptability for irrigation. A map (Pl. III), shows the general geology to consist of ancient igneous and metamorphic rocks, overlain on the lower slopes by clays, shales, and gravels of early to late Tertiary age. The valley lands are covered with sandy soils, chiefly derived from alluvium. A chapter on pumping tests, by Herman Stabler, contains tables of value in determining the proper size of pumps and prime movers for specified lifts, and acreages to be irrigated.

G. A. W.

GEOLOGY AND HYDROLOGY.—*Ground water in Reese River Basin and adjacent parts of Humboldt River Basin, Nevada.* Gerald A. Waring. U. S. Geol. Survey Water-Supply Paper **425**-D. Pp. 35 (95–129), pls. 6, fig. 1. 1918.

Reese River drains a long, narrow basin in central Nevada, and flows northward to Humboldt River near Battle Mountain. The region has long been devoted to stock-raising, but there is possibility of increasing the present areas of hay lands, irrigated by flood water, by developing ground water for irrigation. There are well-developed alluvial fans along the valley borders, and several playas (dry lakes), in the lower parts of the valleys. A geologic map (Pl. VIII), based on the work of the Fortieth Parallel Survey, shows the mountains to consist of ancient granitoid rocks and Tertiary lavas, with sedimentary rocks of Paleozoic and Mesozoic ages. In the valleys there are Tertiary lake deposits in addition to Quaternary lake and stream materials.

G. A. W.

HYDROLOGY.—*Southern California floods of January, 1916.* H. D. McGlashan and F. C. Ebert. U. S. Geol. Survey Water-Supply Paper **426**. Pp. 80, pls. 17. 1918.

The 1916 flood, especially in San Diego County, Calif., was probably the maximum since 1862. For nearly a month San Diego was practically cut off from communication with the rest of the State, except by steamer.

The important feature of this report is the very complete record of precipitation and run-off. Rainfall records, covering the flood period, are given for 156 points well distributed throughout this limited area, complete monthly records for San Diego, Los Angeles, and Santa Barbara, and a discussion of the intensity and distribution of rainfall in southern California. There are complete records of daily discharge for nearly all of the important streams, and tables of crest discharges and run-off summaries which give drainage areas, run-off per square mile, mean rainfall, and depth in inches on drainage areas. The complete base data are published in order that independent studies may be made in greater detail. For purposes of comparison, there are records and information covering all floods since the country was first settled. H. D. McG.

RADIOTELEGRAPHY.—*Airplane antenna constants.* J. M. CORK. Bur. Standards Sci. Paper **341.** Pp. 14, figs. 12. 1919.

This paper contains data observed by the writer while an officer in the Signal Corps, U. S. Army, and is published by permission of the Chief Signal Officer. The purpose of this work was to devise a method for measuring airplane antenna constants (*i. e.*, capacity, inductance, natural wave length) under conditions of actual flight; and to use this method to obtain data on various forms of fixed and trailing wires.

The principle of the method involves a continuous wave oscillator feeding directly into the antenna and substituting for the antenna a variable calibrated condenser and adjusting for the same wave length as with the antenna in the oscillating circuit. The result obtained is the effective capacity of the antenna. Having found this, a variable calibrated non-inductive resistance is varied until the D. C. component of the plate current reads the same as for the real antenna. This gives the effective antenna resistance. Knowing the effective values of capacity at various wave lengths, the true capacity, inductance and natural wave length are readily found.

By this method results were obtained with various forms of fixed wires, and one, two and four trailing wires of various lengths, are summarized.

A method for finding the directional transmitting effect of various antennas is also described. In order to compare the amounts of energy received, a detector tube with a three-stage audio amplifier is used. A transformer is placed in the plate circuit of the last amplifier tube, the secondary of which is connected to the heater coil of a thermocouple connected to a D. C. micro ammeter. This when calibrated is free from many of the uncertainties of the ordinary audibility meter. A typical directional curve of the trailing wire antenna is included in the paper. J. M. C.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

827TH MEETING

The 827th meeting was held at the Cosmos Club, January 3, 1920, with President SOSMAN in the chair and 55 persons present.

Mr. ENOCH KARRER presented two papers, the first being on *Diffusion of light along a searchlight beam.*

The importance of the light diffused along a searchlight beam is pointed out. It aids in the directing of the beam, and makes it possible to use searchlight beams as land marks for service on land and in the air and perhaps as beacons in the lighthouse service. On the other hand, this diffusion means loss of light and interferes with the discerning of the target from positions near the searchlight. Data on the brightness of the diffused light for various angles along the beam were given as well as data on the per cent of plane polarized light in the diffused light. An explanation was offered of the apparent ending of the searchlight beam, and of the curving of it under certain conditions.

Discussion: The paper was discussed by Messrs. CRITTENDEN, HUMPHREYS and SOSMAN.

Mr. KARRER'S second paper was on *The contrast sensibility of the eye under low illumination.*

Data on contrast sensibility were given that were obtained under conditions simulating those that actually obtain in the use of searchlamps. An illuminated strip was projected on a field of known brightness. The length of the strip was increased from zero to a length just visible to the observer. The results obtained are expressed by curves showing the relation between (1) strip length (visual angle) and field brightness, for constant contrast between strip and field; (2) strip length and contrast between field and strip, for constant values of field brightness. These curves lie in groups consistent with each other, and those obtained for two observers are similar. Examples were given of how these data together with the data on diffused light may be applied.

Both of the above papers were illustrated by lantern slides.

The next paper was by Mr. F. E. WRIGHT, on *The contrast sensibility of the eye as a factor in the resolving power of the microscope.*

In this communication attention was directed to three factors which are of importance in high-power microscope work, namely: (*a*) The use of a polarizing prism to eliminate that part of the field light which does not contribute to the diffraction pattern in the image and hence tends to reduce the contrast and to decrease the sharpness and crispness of the image. This phenomenon arises because diffracted beams which emerge from gratings whose interval is of the order of magnitude of half a wave length of light, are sensibly polarized in a plane normal to the lines of the grating. (*b*) A diaphragm of the rectangular type is recommended for use in the image plane of the eyepiece in order to cut out all light except that from the particular object under examination. This device allows the eye to work at best efficiency because it is not disturbed by extraneous light provided, of course, the field of view covers an angle of 10 degrees or more. (*c*) The importance of a field intensity of illumination approaching that of daylight and best adapted for the eye at any particular time is emphasized; the simplest method for securing this is by means of a substage polarizer in conjunction with the polarizing prism; the polarizer can be rotated and with it the intensity of illumination of the field varied. These factors are not important for ordinary observations because the resolving power there required is not great; but in high-power, critical work they are significant and enable the observer to accomplish with comparative ease that which under other conditions is a matter of difficulty.

Discussion: At this stage Mr. KARRER'S second paper and also that of Mr. WRIGHT were discussed, Messrs. CRITTENDEN, SOSMAN, HUMPHREYS, and LITTLEHALES participating in the discussion.

The last paper of the evening was by Mr. L. A. BAUER, on *Further results of observations of the solar eclipse of May 29, 1919.*[1]

A complete series of photographs of the solar eclipse of May 29, 1919, taken by the various astronomical expeditions (Smithsonian Institution at La Paz, Bolivia; Rio de Janeiro Observatory at Sobral, Brazil; and British at Sobral and Isle of Principe, Africa; and the geophysical expeditions of the Department of Terrestrial Magnetism, at Sobral, Brazil, and Cape Palmas, Liberia) was shown. It was shown that the type of the corona was approximately of the intermediate type between that which is seen during years of minimum sunspot activity, when there are great equatorial extensions of the corona, and that shown during years of maximum sunspot activity, when streamers of about the same length extend from the sun in every direction.

The great red prominence seen at the author's station (Cape Palmas, Liberia), on the southeast limb of the sun turned out to be the largest prominence thus far photographed. At the time of totality it was about 100,000 miles high and had a base of about 300,000 miles. With the aid of the data supplied by the Yerkes Observatory it was found that the mean heliographic latitude of the prominence during the eclipse was about 18 degrees south, and on the east limb. With the aid of measurements on the various photographs, the mean heliographic latitude of the pronounced V-rift in the solar corona on the west limb turned out to be about 45° degrees south. Practically diametrically opposite was a less-pronounced rift somewhat in the shape of the letter U.

[1] This JOURNAL 10: 112. 1920.

In conclusion, graphs were thrown on the screen exhibiting the deflection of the rays of light as shown especially by the observations made by Dr. A. C. D. Crommelin of the British party at Sobral. The detailed data as well as a photograph showing the deflected star images had been courteously supplied the author by the Astronomer Royal, of England, Sir FRANK W. DYSON, in time to be presented at the meeting.

Discussion: Mr. BAUER'S paper was discussed by Messrs. HULL and HUMPHREYS.

828TH MEETING

The 828th meeting was held at the Cosmos Club, January 17, 1920, President SOSMAN presiding and 35 persons present.

The program was devoted to the general subject of *Physical laboratory methods applied to aircraft power plants.*

The first paper was by Mr. D. MACKENZIE on *The velocity of flame propagation in gas-engine cylinders.*

For many years automotive engineers have discussed the probable velocity of the flame in the compressed and burning gas in the cylinder of an internal combustion engine. Many have maintained that this velocity was comparatively low and that in a high speed engine, in order to obtain maximum efficiency and power, at least two spark plugs must be used. It has been maintained by these engineers that by igniting the mixture at two points in the cylinder, the necessary time for complete combustion would be greatly reduced as compared with that needed when but one spark plug is used. However, until very recently, no measurements have been made in an actual engine and the determination of this velocity has always been considered to present extreme difficulties.

For several months, the Bureau of Standards has been investigating this subject. A single cylinder gasoline engine, the combustion space, valves, piston, etc., of which are identical with those used on the Liberty aircraft engine, has been employed in this work. Three spark plugs are placed in the cylinder; the first is used to ignite the charge and is connected to the regular ignition system of the engine, the other two plugs are connected at approximately the proper time to a source of direct current, the voltage of which is insufficient to break down the gap between the sparking points of the plugs while under compression, but which is sufficient to cause a spark to pass as soon as ionization of the gap occurs, due to combustion of the surrounding mixture. These spark plugs are so connected with an oscillograph that the time when the flame reaches them is recorded on a strip of photographic film. The distance between the plugs is accurately known and the speed of the oscillograph film is also easily determined. It is obvious, therefore, that by measuring the distance between the points on the film indicating discharge of current across the gaps, the average speed of the flame between these points may be measured.

Determinations have been made of the velocity of flame propagation under many conditions of fuel-to-air mixture ratio, compression, speed, etc. The velocity appears to vary greatly under different conditions and to increase as the flame spreads through the combustion space.

The paper was illustrated by lantern slides.

Discussion: The paper was discussed by Messrs. HAWKESWORTH, WHITE, HUMPHREYS, SOSMAN and JAMES.

The second paper was presented by Mr. S. R. PARSONS on *Cooling radiators for aircraft engines*, and was illustrated by lantern slides.

Airplane radiators absorb engine power because of air resistance and weight, and the most efficient radiator will dissipate heat at the required rate with a minimum absorption of power.

For the high rates of flow of water used in aeronautic practice, heat transfer under given conditions of temperature and air flow is practically independent of the rate of water flow; but the heat transfer is largely influenced by conditions of the flow of air through the radiator, and is found under given temperature conditions to be practically definite for a given *mass flow* of air, whatever combination of density and linear velocity produces that mass flow. The individual air streams passing through the air tubes of cellular radiators appear to show turbulent flow, and spiral vanes or other devices for increasing turbulence, while they may increase the heat transfer, result in every case tested at the Bureau of Standards in decreased efficiency, because of a disproportionate increase in air resistance. High thermal conductivity is of negligible importance in the thin metal walls separating water passages from air passages, but is of some importance in projecting "fins." Highly polished surfaces dissipate heat more rapidly than surfaces only ordinarily smooth.

Air resistance is caused by impact on the front face of the radiator, skin friction in the air passages, and suction on the rear face, the relative importance of the three parts varying widely with different types of construction. Skin friction appears to follow roughly the laws for long tubes. For minimum air resistance, straight and smooth-walled air passages are essential, for anything that deflects the course of the air adds considerably to the resistance. The effects of forms of entrance to and exit from the air passages are of importance, but are not well worked out.

Conditions giving maximum mass flow of air through the radiator, and *to that extent* tending to increase heat transfer for a given flying speed, are identical with those giving minimum air resistance.

Radiators for use on planes flying at the higher speeds should be characterized by straight and smooth-walled air passages, and minimum obstruction of frontal area for a given amount of cooling surface.

The discussion is directly applicable only to radiators in "unobstructed" positions on the airplane, where other parts of the structure do not affect the flow of air through the radiator.

829TH MEETING

The 829th meeting was held at the Cosmos Club, Jan. 31, 1920, with President Sosman presiding and 42 persons present.

Prof. W. J. HUMPHREYS, retiring President, delivered an address on *A bundle of meteorological paradoxes.* The paper was discussed by Messrs. ABBOT, KIMBALL, BAUER, PAWLING and BROOKS. It has been published.[2]

D. L. HAZARD, *Corresponding Secretary.*

[2] This JOURNAL 10: 153. 1920.

NOTE.—I regret that ignorance of the prior publication of Föppl[1] on the fundamental polyhedron of the diamond lattice prevented me from giving due credit to him in a recent note[2] on that subject. ELLIOT Q. ADAMS.

Bureau of Chemistry.

[1] LUDWIG FÖPPL. *Der Fundamentalbereich des Diamantgitters.* Phys. Zeitschr. 15: 191–193. 1914.

[2] ELLIOT Q. ADAMS. *Note on the fundamental polyhedron of the diamond lattice.* This JOURNAL 8: 240–241. 1918.

SCIENTIFIC NOTES AND NEWS

Dr. C. Wythe Cooke has returned to the Geological Survey from private work in Colombia.

Mr. A. E. Fath, geologist in the oil and gas section of the U. S. Geological Survey, has taken furlough for three months to engage in private work in foreign lands.

Mr. Charles S. Howard, formerly instructor in electrical engineering and physics at the U. S. Naval Academy at Annapolis, has been appointed junior chemist in the quality-of-water division, of the Water Resources Branch, U. S. Geological Survey.

Dr. Joseph Paxson Iddings, formerly professor of petrology at the University of Chicago, and until recent years geologist with the U. S. Geological Survey, died at his home at Brinklow, Maryland, on September 8, 1920, in his sixty-fourth year. Professor Iddings was born at Baltimore, Maryland, January 21, 1857. He entered the Geological Survey as assistant geologist in 1880, shortly after its foundation, and retained his connection therewith while professor at Chicago in the years 1892 to 1908. Since 1908 he had devoted his attention entirely to independent petrologic and geologic work. He was the author of two text-books and many papers on the mineralogy and petrology of the igneous rocks. He was a member of the Academy and of the Geological Society of Washington.

Mr. Paul Moore, Director of the Information Bureau of the War Trade Board, has been appointed Secretary of the Division of Research Extension of the National Research Council.

Dr. F. Hastings Smyth, formerly captain in the Chemical Warfare Service, joined the staff of the Geophysical Laboratory, Carnegie Institution of Washington, in September.

Dr. Samuel Mills Tracy, agronomist with the U. S. Department of Agriculture, died on September 5, 1920, in his seventy-fourth year. Dr. Tracy was born at Hartford, Vermont, April 30, 1847. He was professor of botany and agriculture at the University of Missouri from 1877 to 1887, director of the Mississippi Agricultural Experimental Station from 1887 to 1897, and was appointed special agent in forage crop investigations with the U. S. Department of Agriculture in 1897. His research work was specially directed to the botany of the Southern States.

A new "division of non-ferrous metallurgy" has been created in the Bureau of Mines. Mr. A. E. Wells, of the Bureau's staff, has been placed in charge. The headquarters of the division will be at Salt Lake City, Utah.

Mr. R. M. Wilhelm, chief of the thermometer laboratory of the Bureau of Standards, resigned in September to accept a position with the C. J. Tagliabue Manufacturing Company, of Brooklyn, New York, manufacturers of thermometric apparatus.

Mr. W. P. Woodring and a party from the U. S. Geological Survey have left for Haiti to conduct a reconnaissance geologic examination of the Republic of Haiti at the request of that government.

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BOTANY.—*The effect of salts of boron upon the distribution of desert vegetation.*[1] KARL F. KELLERMAN, Bureau of Plant Industry.

The disastrous experiences of the past two seasons in the use of fertilizers contaminated with varying percentages of borax[2] has sharply drawn attention to the importance of considering boron compounds not only in fertilizer investigations but in investigations of alkali deposits wherever agricultural developments are to be considered. While geologists are familiar with commercial developments of borax, it has not been generally appreciated by botanists or others interested in the vegetation of the desert regions that extensive deposits of borax are recorded in many localities in the western United States.

It is true that, in reports of early explorations of the West and Southwest, reference is made to the occurrence of borax and also to the barrenness of some of these regions. For example, the following quotation is made from the article[3] entitled "Borax in America" by W. O. Ayers, M. D.:

"A glance at the map of the State of Nevada shows a large number of dotted spots, individually of no great extent, scattered over the desert regions east of the Sierra Nevada. Most of them are without designation, but a few are marked 'Soda Flat,' 'Salt Marsh,' etc. They all have probably a common origin; they are places which long ago (how long we cannot tell) were covered with water, since removed by solar evaporation. Each consists of an extent of entirely flat sur-

[1] Address of the Retiring President (1919), of the Botanical Society of Washington, February 3, 1920. Received Aug. 24, 1920.

[2] SCHREINER, BROWN, SKINNER, and SHAPOVALOV. *Crop Injury by Borax in Fertilizers.* U. S. Dept of Agric. Circular 84.

[3] Popular Science Monthly **21**: 358. 1882.

face of dried mud, sometimes absolutely bare, sometimes covered with saline deposits. It had been known for years that these deposits were both what is there universally called 'alkali' (carbonate of soda) and salt. But it was not until 1871 that much attention was drawn to the fact that several of them contained also deposits of borates, though published mention had been made some time earlier that these existed there.

"The number of these 'marshes,' which are marked by borate deposits, it is impossible to state, as so large an extent of that arid region remains as yet very imperfectly known."

The earliest records pointing to a rather wide distribution of compounds of boron on the Pacific Coast are shown in the following quotation from the Proceedings of the California Academy of Sciences, contribution by J. A. Veatch, January 17, 1859:

"The existence of boracic acid in the sea-water of our coast was brought to my notice in July, 1857. I had, in the month of January of the previous year, discovered borate of soda and other borates in solution in the water of a mineral spring in Tehama county, near the upper end of the Sacramento Valley. Prosecuting the research, I found traces of boracic acid—in the form of borates—in nearly all the mineral springs with which the State of California abounds. This was especially the case in the Coast mountains. . . . . . .

". . . . . . This led to an examination of the sea-water, and a detection of an appreciable quantity of boracic acid therein. It was at Santa Barbara, where I first detected it, and subsequently at various points, from San Diego to the Straits of Fuca. It seems to be in the form of borate of soda, and perhaps of lime. The quantity diminishes toward the North. It is barely perceptible in specimens of water brought from beyond Oregon, and seems to reach its maximum near San Diego.

"This peculiarity seems to extend no great distance seaward. Water taken thirty or forty miles west of San Francisco gave no trace of acid."

It is perhaps a question whether the desolate character of some of the western and southwestern deserts can be directly correlated with the occurrence of borax in quantity within these areas. Apparently no such correlation has been suggested, either by ecologists or by engineers or agriculturists interested in reclamation and irrigation problems in these regions. The Smoke Creek Desert, the Carson Desert, Death Valley, and the Mojave Desert are remarkable for their barrenness; and in view of the occurrence of borax in these regions, it would seem to be a fair question as to whether the contamination of borax in the soil might not be responsible to as great a degree as the low rainfall, for the absence of vegetation. Furthermore, those familiar with the topography of these deserts will recall the peculiar absence of vegetation from mud flats even when these are gradually drying out; they occasionally dry into perfectly level plains, hard and smooth, apparently not badly troubled with alkali but with no sign of vegetation. These playa formations in the vicinity of Hazen and Fallon in the Truckee-Carson region, have been given more or less consideration with studies of the alkali difficulties of the Truckee-Carson irrigation project. While some of the reasons for the refractory character of these soils have been traced to the impermeability of soils,[4] other areas that appeared too low in total salt concentration to be dangerous to crop production were not complicated by unusual colloid problems and yet remained practically barren.

In view of the records of the rather wide distribution of borax in this region, it seems not unreasonable to suggest that the irregular and rather definitely located occurrence of borax may explain the injury to plants on these small areas. The number of localities in which commercial borax production has been attempted in the West will be surprising to most people. The areas in which commercial borax development has taken place within recent years or is now under way are well set out in the section on borax from the 1913 report on "Mineral Resources of the United States."[5]

It should be remembered, however, that the deposits of borax ordinarily are not recorded either by the geologists or commercial prospectors unless of considerable magnitude. It is not improbable, therefore, that the areas now recorded as showing borax report only a small fraction of the deposits which, from an agricultural or botanical point of view, are of prime significance. From the data reported by Mr. Yale and Mr. Gale, and from reports of other investigators, the following list apparently represents the areas in the United States where compounds of boron have been found.

[4] KELLERMAN, KARL F. *The relation of colloidal silica to certain impermeable soils.* Science 33: 189. 1911.

[5] YALE, CHARLES G., and GALE, HOYT S. *The production of borax in 1913.* Mineral Resources of the U. S., 1913—Part II. 1914.

California: Furnace Creek, Death Valley; old abandoned borax claims in the Amargosa Canyon; colemanite discovered in Tick Canyon, a branch of Soledad Canyon, 40 miles north of the city of Los Angeles, and 5 miles from Lang Station, on the Southern Pacific; Slate Range Marsh, San Bernardino; in Inyo County 100 miles north of the Slate Range District; at the mouth of Furnace Creek and Resting Springs in Death Valley; Mono Lake; Owens Lake; Clear Lake; small quantities in spring at Red Bluff, Tehama County; Tuscan Springs, Tehama County, 8 miles east of Red Bluff; near the mouth of the Pitt River; 40 miles north of the Tuscan Springs several similar localities too small to be of any practical importance; a reconnaissance of the "coast range" of mountains, from the neighborhood of Shasta over a length of some 30 miles towards the South brought to light borates in the numerous small springs abounding in that locality but only in minute quantities; other localities between Clear Lake and Napa City; in Siegler Valley there is a hot spring containing borate of strontia and other borate salts; a borate spring in Suisan Valley; Kern County, 10 miles from Kalienti; 20 miles west of San Bernardino ulexite occurs in the Cane Spring District; Lake Elsinore, Riverside County.

Nevada: Ulexite occurs abundantly in the Arizona Desert, and near Wadsworth, Nevada; on the eastern slope of the Sierra Nevada, near Walker's Pass, borax is found; also in Panamint and Death Valley in Lower Nevada; borax found in Esmeralda County in Fish Lake Valley, Clayton Valley, Big Smoky Valley (locally known as the San Antonio Marsh, in the Silver Peak Quadrangle), Teels Marsh, Rhodes Marsh, Fish Lake Pond; at Sand Springs in Churchill County, 100 miles from Columbus Marsh; Hot Springs, 50 miles farther to the northwest; mud lakes in the western part of the State, one in the vicinity of Ragtown, Churchill County; in Humboldt, Land, Whitepine and Lincoln Counties there are beds of salt containing borax.

Oregon: Curry County; Harney County, extending over 10,000 acres south of Lake Algord.

Wyoming: Salts in Union Pacific Lakes, called Big Lake, Track Lake, and Red Lake, vary from $1\frac{1}{2}$ parts per thousand to $\frac{3}{4}$ part per thousand of borax.

In addition to these localities, I have personally collected small samples in the alkali spots in Kern County, Calif., where plants were either dying or completely absent. Borax percentages of significant size were found in these samples, although, with the rather high content of the white alkali salts in these spots, it is difficult to determine the relative importance of borax and the other salts in the alkali injury. Somewhat similar conditions exist in regard to Lake Elsinore, in Riverside County. The water of Lake Elsinore shows an appreciable percentage of borax and this suggests the possibility that the destructive injury following the use of Lake Elsinore water in irrigation may be partly due to borax poisoning, as well as to injury from other alkali salts. In this connection it is worthy of note that the lakes of the Southwest, famous for the remarkable clearness of the water, in many cases at least are more or less strongly impregnated with borax. It is true that the salt content in Lake Elsinore is high in relation to the percentage of borax; in the case of Clear Lake, Owens Lake, and Mono Lake, the comparison with the other salts is much higher. I am inclined to suggest, therefore, that wherever there are lakes in which the temperature of the water is sufficient for satisfactory development of aquatic plants but which remain free of vegetation, they should be prospected for the possible occurrence of borax.

Plant physiologists have frequently included boron compounds in determining the toxicity of various compounds upon plants, both in water cultures and in sand and in soil. As is the case with the very scattered literature dealing with field applications of borax to crop plants, there are some contradictions and differences of opinion regarding the toxic action both of borax and other boron compounds. A fairly complete review of this literature up to 1914 has been published by Dr. Brenchley, of the Rothamsted station. Following this review Dr. Brenchley concludes that boric acid seems to be less harmful to the higher plants than compounds of copper, zinc, and arsenic; and, further, that below a certain amount of concentration boron compounds exert a favorable influence upon plant growth.

From a review of much of the literature reported upon, I am inclined to doubt the validity of this last opinion, considering the stimulating effect to be due to a suppression of the growth of competing organisms such as bacteria and molds on the control plants of water cultures and the bacteria and protozoa in the sand and soil cultures. It may be doubted also whether the conclusion regarding the relative toxicity of boron compounds and compounds of zinc and copper is valid. If one is considering plants growing in natural soil, zinc and copper compounds are certain to become transformed into insoluble compounds much more rapidly and completely than is the case with boron form deposits that represent natural accumulations. Therefore, it may not unfairly be presumed that boron will prove to be a more toxic element than either zinc or copper.

The toxicity of boron compounds to different crops under field conditions has not been adequately investigated. It will almost certainly be found that different crops will show a great range in their resistance to borax poisoning, and it is probable that there may be found to be some direct correlation between the action of the plant in absorbing boron compounds and the limit of the toxic concentrations. In rather extensive experiments upon the effect of manure treated with different compounds of boron, Dr. Cook makes the following statement:[6]

"It apparently made little difference in the quantity of boron absorbed by the plants tested whether boron was added to the soil as borax or as calcined colemanite. The addition of lime with borax had no definite effect in preventing the absorption of boron. Wheat and oats absorbed very little boron, while leguminous and succulent plants absorbed comparatively large amounts."

It seems clear that much additional investigation, both in the field and laboratory, is necessary before it will be possible to determine the significance of borax either in its relation to natural vegetation or its bearing upon agricultural development in irrigation projects or in the use of fertilizers. In taking up new studies it should be emphasized, however, that the investigator should not remain blind to other compounds that might prove even more important in their relation to vegetation than compounds of boron; for example, in several of the regions where borax has been produced commercially, quicksilver ores also occur.

[6] Cook, F. C. Journ. of Agric. Res. 5: 888.

MINERALOGY.—*The nomenclature and classification of sulfide minerals.* EDGAR T. WHERRY, Washington, D. C.[1]

In a paper published in this JOURNAL over 3 years ago[2] the writer put forward a plan for the nomenclature and classification of the native elements, based in a general way upon that followed in Dana's System of Mineralogy (6th edition), but differing in certain important respects. The fundamental rules of nomenclature are as follows: If only one form of an element is known, the chemical name is used; polymorphous forms are named by applying crystallographic adjectives to the chemical names; and varieties based on isomorphism are also described by adjectives, constructed by adding the suffix *iferous* to the names of the elements present in the lesser amounts. The rules for classification are: Two main divisions, non-metals and metals, are recognized, and these are subdivided into groups on a strictly crystallographic basis. For use with minerals composed of two or more elements in combination, this plan obviously requires some modification, and in the present paper a set of rules applicable to the sulfides and related minerals is formulated.

Nomenclature.—The name first proposed for each mineral is adopted, foreign names being translated or transliterated. The ending *ite* is added in every case, except where some name without such ending is in common use. Separate mineral names are used for polymorphous forms.[3] In minerals in which one element is clearly essential and others replace it isomorphously, in widely varying but never significant amounts, the plan adopted in the preceding paper is followed: the name of the replacing element, with the suffix *iferous*, is used as an adjective. On the other hand, in minerals which belong to complete isomorphous series, single names are given to the series, and separate ones to

[1] The data for this paper were assembled while the writer was Assistant Curator of the Division of Mineralogy and Petrology in the U. S. National Museum. Received July 26, 1920.

[2] This JOURNAL 7: 447-456. 1917.

[3] The use of Greek-letter prefixes, which has certain advantages, has not been introduced systematically, since it is ordinarily limited to discussions of stability, relationships, etc.

their end-members, if these are well known as individual species.

Classification.—With the sulfides proper are ranged all other compounds of analogous character, comprising not only the selenides, tellurides, arsenides, antimonides and bismuthides, usually so treated, but also the oxysulfides, nitrides, phosphides, carbides, and silicides, which are not as a rule assigned any definite status. These are separated first on the basis of the metallic or non-metallic character of the more basic element concerned, and next into chemical divisions, depending on the ratios of the basic to the acidic elements present. The divisions are finally subdivided into groups on a crystallographic basis, as was done with the elements. As before, the order in which groups are taken up is that of decreasing crystallographic symmetry (trigonal, however, preceding tetragonal), the final group in most divisions including amorphous, colloidal, and cryptocrystalline, meta-colloidal, members, together with those of which the crystallization is as yet unknown; and the order of the individual minerals within the groups is based on the positions of the constituent elements in the Periodic System.

While there is nothing particularly novel about these rules, they do not appear to have been applied consistently heretofore. In the present work exceptions are admitted only for especially urgent reasons, and the tabulation, which follows, is accordingly uniform and systematic to an unusual degree. Discussion leading to its further improvement is, however, invited.

The first column of the table contains the names of the species and varieties recognized, worked out in accordance with the above principles. No new names are proposed in this paper, although a few old ones are redefined. The second column contains the composition of each; isomorphous replacement[4] is repre-

[4] Isomorphism was formerly considered to exist between single bivalent elements and pairs of univalent ones (for instance, Pb and Ag_2) but recent studies have shown supposed instances of this to be mixtures. Only isomorphous replacement of elements of like valence is here admitted. It may also be noted that the argentite and galena groups are here widely separated, since their structures must be entirely different.

sented by a comma, the element present in largest amount being placed first; and in the case of complete isomorphous series and double compounds the formulas are written separately, with a period between, not implying any particular interpretation of structure of the crystal, but so as to bring out to the best advantage the numerical relationships between the constituents. Variability in composition aside from typical isomorphism is frankly admitted, and a dash placed between the numbers representing the limiting amounts of the variable elements. The third column contains explanations of changes from current usage, important synonyms, references for minerals omitted by Dana, etc.

SULFIDES, OXYSULFIDES, SELENIDES, TELLURIDES, AND CARBIDES OF NON-METALS AND SEMI-METALS

X: 1 DIVISION		New; ratio X ranging from 1+ to 3.
WEHRLITE GROUP. TRIGONAL		New; placed by Dana after the "stibnite group," but the formula-type is quite different.
Wehrlite	$Bi_{1-2}(Te,Se,S)$	Synonyms: "gruenlingite," "joseite," (Dana No. 32), "oruetite," and "pilsenite;" composition widely variable.
NON-CRYSTALLIZED GROUP		New.
(Hydrocarbons)	H_xC	Chiefly cryptocrystalline.
Quisqueite	$C_{2-3}S$	Has been grouped with native elements, but is apparently a compound; amorphous, colloidal.
4:3 DIVISION		New.
DIMORPHITE GROUP. ORTHORHOMBIC		New.
Dimorphite	As_4S_3	Has been confused with orpiment, but is evidently distinct.
1:1 DIVISION		New.
MOISSANITE GROUP. TRIGONAL-HEMIMORPHIC		New.
Moissanite	SiC	Meteoritic; the name "carborundum" has priority, but was proposed for an artificial product.
REALGAR GROUP. MONOCLINIC.		
Realgar	AsS	

2:3 DIVISION		New.
TETRADYMITE GROUP. TRIGONAL.		Separated but not named by Dana.
Tetradymite	$Bi_2S_3.2Bi_2Te_3$	
Tellurobismuthite	Bi_2Te_3	Dana's "tetradymite, variety 1;" name a translation of "tellurwismuth."
HYDROUS ARSENIC SULFIDE. GROUP. TETRAGONAL.		New.
(Hydrous arsenic sulfide)	$As_2S_3.H_2O$	Described, without name, by E. Monaco, *Ann. Scuoli Agric. Portici*, [2], 4: 7–11. 1903. Sometimes indexed by the German name "arsenschwefel," but this is not a satisfactory mineralogical term.
STIBNITE GROUP. ORTHORHOMBIC.		
Orpiment	As_2S_3	Crystallization monoclinic, but peri-rhombic.
Kermesite	$Sb_2O_3.2Sb_2S_3$	Included here for simplicity.
Stibnite	Sb_2S_3	"Antimonite."
Bismuthinite	Bi_2S_3	
Antimoniferous var.	$(Bi,Sb)_2S_3$	Distinctness affirmed by Murdoch, *Micr. detn. opaque min.*, p. 131. 1916.
Guanajuatite	$Bi_2S_3.2Bi_2Se_3$	
Selenobismuthite	Bi_2Se_3	Name an abbreviated translation of "selenwismuthglanz."
NON-CRYSTALLIZED GROUP		New.
(Amorphous orpiment)	$As_2S_3.xH_2O$	Probably the form of arsenic sulfide which occurs in hot-spring deposits; not yet assigned a special name; not in Dana.
Metastibnite	$Sb_2S_3.xH_2O$	Amorphous, colloidal.
Karelinite	$Bi_2O_3.2Bi_2S_3$	"Bolivite;" an oxysulfide of uncertain homogeneity; classed by Dana as a variety of bismite.
1:2 DIVISION		New.
MOLYBDENITE GROUP. TRIGONAL.		
Molybdenite	MoS_2	
NON-CRYSTALLIZED GROUP		New.
Jordisite	MoS_2	Cornu, *Z. Chem. Ind. Kolloide*, 4: 190, 1909; (not in Dana); amorphous, colloidal.
Tungstenite	WS_2	
1:X DIVISION		New; ratio X ranging from 1+ to 6
NON-CRYSTALLIZED GROUP		New.
Arsensulfurite	AsS_{4-6}	Sometimes grouped with the native elements, but the constituents seem likely to be combined.
Patronite	VS_{3-4}	

SULFIDES, OXYSULFIDES, SELENIDES, TELLURIDES, NITRIDES, PHOSPHIDES, ARSENIDES, ANTIMONIDES, BISMUTHIDES, CARBIDES AND SILICIDES OF METALS

X:1 DIVISION	New; ratio X ranging from 3 to 11; part of Dana's "basic division."
COHENITE GROUP. ISOMETRIC	New; included by Dana with native elements, but evidently compounds.
Cohenite ... $(Fe,Ni)_{3-4}C$	Meteoritic; includes "chalypite."
STUETZITE GROUP. HEXAGONAL	New.
Stuetzite ... $Ag_{3-4}Te$	
SCHREIBERSITE GROUP. TETRAGONAL.	New; included by Dana under isometric native elements.
Schreibersite ... $(Fe,Ni)_{3-4}P$	Meteoritic; includes "rhabdite."
NON-CRYSTALLIZED GROUP	New.
Whitneyite ... Cu_9As	"Darwinite;" homogeneity affirmed by Murdoch, *op. cit.*, p. 74, but discredited by Borgström, *Geol. för. förh.* 38: 95. 1916.
Algodonite ... Cu_6As	Homogeneity affirmed by Borgström, *loc. cit.*, but questioned by Murdoch, *op. cit.*, p. 37.
Horsfordite ... Cu_6Sb	Homogeneity affirmed by Murdoch, *op. cit.*, p. 135.
Chilenite ... $Ag_{11}Bi$	The formula Ag_6Bi often given does not agree with the analyses; homogeneity affirmed by Murdoch, *op. cit.*, p. 125.
3:1 DIVISION	New; part of Dana's "basic division."
DYSCRASITE GROUP. ORTHORHOMBIC.	
Domeykite ... Cu_3As	Crystallization peri-hexagonal; includes "condurrite," "keweenawite," "ledouxite," "mohawkite," "orileyite," "stibiodomeykite," etc., the heterogenous character of most of which has been shown by Murdoch, *op. cit.*, pp. 38–39.
Arsenargentite ... Ag_3As	"Huntilite."
Dyscrasite ... Ag_3Sb	"Stibiotriargentite;" includes "animikite," "chanarcillite" and "stibiohexargentite," impure forms.
5:2 DIVISION	New; ratio somewhat variable.
NON-CRYSTALLIZED GROUP	New.
Bismuthaurite ... $Au_{2-3}Bi$	"Maldonite;" included by Dana with native elements, but has as much right to be called a compound as other members of this division.
Ferrosilicite ... $Fe_{2-3}Si$	Meteoritic; Shepard, *Amer. Jour. Sci.* [1] 28: 259. 1859.

Siderazotite	Fe_5N_2	"Silvestrite;" ending *ite* added for uniformity; included by Dana with native elements, but evidently a compound.
2:1 DIVISION		New; part of Dana's "monosulfides, ..."
ARGENTITE GROUP. ISOMETRIC.		New; part of Dana's "galena group."
(Isometric chalcocite)	Cu_2S	The stable form at high temperatures, probably represented in massive occurrences of "chalcocite;" not yet assigned a separate name.
Eucairite	$Cu_2Se.Ag_2Se$	
Argentite	Ag_2S	"Jalpaite;" distinctness affirmed by Murdoch, *op. cit.*, p. 140.
Cupriferous var.	$(Ag,Cu)_2S$	
Aguilarite	$Ag_2(S,Se)$	Compare Quercigh, *Riv. min. crist. Ital.*, 44: 26. 1915.
Naumannite	Ag_2Se	
Hessite	Ag_2Te	
CHALCOCITE GROUP. ORTHORHOMBIC.		
Chalcocite	Cu_2S	
Stromeyerite	$Cu_2S.Ag_2S$	
Acanthite	Ag_2S	
NON-CRYSTALLIZED GROUP		New.
Berzelianite	Cu_2Se	
Crookesite	$7Cu_2Se.Tl_2Se$	
(Amorphous argentite)	Ag_2S	Occurrence in nature affirmed by Cornu. *Z. Chem. Ind. Kolloide* 4: 187. 1909; not in Dana; not yet named.
Petzite	$3Ag_2Te.Au_2Te$	
4:3 TO 8:5 DIVISION		New.
BORNITE GROUP. ISOMETRIC.		New.
(Isometric high-sulfur chalcocite)	$Cu_2S_{1-1.2}$	Compare Posnjak, Allen, and Merwin, *Econ. Geol.* 10: 492. 1915; not yet named.
Bornite	Cu_5FeS_4	The old formula Cu_3FeS_3, has been discredited.
MAUCHERITE GROUP. TETRAGONAL		New.
Maucherite	Ni_3As_2	"Placodine," artificial; "temiskamite;" the formula has been suggested to be Ni_4As_3 by Palmer, *Econ. Geol.* 9: 664. 1914.
HIGH-SULFUR CHALCOCITE GROUP. ORTHORHOMBIC		New.
(High-sulfur chalcocite)	$Cu_2S_{1-1.2}$	Compare Posnjak *et al*, *loc. cit.*; not yet named.

NON-CRYSTALLIZED GROUP......		New.
Umangite..........	Cu_3Se_2	
Rickardite..........	Cu_4Te_3	
Kalgoorlite........	$(Ag,Au,Hg)_3Te_2$	Homogeneity uncertain.
1:1 DIVISION...............		New; part of Dana's "monosulfides. . ."
GALENITE GROUP. ISOMETRIC...		Part of Dana's "galena group."
Oldhamite..........	CaS	Meteoritic, placed by Dana after sphalerite group, but not tetrahedral.
Galenite............	PbS	"Galena."
Clausthalite.........	PbSe	Includes "zorgite" (Dana No. 52), an impure form.
Altaite.............	PbTe	
Pentlandite.........	xFeS.yNiS	Placed by Dana after sphalerite group, but not tetrahedral; regarded as an isomorphous series; end-members unknown.
SPHALERITE GROUP. ISOMETRIC-TETRAHEDRAL.		
Sphalerite..........	ZnS	"Cleiophane."
Cadmiferous var	(Zn,Cd)S	"Przibramite."
Ferriferous var..	(Zn,Fe)S	"Blende;" includes "marmatite," "cristophite," etc., high-iron varieties.
Metacinnabarite.....	HgS	
Tiemannite.........	HgSe	
Alabandite..........	MnS	
COVELLITE GROUP. HEXAGONAL.		Dana's "cinnabar-wurtzite-millerite group" is here separated into several on the basis of crystallization.
Covellite............	CuS	
Troilite.............	FeS	Meteoritic; owes its 1:1 ratio to its formation in the presence of excess iron.
Niccolite...........	NiAs	
Arite...............	xNiAs.yNiSb	An isomorphous series.
Breithauptite........	NiSb	
WURTZITE GROUP. HEXAGONAL-HEMIMORPHIC.		
Wurtzite...........	ZnS	
Manganiferous var..........	(Zn,Mn)S	"Erythrozincite;" distinctness affirmed by Murdoch, *op. cit.*, p. 148.
Greenockite........	CdS	
MILLERITE GROUP. TRIGONAL-RHOMBOHEDRAL.		
Millerite...........	NiS	Includes "beyrichite" (Dana No. 76).

GUADALCAZARITE GROUP. TRIGONAL-HEMIMORPHIC.		
Guadalcazarite	HgS	Has been confused with metacinnabarite, but differs in crystallization and important physical properties; compare the writer, *Amer. Min.* **5**: 35. 1920.
CINNABARITE GROUP. TRIGONAL-TRAPEZOHEDRAL.		
Cinnabarite	HgS	The ending *ite* is added for uniformity.
HAUCHECORNITE GROUP. TETRAGONAL		New.
Hauchecornite	$4NiS.NiBi$	Composition uncertain.
CHALCOPYRITE GROUP. TETRAGONAL-SPHENOIDAL		Marked off though not named by Dana.
Chalcopyrite	CuS.FeS	Includes "barnhardtite," "barracanite," "cubanite" (Dana No. 81) and "cupropyrite," impure forms, Murdoch, *op. cit.;* formerly regarded as a cuprous-ferric sulfide, but X-ray study shows the Cu and Fe to have analogous positions.
Stannite	$2CuS.SnS.FeS$	
Zinciferous var.	$2CuS.SnS.(Fe,Zn)S.$	
CHALMERSITE GROUP. ORTHORHOMBIC		New.
Chalmersite	$CuS.2FeS$	
Empressite	AgTe	
Muthmannite	xAgTe.yAuTe	"Krennerite" in part.
Teallite	SnS.PbS	
(Orthorhombic pyrrhotite)	FeS	Artificial; "α-pyrrhotite."
NON-CRYSTALLIZED GROUP		New.
(Amorphous covellite)	CuS	Occurrence in nature affirmed by Cornu, *loc. cit.;* not in Dana; not yet named.
Voltzite	$ZnO.4ZnS$	Included here for simplicity.
(Amorphous sphalerite)	ZnS	Mentioned but not named by Dana.
Xanthochroite	$CdS.xH_2O$	Rogers, *Journ. Geol.* **25**: 524. 1917.
(Amorphous cinnabarite)	HgS	Occurrence in nature affirmed by Cornu, *loc. cit.;* not in Dana; not yet named.
Onofrite	$5HgS.HgSe$	
Coloradoite	HgTe	
Lehrbachite	xHgSe.yPbSe	An isomorphous series.
Hydrotroilite	$FeS.xH_2O$	Sidorenko, *Mem. soc. nat. Nouv. Russie* **24**: 97, 1901; *Neues Jahrb. Min. Geol.* **1902**, II, ref. 397; not in Dana.
Jaipurite	CoS	

5:6 TO 3:4 DIVISION		Part of Dana's "intermediate division."
LINNEITE GROUP. ISOMETRIC		Marked off but not named by Dana.
Linneite	$CoS.Co_2S_3$	"Linnaeite;" includes "carrollite" (Dana No. 82), shown to be a mixture by Murdoch, *op. cit.*, p. 37; also "sychnodymite," which is apparently similar; compare Zambonini, *Riv. min. crist. Ital.* **47**: 40. 1916.
Siegenite	$x(CoS.Co_2S_3).$-$y(NiS.Ni_2S_3)$	Regarded as an isomorphous series, of which the preceding and following are end members.
Polydymite	$NiS.Ni_2S_3$	Has been assigned another formula, but the analyses agree as closely as could be expected with this one.
PYRRHOTITE GROUP. HEXAGONAL		New.
Pyrrhotite	$FeS_{1\text{-}1.2}$	"β-pyrrhotite."
STERNBERGITE GROUP. ORTHORHOMBIC		New.
Sternbergite	$AgFe_2S_{3\text{-}4}$	"Argentopyrite," "frieseite," etc.; composition not certain; compare Zambonini, *loc. cit.*
Leucopyrite	$FeAs.Fe_2As_3$	Included by Dana under loellingite, but apparently independent.
Daubreelite	$FeS.Cr_2S_3$	Meteoritic; shows cleavage in one direction
1:2 DIVISION		Dana's "disulfides. . . . ."
PYRITE GROUP. ISOMETRIC-PYRITOHEDRAL		Part of Dana's "pyrite group."
Hauerite	MnS_2	
Pyrite	FeS_2	
Nickeliferous var	$(Fe,Ni)S_2$	"Bravoite;" the so-called "cobalt-nickel-pyrite" contains cobalt also.
Arsenoferrite	$FeAs_2$	
Smaltite	$CoAs_2$	Includes "bismutosmaltite" and "chathamite," apparently mixtures.
Cloanthite	$NiAs_2$	This and the preceding form limited isomorphous mixtures, but the series has not received a separate name.
Laurite	RuS_2	
Sperrylite	$PtAs_2$	
COBALTITE GROUP. ISOMETRIC-TETARTOHEDRAL		New; includes minerals of this division containing two different non-metals; compare Bragg, X-rays and Crystal Structure, p. 154. 1916.

(Tetartohedral pyrite)	$Fe(S,X)_2$	The variety of pyrite showing this symmetry probably contains arsenic or some other element isomorphously replacing part of its sulfur.
Cobaltite	CoSAs	
Gersdorffite	NiSAs	Includes "corynite" (Dana No. 91), an impure variety.
Ullmannite	NiSSb	
Willyamite	CoSSb	This and the preceding form limited isomorphous mixtures.
Kallilite	NiSBi	
MARCASITE GROUP. ORTHORHOMBIC.		
Krennerite	$xAgTe_2.yAuTe_2$	An isomorphous series.
Calaverite	$AuTe_2$	
Nagyagite	$(Pb,Au)(S,Te,Sb)_2$.	Composition uncertain.
Marcasite	FeS_2	
Arsenopyrite	FeSAs	"Mispickel."
Loellingite	$FeAs_2$	
Glaucodotite	xCoSAs.yFeSAs	The ending *ite* is added for uniformity; includes "danaite" and "alloclasite" (Dana No. 102), an impure form, Murdoch, *op. cit.*, p. 37.
Safflorite	$CoAs_2$	Includes "badenite," apparently an impure form.
Wolfachite	NiSAs	Only known in impure form.
Rammelsbergite	$NiAs_2$	
SYLVANITE GROUP. MONOCLINIC.		
Sylvanite	$AgTe_2.AuTe_2$	Includes "goldschmidtite," a variety of unusual habit.
Melonite	$NiTe_2$	
NON-CRYSTALLIZED GROUP		New.
Melnikovite	$FeS_2.xH_2O$	In part amorphous and in part metacolloidal, cryptocrystalline.
1:X DIVISION		New; ratio X ranging from 2+ to 3.
SKUTTERUDITE GROUP. ISOMETRIC PYRITOHEDRAL		New.
Skutterudite	$CoAs_{2-3}$	Includes much so-called "smaltite."
(High-arsenic cloanthite)	$NiAs_{2-3}$	Analogous to the preceding; not yet assigned a separate name.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

830TH MEETING

The 830th meeting was held at the Cosmos Club, February 14, 1920. President SOSMAN presided and 38 persons were present.

The first paper by Messrs. W. F. MEGGERS and PAUL D. FOOTE on *A new microphotometer for photographic densities* was presented by Mr. MEGGERS.

The new microphotometer for measuring photographic densities is essentially the micropyrometer described in the Bulletin of the Bureau of Standards (**9**: 475. 1913) except that a microscope of higher power is used. The photographic plate is mounted just below the objective of the microscope on a horizontal bed movable with a graduated screw and is illuminated beneath by an intense beam of light from a tungsten ribbon lamp. Light transmitted by a small portion of the photographic plate, the image of which is adjacent to that of the tip of the pyrometer lamp, is matched with equal filament brightness by adjusting the current through the lamp. The ammeter readings are readily translated into measurements of photographic densities. If the tip of the pyrometer lamp filament be regarded as a filar in the eye-piece, the relative positions or wave lengths of spectral lines on a plate are measured at the same time that their photographic densities are measured.

An example of the use of this microphotometer for measuring wave lengths and densities of spectral lines is given and it appears that the visually estimated intensities of such lines are a geometric series in accordance with Fechner's law.

Illustrations of this microphotometer's application to the measurement of energy distribution in a broad spectral line and to the measurement of spectral sensitivity of a photographic plate are given.

Measurements of photographic density when the plate is illuminated by parallel light are found to be much larger than when the illumination is diffuse. This experience calls attention to the importance of specifying the character of the illumination when measurements are made on light transmission of diffusing media. The paper was illustrated by lantern slides.

Discussion.—The paper was discussed by Messrs. SOSMAN and HUMPHREYS.

The second paper, also by Messrs. FOOTE and MEGGERS, was presented by Mr. FOOTE. The title was *Atomic theory and low-voltage arcs in caesium vapor.* The paper was illustrated by lantern slides. Full publication may be found in Phil. Mag. Series 6, **40**: 80. 1920.

The above paper was discussed by Messrs. SOSMAN and TUCKERMAN.

The final paper by Messrs. E. F. MUELLER and M. S. VAN DUSEN, on *Heat of combustion of volatile liquids*, was presented by Mr. MUELLER. The paper was illustrated by lantern slides and the burner used by the authors was exhibited. Messrs. FOOTE and SOSMAN discussed this paper.

831ST MEETING

The 831st meeting was held at the Cosmos Club March 13, 1920, with President SOSMAN presiding and 60 persons present.

The first paper was by Mr. E. D. WILLIAMSON on *Earthquakes and the elastic properties of the earth.*

Data from geographic and astronomic sources have established some qualitative measure of the earth's rigidity, average density, and the distribution of the earth's mass. Earthquake records, properly interpreted, give us an immediate check on the conclusions which have been reached.

Two of the types of waves propagated as the result of a seismic disturbance travel through the earth with velocities in each case inversely proportional to the square root of density but depending in one case on the rigidity and in the other on both the compressibility and rigidity. It is necessary then to find the relation of the velocity of the wave to the depth beneath the surface of the earth to get further information as to the variation of these other quantities. Wiechert at Gottingen first solved the problem by graphical means, but since then more direct analytical methods have been developed to find from a transit-time curve, the path of the wave through the earth and its velocity at various points.

The results to which the writer and L. H. ADAMS were led by their investigations are outlined in the second paper, presented by Mr. L. H. ADAMS on *The nature of the interior of the earth.* It has long been known that since the average density of the earth (5.5) is so much higher than the density of ordinary surface rocks, the central portion must have a very high density—probably 10.0 or more. To account for this interesting fact we may assume either that the center of the earth is composed of relatively heavy forms of matter or that the extreme pressures in the interior—two or three millions of atmospheres—have compressed the ordinary rock material to one-third to one-quarter of its original volume. With regard to the second hypothesis, we have no information to guide us in forming an opinion concerning the behavior of matter at these enormous pressures so far beyond the range of laboratory experimentation. Fortunately, however, the data on the propagation of distant earthquakes may be made to shed some light on this important question. Starting with the known velocity v of the transverse vibrations at the distance r from the center of the earth, the density ρ produced by *compression* alone may be calculated by graphical integration and successive approximation, using the equation:

$$\log_e \frac{\rho}{\rho_0} = h \int_{r_0}^{r} \frac{m}{r^2 v^2} \, dr$$

in which m denotes the mass contained within the sphere of radius r, and h is a constant.

The results of this operation show that it is impossible to account for *all* of the excess density in the interior by *compression* alone. It does account for a surprisingly large part of it, however. The difference must be attributed to a segregation toward the center of heavy material, presumably metallic iron, and we thus have a quantitative measure of the amount of this segregation.

Finally, mention is made of the fact that from the center of the earth out to about 0.5 of the distance to the surface, the properties of the material composing this central portion of the earth are such that transverse vibrations are not transmitted. This part of the earth, therefore, is lacking in rigidity; in other words, it is not a solid and therefore must be considered in spite of its high density to be either a gas or a liquid, depending on whether or not the temperature is above the critical point, liquid-vapor, of the material.

Both the above papers were illustrated by lantern slides.

Discussion.—Both the above papers were discussed after the reading of the second, Messrs. BEALL, SPENCER, BOWIE, LAMBERT, HUMPHREYS, TODD, HAWKESWORTH, and SOSMAN participating in the discussion.

The last paper of the evening by Messrs. H. C. DICKINSON and C. H. MEYERS on *A 15-atmosphere manometer and a 100-atmosphere piston gage* was presented by Mr. DICKINSON.

A fifteen-atmosphere mercury manometer and a one hundred-atmosphere piston gage were described. The manometer consists of five glass U-tubes 250 cm. long, connected in series, each of which may be by-passed by a valve. Four of these tubes may be used to measure multiples of three atmospheres, while any fraction of three atmospheres may be measured on the fifth. To avoid rusting of steel parts and fouling of mercury surfaces, pure ethyl alcohol is used to transmit the pressure, between tubes. The pressure transmitting liquid may be admitted into the manometer between any two U-tubes. The temperature of the manometer is measured by a thermometer which has a bulb located behind the center of the manometer and of the same length as the U-tubes. The accuracy of the manometer-temperature measurement is improved by an air circulating fan which keeps the room temperature very uniform.

The piston gage consists of a hardened steel piston of approximately one square centimeter area, floating on oil inside a hardened selel cylinder. A dead weight load is applied to this piston through a plunger specially designed to transmit only a vertical force component to the piston. For the purpose of cutting down leakage past the piston at higher pressures, the cylinder has been made with a re-entrant part which encircles the piston so that the pressure is applied to the outside as well as the inside of the cylinders. A mechanical device has been applied which rotates the piston slowly, without producing any uncertain axial forces exceeding 0.05 gram under regular operating conditions. An auxiliary U-tube partly filled with mercury, separates the oil in the gage from the pressure to be measured and indicates any movement of the piston. This manometer has a range of about fifty grams per square-centimeter, hence the use of weights smaller than 50 grams is avoided.

Comparisons of the piston gage with the manometer, which were made before the present rotating device was used, give 1.3031 square centimeters at the effective area or 1.1302 centimeter as effective diameter at 25 degrees C., whereas direct measurements of the diameter of the piston give 1.1298 centimeters. The results of the comparison up to 15 atmospheres showed variations from the mean, due to both gages combined, corresponding to 1.5 mm. pressure. Further comparison at pressures above 15 atmospheres will be made.

The gage described in this paper was exhibited and operated by the authors at the close of the meeting.

Discussion.—The paper was discussed by Mr. White.

S. J. Mauchly, *Recording Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

143RD MEETING

The 143rd regular meeting of the Botanical Society of Washington was held at the Cosmos Club, 8 p.m., April 6, 1920. Sixty members and thirty-three guests were present.

Under "Brief Notes and Reviews of Literature," Mr. F. L. Lewton exhibited three specimens of the fruit of a large leguminous tree, *Andira excelsa* HBK, known in Tabasco, Mexico, as "Macayo." The seeds contain a poisonous alkaloid. They are used locally as a vermifuge and purgative, but because of their poisonous nature, have been the subject of several articles sounding a warning against the careless use of them. The fruits are oval, 8–12 centimeters long, and grooved on one side with a roughened surface resembling the convolutions of the brain.

Prof. A. S. Hitchcock read an illustrated paper on *A botanical trip to British Guiana*. He stated that British Guiana has an area of about 90,000 square miles, extending back from the coast about 400 miles. The climate is strictly tropical, the temperature at Georgetown varying in summer from 82° at night to 88° in the day, and in winter from 78° to 84°, F. The rainfall at Georgetown averages about 90 inches, distributed somewhat vaguely into two wet and dry seasons. In the interior the distribution is nearly normal for Tropical America, the wet season being from April to August. The vegetation is characteristic of the lowland tropics. Mangrove formations line the sea coast and extend up the rivers 30 miles or more. In the main the country is covered with forest, but the Venezuelan savannas extend across the southern part of the Colony.

Prof. Hitchcock collected all kinds of flowering plants, though special attention was given to the grasses. About 1100 numbers were obtained, including 108 sets of grasses. The trip was made under the auspices of the U. S. Department of Agriculture, the New York Botanical Garden, and the Gray Herbarium.

144TH MEETING

The 144th regular meeting of the Botanical Society of Washington was held at the Cosmos Club, 8 p.m., May 4, 1920. Thirty-two members and four guests were present.

Under "Brief Notes and Reviews of Literature," Dr. C. D. Marsh discussed the peculiar appearance of defoliated aspens which he had observed in the Wasatch Mountains. The trees had put out their foliage on certain branches, only producing dense clusters of very large leaves, which gave a "witches-broom" effect.

An illustrated paper on *The phytogeography of the Coeur d'Alene basin of northern Idaho* was read by Dr. H. B. Humphrey. He explained that in pre-miocene times that fork of the Columbia River draining the western slopes of the Bitter Root Mountains flowed northward through the Purcell trench. Eruptions of lava which crept up the valley obstructed the flow of the river, but through long-time erosion the stream reopened its channel and was probably active until the recent ice age. The retreating glaciers of the ice age left a dam of pleistocene gravel in the valley at the head of the present Coeur d'Alene Lake. The average elevation of this gravel dam is 2,155 feet above sea level. This deposit of gravel caused the Coeur d'Alene basin to fill and form a lake of great extent.

Ancient markings indicate that the surface elevation of this lake was approximately 2,135 feet above sea level, or approximately 20 feet lower than the crest of the gravel dam. This lake subsequently found an outlet through the present Spokane River.

Excessive deposition of silt brought down from the mountains resulted in the development of river banks throughout the length of the east and southeast arms of the lake. The seasonal inundations have gradually raised the floor of the basin. Aided by the accumulation of vegetable detritus, development of meadows followed. The filling-in process has progressed slowly, leaving at the upper reaches of the old lake arms a flood plain of highland meadows and typical mesophytic vegetation, which tapers off into lowland meadows and marshes followed by common hydrophytes such as Sparganium, *Acorus calamus*, *Equisetum fluviatile*, Sagittaria, etc., and finally by such plants as Potamogeton, Utricularia, Nymphaea, etc.

That the development of the present flood plain has taken place within relatively recent times is supported by the fact that the bottom of these tributaries of the Coeur d'Alene basin as far as investigated has been found to be cored by a deposit of almost pure diatomaceous sediment varying in depth from a few inches to several feet. The early development of river banks throughout the Coeur d'Alene and St. Joe arms of the lake furnished channels down which vast quantities of silt have been conveyed. Only at the height of the spring flood, therefore, is there an appreciable deposition over areas beyond the confines of the river banks. As a result the soil of the meadows is very largely composed of diatomaceous earth and muck in various stages of development.

In a short paper on *Plant pathology in Denmark in recent years,* Dr. F. Kolpin Ravn, professor of plant pathology in the Royal Agricultural College of Denmark, Copenhagen, described the organization for investigational work in plant pathology provided for at the Royal College of Agriculture and Experiment Stations. The College also conducts winter schools and extension work. The plant inspection service is under a special commission which inspects and certifies plant products exported to foreign countries and acts as a judicial body in connection with a new system of seed certification which guarantees the purity and viability of practically all the seed sold in Denmark.

Chas. E. Chambliss, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Mr. REEVES W. HART has recently resigned from the Leather Section of the Bureau of Standards, to become research chemist at the Benicia tannery of Kullman, Salz and Company, at Benicia, California.

Mr. MAYO D. HERSEY, chief of the Aeronautic Instrument Section of the Bureau of Standards, resigned in October to take the position of Associate Professor of Properties of Matter, in the department of physics of the Massachusetts Institute of Technology. He will be succeeded at the Bureau by Dr. F. L. HUNT.

Major LAWRENCE MARTIN, of the General Staff, U. S. Army, has been ordered to report to the Secretary of State for temporary duty to assist in preparing a report to the President on the proposed western boundaries of Armenia.

Mr. KENNETH P. MONROE has resigned from the color laboratory of the Bureau of Chemistry to accept a position at the Jackson Laboratory of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

Professor HARMON NORTHROP MORSE, professor of inorganic and analytical chemistry and director of the chemical laboratory of Johns Hopkins University, and a non-resident member of the ACADEMY, died on September 8, 1920, at Chebeague Island, Maine, in his seventy-second year. Professor Morse was born at Cambridge, Vermont, October 15, 1848. He became connected with Johns Hopkins University in 1876, shortly after completing his academic and scientific education at Amherst and at Göttingen, and was connected with the institution from that date until the time of his death. His publications covered a wide range of inorganic, analytical, and physico-chemical subjects, but his attention was particularly directed during recent years to the measurement and theory of osmotic pressures.

Dr. C. NUSBAUM, formerly of the Magnetic Section of the Bureau of Standards, has been appointed research associate in the Division of Industrial Research and Cooperation of the Massachusetts Institute of Technology.

Dr. P. V. WELLS is returning to the Bureau of Standards after completing his investigations on the stratification of thin soap films, which he has been carrying forward at the laboratory of Professor PERRIN in Paris. Dr. Wells attended the recent meeting of the British Association.

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BOTANY.—*The North American species of Agonandra.* PAUL C. STANDLEY, U. S. National Museum.[1]

While working with the woody plants of Mexico, the writer has segregated from time to time from the undetermined Mexican plants in the National Herbarium a rather large number of sheets which evidently belonged to one genus. The specimens come from many widely separated localities, and although of rather characteristic general appearance, it is remarkable to find that none has ever been named generically or even referred to a family. Recently the writer determined that one of the forms had been named by DeCandolle, who applied the name *Schaefferia racemosa,* basing his description upon one of Sessé and Mociño's sketches of Mexican plants. It was evident, however, that the plant had nothing in common with the genus *Schaefferia,* which belongs to the family Celastraceae.

Careful examination of the Mexican material and comparison with the herbarium specimens available show that the former belong to the genus *Agonandra,* a member of the family Opiliaceae. Neither the genus nor the family has been reported heretofore from North America. Only one species of *Agonandra* has been described, a native of Brazil and Colombia, and it has been the only known American representative of the family, the other

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 21, 1920.

genera of the small group being restricted to Africa, Asia, Australia, and the East Indies. The occurrence of the genus in Mexico is a matter of considerable interest, and it is still more interesting in view of the fact that three species, apparently, are represented in Mexico. These are described below.

Agonandra Miers (Ann. Nat. Hist. II, 8: 172, nomen nudum. 1851); Benth. & Hook. Gen. Pl. 1: 349. 1862.

Shrubs or small trees, glabrous or pubescent; leaves alternate, petiolate, estipulate, entire, somewhat succulent, with inconspicuous venation; flowers very small, green, usually dioecious, racemose; calyx minute, cupular, obscurely 4 or 5 lobate; petals 4 or 5 in the staminate flower, narrow, the stamens 4 or 5, opposite the petals, alternating with conspicuous scalelike glands of the disk; petals none in the pistillate flower, the disk urceolate, surrounding the ovary; fruit a drupe, the seed erect.

KEY TO SPECIES

Leaves acute or acuminate at apex, or sometimes obtuse and abruptly pointed; young branches glabrous............1. *A. racemosa.*
Leaves rounded or obtuse at apex; young branches finely puberulent.
  Fruit 8 mm. long............................2. *A. obtusifolia.*
  Fruit 15 mm. long............................3. *A. conzattii.*

1. **Agonandra racemosa** (DC.) Standl.

Schaefferia racemosa DC. Prodr. 2: 41. 1825.

Shrub or small tree, 4 or 5 meters high, glabrous throughout, the branches very slender, green when young; petioles 4 to 9 mm. long; leaf blades lanceolate to broadly elliptic-ovate or even rounded, 4 to 7.5 cm. long, 1 to 4.5 cm. wide, cuneate to broadly rounded at base, pale beneath; racemes longer or shorter than the leaves, the flowers pedicellate, bracts acute or acuminate, covering the buds but caducous in anthesis; petals about 2.5 mm. long; fruit subglobose, about 8 mm. long.

SPECIMENS EXAMINED:

SONORA: Sierra de Alamos, 1890, *Palmer* 298.

SINALOA: La Rastra, alt. 600 meters, 1899, *Goldman* 361. Along road from Culiacán to Las Flechas, 1899, *Goldman* 313.

TEPIC: María Madre Island, May 11, 1897, *Maltby.*

COLIMA: Manzanillo, 1890, *Palmer* 1009.

MICHOACÁN OR GUERRERO: Sierra Madre, alt. 480 meters, in granitic soil, *Langlassé* 860. San Marcos to Copala (Guerrero), alt. 60 to 150 meters, *Nelson* 2290.

Langlassé's specimen is remarkable for its narrow leaves; the vernacular name is given as "palo de golpe." One of Goldman's specimens (no. 313) bears fruit and staminate flowers upon the same branch, but all the other specimens of the genus examined are from dioecious plants, so far as the specimens show.

Some of the specimens agree excellently with Sessé and Mociño's plate,[2] upon which the species was based. This is far superior to many of the plates of the series, and shows plainly the scalelike glands of the disk in the staminate flower.

Agonandra racemosa is more nearly like *A. brasiliensis*, the type of the genus, than is either of the following species. In *A. brasiliensis* the staminate flowers are densely glandular-puberulent rather than glabrous.

2. **Agonandra obtusifolia** Standl., sp. nov.

Shrub, 1 to 3 meters high, with long stout spreading branchlets, these green, striate, and finely puberulent, the older branches gray; petioles 2 to 4 mm. long, puberulent; leaf blades narrowly oblong to oblong-ovate, 2 to 5 cm. long, 0.6 to 1.5 cm. wide, cuneate at base, glabrous; staminate racemes 1 to 2 cm. long, glabrous, borne on old wood, the flowers short-pedicellate; stamens 3 times as long as the petals; fruit subglobose, yellow.

Type in the U. S. National Herbarium, no. 572649, collected in the vicinity of Victoria, Tamaulipas, Mexico, altitude 320 meters, in 1907, by Edward Palmer (no. 421).

ADDITIONAL SPECIMENS EXAMINED:

TAMAULIPAS: Vicinity of Tampico, 1910, *Palmer* 507. Buena Vista Hacienda, June 16, 1919, *Wooton*.

VERACRUZ: Vicinity of Pueblo Viejo (near Tampico), 1910, *Palmer* 423.

Palmer gives the vernacular name as "granadillo," and Wooton as "revienta cabra." Palmer reports that the shrub grows in hedgerows or in rich wooded bottom lands; the leaves are light or dark green. The abundant fruit, he states, appears as if covered with honey dew; it has a sweet, watery flavor, but is not eaten by the natives.

Agonandra obtusifolia is easily distinguished from *A. racemosa* by the characters given in the key. The leaves average much smaller and narrower than in the latter species, and the petioles are relatively much shorter. The coarse, stiff branches indicate a different habit of growth.

[2] A.DC. Calq. Dess. Fl. Mex. *pl. 169*, *pl. V, B.*

3. **Agonandra conzattii** Standl., sp. nov.

Branches stiff, the young ones green, striate, minutely puberulent, the older ones grayish; petioles slender, 2 to 3 cm. long, minutely puberulent; leaf blades lance-oblong to oblong-ovate, 2 to 3 cm. long, cuneate-acuminate at base, rounded or very obtuse at apex, glabrous; fruit subglobose, 1.5 cm. long, the stout pedicels 5 to 6 mm. long.

Type in the U. S. National Herbarium, no. 1012311, collected at Portillo de Coyula, Distrito de Cuicatlán, Oaxaca, Mexico, altitude 1600 meters, April 23, 1919, by C. Conzatti (no. 3558).

A sterile specimen from Tehuacán, Puebla (*Rose & Rose* 11221), is probably the same species. Prof. Conzatti gives the vernacular name as "maromero."

Agonandra conzattii is related to *A. obtusifolia* more closely than to *A. racemosa*. It differs chiefly in the size of the fruit, which is twice as large as in *A. obtusifolia*. Several fruiting specimens of the latter species have been seen by the writer, and in all of them the fruit is very uniform in size; therefore it seems probable that the much larger fruit of the Oaxaca plant is a character of specific value.

ENTOMOLOGY.—*Notes on the Harris collection of sawflies, and the species described by Harris.* S. A. ROHWER, Bureau of Entomology.[1]

Harris wrote four papers[2] dealing with sawflies. Two of these were mere lists of the species and published as a part of a list of the animals and plants of Massachusetts. In these lists occur a number of new names unaccompanied by descriptions which stood as *nomina nuda* for many years. Later, in 1841, Harris characterized a few of these species but many of them remained *nomina nuda* until many years later, when Norton studied the Harris collection and described the new species. The unfortunate thing about this was that in describing the species Norton accredited the species to Harris and there has

[1] Received June 8, 1920.

[2] *List of the insects of Massachusetts,* in Hitchcock's Rept. Geol. Mineral. Bot. and Zool. Mass., 566–595. 1833. Sawflies treated on p. 586.

Ibid., second edition, enlarged, 553–601. 1835. Sawflies treated on pp. 582–584.

A report on the insects of Massachusetts, injurious to vegetation. Cambridge, 1841. Reprinted in 1842, second edition in 1852.

Sawfly of the raspberry; Selandria (Hoplocampa) rubi, New Engl. Farmer II, 2: 33. figs. 1850.

been some confusion as to whom the species should be accredited. Most of the species listed by Harris had been examined by Say and the names published by Harris were manuscript names supplied by Say. It is very fortunate that in describing the species Norton chose to use the names first proposed by Say.

In treating the species described by Harris it has been considered desirable to list all of the names for which no author was given, published in the second (1835) edition of the *Insects of Massachusetts*, and to make notes as to the present status of these names. Certain notes on the types of species described by Harris are also added, and notes on a few of Norton's species, the types of which are in the Harris collection, are appended.

The Harris collection of sawflies is now housed, in one drawer, in the Museum of the Boston Society of Natural History, Boston, Massachusetts. The specimens are carefully cared for and with the exception of damage done years ago are in a fair state of preservation.

Besides containing specimens determined by Norton and Harris there are in the collection specimens of certain species determined by Say. Some of these specimens belong to species which were previously described by Say. These specimens were years ago labeled as Say's types. They are not types in the usual understanding of the word, although certain of them might well be chosen as neotypes.

Mr. C. W. Johnson has kindly looked over the manuscript for this paper and under date of May 9, 1918, states he has marked the specimens here designated as types.

SPECIES LISTED IN 1835 CATALOGUE

Cimbex ulmi Harris, Cat. Ins. Mass. 586, nomen nudum. 1833; ed. 2, 582, nomen nudum. 1835; Ins. Injur. Veget. 374. 1841.

In the last reference the female is described, and the statement is made that the name is that used in the manuscript lectures of Peck and that "the male is *Cimbex Americana* of Dr. Leach."

Type female with no. 128 in Harris collection. Mr. C. W. Johnson has kindly examined this specimen and says it runs to var. *decimaculata* in MacGillivray's key.[3]

[3] Conn. Geol. Nat. Hist. Survey Bull. 22: 104. 1917.

Tenthredo (Schyzocera) **calceola** Harris, Cat. Ins. Mass. 582, nomen nudum. 1835.

This name was never published in connection with any description, but in the manuscript list of Harris under no. 173 the name is listed as having been supplied by Say. To this Harris has added a note that it is not a *Schizocera* but belongs to *Lophyrus*. Later Harris described part of the material under his number 173 as *Lophyrus abietis*, q. v.

Tenthredo (Lophyrus) **flavida** Harris, Cat. Ins. Mass. 582, nomen nudum. 1835.

A nomen nudum and not now represented by specimens in the Harris collection.

Tenthredo (Hylotoma) **scutellata** Harris, Cat. Ins. Mass. 582, nomen nudum. 1835.

Hylotoma scutellata Say, Boston Journ. Nat. Hist. 1: 211. 1836. Not Lepeletier, 1823.

A rather common species now known as *Agre sanguinea* (Klug.).

Tenthredo (Allantus) **sambuci** Harris, Cat. Ins. Mass. 586, nomen nudum. 1833; ed. 2, 582, nomen nudum. 1835.

Allantus epinotus Say, var. a (*A. sambuci* Harris) Norton, Boston Journ. Nat. Hist. 7: 258. 1860.

Macrophya epinotus Say, Norton, Trans. Amer. Ent. Soc. 1: 268. 1867, where *sambuci* is quoted in synonymy. Not *Macrophya sambuci* (Latrielle. 1805).

Norton in 1860 gave standing to the manuscript name *sambuci* of the Harris catalogue by associating it with variety *a* of *Macrophya epinota* (Say). The type specimen, no. 269 Harris collection, is apparently what I consider *Macrophya mixta* MacGillivray, but inasmuch as the name *sambuci* is preoccupied there is no change necessary.

Tenthredo (Allantus) **media** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1860 as a variety of *Macrophya bifasciata* (Say) and now considered as a synonym of it.

Tenthredo (Allantus) **tacita** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1860 and now considered a good species in *Strongylogaster*.

Tenthredo (Allantus) **melisoma** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A name given standing by Norton in 1860 when he considers it a synonym of *Strongylogastroidea terminalis* (Say).

Tenthredo (Allantus) **trosula** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A species described by Norton in 1860 and now considered a good species of *Macrophya*.

Tenthredo (Allantus) **trisyllabus** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A species described by Norton in 1860 and now considered a good species of *Macrophya*.

Tenthredo (Allantus) **atroviolacea** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A species described by Norton in 1860 and now considered a good species in the genus *Lagium*.

Tenthredo (Allantus) **obesa** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A species described by Norton in 1860 and now[4] considered as the correct name for *Eriocampa rotunda* (Norton).

Tenthredo (Allantus) **marginicollis** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861 and now known as *Periclista marginicollis* (Norton). The type, in Harris collection under no. 268, lacks antennae but is otherwise in good condition.

Tenthredo (Allantus) **coronatus** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A name given standing by Norton in 1860 when he quoted it in synonymy with (*Allantus*) *Tenthredo basilaris* Say. Type in Harris collection under no. 310.

Tenthredo (Allantus) **tarda** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A species described by Norton in 1860 and now placed in the genus *Lagium*.

Tenthredo (Selandria) **vitis** Harris, Cat. Ins. Mass. 586. 1833; ed. 2, 583. 1835; Ins. Injur. Veget. 378. 1841. Norton, Proc. Boston Soc. Nat. Hist. 8: 219. 1861.

Selandria vitis Harris, 1832. A discourse delivered before the Mass. Soc. on fourth anniversary, published in New England Farmer. Page and reference unknown. See account in 1841.

[4] MacGillivray, Can. Ent. 40: 368. 1908.

This species has usually, and correctly, been accredited to Harris and is, as pointed out by Norton, a synonym of *Erythraspides pygmaea* (Say). Type, allotype, and a paratype male under no. 172 in Harris Collection.

Tenthredo (Selandria) **barda** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Say in 1836 and now referred to the genus *Tomostethus* where it is a good species.

Tenthredo (Selandria) **pygmaea** Harris, Cat. Ins. Mass. 583. 1835.

This refers to *Erythaspides pygmaea* (Say), described in 1824.

Tenthredo (Selandria) **halcyon** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A species described by Norton in 1861 and now considered a good species in *Hoplocampa*. Type in Harris collection under no. 266, nothing but wings and enough of thorax and legs to keep them on pin.

Tenthredo (Dosytheus) **aprica** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

A species described by Norton in 1861 and now known as *Dolerus apricus* (Norton). Type in Harris collection under no. 311.

Tenthredo (Emphytus) **tarsata** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Say in 1836 and now known as *Macremphytus tarsatus* (Say).

Tenthredo (Emphytus) **mellipes** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861 and now known as *Emphytus mellipes* Norton. Type in Harris collection under no. 122. The Maine specimen is so badly damaged that the specimen from New Hampshire is chosen as lectotype.

Tenthredo (Emphytus) **aperta** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861 and now known as *Emphytina aperta* (Norton). Type female and allotype male in Harris collection under no. 178.

Tenthredo (Nematus) **integra** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Say in 1836 and now known as *Pteronidea integra* (Say).

Tenthredo (Nematus) **melanocephala** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Never described, name used by Hartig in 1837.

Tenthredo (Nematus) **ventralis** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Refers to a species described in 1824 by Say and now known as *Pteronidea ventralis* (Say).

Tenthredo (Nematus) **pallicornis** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861 and treated by Marlatt as *Pontania*. Marlatt is in error, the type is in Harris collection and bears no. 183. It is synonymous with *Diphadnus appendiculatus* (Hartig).

Tenthredo (Nematus) **fulvipes** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Species described by Norton in 1861 but name preoccupied by Fallen. The type of Norton's species is under no. 357 in Harris' collection and is a single male in poor condition. What Marlatt considered as this is now known as *Amauronematus semirufus* Kirby. Norton's type is not *Amauronematus*, but the name *fulvipes* is preoccupied,

Tenthredo (Nematus) **labrata** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861. The type is under no. 182, Harris collection, but notes have been lost and standing of species will have to be investigated.

Tenthredo (Nematus) **stigmatus** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861. The type is a single female with the head and thorax badly eaten and is under no. 435 in Harris collection. It is what is now known as *Pachynematus extensicornis* (Norton) and is a synonym of that species.

Tenthredo (Nematus) **monochroma** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861. The type is under no. 436 in Harris collection. It has only thorax, right wings (except apex) and right hind leg to tarsus remaining. These remains do not indicate that Marlatt was correct in placing this species in *Pteronidea*. It seems that it is *Amauronematus* and Dyar[5] was probably correct in 1894 when he considered the species which Marlatt later described as *Amaurone-*

[5] Can. Ent. 26: 187. 1894.

matus dyari as this species. The thorax, however, also suggests that it may be *Pachynematus* but in that genus there is nothing which *monochroma* can be; *P. apiceae* Rohwer comes nearest. Until what remains of the type has been carefully compared with a number of different species the standing of *monochroma* Norton must remain uncertain.

Tenthredo (Cladius) **isomera** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861. The type is a rather dirty female under no. 185 in the Harris collection. In 1892 Riley synonymized Norton's species with the common European species, *Cladius pectinicornis* (Foucroy), but a recent study of American and European material demonstrates that the two are not the same and makes it necessary to reinstate Norton's name. The differences between the two forms are discussed in detail in a paper on the Cladiinae now in press.

Tenthredo (Lyda) **maculiventris** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1869. There is no specimen of this species in the Harris collection and there seems to be no doubt that the type is lost although it is possible that the paratype is in the Cambridge Museum. MacGillivray[6] recognizes this species and places it in *Itycorsia.*

Tenthredo (Lyda) **ochracea** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1869 and now placed in the group *Itycorsia.* Not in Harris collection but a specimen from "Mass." in Academy of Natural Sciences of Philadelphia is undoubtedly the type.

Tenthredo (Lyda) **rufofasciata** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1869 and now correctly treated by MacGillivray[7] as *Anoplolyda.* The type is somewhat imperfect and is no. 382, Harris collection. Paratypes are in Philadelphia. The type locality is, according to Harris' manuscript list, Dublin, New Hampshire.

Tenthredo (Lyda) **calceata** Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

This has never been described.

[6] Conn. Geol. Nat. Hist. Survey Bull. **22**: 33. 1917.

[7] Conn. Geol. Nat. Hist. Survey Bull. **22**: 41. 1917.

Xyela infuscata Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861 and correctly treated by MacGillivray[8] as *Macroxyela*. The type is no. 186 in Harris collection. It is in good condition and according to Harris' manuscript list was collected April 25, 1827.

Cephus abbreviatus Harris, Cat. Ins. Mass. 583. 1835.

This was described by Say in 1824.

Cephus integer Harris, Cat. Ins. Mass. 583, nomen nudum. 1835.

Described by Norton in 1861 and now correctly treated as *Janus*. Type a single female in good condition under no. 354 in Harris collection.

Cephus heteropterus Harris, Cat. Ins. Mass. 584, nomen nudum. 1835.

Described by Norton in 1861. The type is lost, but a paratype which lacks the head and has part of the thorax eaten away is in Harris collection under no. 314, and according to Harris' manuscript list came from Dublin, New Hampshire. This species is undoubtedly synonymous with *Janus abbreviatus* (Say). The differences mentioned by Norton are not specific as they exist in a reared series now in the National Museum. The venation of the paratype is abnormal.

Cephus filicornis Harris, Cat. Ins. Mass. 584, nomen nudum. 1835.

This was given standing by Norton in 1861 in connection with the description of *Cephus integer*. The specimen he examined is damaged and is in the Harris collection under no. 283. It is, as stated by Norton, the male of *integer*.

Xiphydria albicornis Harris, Cat. Ins. Mass. 584, nomen nudum. 1835; Ins. Injur. Veget. 392. 1841.

This species is correctly synonymized with *Xiphydria maculata* Say. The type is the New Hampshire specimen under no. 302 in Harris collection. The type locality is Dublin, New Hampshire, according to Harris' manuscript list. Type locality determined by list and published statement that he is indebted to L. W. Leonard for the specimens.

Xiphydria mellipes Harris, Cat. Ins. Mass. 584, nomen nudum. 1835; Ins. Injur. Veget. 392. 1841.

Type a single female under name *Xiphydria tibialis* Say and bearing

[8] Conn. Geol. Nat. Hist. Survey Bull. 22: 32. 1917.

Harris' no. 303 in Harris collection. This specimen, according to Harris' manuscript list, was collected by L. W. Leonard at Dublin, New Hampshire (the type locality test, the published statement that Harris was indebted to Leonard for specimens), and was sent under no. 1457. This specimen is in fair condition but lacks the antennae, except the right scape and pedicel.

This species has been synonymized incorrectly with *Xiphydria maculata* Say. It is the same as and will replace the name of the species which the author[9] treated under the name *provancheri* Cresson.

Oryssus haemorrhoidalis Harris, Cat. Ins. Mass. 584, nomen nudum. 1835; Ins. Injur. Veget. 394. 1841.

The type is in good condition but mounted on a pin which is badly verdigrised. It is in Harris collection under no. 304 and according to the Harris manuscript list was collected at Dublin, New Hampshire, by L. W. Leonard. The type agrees with the treatment given by the author[10] in 1912, but in a paper now in press the necessity of uniting *terminalis* and *haemorrhoidalis* is pointed out.

Oryssus maurus Harris, Cat. Ins. Mass. 584, nomen nudum. 1835; Ins. Injur. Veget. 394. 1841.

The type is in good condition and in the Harris collection under his no. 305. It and a paratype under no. 1033 were collected at Dublin, New Hampshire, by L. W. Leonard, according to the manuscript list of Harris. No specimens agreeing with the type or paratypes have been seen and although this is very likely *sayii* Westwood, it seems best to delay a definite statement.

Oryssus affinis Harris, Cat. Ins. Mass. 584, nomen nudum. 1835; Ins. Injur. Veget. 394. 1841.

Type in good condition, except that the apices of the antennae have been eaten, in Harris collection under no. 306. According to the manuscript list the type was collected at Dublin, New Hampshire, by L. W. Leonard. This is undoubtedly the same as *sayii* Westwood, as treated by the writer.[11]

Sirex abdominalis Harris, Cat. Ins. Mass. 584, nomen nudum. 1835; Ins. Injur. Veget. 392. 1841.

Three males under no. 355 in the Harris collection. According to the manuscript list these were collected at Boston, Cambridge and

[9] Ent. News 29: 109. 1918.

[10] Proc. U. S. Nat. Mus. 43: 151. 1912.

[11] Proc. U. S. Nat. Mus. 43: 152. 1912.

Milton (1832) and are all the same species, although one of them is smaller and lacks the head. These agree with Bradley's interpretation of the species,[12] and are the same as *flavicornis* (Fabricius).

OTHER SPECIES DESCRIBED BY HARRIS

Besides the species listed in the 1835 Catalogue, many of which were not described by Harris, certain other species were described by Harris in some of his economic papers. A list of these with notes on the types follows:

Urocerus nitidus Harris, Ins. Injur. Veget. 391. 1841.

Type a badly eaten specimen in the Harris collection under no. 448 and with name label *cyaneus*. That this is the type is proven by the manuscript list, which also adds that it was collected at Dublin, New Hampshire, by L. W. Leonard. What is left of this specimen proves that it is correctly synonymized with *Sirex cyaneus* Fabricius by Bradley.[13]

Lophyrus abietis Harris, Ins. Injur. Veget. 376. 1841.

Under this name in the Harris collection there are two males and two females. One of the females is on a long pin and bears no number label and has not been considered as part of the type material. The other three specimens bear the no. 173 which in the Harris manuscript list refers to "*Schyzcera calceola* S. n. sp." with the added note that Say is wrong and that it "belongs to *Lophyrus*." There is also an account of one specimen collected on pitch pine and specimens reared from larvae on fir. One of the males is a *Monoctenus*, the other is *Diprion* but badly eaten. The remaining female, which is without appendages, must be the type. It is the same as that treated by Norton and is the one now treated under that name. The species will be treated in more detail in a later paper.

Selandria rosae Harris, Ins. Injur. Veget. 380. 1841.

The type of this species seems to be lost, but, in view of the description and biological notes, there can be no doubt that it is *Caliroa aethiops* (Fabricius).

Selandria rubi Harris, Address N. Darling, New Haven, 13. 1845; Norton, Proc. Boston Soc. Nat. Hist. **8**: 221. 1861. (Treated in subgenus *Hoplocampa*.)

[12] Journ. Ent. Zool. 5: 18. 1913.
[13] Journ. Ent. Zool. 5: 14. 1913.

The type is a single female specimen in the Harris collection without a number but with a name label which is folded to hold a detached wing. This specimen is badly broken but enough remains to make it certain that our present understanding of it as *Monophadnoides rubi* (Harris) is correct.

OTHER TYPES IN HARRIS COLLECTION

Besides the types and species listed above the Harris collection also contains certain other types. These are listed below.

Trichiosoma bicolor Norton, Proc. Boston Soc. Nat. Hist. 8: 150. 1861.

The specimen mentioned in the original description as in the Harris collection is a paratype and is now in the Harris collection under no. 511. According to the manuscript list this came from Maine (Randall 1836). This specimen is the same species as described by MacGillivray[14] under the name *confusum*.

Allantus dubius Norton, Proc. Boston Soc. Nat. Hist. 7: 241. 1861.

Two specimens, both which lack head and most of the abdomen, are in the Harris collection under no. 393 and are types.

Nematus bivittatus Norton, Proc. Boston Soc. Nat. Hist. 8: 158. 1861.

Type a single female in Harris collection under no. 184, in good condition, except that it is dirty and on a disk so it cannot be seen well. There is another different female, under no. 184, which is not a type. This species is correctly treated by Marlatt.

Allantus tricolor Norton, Journ. Boston Soc. Nat. Hist. 7: 247. 1860.

Type in Harris collection under no. 515.

Allantus angulifer Norton, Journ. Bos. Soc. Nat. Hist. 7: 252. 1860.

Paratype in Harris collection under no. 430.

Allantus mellinus Norton, Journ. Boston Soc. Nat. Hist. 7: 248. 1860.

Type and allotype in Harris collection under no. 516.

Allantus signatus Norton, Journ. Boston Soc. Nat. Hist. 7: 247. 1860.

Type and one paratype (broken) in Harris collection under no. 431. According to Harris' notes the type locality is Hallowell, Maine.

[14] Conn. Geol. Nat. Hist. Survey Bull. 22: 103. 1917.

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.—*Geothermal data of the United States.* N. H. Darton. U. S. Geol. Survey Bull. 701. Pp. 97, pl. 1, figs. 3. 1920.

A compilation, by States, of all available data on observations of temperatures below the surface of the earth. Several hundred of these were taken by the writer and his associates with the Darton maximum self-registering thermometer, a slight modification of that used by William Hallock. The geologic relations of the wells in each State are discussed. In most wells that penetrate sedimentary rocks not greatly disturbed, there seems to be no distinct relation between the formation penetrated and geothermal gradient. A striking exception is the Des Moines well in Iowa which shows a sudden change from a rate of increase of 1° in 75 feet above the Devonian to 1° in 272 feet below the top of it. The Comstock Lode, Nevada, is noted as a well-known instance of the influence of hot volcanic material below the surface in raising the geothermal gradient. In the State of Washington heat from old lava flows is assumed to be the cause of unusually hot flows of water from wells. Unusually low gradients in the Northern Peninsula of Michigan have been ascribed to the proximity of Lake Superior. By means of a map it is shown that in South Dakota the temperature gradient increases very regularly with the depth below the surface of the granite and quartzite bedrock floor on which the Upper Cretaceous was deposited.

M. I. Goldman.

GEOLOGY.—*Oil in the Warm Springs and Hamilton domes near Thermopolis, Wyoming.* A. J. Collier. U. S. Geol. Survey Bull. 711-D. Pp. 13 (61–73), pls. 4, fig. 1. 1920.

The Warm Springs domes are two high places on the east end of the Thermopolis anticline and the Hamilton dome is a short distance west of its west end. The Thermopolis anticline is a well-known and well-marked arch of the rocks extending about 22 miles northwest through Thermopolis, where it has some large hot springs and travertine deposits near its crest. The anticline is not symmetrical, since the dips are about 45° on the south side and 7° on the north side. The rock formations involved belong to the Cretaceous, Jurassic, Triassic, and Carboniferous systems. In the Warm Springs domes about 4 miles east of Thermopolis the Chugwater, a Triassic formation, is exposed at the surface, and the oil sand is reached in the Carboniferous-Embar group. In the Hamilton dome the rocks exposed at the surface are Cretaceous, and the productive sand is in the Triassic-Chugwater formation. Unlike the light high-grade Cretaceous oils found in Wyoming the oil from the Warm Springs domes is heavy and dark. Its specific gravity is about 19.1° Baumé. That produced in the Hamilton dome is of a little better grade than the Warm Springs oil, having a gravity of nearly 23° Baumé. The production of the Warm Springs domes is given as about 1000 barrels per day. No production is given for the Hamilton dome, as the oil had been struck too recently to justify an estimate. A. J. C.

GEOLOGY.—*Gas in the Big Sand Draw anticline, Fremont County, Wyoming.* A. J. COLLIER. U. S. Geol. Survey Bull. 711-E. Pp. 9 (75–83), pl. 1, figs. 2. 1920.

The Big Sand Draw anticline, 18 miles southeast of Riverton, Fremont County, Wyoming, is so largely concealed by overlying rocks that it was impossible to say whether it was a pitching fold or one of the most promising anticlines of the region.

The rocks involved are the Tertiary, White River and Wind River formations which unconformably overlie the Cretaceous, Mesaverde, Steele, Niobrara, Carlile, and Frontier formations. At the north end of the anticline the Mesaverde formation and Steele shale are exposed, showing on the west limb a dip of 43° and on the east limb a dip of 25°. Farther south there are occasional exposures of the Steele shale showing dips to the east. The overlying Wind River formation is apparently also folded into an anticline but with very low dips.

In 1918 two wells were put down, striking gas rated at 7000 and 10,000 cubic feet per day. The gas is contained in one of the Frontier sands locally called the Wall Creek sand.

The field will be tested further to determine whether or not oil may be found either in the wells already drilled or in wells lower down on the flanks of the anticline. A. J. C.

GEOLOGY.—*The Abram Creek-Stony River coal field, northeastern West Virginia.* George H. Ashley. U. S. Geol. Survey Bull. 711-F. Pp. 19 (85–103), pls. 2. 1920.

The report describes the Abram Creek-Stony River coal field in Grant, Mineral and Tucker counties, West Virginia. The area is of special interest because it contains a large body of low-volatile semi-bituminous coal nearer to tidewater than any other Appalachian coals except those of the Georges Creek and Upper Potomac fields. The field is undeveloped and without railroads but requires only a few miles of branch roads to connect with Baltimore and Newport News. The coals are found in the Pottsville, Allegheny and Conemaugh formations; they occur in a score of beds ranging in thickness from $1^1/_2$ to 20 feet, of which three beds are widely minable in the area studied. All the beds are more or less broken up by partings. A number of analyses are given, and show that the coals of this field are of lower grade than any of the competing coals now on the market, averaging 11.4 per cent of ash and 2.31 per cent of sulfur, with a heating value of 13,100 B.t.u. The estimated recoverable tonnage of the three principal beds is 422,760,000 tons. J. D. Sears.

GEOLOGY.—*Geology and oil and gas prospects of the Huntley field, Montana.* E. T. Hancock. U. S. Geol. Survey Bull. 711-G. Pp. 44 (105–148), pls. 4, figs. 2. 1920.

The Huntley field, in Yellowstone and Big Horn counties, is in reality an eastward extension of the Lake Basin field, described by the same author in U. S. Geol. Survey Bull. 691-D. Rich alluvial deposits and gravel terraces border the Yellowstone, while south of the river the interstream areas are commonly high table lands. Surface rocks include strata of the Colorado, Eagle, Claggett, Judith River, Bearpaw, Lance and Fort Union formations, with later gravels and alluvium. The long narrow zone of faults extending across the Lake Basin field was observed to continue eastward across the Huntley field, demonstrating a belt almost 100 miles in length. The structure of the area is considered in its relation to the major uplifts of south-central Montana and central Wyoming. A few structural features are pointed out which seem favorable for accumulations of oil and gas, and a discussion is given of the factors that should be considered by anyone who contemplates drilling in this field. J. D. Sears.

GEOLOGY.—*Preliminary report on the chromite of Kenai Peninsula, Alaska.* A. C. GILL. U. S. Geol. Survey Bull. **712**-D. Pp. 31 (99–129), pls. 3. 1919.

The chromite deposits of Kenai Peninsula are situated at two localities near the southwest end of the peninsula. One of these, the Claim Point property near the coast, is the only producer of chrome ore in Alaska, and furnished about 1000 tons yearly in 1917 and 1918. The chromite occurs in masses of dunite, which are surrounded by beds of more or less metamorphosed clastic rocks, chiefly slates and graywackes. The outstanding peculiarity of the Kenai Peninsula chromite bodies is their continuity for considerable distances in the shape of bands or layers, as contrasted with the "pockety" character exhibited by such ores at most localities. Estimates of exportable ore are: Port Chatham (at coast), above tide level, 32,300 tons; below tide level, 12,600 tons; Red Mountain (interior) 195,600 tons.

J. D. SEARS.

GEOLOGY.—*Placer mining in the Tolovana District, Alaska.* R. M. OVERBECK. U. S. Geol. Survey Bull. **712**-F. Pp. 8 (177–184). 1920.

Mining in the Tolovana district in 1918 was practically restricted to the gold placer deposits in the vicinity of Livengood, north of Fairbanks. Other minerals occurring in the district, not yet known in sufficient quantity to be of economic importance, are chromite, scheelite, stibnite, and possibly platinum. The value of the output of placer gold in the Tolovana district in 1918 was about $875,000, compared with $1,160,000 in 1917. This is about 15 per cent of the total placer gold production of Alaska in 1918, and gives the Tolovana district second place. The deposits of Livengood Creek and its branches are described, of which most are buried or bench placers. The paper is supplementary to a report on "The Gold Placers of the Tolovana District" by J. B. MERTIE, JR. (U. S. Geol. Survey Bull. **662**: 221–277, 1917).

J. D. SEARS.

GEOLOGY.—*The Upton-Thornton oil field, Wyoming.* E. T. HANCOCK. U. S. Geol. Survey Bull. **716**-B. Pp. 18 (17–34), pl. 1, fig. 1. 1920.

The report deals with an area on the southwest flank of the Black

Hills at the boundary of Weston and Crook counties in northeastern Wyoming. Of the rocks exposed the highest is about 1200 feet above the base of the Upper Cretaceous Pierre shale, the lowest about 100 feet above the basal Upper Cretaceous Dakota sandstone. From the records of nearby borings about 2830 feet of rocks beneath this, to a depth of 398 feet in Mississippian limestone, are described. The structure is represented by contours at 50-foot intervals and by diagrammatic cross sections. The general southwest dip of the region is interrupted in the Upton and Thornton domes which lie along a common axis trending parallel to the general strike. Dips range from a few degrees to 25°. The Thornton dome is about 2 miles wide by 6 long and rises about 500 feet above the syncline which bounds it on the east. The Upton dome is about 1½ miles wide and 4 long, and about 100 feet high. The only developments on these domes are two dry holes apparently well located and drilled to the red beds, but a number of wells are daily producing 5 to 10 barrels of high-grade light oil from a sandstone immediately above the Greenhorn limestone, lying 450 to 850 feet below the surface in a structural terrace about a mile long and wide just beyond the northwest nose of the Thornton dome, which is the more northerly of the two domes.

M. I. GOLDMAN.

GEOLOGY.—*The Sunset-Midway oil field, California.* Part II. *Geochemical relations of the oil, gas and water.* G. S. ROGERS. U. S. Geol. Survey Prof. Paper **117**. Pp. 103, pls. 2, figs. 8. 1920.

Part I of this paper describes the general geology of the Sunset-Midway region and the development and underground conditions in the productive field, and discusses also the origin and migration of the oil. California petroleum differs in many important respects from the varieties produced in other parts of the United States, and a considerable amount of chemical study has been devoted to it. Part II describes the chemical and physical properties of the California oil and gas, and discusses the relations of these properties to the geologic occurrence, emphasizing especially the importance of the chemical action of mineralized water as a cause of variation in gravity of the oil and the formation of carbon dioxide in the gas. The paper includes also some figures on the geothermal gradient, and a discussion of the occurrence and nature of oil-field waters and their invasion of oil sands.

J. D. SEARS.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

832ND MEETING

The 832nd meeting was held at the Cosmos Club, March 13, 1920. President SOSMAN presiding and 35 persons present.

W. W. COBLENTZ: *Some characteristics of spectro-photoelectrical sensitivity in solids.*

In introducing the subject the speaker said that numerous solid substances, which have a low electrical conductivity in the dark, have a high electrical conductivity when exposed to light, selenium being the most widely known example. This photo-sensitive property is a function of the temperature of the substance; also of the intensity and of the wave length of the thermal radiation stimulus. It is found that the photo-electrical response of substances in general is fairly regular throughout the visible spectrum, terminating in a band or bands of high sensitivity in the extreme red or near infra-red spectrum. On decreasing the temperature of the substance, its intrinsic photoelectrical sensitivity is greatly increased throughout the whole spectrum and the point of maximum sensitivity is shifted toward the short wave lengths.

On a few rare occasions experimenters have observed that on exposure of selenium to light from an incandescent lamp the galvanometer gave a negative deflection, indicating an apparent rise in resistance which is higher than that which obtains in the dark, whence the name "photo-negative response." In one case, using light dispersed into a spectrum, it was observed in a sample of stibnite (Sb_2S_3) that this photo-negative property is caused by yellow and green light (wave lengths less than 0.65μ), whereas the red and infra-red rays produced a photo-positive reaction.

Molybdenite is a natural sulfide of molybdenum, some samples of which mineral are photoelectrically sensitive. In addition to the photo-positive properties just described, the speaker presented observations on a photo-negative reaction which was found localized in a small spot, perhaps 1 mm. in diameter, in the crystal. This photonegative property appears to depend upon the magnitude of the potential applied to the crystal, and is produced by wave lengths less than 0.65μ. Furthermore, this photo-negative property seems to depend not only upon the magnitude of the potential applied but also upon the direction of the current through the crystal. The photo-positive action is the same as a resistance decrease caused by a rise in temperature of the molybdenite. The photo-negative reaction is similar to the building up of a counter e. m. f.

In this work the radiation stimuli of different wave lengths were of equal energy value. Hence, if this phenomenon were the result of heating and of electrolytic action, the photo-positive response should occur in the short wave lengths where the absorption is the greatest in the crystal, and the photo-negative response should occur in the long wave lengths, where the photo-electric reaction is the greatest. In this respect, the observed phenomena are just the reverse of what one would expect.

Discussion: This paper was illustrated by lantern slides and was discussed by Messrs. SOSMAN and HAWKESWORTH.

S. M. BURKA: *Hypersensitizing commercial panchromatic plates.*

Ordinary photographic plates, which owe their sensitivity to the silver halides alone, are sensitive only to the violet and blue regions of the spectrum. If, however, suitable dye-stuffs be added, either by the laboratory method of bathing the plates in a solution of the dye, or by the commercial method of incorporating the dye in the emulsion, the plates become sensitive to other regions.

The effect of ammonia on the sensitivity of commercial plates containing dyes was investigated. As a result of numerous trials, using varying concentrations of ammonia, the procedure finally adopted was to bathe the plates before exposure for four minutes at 16° to 18° C. in a solution of 3 cc. ammonia (20 per cent NH_3) in 75 cc. water and 25 cc. ethyl alcohol and dry as rapidly as possible. They were then exposed in a grating spectrograph and the spectral sensitivity determined. In a number of cases the speed was also determined by a sensitometer of the Chapman Jones type, and by the Hurter and Driffield method.

The sensitivity of orthochromatic (sensitive to green and yellow) plates showed, with one exception, no appreciable change. Every panchromatic (sensitive to all colors) plate tried (nearly a dozen different brands) had its speed increased at least 100 per cent to white light and over 400 per cent to red. The sensitivity was also extended 100 or more Angstrom units into the red. The strong minimum in sensitivity in the green shown by most plates was to a great extent smoothed out. The most striking increase in sensitivity was shown by a Wratten and Wainright panchromatic plate which was used three years after its "expiration" date. The speed was increased over 600 per cent throughout the region from H_β to beyond H_α.

The action of the ammonia seems to be specific towards the pinaverdol and pinacyanol series of dyes. Practically all orthochromatic plates are dyed with erythrosin. The exceptional plate mentioned above is a pinaverdol plate.

Bathing a plate after exposure but before development has no effect on the speed.

The ammoniated plates deteriorate rapidly, showing chemical fog in development, so that most brands are useless four or five days after treating. The plates should, therefore, be used a day or two after ammoniating and overdevelopment should be avoided. They should also be kept cool. If the plates are used immediately after drying, greater increase in sensitivity can be obtained by omitting the alcohol from the bath and using $3^1/_2$ cc. ammonia to 100 cc. of water.

Discussion: This paper was also illustrated by lantern slides and was discussed by Messrs. SOSMAN, WHITE, HUMPHREYS and Miss KLEINSCHMIDT.

H. S. BOYD and C. G. PETERS: *The calibration of precision end gages.* The paper was presented by Mr. BOYD. Precision end standards or gages, which are blocks of hardened steel or of other materials made with two opposite faces plane, parallel and a specified distance apart, are used as master gages for precise mechanical work. The fact that these gages are made so nearly perfect that it is impossible to determine their errors with any contact micrometric instrument has necessitated the use of interference apparatus and methods for their calibration. With these methods, developed at the Bureau of Standards, the above mentioned properties of gages can be determined with an error of only a few millionths of an inch. In testing the planeness of the gage surface a plane glass test plate is placed in contact with the surface and illuminated with monochromatic light. The planeness of the surface is determined from the shape of the interference fringes. The length of the gage is obtained by comparison with the standard light waves. An interferometer mirror is placed in contact with each end of the gage, thus forming a Fabry and Perot interferometer. The length of the gage is then determined from the number of waves of known length between the two interferometer plates. When the interferometer constructed in the manner just described is viewed in parallel monochromatic light, the parallelism of the gage surfaces can be determined from the expansion or contraction which takes place in the ring system when the eye is moved perpendicular to the line of sight. After gages of various sizes have been standardized other gages can be calibrated by comparison with these standards. To accomplish this a standard and an unknown gage are placed in contact with a plane plate of glass. Another plane plate of glass placed over the gages is illuminated with monochromatic light to show straight fringes. The difference in the length of the two gages is determined from the relative displacement of corresponding fringes.

Discussion: The paper was illustrated by lantern slides and was discussed by Messrs. WHITE, PETERS, MUELLER, SOSMAN, FERNER, TUCKERMAN and L. J. BRIGGS. A number of gages were exhibited by Mr. BOYD.

S. J. MAUCHLY, *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

328TH REGULAR MEETING

Held February 5, 1920, at the Cosmos Club, with President WALTON presiding, and 30 members and 3 visitors present.

The recording secretary made a statement regarding the importance of speakers furnishing him with abstracts of their remarks and announced that hereafter speakers will be furnished with blank forms for abstracts

New member: EDWARD A. CHAPIN of the Biological Survey.

The regular program was as follows:

N. E. McINDOO: *The olfactory sense in Orthoptera.* In making a comparative study of the disposition of the olfactory pores in Orthoptera, both sexes of 21 species belonging to 20 genera and representing the 6 families were examined. Olfactory pores are more widely distributed in Orthoptera than in any of the higher orders of insects. They are always found on the legs, antennae, and anal stylets; usually on the wings (if present), abdominal segments, cerci, head, and all the mouthparts; and sometimes on the thoracic segments and ovipositor. Relative to the antennae a few usually lie on the first segment, but always many on the second segment. In regard to the total number of pores found, mantids and phasmids have the smallest number, certain acridids have the largest number, while the remaining species have a median number of about 1000. The newly hatched croton bug has 44.5 per cent as many pores as the adult female, and also the pores in the six instars of the grasshoppers gradually increase from 46 per cent in the first instar to 100 per cent in the adult female. Externally these organs are usually oblong, sometimes almost slit-shaped, but the eye-shaped type is the most common. Internally each one has a spindle-shaped sense-cell whose peripheral end unites with the pore aperture in the chitin, thus allowing the external air to come into direct contact with the nerve. Experiments were performed on grasshoppers and crickets to determine whether the so-called olfactory organs on the antennae receive olfactory stimuli. Since the antennae were cut off just distal to the olfactory pores on the first and second segments it appears from the reaction times obtained that the remainder of the antennal segments, which bear the so-called olfactory organs, do not serve as an olfactory receptor as other investigators claim.

In answer to questions by various members, Dr. McINDOO stated it as his belief that the antennal organs commonly supposed to be olfactory are tactile, and serve for the detection of air currents; that evidence of the olfactory nature of the organs he had discussed was obtained by removal of appendages and painting over the other organs with beeswax and vaseline; and that in order to eliminate the element of shock he had delayed his experiments for 24 hours after mutilation. Mr. MIDDLETON questioned Dr. McINDOO on whether all the types of organs represented (those he interpreted as olfactory and those believed by others to furnish insects with that sense) were found mixed together in the same locality or cluster, suggesting that if not, by eliminating certain types of organs by coating those portions of the body wall containing them, the true organs might be determined and that some further information on the constitution of an odor might be arrived at through a study of the structure of the organs whose irritation or disturbance gave rise to reactions indicating olfactory sense. Dr. Böving discussed certain organs on coleopterous larvae the function of which he did not know. These structures are similar in form to certain of the organs discussed by Dr. McIndoo. Dr. Quaintance thought that such studies should lead to practical use of the knowledge gained and suggested that some substance distasteful to bees might be placed in sprays and thus eliminate the serious loss in hives due to bees feeding on sprayed flowers.

Symposium on laboratory methods and devices for breeding and rearing insects.

J. A. Hyslop: *Subterranean insects.* The technique described was developed during ten years of biological and ecological investigations on the coleopterous family Elateridae with occasional studies on other insect groups. The unit system universally used in library indexing was found to be admirably adaptable to this work. Each specimen on being received at the laboratory was isolated in an individual cage and given an accession number in chronological sequence. A 3 × 5 card bearing this number was prepared and all collecting data were recorded. Subsequent notes were recorded on similar cards and the cards filed in numerical order. The cages were tinned salve boxes ranging in size from one inch in diameter and one-half inch in depth to two and one-half inches in diameter and one inch in depth, depending upon the size and nature of the material. These cages were arranged in numerical order in shallow galvanized iron trays measuring 18 × 24 inches and the trays filed in sequence in slide stacks below the work bench in the laboratory insectary, each tray bearing on its exposed edge the first and last accession numbers contained in that tray. By systematizing the method of procedure in examining this material and in making notes it was possible, with two inexperienced laboratory assistants, to keep careful daily records of over four thousand specimens. The significant feature of this method of handling insectary material is the absolute systematizing of the routine work, the reduction of the size of the cage to a minimum and its style to the greatest possible simplicity. Laboratory conditions were made absolutely artificial, no attempt being made to reproduce a natural environment indoors. The data collected by this process was very accurate for the existing known conditions, and field observations and notes were very easily correlated with this data so that it could be applied to normal field conditions. Mr. Hyslop stated that "our experience has convinced us of the feasibility of the following biological laboratory law: *The accuracy of biological laboratory observations is inversely proportional to the size of the cage and directly proportional to the thoroughness of the system of observing.*"

F. C. Craighead: *Wood-boring insects.* In the past five years the author and several assistants have reared a great many coleopterous larvae. Stress was laid on the fact that the best results were secured through the reproductions of conditions, as near as possible, to those existing in nature. Humidity was found to be the most important factor and by regulating this to a practically constant degree throughout the year the best results were obtained. To secure this result those types of cages which could be tightly closed were found most satisfactory, such as museum jars, fruit jars, and smaller phials with screw tops. For successful breeding of these insects it is necessary to know beforehand certain conditions under which they live. For instance, in each species of wood-boring beetles a decided preference is nearly always shown for a particular condition of wood. It may be green wood, that which is thoroughly seasoned, or perhaps that which has undergone a certain stage of decay. In such cases it is absolutely necessary to exactly duplicate this condition in order to propagate the species.

E. R. Selkregg: *Fruit-infesting Lepidoptera.* The larvae of the codling moth and similar larvae are allowed to spin cocoons in pupation sticks where their transformation to pupae can be observed. These pupation sticks, one of which was exhibited, consist of a strip of wood with numerous sawcuts part way through, over which is placed a strip of transparent celluloid and then an uncut strip of wood. Glass battery jars are the most convenient rearing cages, furnishing approximately natural conditions for development of various stages. They are easily handled and quickly moved about the insectary. The insects develop in these jars at the same rate as in nature, according to definite observations.

R. A. Cushman: *Hymenopterous parasites.* Rearing of these insects is very easy with almost any sort of jar, box, or phial, depending on the size of the specimen or amount of material. Moisture should be very sparingly employed. Host remains and cocoons of parasites should always be preserved as from them can be learned much regarding the habits and development of the parasite. Breeding of parasites as distinguished from rearing is a much more difficult matter. These insects are so strongly heliotropic that they spend practically all of their time in crawling about the top of the cage. The best results were obtained with small cages which brought the material to be parasitized close to the top and sides of the cage. Various types of small cages were described and exhibited and the method of handling them described. A small cage entirely of glass for photographing living insects was also described and photographs of cages and living insects were exhibited. After oviposition has been secured the treatment depends almost entirely on the nature of the host, and since insects of practically all sorts are attacked by parasites, the worker with parasites is perhaps more largely benefitted by the ideas brought out in such a symposium as this than any other.

S. A. Rohwer: *Insectaries.* The speaker stated that in constructing insectaries efforts should be made to approximate natural conditions, and as the amount of time available for discussion was limited he only called attention to a few points which had been gained from his experiments in constructing insectaries at the Eastern Field Station of the Bureau of Entomology. It is important to confine the work done in an insectary to one type of rearing or to rearing of insects of one order. The cone type roof with broad eaves is much more satisfactory than any other type used. Illustrations and blue print plans of the insectaries of the Eastern Field Station were exhibited. The use of hinged wooded doors to afford protection and permit changes in ventilation was emphasized. It was pointed out that such means of protection is much more satisfactory than canvas curtains. Graphs showing how the temperature of an insectary protected by canvas curtains departed from the temperature of the surrounding air and varied much more than that of an insectary protected with wooden doors were presented. These graphs showed that even under the most favorable conditions of ventilation the temperature of the insectary protected with canvas curtains showed an unusual range and often departed as much as 15 degrees F. from the surrounding air. This forces the conclusion that unless it is possible to be at hand continually and alter the canvas curtains the use of canvas in the construction of insectaries is unsatisfactory. Mention was made of the value of a vestibule entrance for insectaries containing exotic insects, and also of the use of a dark room, with only one source of light, in removing insects from cages. It was recommended that an effort be made to standardize insectaries and that they be built on the sectional basis.

In discussing the preceding papers on rearing cages and devices, Mr. Rohwer called attention to the apparent differences in opinion between the previous speakers. One speaker had stated that he had better success under most artificial conditions; another speaker had emphasized the great importance of duplicating natural conditions; another had implied that humidity had but little effect. From the standpoint of the taxonomist it seems to be of great importance to know under what condition material was reared because there seems to be more variation in color in reared hymenoptera than in collected. The only way to explain this great variation in some forms is to assume that there was a difference in conditions under which they were reared. We know from experiments on Lepidoptera that melanistic or albinistic races can be produced by changing humidity. It is therefore only fair to the taxonomists that records of the kind of rearing devices and approximation of natural conditions be recorded.

Dr. Quaintance described briefly the ingenious device perfected by Mr. R. L. Nougaret for the study of the grape phylloxera in California. The vines are planted in two large flower pots, one above the other and the whole placed in a deep pit. When it is necessary to examine the colonies of phylloxera the pots are raised out of the pit by means of a derrick. Mr. Heinrich emphasized the necessity of having the food furnished to larvae in its natural condition, citing the formation of poison in the leaves of wild cherry after they are picked. Mr. Greene stated that to rear diptera successfully natural conditions must be maintained. R. A. Cushman, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Division of Mechanical Technology of the National Museum has constructed and placed on exhibition a model of the flying machine designed and constructed in 1491 by LEONARDO DA VINCI.

An unexpected result of the National Prohibition Act is the acquisition by the National Museum of an excellent skull of the mammoth, *Elephas primigenius*, the second specimen of its kind ever found in the United States. It had long been exhibited in a Cincinnati bar-room and the proprietor had refused all offers for it until prohibition rendered it valueless in its existing location, when it was acquired for a small sum by the Museum.

Mr. A. V. BLEININGER, ceramic chemist and head of the ceramic division of the Bureau of Standards, resigned in September to become research chemist for the Homer-Laughlin China Company, of East Liverpool, Ohio.

The Carnegie Institution of Washington published in September the second volume of *The Cactaceae*, by N. L. BRITTON and J. N. ROSE. An abstract of the first volume appeared in this JOURNAL for August, 1919. Two other volumes are yet to appear.

Dr. NORAH E. DOWELL, formerly instructor in geology at Smith College, has beeen appointed assistant geologist in the U. S. Geological Survey for duty as office geologist and research assistant in the Ground Water Division.

Dr. J. W. FEWKES, of the Bureau of American Ethnology, spent August in the excavation and repair of Cedar Tree Tower in the Mesa Verde National Park, Colorado.

Dr. AUGUST F. FOERSTE, of Dayton, Ohio, spent the summer in the Division of Paleontology of the National Museum, cooperating with Dr. R. S. BASSLER on a monograph of the Silurian cephalopods.

Mr. J. W. GIDLEY, of the section of vertebrate paleontology, U. S. National Museum, visited Williamsburg, Virginia, in September, to investigate the discovery of remains of an extinct species of whale, reported by Dr. DONALD W. DAVIS, of the College of William and Mary. Material was secured for the Museum, although not sufficient for a skeleton mount.

Mr. A. K. HAAGNER, director of the zoological park at Pretoria, South Africa, visited Washington in September, on his way to London. Mr. Haagner came to the United States in charge of a shipload of African animals which had been collected at Pretoria during the war for various American zoological parks, and which arrived at Philadelphia in September.

Dr. Rodney B. Harvey, formerly plant physiologist in the Bureau of Plant Industry, U. S. Department of Agriculture, has resigned to accept the position of assistant professor of plant physiology at the University of Minnesota and assistant plant physiologist at the Minnesota Experiment Station.

Mr. P. C. Holdt has been appointed research associate at the Bureau of Standards, representing the American Paint and Varnish Manufacturers' Association.

Dr. T. Harvey Johnston, of Queensland, visited the National Museum in September, on a mission to various parts of North and South America for the purpose of studying the cactus and means of controlling it.

Mr. Benjamin R. Jacobs has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, to become director of the National Cereal Products Laboratories, with offices in Washington.

Mr. Neil M. Judd, Curator of American Archeology, U. S. National Museum, returned to Washington October 1st, after having spent the spring and summer months in the Southwest, engaged in archeological research for the Bureau of American Ethnology and the National Geographic Society.

Mr. Alan Leighton, formerly chemist with the Bureau of Mines at Pittsburgh, has been transferred to the Bureau of Animal Industry, U. S. Department of Agriculture.

Dr. William A. Locy, professor of biology at Northwestern University, and author of *Biology and its makers*, spent the summer in Washington in historical research, chiefly in the library of the Surgeon General's Office.

Mr. H. C. Raven, zoological collector and naturalist with the Smithsonian African Expedition under the direction of Mr. Edmund Heller, returned to Washington on September 21.

Mr. E. J. Ruh has been appointed research assistant at the Bureau of Standards by the International Nickel Company.

Miss Lily B. Sefton, formerly of the Bureau of Stndards, has been appointed assistant professor in the department of chemistry of the University of West Virginia, at Morgantown, West Virginia.

Dr. R. J. Tillyard, director of the Cawthron Institute of Scientific Research at Nelson, New Zealand, visited Washington during the summer. Dr. Tillyard has spent seventeen years in Australia, devoting himself to research on the Neuropteroid insects, recent and fossil. He returned to New Zealand in October.

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CIVIL SERVICE REFORM.—*A reorganized Civil Service.* EDWARD B. ROSA, Bureau of Standards.[1]

I. INTRODUCTION

The United States Government may be likened to a great business organization of which Congress is the Board of Directors and the taxpayers are the stockholders. The various departments, bureaus, and other branches of the government are managed by secretaries, directors, division chiefs and various assistants, the chief executive officer over all being the President. There are altogether several thousand men in responsible administrative positions in the government's complex organization who are concerned with problems of administration and business management, and who at the present time are specially interested in the employment policy of the government. There are several hundred thousand employees of the government who are not only interested in this question, but vitally concerned, and are calling the attention of Congress and the public to the fact that the government's employment policy needs revision and bringing up to date. The administrative officers of the government, like the managers of a business, represent the employer, and think first of the question from the standpoint of the management, not, however, overlooking the interests and the rights of the employees. The representatives of the employees properly think first of the interests of the employees, but they *should* not and *do* not overlook the interests of the government, and they are rendering a great service at the present time in publicly discussing the questions at issue.

[1] An address delivered before the Washington Academy of Sciences on October 23, 1920.

This paper is a discussion of the government's employment policy from the administrative standpoint, but with careful regard for the interests of employees. The cardinal principle underlying this discussion is that in the government service, even more than in private business, administration should be reasonable and just, and administrators competent and efficient. Officers should be held responsible for results and should be given sufficient authority and means to work with, so that there can be no excuse for failure or for inefficiency. But autocracy, irresponsibility, and selfish interest have no place in the public service. The question, therefore, is—What changes in the employment policy of the government should be made in order that the government service may be put on a very high plane, that it shall offer so attractive a career that able men and women may be secured and the best retained in the service, and that it shall rank with the very best organizations anywhere in the integrity, ability, and efficiency with which it is conducted? There is very much in the government service now to be proud of, more than many people think. But there are serious handicaps to efficiency which can be removed, and the government's haphazard employment policy is one of them.

2. NEED FOR IMPROVEMENT

The administration of the Civil Service on the merit system, free from patronage and politics, has been steadily extended until it covers a very large part of the federal government. In this extension the Civil Service Commission has been an effective agency, in spite of a serious handicap arising from an insufficient personnel. The Commission has ample authority as well as the good-will of administrators and the moral support of the public, and has done a work of immense importance. Nevertheless, it cannot be denied that there are serious defects in the Civil Service. Charges are sometimes made of favoritism in appointments and promotions, and of too little consideration of the employee's point of view. In many cases insufficient means are provided for learning whether the employees are satisfied, and of answering complaints. On the other hand, the standard of the personnel throughout the government service is not what it should be, the quantity and quality of work done in many cases is unsatisfactory, experienced and competent men and women are leaving the service in large numbers, and their places are being taken by others, on the average less experienced and less competent. Owing to an inadequate and irrational salary scale, many branches of the government service are so unremunerative and unattractive that their administrative officers have much difficulty in keeping positions filled. Under such circumstances it is impossible to maintain proper discipline or a high standard of efficiency, and the consequences of a lowered morale are plainly evident. The situation is far more serious than it was eighteen months ago when Congress appointed a special commission to study and report upon it.

3. LEGAL DIFFICULTIES

The merit system presupposes an honest, unbiased, and competent administration of the personnel; appointments without favor, promotions when earned, security of tenure, opportunity to make good, recognition of work well done. The government should be a just and reasonable employer, if not indeed a model employer, and the administrative officers of the government should not only be authorized and required to deal justly and equitably by the employees under their supervision, but they should be empowered to do so. In general, this is far from being realized, and the greatest handicap to good administration is not in the faults and frailties of administrative officers (serious as they may be in some cases) but in the laws and limitations imposed upon the administrators, which tie their hands and make good administration exceedingly difficult; and in the lack of adequate personnel in the Civil Service Commission, which makes it impossible for it to cooperate with administrators as effectively as it should, or to exercise the supervision over appointments and promotions which the law contemplates and which administrators would welcome.

The most serious of these legal difficulties are the following:

(1) The system of statutory positions with inflexible and generally inadequate salaries, which often make appointments and promotions difficult or impossible.

(2) Unequal salaries in different services for a given kind of work and degree of responsibility.

(3) The legal prohibition of transfer and promotion from a position in one department to a lump-fund position in another at a higher salary, no matter how much such promotion is merited or how strongly it is recommended by the administrative officers concerned.

(4) The legal restriction requiring three years' service before transfer from one department to another in Washington.

(5) The apportionment system which often makes it impossible to appoint the most competent eligibles, and sometimes rules out all the applicants from several states.

(6) The entire lack, until very recently, of a retirement system for aged or disabled employees, which made it necessary to retain thousands who under other conditions would have been retired to the advantage of the service.

4. STANDARDIZED CIVIL SERVICE

If the classification of the Civil Service as proposed by the Congressional Commission is effected, so that there will be a standardized system of positions and titles, with systematic specifications of qualifications and duties, and salaries that are uniform throughout the service for comparable duties and responsibilities, then it would be possible to dispense with the present inflexible statutory positions and the unrestricted and unstandardized lump-fund positions and replace both by the new standardized and classified system of positions, which would be defined and authorized by law. This would do away with the first two of the above-named legal limitations, and remove the reason for the third and fourth, which could then be repealed.

The fifth difficulty probably cannot be entirely removed, although more active recruiting of eligibles from States below their quota would furnish better material and so satisfy the apportionment law without lowering the standards of the service, at least not as much as would otherwise be inevitable. The tendency of the apportionment system is necessarily to lower the service in Washington, because very often the best men in distant States cannot afford to come to Washington at considerable expense, in view of the inadequate salaries paid by the government. The result often is that inferior men who need a job are certified from distant States and are appointed ahead of abler men from nearby States that have their full quota.

Active recruiting by representatives of the Civil Service Commission in those more distant States would perhaps go far toward remedying the difficulty, but it would involve some expense.

The last difficulty mentioned has lately been partially met, although compulsory retirement on $30 to $60 per month, according to length of service, is not an attractive proposition in the higher grades of the service, especially when it is learned that the salary deductions (to be credited to the pension fund) are proportional to the salary, but the benefits are not. For example, the deductions for a $4800 position are four times as much as for a $1200 position, but the retiring allowance is no more than for the latter position.[2]

If through the adoption of a budget system or otherwise, funds are made available so that adequate salaries can be paid and promotions can be made systematically and without undue delay, and work can be planned ahead and carried out consecutively by those who plan and begin it, the most serious handicaps to efficiency will be removed and a long step forward in good government will have been taken. One of the greatest handicaps to good administration is the lack of inducement for a career, arising from inadequate salaries for administrative positions in nearly all branches of the government service. Adequate salaries which would be an incentive for the best to remain in the service of the government would be of great value to the service, and would remove many difficulties arising from inexperienced men filling responsible positions. With so great a turnover in the personnel, including administrative officers, mistakes in administration are to be expected. It is no more possible to operate an important department of the federal government satisfactorily with a large proportion of inexperienced officers and employees than it would be to operate a bank or a great mercantile establishment successfully with inexperienced officers and employees. The wonder is in some cases that the government departments

[2] So far as the higher positions are concerned, therefore, the retirement law offers no incentive for entering the government service, but is one more reason for increasing salaries. For the deductions from salary, coming after so many increases in the cost of living, are in many cases like the straw that breaks the camel's back.

do as well as they do. Many men of ability and experience are serving the government at salaries below a living wage. But the losses to the service due to resignations of such men in responsible positions are very serious and the situation is steadily growing worse.[3] Paying low salaries to men in important administrative positions leads to inefficiency and waste rather than economy.

5. FUNCTION OF CIVIL SERVICE COMMISSION

The function of the Civil Service Commission as an employment agency is to be of maximum service to the executive departments in filling positions and administering the personnel. In addition to safeguarding the interests of the public and of the employees by keeping the service free from the effects of politics and favoritism, it is able to render great assistance to administrative officers by finding men and women who are qualified for the various positions to be filled, taking full account of the needs of the service and of the importance in many cases of special training and experience. In the case of supervisory and technical positions, administrative officers and their trained assistants who know the requirements of the work and the qualifications needed, and who are responsible for the results obtained, should be given a large measure of authority as well as of responsibility in making appointments and promotions. The Civil Service Commission should, however, be closely in touch with the bureaus and departments and should be so well acquainted with the needs of the service that it can advise, or overrule, if necessary, intelligently and sympathetically. The experience of the Civil Service Commission shows that administrative officers as a rule welcome its assistance and advice when they can deal directly and can understand one another. Difficulties, when they occur, are generally caused by lack of understanding from lack of contact. Prompt and efficient administration is important; excessive formality and routine, involving unbusiness-like delay and unnecessary expense, should be avoided.

[3] See editorial in Chicago Evening Post, Sept. 8. 1920, page 44, concerning "Young Men in Government Service."

The entire government service may be likened, not to a single large corporation which has one employment agency, but to a large number of corporations of many different kinds associated in a great group by a holding corporation. An employment agency maintained by the holding corporation would not select the personnel nor make promotions for every separate company. The officers of the separate companies in intimate contact with the personnel and the work would do that. But the central agency could be of great service in finding men, arranging transfers from company to company, formulating policies, checking the practice of the several companies, and cooperating with and advising and educating their employment officers. Such a case is not perfectly analogous to the federal government, but it is nearer to it than a single corporation having one employment agency.

6. EXTENSION AGENTS AND ADVISORY COUNCIL

Extension agents of the Civil Service Commission located in the departments or going about from bureau to bureau would be able to render important assistance to administrators and to keep the Commission informed as to the operation and the needs of the service. Personal contact between the representatives of the Civil Service Commission and administrative officers is very essential to avoid misunderstanding and ungrounded suspicion, as well as to give the Commission fuller knowledge of the needs of all branches of the service, and to give administrative officers more intimate knowledge of Civil Service procedure and the practice of other branches of the service.

The meeting together of such a body of liaison officers for conference and to report to the Commission would enable each one to become acquainted with the best administrative methods prevailing in the departments, and to carry back to the department or establishment he was serving information and suggestion of the greatest value to administrators. Such extension agents should be men of high character and attainments, possessing tact and talent for dealing with men, and with considerable experience in the government service. They would acquire an intimate knowledge of the quality of the personnel of their respective departments, and would serve an important function in helping the Commission to keep the salary scale equalized in the various departments.

They would keep in touch with the eligible lists of the Commission, and would be able to advise administrative officers as to the qualifications of the men available for appointment or transfer, and whether the standard for promotion in a given bureau or department was in agreement with the service generally. Indeed, without the coordinating influence of such liaison officers, it is difficult to see how a standardized service could be kept standardized and uniform.

An alternative method would be for the bureaus and departments to employ expert personnel officers (corresponding to employment managers in the industries) who would keep in close touch with the Civil Service Commission, and thus secure the close personal contact and cooperation between the Commission and the departments which is so necessary. Of the two, it would seem that the extension agents of the Commission are to be preferred, although in any event the employment of trained specialists as personnel officers or employment managers in the bureaus and departments should be encouraged.[4]

[4] To realize how utterly impossible it is for the Civil Service Commission at present to perform all the functions described above, one has only to consider the low salaries paid and the inadequate staff provided. Whereas many other branches of the service pay their most responsible officers $3000 to $4500, and in some cases $5000 to $7500 or even more, the Civil Service Commission has only two positions (aside from the Commissioners themselves) paying more than $2400, namely the chief examiner at $3500 and the secretary who gets $2500 *and no bonus*. They have a lump sum of $100,000 for salaries, carrying a provision that no salary higher than $1800 shall be paid therefrom. 358 clerks and examiners have an average salary of $1311 (besides the bonus). Included in this number are 41 college graduates averaging $1602. These are the men who examine and rate those entering the service, even in the highest grades, including all the technical services, and who are supposed to supervise the administration of the government's employment policy, approve promotions and transfers, and see that the law is obeyed.

The Civil Service Commission maintains 12 district offices and holds examinations all over the United States, and because of the great turnover in the service was called upon to recruit 200,000 new employees last year in spite of the fact that the whole number of employees was reduced by 100,000 during the fiscal year. But for lack of funds to pay salaries, they are obliged to operate these offices largely

A Civil Service Advisory Council composed, as proposed by the Congressional Commission, of representatives of the administrators and of the employees, could render a very important service in connection with administrative questions.[5] It could be of great service to the Commission in connection with current administration and also in connection with modifications of procedure, revision in classification, or recommendation to Congress regarding changes in the scale of pay. It could serve as a channel of communication between the Commission and the constituencies represented by the members of the Council, bringing suggestions or criticisms or complaints and taking back the views or the answers of the Commission.

Although it would have no authority or administrative function, it would serve a useful purpose in keeping the Commission in closer touch with administrators and employees, and afford an opportunity for exchange of views on all questions of common interest. This is one of the most progressive features of the Commission's bill, and if the members of the Council take the matter seriously and attend meetings regularly, as it seems certain they would do, they could not fail to exert helpful influence. Such a Council is indeed a departure in practice, but it seems abundantly worth trying, with the hope that it will aid materially in promoting a good understanding between employees, administrators, and the Civil Service Commission, and a better understanding of the truth about the service by the general public. There is a great deal of suspicion in the public mind, and frequent irresponsible and exaggerated statements about politics and inefficiency in the public service are made; and such a Council

with men and women borrowed from various departments, 222 such people being detailed to field offices at the present time. Being away from their home stations, and often overlooked when promotions are made, these men cannot be expected to take a very lively interest in their work, or make a great success of it.

It is not more law or more authority that the Civil Service Commission needs, but an adequate and well paid permanent staff. This would make it possible for the Commission to discharge with credit and success the high duties resting upon it and to raise the tone of the government service everywhere.

[5] The Council is to consist of twelve members, six to be appointed by the President to represent the administrators and six to be elected by the employees from among their own number.

if wisely constituted could accomplish much in removing doubts and creating confidence.

7. EFFICIENCY RECORDS

An efficiency record should be kept, at least for all employees below the senior grades, and promotions made in the light of this record. When employees of the senior grades for whom no regular efficiency record is kept are recommended for promotion, a very full statement should be made to the Civil Service Commission as to the quality of the work done and degree of responsibility carried and any other reasons for making the promotion. A statement of this kind supported by documents, when practicable, would be the full equivalent of an efficiency record. Such a system of efficiency ratings, if intelligently and systematically carried out, would be a stimulus to employees and an important element in a real merit system. The form in which such efficiency ratings are expressed may be prescribed by the Commission in order that they be uniform and comparable. But the method of arriving at the ratings and details of the record kept may be left to the various bureaus and departments. These will naturally vary according to the kind of service and grades of personnel in the different services, but in every case they should take account of all elements that determine the efficiency of employees.

In many cases formal examinations are held to qualify men and women for higher positions, especially in connection with systematic courses of instruction and training. Such examinations, which are usually optional and competitive, are useful in making efficiency ratings preparatory to promotion. Compulsory examinations of a formal character will not generally be necessary or desirable in making promotions if an effective system of efficiency ratings is maintained. In some cases, however, they will be necessary, and hence provision should be made for such examinations whenever desired by the responsible administrator or the Civil Service Commission. Possibly it would work out that they would be useful and practicable in many cases.

8. PROMOTION ON MERIT

Promotions should be made when merited. In the case of younger employees, at least, frequent promotions by small steps are better than infrequent promotions of larger amount. Promotions are made in recognition of increased earning power and to avoid losing employees through resignation. The government is in competition with business and educational institutions both in appointing and holding its employees. In most cases it pays relatively low salaries for special qualifications, and imposes conditions as to hours of service and limitations as to one's free time which are often a real hardship.[6] Moreover, men in the scientific and technical branches of the government service acquire information and training of great value in the business and educational world, and they are eagerly sought for at a much higher rate of compensation. This is one of the most serious obstacles to efficiency and success in the government service and must be faced squarely if the government's work is to be conducted on a high plane.

It is not expected ever to have salaries so high in the government service that such a flow of able men out into commercial and educational work would be prevented. Indeed, it is not desirable to try to prevent it altogether. But enough good salaries should be provided so that a reasonable proportion, at least, of able and experienced men could be retained, to serve as administrators and educators to the rising personnel. In many cases the work is so important or so technical that only men of special training and considerable experience are competent to undertake it. In these cases the salaries should be such as to

[6] Scientists and engineers in the service of the government work six days a week, eleven months in the year or more, often putting in a great deal of overtime without extra pay, and are restrained from accepting retainers or extra compensation from outside sources which would be perfectly proper in private employment. The absence of Sabbatical years and of the generous retiring pensions of the colleges are a further deterrent to men of standing from entering the government service from the colleges. These facts in conjunction with the inadequate salaries of the government explain why it is generally impossible to recruit the higher positions from the colleges, and why administrators are so anxious to retain able and successful men who have been developed in the government service, and why it is so important to be able to select good material for the entering grades.

make it possible to build up and maintain an able and experienced staff. The needs of the government service should be the first consideration. Training men for the industries should be incidental. The present inadequate salary scale in many departments leads to resignations in a great many cases just when the men are becoming really useful. This makes the work unsatisfactory and its costs excessive. It is one of the most important causes of inefficiency in the government service.

It is so important and yet so difficult to keep men of first-class ability, that promotions which are deserved but which would otherwise be deferred are often made on short notice to avoid a loss that would be hard to remedy. So long as the pay in many classes of the service is below the market, it is important to permit promotions to be made at any time, always provided that they are merited and the Civil Service requirements are satisfied. A systematic review of the entire personnel of a bureau or administrative unit with respect to promotions should be made at least once each year. In many cases this is done twice a year or oftener, although of course only a part (and often a small part) of the employees are promoted at each promotion period.

The government service should offer a career to those who are competent and ambitious and desire to remain in the service. Advancement of men to higher places made vacant by resignation or promotion is a normal procedure. On the other hand, it is frequently necessary to bring in new men of special training or qualifications from outside in order to keep up the standard and prevent inbreeding. The administrative officer responsible for results is more anxious than anyone else to keep his staff satisfied and to keep up the quality of the personnel. No rules of procedure should be made which will embarrass wise administration. On the other hand, the Civil Service Commission should have full information and be in position intelligently to approve or to withhold approval if necessary.

In many cases appointments and promotions are so carefully and competently handled that such approval would be prompt and nominal. But when complaints were made, or when careless or biased administration was shown in any given branch of the service, investigation of each case would be made until improvement in conditions made it unnecessary. It would be physically impossible for the Civil Service Commission to give the careful consideration to every case that is usually given by administrative officers in the bureaus and departments. This is, however, quite unnecessary. But to be in a position to advise and approve, and to investigate when need be, is possible and very necessary.

9. APPOINTMENTS, TRANSFERS, AND REINSTATEMENTS

The method heretofore in use by the Civil Service Commission of certifying names for appointment upon request should be continued. Such names will be taken from registers established by examinations (assembled or non-assembled) or from lists of persons eligible for reinstatement or transfer. Appointments should be made at salaries that are just and in accord with the standardized scale. Credit should be given for experience or qualifications in excess of the minimum required for appointment to any given class.

A requirement that appointments be made always to the lowest grade of the class entered, and hence that men and women of widely varying qualifications be graded together and given the same salary upon entrance, or any other limitation that prevents doing justice to new appointees, will result in serious injury to the service without any compensating advantage.

It is impossible always to rate men accurately on entering, and a careful appointing officer, no matter how conscientious, will often find that he has given a man on entering less than he deserves. When it is demonstrated that such is the case, the error should be corrected, and hence it will sometimes be necessary to advance the pay sooner than usual. On the other hand, it will sometimes be necessary to reduce the pay and grade.

In some branches of the service new appointees are of practically no value to the government until they have gone through a course of special instruction to qualify them for their duties. Their entering salaries are less than would otherwise be given.

For six months or a year in such cases even well educated men or women are really going to school in the laboratory or training class. Some progress rapidly and at the end deserve a considerable advance in pay in recognition of their ability and usefulness. Others deserve smaller promotions, or perhaps have demonstrated their incapacity and are dropped. Any arbitrary rules about promotion that prevent the proper recognition of different degrees of progress and usefulness would be very undesirable.

In certifying persons for reinstatement or transfer, an effort should be made to find positions which the applicants are thoroughly competent to fill, and where they are needed and will be welcomed. A transfer from one department should require sufficient advance notice so that the vacancy created by the transfer may be properly filled unless the consent of the heads of the bureaus or establishments concerned is secured for an earlier transfer. No other barriers should be interposed provided all rules of the classification authorized by the law and of the Civil Service Commission are complied with. If the transfer is to a position of higher salary, qualification for such position must be clearly established.

At present, transfers between departments to positions at higher salaries are forbidden by law, unless the position is a statutory one. If a man or woman is unfortunate enough to get into a position where promotion is impossible, and the salary is inadequate, the law forbids correcting the injustice by transfer to a lump-fund position at a just salary, but requires that the injustice be continued for at least a year in the new position. This is one of the most serious defects of the present system, and every consideration of justice and good administration requires that it be corrected.

A transfer register maintained by the Civil Service Commission would contain the names and qualifications of all applicants for transfer. Only those giving satisfactory reasons for seeking a transfer would be placed on the register. In some cases such application would reveal causes for dissatisfaction which could readily be remedied without a transfer. In other cases, the interests of the service, as well as of the individual, will be promoted by a transfer. In every case an effort would be made to do justice to the employee without sacrificing the public interest. This will contribute to making the government service more attractive, and in helping to raise the standard of the personnel and to increase its efficiency.

10. PERSONNEL COMMITTEES

Personnel committees should be established in every bureau or administrative unit to assist in the administration of the personnel. The composition and duties of these committees will vary considerably in different cases, but they should consist of administrators or their assistants. If the organization is such that the employees feel the need of a committee of their own, to present their point of view to the administrators, it should be provided. Such representatives should, as a matter of course, be chosen by the employees themselves. Even though the method of handling the personnel is satisfactory to the employees without a special committee of their own, there should be provision for giving them an opportunity to be heard on all matters affecting salary, promotion, character of work, and working conditions generally. Every effort should be made to make the government service satisfactory to employees and creditable to the government. To remove sources of complaint, to make the work and the working conditions attractive, to interest employees in their work, and to make them feel that they are a part of the government; all this will make it easier to retain the most desirable employees, and hence will aid in improving the service. The golden rule can be applied in the government service as well as in industry, and with just as good results.

It is probable, however, that a large majority of complaints of favoritism in promotions are not well founded. Employees sometimes overestimate their own worth or underestimate their fellows. It is only natural that men or women who are not promoted because they are not doing as well as the average should feel that their worth is undervalued, or that someone who is given rapid promotion is favored. If provision is made for hearing and answering such complaints without needless publicity, it will help administrative officers who are faithful and competent. And if through oversight an injustice has been done, it can be corrected. No administrative officer intends to do an injustice, but he cannot have perfect knowledge and he cannot escape mistakes occasionally. A willingness to review a decision if requested, and to explain the reasons for such decision, will promote good relations. The existence of such committees gives the administrative officer a chance to explain; without them it is more difficult either to ascertain the need or to make the explanation.

11. COOPERATION BETWEEN EXECUTIVES AND THE CIVIL SERVICE COMMISSION

The constant aim throughout the service should be to secure an intelligent and sympathetic handling of personnel problems. While on the one hand avoiding autocratic methods, we should not go to the other extreme of taking away authority from those who are responsible for results. To develop enthusiasm and loyalty, and to build up an efficient organization will be impossible if employees are dissatisfied with their treatment or if controversy and conflicts occur. Cordial cooperation between the executives of each department and the Civil Service Commission is absolutely necessary. The primary thought and duty of the Commission should be, not to prevent administrators from doing wrong, but to assist them in handling personnel problems and in raising the morale and efficiency of the employees. If the legal impediments to good administration could be removed, the staff of the Civil Service Commission greatly strengthened, and the Commission assisted by an able and representative Advisory Council, it would be found that the executive departments would welcome the greater cooperation of the Civil Service Commission, and that there would be no need for drastic rules to prevent bad administration. The various features outlined above combined with our present system would, it is believed, provide a practical and thoroughly satisfactory Civil Service system, and in connection with a budget system and detailed and systematic public reports by the Civil Service Commission and the Budget Bureau would accomplish wonders in the government service.

12. THE RECLASSIFICATION REPORT

Many of the changes suggested above are contained in the bill drawn up by the Congressional Reclassification Commission, and given in its report. The outstanding features of that report, which are also given above, are as follows:

(1) The standardized system of positions, with duties defined and compensation fixed, applying to all departments alike and taking the place of present statutory and lump-fund positions.

(2) Provision for amending the specifications or adding new positions from time to time as needed.

(3) The rates of compensation provided in the schedule which are made a part of the bill are more nearly adequate than those now in effect, although the increase over present compensation, estimated by the Commission to be on the average less than ten per cent, is certainly conservative.[7]

(4) Provision for a Civil Service Advisory Council of a representative character and of personnel committees in the various departments and subdivisions thereof.

(5) Provision for appeals and the hearing of complaints on any matter coming under the jurisdiction of the Civil Service Commission.

(6) Removal of present restrictions covering transfers from one department to another.

(7) Provision for efficiency ratings upon which increases or decreases in compensation shall be made.

These important provisions constitute the main features of the reorganized civil service, and it is believed that the difficulties discussed below can be easily remedied without injury to the system, but on the contrary with great benefit to the service. Congress is entitled to the thanks of the executive departments for creating the Reclassification Commission and giving an opportunity for a thorough study of its report. The Commission has done a service of tremendous importance, and presented a plan that merits most careful consideration. Neither Congress nor the Commission, however, would wish to have it enacted into law unchanged if it can be shown that some of its provisions would be detrimental to the best administration. The follow-

[7] The Bureau of Labor Statistics and the National Industrial Conference Board find that the cost of living has increased a hundred per cent since 1914.

ing suggestions are made after very careful study and conference with many experienced administrators as well as with others who look at the matter from other points of view.

13. INITIAL COMPENSATION AND RESTRICTION ON PROMOTION

Section 7 of the bill provides in paragraph (*a*) that "upon appointment to a position in a class, an employee shall be paid at the minimum rate prescribed for such class."

It is a well established custom to appoint men receiving high rank in competitive examinations to positions at higher salaries than are given to those who get middle or low grades in the same examination. These grades depend in part on the formal examination (when such is held) and in part on the training and experience of the men as shown in their papers. For example, an examination may be held for associate physicist or chemist at salaries ranging from $2000 to $2700 (according to present salary scales), and a considerable number of men may pass the examination with grades ranging from, say, 95 down to 70 per cent. Several of the highest may be offered the maximum salary, and others $2400, $2200 or $2000. Finally, when all positions of associate physicist are filled, there may be some men at the lower end of the register who are glad to accept a position as assistant physicist at $1800, hoping to get an early promotion to associate physicist at $2000 or more, for which they have qualified. The new proposal is to make a very radical departure in practice and to group all new appointees together and give them the lowest salary in the class, in this case $2000. Moreover, it is provided that men cannot be promoted oftener than once a year. It would, therefore, require several years for a man to get up to the $2700 for which he was qualified upon entering. The result, of course, would be that the better men who deserved more than the minimum salary would refuse the position, and less competent men would be appointed at the lowest salary. The only way the $2700 men could be obtained would be to grade them higher than would otherwise be necessary, and rate them as physicists at $3000 and so pay them more than they deserve in comparison with others, or induce them to take $700 less than they deserve and wait several years to get up to what they should receive at the start. Either alternative is bad. The only fair and businesslike method is to do what has long been done, namely, to give men on entering salaries that are as nearly just and equitable as it is possible with limited information to do, and if subsequently they are found to have been rated too high or too low to remedy the error at an early date. The same principles apply to clerical positions, to the skilled trades, and the other classes of positions.

If men develop rapidly and deserve promotion more frequently than the average they should receive it. By refusing to grant it we not only do them an injustice, but we frequently drive them out of the service and so do the government an injustice. Moreover, we discourage the ablest men by such a method and put a premium on mediocrity. A system which requires the appointment of men and women of widely different merit at the same salary, and refuses to recognize adequately exceptional ability or achievement, cannot be a success in the government service any more than it would be in private employment. Testimony on this point is unanimous and to impose such a system upon the executive departments would be a long step backwards.

14. REPORTING OF EFFICIENCY RATINGS

It is doubtful whether the provision of Section 8 (*b*) that efficiency "ratings for each class be open to inspection during regular office hours by any employees of such class" is a wise one. It is like the marking system of school days, but goes further and would permit busybodies to go to the office and get the marks of all the men and women of a given class and make any use of them they see fit. The theory of the provision is that if the ratings are perfectly just the administrative officer can have no objection to their being made known; moreover, the employees wish to know if they have been given the credit they deserve. If they are not just and impartial, a complaint may be filed and the matter be investigated. Unfortunately the rating of human beings by other human beings is not a measurement of precision, and if it were, the persons being rated would not agree with one another as to whether the ratings were just. It seems probable that this provision would give rise to misunderstandings, heart-burnings, and ill feelings, without doing any good. It would seem to meet all requirements of the case if the record is always open to the Civil Service Commission and any employee can learn his rating if he desires it. It will be time enough to enter complaint if employees are dissatisfied with the promotions, or with the explanation or lack of explanation if promotions are not made. Efficiency ratings are not ends in themselves, but means to an end. They are to assure systematic consideration of each employee with respect to his work and his usefulness, and to be a shorthand record of the judgment reached. The judgment will appear publicly from time to time when promotions are made. If the ratings are made public before the promotion period, there would be efforts made by some to get their ratings raised in order to increase the chances of promotion. This would throw an intolerable burden on personnel officers. If several hundred thousand efficiency ratings of government employees were regularly transmitted to the Civil Service Commission, a very large number of clerks would be required to handle and file and study them; and if administrative officers were to be overruled by clerks on the evidence of such records, without personal contact with such officers and without personal knowledge of the employees, no end of trouble would be caused. It seems far better not to transmit the efficiency records to the Commission but to have them accessible to the representatives of the Commission at all times, and made use of whenever complaints are made and the Commission has any doubts about the merits of a proposed promotion. They would also be examined for the purpose of testing the completeness of the records of a given unit of the service, and to see whether the ratings were in accordance with the general system. In forming such a judgment it would be necessary to confer with personnel officers and be able to get full information about the men and women and their work.

It is therefore suggested that Section 8 (*c*) be omitted and that the second sentence of Section 8 (*b*) be changed to read as follows: "Such current ratings shall be open to examination by the representatives of the Civil Service Commission; and the rating of any employee shall be given him on request."

15. METHOD OF APPOINTMENTS AND PROMOTIONS

Section 9, entitled "Promotion Appointments," describes an elaborate method of filling vacancies or new positions and of making promotions from one class to another. It is provided that upon request from the head of a department the Commission shall certify:

(1) The names of employees available for transfer from some other department, "one of whom shall be appointed unless the Commission approves the appointing officer's written objections to such appointment."

(2) In that case the names of persons available for reinstatement are certified, and must be investigated and one appointed, or all rejected with reasons in writing.

(3) Then, if no appointment is made, a competitive examination shall be held for the given position, open to anybody in the government service qualified to compete.

(4) Finally, if none of these methods provides a satisfactory appointee, names may be certified from an eligible list established by examination of applicants not in the government service.

This complicated and time-consuming process gives preference to persons seeking a transfer or reinstatement over those in the same bureau and in line for promotion. It violates one of the most important principles of good administration, namely, that when a man deserves promotion to a higher position in the same line of work and for which he has been preparing, he should receive it rather than a stranger who is brought in and put over him. If the method were carried out as described, it would not only be cumbersome and time-consuming, but would destroy the morale of the service. It seems far better to continue to do as heretofore, namely, to promote within the Bureau if there are men who are competent and deserve promotion; if not, to apply to the Civil Service Commission for eligibles, and these may in the discretion of the Commission include the names of persons eligible for reinstatement or transfer. Such a method, if intelligently and conscientiously administered (as it is fair to assume it would be under the improved conditions expected under the reorganized service), would afford competitive promotion based on efficiency, without the formality and delay incident to special examinations. If a man does not measure up to the prevailing standard for promotion to the next higher grade or class (which standard is determined by the best average of others in the same class), he would not receive such promotion. He, therefore, knows that he is in competition with others, and it is an effective stimulus. On the contrary, he knows that if he makes good, his position is secure, and he can be promoted without fear that someone from a distance (who might be able to pass a better examination)can take his position away from him. The following paragraph is suggested as a substitute for (*a*) of Section 9:

> Section 9 (*a*). Whenever the head of a department desires to fill a position otherwise than by promotion, he shall request the Commission to certify the names of persons eligible to fill such position. Names so certified may include those eligible for reinstatement or transfer from one bureau or department to another. Any employee may apply to the Commission for transfer, but transfers will be made only with the approval of the Commission.

It is suggested that paragraph (*c*) of Section 9 be omitted, as it describes a class of cases of rare occurrence, and the Commission can make rules for such cases without it being set forth in detail in the law.

16. TRANSFERS

Section 10 provides for the transfer of an employee from a position in one class to a vacant position in the same class at the same rate of compensation in some other department, with the approval of the Commission. The approval of the administrative officers or heads of departments concerned is not required. At present such approval is necessary and it seems desirable that this practice be continued, where a transfer on relatively short notice is desired. Very seldom, if ever, would it be refused under the new conditions assumed, if the reasons for the transfer were such that the Civil Service Commission would give its approval. It would appear desirable, however, not to limit transfers to positions in the same class and at the same salary. Very frequently men and women accept positions in the government service below what they are qualified to fill, and at salaries which are inadequate. They do so in order to get a start, hoping for an early improvement in status. When an opportunity occurs for a transfer to a higher position for which they have already qualified, they should be permitted to accept the better place, with the approval of the Commission. To adjust misfits and correct injustices is a pleasure to administrative officers as well as a duty, and it would be a misfortune to have any impediment in the law to doing justice in such cases. If it is suggested that advantage would be taken, if this were permitted, to make undeserved transfers to positions at higher salaries, the answer is that the Civil Service Commission must approve the transfer. It is an open transaction, complaint can be made by any employee who feels that he is injured, and it is very improbable that such cases would occur often, if ever.

17. SYSTEMATIC STUDY OF PERSONNEL TURNOVER

The losses in the personnel due to resignations and dismissals, and the transfers from one branch of the service to another, should be systematically tabulated and studied by the Civil Service Commission. There are many causes for such resignations and transfers that are inevitable and proper, and the resultant resignations and transfers do not reflect upon the government's employment policy or upon the administration of the service. However, resignations or applications for transfer due to inadequate salary, too slow promotion, dissatisfaction with working conditions or with the administration of a particular unit of service should be investigated, and the information so obtained would be of the greatest value in improving the service. This would be a very effective method of locating and correcting unfair or incompetent administration of the personnel.

Two of the most difficult questions to handle in the proposed new system will be those involving modifications in the classification and adjustments in the salary schedules. The government is in competition with the industries, the colleges, and all other employers, and the scale of wages and salaries is partly determined by this competition. Conditions will vary from time to time, and if the Civil Service Commission makes a systematic and scientific study of the government's employment problems and policies and gives the administrators, individually and collectively, the benefit of that study, it could not fail to raise the standard of administration and benefit the service enormously. The Commission could embody the results of this study in its annual report so that Congress and the public would have a more accurate knowledge of the conditions of the service, and any recommendations to Congress respecting changes in classification or in salary schedules could be supported by very full and reliable data from actual experience. This kind of work could be done by the Civil Service Commission better than by anyone else, if a competent and adequate staff could be provided for the purpose; and it is very essential that it be done competently, if at all.

18. SUMMARY AND CONCLUSION

In conclusion, it cannot be too strongly emphasized that the breakdown of our present Civil Service system, in so far as it has failed, is not due to the system itself but to the unfavorable conditions existing, which have made it impossible to carry out the system properly. In the reorganized Civil Service system described above, the main features of the Civil Service law and procedure would be the same as now, but there would be eight additions to procedure or improvements in conditions which would together be of immense importance. These eight improvements in procedure and conditions are as follows:

(1) A system of standardized positions with more adequate salaries, and provision for revising it and keeping it up to date.

(2) An enlarged and strengthened Civil Service Commission.

(3) An Advisory Council to the Commission consisting of representatives of employees and administrators.

(4) Civil Service extension agents or liaison officers detailed to the various departments.

(5) Personnel committees made up of administrative assistants in all the various bureaus and departments to assist in the administration of the personnel.

(6) Employees' committees and systematic provision for hearing and answering complaints.

(7) Efficiency ratings and promotions based on the same.

(8) The removal of restrictions on transfers and the provision of a transfer register at the Civil Service Commission to facilitate deserved and desirable transfers.

These additions and improvements would complete and greatly strengthen the present Civil Service system. So long as the Civil Service Commission does not have the staff to advise and cooperate effectively with administrative officers, and to coordinate the system as a whole, it cannot be expected that it will work satisfactorily. With an utterly inadequate scale of government salaries and a rapidly changing personnel among administrators as well as among employees generally, it cannot be expected that administration will be entirely successful or satisfactory. With no adequate provision for hearing and answering complaints and correcting errors or injustices complained of, it cannot be expected that employees will refrain from criticism. Congress and the public hear not only of many well-grounded complaints, but also of many that have little basis in fact. What we should do is not discard a practicable and well-tried system, nor discredit administrators who are today confronted with an impossible task, nor add burdensome restrictions and cumbersome routine which would make that task more difficult; but we should, after removing the legal difficulties, round out and complete the present system, educating and helping administrative officers instead of hampering them in their work, and above all, refrain from burdening the Civil Service Commission with an enormous mass of routine administration which it would be impossible to handle successfully.

The responsible administrative and technical officers who conduct the various branches of the executive departments of the government represent collectively more of ability, integrity and loyalty, than they are commonly given credit for. They realize more fully than those outside the government the defects and inefficiency of the government service, although these are grossly exaggerated in the press and on the platform. They also realize better than outsiders the tremendous handicaps to efficiency which are beyond their control. No private business could succeed with such handicaps as well as the government does, and very many do worse, as it is. If the executive departments could have a fair chance for a few years, with a reorganized Civil

Service system and a budget, they could show the country results which would be both creditable and gratifying.

The United States government is the greatest business organization in the country. It employs more than half a million men and women in hundreds of different kinds and grades of work. The Civil Service Commission is doing its best to supervise the administration of the personnel of this great business, which is not only larger but more complex than any other in the country. If the Commission could have a larger and better paid staff, its work would be done more adequately, the personnel in all departments would be better handled, the service would be elevated and the government would be enormously benefitted. Surely no one can question the importance of this great task, and no one doubts the need for improvement. Before adopting a more complicated method of administration which will enormously increase the difficulties of the Commission, let us have a more adequate operation of the present system, with such improvement in conditions and in details of operation as can readily be provided. It is believed that the changes suggested above, and summarized below, in the administrative proposals of the Congressional Reclassification Commission are justified by experience, and that they would simplify and improve the procedure proposed and remove the most serious difficulties to the Report as presented.

LIST OF CHANGES PROPOSED IN THE BILL OF THE RECLASSIFICATION COMMISSION (S. 4106, MARCH 22, 1920)

1. Section 5 (*d*). Omit second sentence. (Section complete without this sentence.)

2. Section 7 (*a*). Omit last sentence.
(*b*). Omit last sentence.

3. Section 8 (*b*). Change second sentence as indicated on page 552.
(*c*). Omit entire paragraph.

4. Section 9 (*a*). Substitute paragraph on p. 554.
(*c*). Omit entire paragraph.

5. Section 10 (*a*). Change so as to permit transfer at a different salary in the same class or to another class.

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GEOCHEMISTRY.—*Notes on the analysis of mineral sulphide water.*[1] J. G. FAIRCHILD, U. S. Geological Survey.

In the course of analysis of a sample of water from the Texas oil field which was highly charged with alkaline sulphide, the author was at a loss to find a method of detecting and estimating not only the total sulphide sulphur but also the carbon dioxide as half bound and wholly bound. When the soluble salt of a heavy metal, such as cadmium chloride, is added to an alkaline sulphide water an insoluble sulphide is formed and an amount of hydrochloric acid is liberated equivalent to the sulphide present; thus,

$$MSH + CdCl_2 = CdS + MCl + HCl$$

where M is an alkali metal.

If only the total sulphide and carbonate are to be determined, the problem is very simple, for all that is necessary is to introduce into a measured quantity of the mineral water undergoing analysis the soluble salt of a heavy metal, acidify the water with a small quantity of acetic acid, and absorb the liberated carbonic acid in the usual way, but if the presence of bicarbonate is to be determined, then a modification of this procedure becomes neces-

[1] Published by permission of the Director, U. S. Geological Survey. Received Oct. 15, 1920.

sary. As soon as the sulphide is precipitated the liberated acid immediately breaks up all the carbonate, or at least an uncertain quantity of it.

A series of synthetic waters was prepared, each being the approximate counterpart of the mineral water under examination.

TABLE I

ANALYSIS OF THE TEXAS MINERAL WATER IN PARTS PER 100,000

Positive ions		Negative ions	
Na	2480.0	Cl	4231.0
Ca	261.3	SO_4	131.9
Mg	46.9	S	40.0
K	None	CO_3	28.7
		HCO_3	9.7

This ratio of S to total CO_2 is 1.4 to 1.0. Tests were first made on water containing only sodium hydrosulphide and sodium carbonate. In preparing the sodium hydrosulphide, 100 cc. $N/10$ NaOH was saturated cold with hydrogen sulphide, then heated to boiling in a current of hydrogen sulphide and cooled. A few cubic centimeters of this liquid remained neutral to phenolphthalein for a few seconds. This solution was then mixed with one containing 0.1 gm. Na_2CO_3, and the whole was diluted to 1 liter with water free from carbon dioxide. The percentage of total sulphur, as determined iodometrically, was 0.369 gm. per liter. This amount was confirmed gravimetrically by precipitating the sulphur as cadmium sulphide, which was in turn converted to and weighed as cadmium sulphate. The result showed 0.388 gm. of sulphur per liter, or a somewhat higher figure for the gravimetric method. However, the difference between the two methods was only 5 per cent and could easily be accounted for by slight impurities in the cadmium sulphate or by difference in the samples taken. The sulphur content of the natural mineral water at the time of determining the alkalinity was found to have changed to 0.156 gm. of sulphur per liter. The total alkalinity as determined by $N/20$ HCl was equivalent to 0.600

gm. NaOH per liter. This amount was divided as follows: NaOH equivalent to S″, 0.195 gm. per liter; NaOH equivalent to CO_3'', 0.382 gm.; NaOH equivalent to HCO_3', 0.064 gm.—a total of 0.641 gm. NaOH per liter, or a difference of 6.4 per cent from the titration value.

The apparatus for determining carbon dioxide was of the usual form, a good illustration of which can be found in figure 21 (page 218) of Bulletin 700 of the United States Geological Survey. The only change made was the substitution of a Peligot tube containing $K_2Cr_2O_7 + H_2SO_4$ for the calcium chloride tube which is attached directly to the water condenser. This mixture was preferred for oxidizing traces of hydrogen sulphide and absorbing moisture and fumes of ammonia as explained further on.

The method.—Briefly, the method used is based on the expulsion of half bound carbon dioxide together with volatile hydrogen sulphide from the sample by boiling it for 5 minutes in a rapid current of pure hydrogen, and fixing these products in an absorbing solution composed of ammoniacal chlorides of cadmium and barium. This is the first operation. The second involves the separation of these volatile products by acidifying this ammoniacal mixture with acetic acid in order to liberate again the carbon dioxide while the hydrogen sulphide remains fixed as cadmium sulphide. The ammoniacal absorbing solution is composed of 10 cc. strong ammonia, freed from CO_2 and containing a few cc. of $BaCl_2$ solution, about 5 cc. $CdCl_2$ solution (1 cc. = 0.01 gm. S), and about 20 cc. water free from CO_2. This solution is contained in a Peligot tube which is attached directly to the water condenser. A 100 cc. sample of the artificial water was taken by means of a pipette and introduced into the boiling flask. A stream of purified hydrogen (from Zn + HCl) was passed rapidly for a few minutes through the apparatus; then heat was applied to the flask, which was boiled vigorously for 5 minutes and allowed to cool for half an hour in the current of hydrogen. The Peligot tube containing CdS and possibly $BaCO_3$ was then substituted for the flask whose remaining sulphide content was precipitated by the addition of a solution of 5 cc. $CdCl_2$ and set aside for the moment and stoppered. Connection was then made to the regular carbon dioxide train (with the chromic acid tube), air free from carbon dioxide was drawn through the train and 15 cc. 1–1 acetic acid was introduced into the ammoniacal cadmium chloride, partly precipitated as cadmium sulphide together with barium caibonate, by means of a small separatory funnel attached to the Peligot tube. The tube was immersed in a boiling water bath, and the aspiration continued for 30 minutes. Any un-neutralized ammonia fumes may now be caught in the chromic acid. After the test the soda-lime tube showed no increase in weight. The flask containing the non-volatile hydrogen sulphide and carbon dioxide was next replaced, 4 cc. 1–1 acetic acid was added to decompose the normal carbonate, and the solution was boiled for a few minutes and cooled 30 minutes more in a current of air free from carbon dioxide. The soda-lime tube showed a gain of 0.0407 gm., whereas 0.0415 gm. was present. Therefore no carbonate formed in this water, a fact confirmed by repeated tests.

Inasmuch as no half-bound carbon dioxide was formed in the above mixture a new solution was made up of a like amount of sodium hydrosulphide, but containing 0.84 gm. of $NaHCO_3$ per liter, the chemical equivalent of the sodium hydrosulphide present. The first test on 100 cc. boiled as above described in a current of hydrogen showed that 0.0078 gm. CO_2 had been driven over into the Peligot tube, as against a possible 0.022 gm. An iodometric determination of the volatilized sulphide gave 0.0098 gm., or 38.8 per cent of the total present. Below is a table of the results obtained by decreasing the ratio of the sulphide to the bicarbonate present in the generator. This ratio was effected by using smaller aliquot portions, and at the same time keeping the amount of sodium bicarbonate nearly constant. Although the water mixture was kept under a layer of toluol in a well-stoppered bottle, its sulphide concentration grew less within a week, hence an occasional check on the sulphide value was necessary.

TABLE 2

TABLE SHOWING THE BEHAVIOR OF NaSH AND $NaHCO_3$ ALONE WHEN BOILED IN HYDROGEN

No. of test	Fixed CO_2		Volatile S (by difference)	
	Quantity in grams	Percentage	Quantity in grams	Percentage
1[a]	0.044	86.3	0.0253	38.8
2	0.044	80.0	0.0126	46.5
3	0.044[b]	72.2[b]	0.0159	....
4	0.066	83.2	0.0157	74.9[c]
5	0.055	86.3	0.008	67.5

a Same room temperature for $1^3/_4$ hours: CO_2 87.7; S 24.4.
b Very rapid boiling.
c High.

The percentages shown indicate that the fixed CO_2 remains fairly constant. The figure for volatile CO_2 ranged from 0.006 to 0.014 gm., depending on the rate of boiling and the flow of hydrogen. This rate has a more marked effect on the amount of volatile sulphide as well. An effort was therefore made to pass the hydrogen at as nearly a uniformly rapid rate as possible. In all the tests made the sum of fixed and volatile CO_2 was within 0.001 to 0.003 gm. of the total present. The quantities of sulphide were in closer agreement with the total present, about 0.001 gm. Because of the greater ease in dealing with the fixed sulphide left in the flask, this portion was determined iodometrically, and the volatile sulphide was obtained by difference. From time to time blank tests for CO_2 were made in order to check up the apparatus, no blank of more than 0.001 gm. being accepted. Most blanks were nearly zero.

Another solution was now prepared, containing magnesium chloride in an amount equal to that present in the natural water to be analyzed, namely, about 3.3 gm. $MgCl_2.6H_2O$ per liter. It was thought possible that such a solution might on boiling show hydrolysis of the $MgCl_2$, the effect of which would be to liberate more half-bound CO_2 than had been recovered above.

TABLE 3

Table Showing the Additional Effect of $MgCl_2$

No. of Test	Fixed CO_2		Volatile S	
	Quantity in grams	Percentage	Quantity in grams	Percentage
1	0.044	66.3	0.0243	77.7
2	0.044	71.8	0.0126	73.5
3	0.077	76.6	0.006	66.6

The alkalinity of this water as determined by titration with $N/20$ HCl was equivalent to 0.928 gram NaOH per liter. This amount was divided in terms of NaOH as follows:

TABLE 4

Equivalent Radicals in Terms of NaOH in Grams per Liter

CO_3''	HCO_3'	S''	Total
0.253	0.068	0.672	0.993

The difference between the two totals obtained is only 6.5 per cent, a fairly close agreement after the errors liable to occur in individual determinations are taken into consideration.

A final solution containing 4.7 gm. $MgSO_4.7H_2O$, 7.3 gm. anhydrous $CaCl_2$, 100 cc. $N/10$ NaSH, 0.84 gm. $NaHCO_3$, and 15 gm. NaCl per liter was prepared. An excess of $CaCO_3$ separated out, leaving the solution saturated with calcium bicarbonate. The carbon dioxide remaining in solution was 0.313 gm. per liter, and the sulphur was 0.278 gm. per liter. A test on 100 cc. of this solution gave: fixed CO_2, 73.5 per cent; volatile sulphur, 89.2 per cent. Upon comparing all the figures obtained, it will be observed that although no relation exists between the total carbonate and the total sulphur, yet a relation does exist between the fixed or volatile sulphur and the total sulphide.

Summary.—The alkalinity of a water containing a mixture of the sulphohydrates and bicarbonates of the alkalies and alkaline earths appears to increase continuously with the escape of hydrogen sulphide or with the precipitation of atomic sulphur. In such a water, therefore, the number of bicarbonate ions is gradually decreasing as the number of the hydroxyl ions is increasing. The acidity of calcium and magnesium chlorides toward the alkaline sulphides is pronounced but has less effect on the bicarbonates.

Although the addition of a few cubic centimeters of neutral barium chloride solution to an ordinary carbonate water aids in breaking up the bicarbonate ions, it has no such effect if the water contains a considerable quantity of alkaline sulphides.

Hydrogen sulphide is volatilized much quicker and more completely at boiling than at room temperature, but a certain percentage is not expelled by a rapid current of hydrogen even after one or two hours.

A discussion of the reduction of sulphates by organic matter has been published by C. E. Siebenthal.[2] The author has been able to produce noticeable amounts of H_2S in a hydrogen generator containing about 20 per cent H_2SO_4, about 0.5 gm. NaCl, some KI and $SnCl_2$, some $CaSO_4$ and organic matter derived from the oxidation of fruit in nitrosulphuric acid. The H_2S was sufficiently strong to mask the Gutzeit test made for arsenic.

Acknowledgment is due to Dr. Chase Palmer, recently of the United States Geological Survey, at whose suggestion and with whose cooperation this work was undertaken and carried out.

CONCHOLOGY.—*The Caecidae and other marine mollusks from the northwest coast of America.*[1] PAUL BARTSCH, U. S. National Museum.

The "Summary of the Marine Shell Bearing Mollusks of the Northwest Coast of America," by Dr. William H. Dall, about to be published by the U. S. National Museum as Bulletin 112, contains references to a number of species, of which no descrip-

[2] U. S. Geol. Survey Bull. **606**: 62–66. 1916.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 22, 1920.

tions have as yet been published. I have therefore briefly characterized these forms in the present paper to give a proper status to these names.

The family Caecidae is being subjected to a thorough revision at the present time by the writer, and only those West American forms which are listed in the above mentioned summary are considered here. The species belonging to the region farther south will be dealt with in the fuller report.

Key to the Genera of the Family Caecidae

Operculum conic . . . . *Brochina*.
Operculum flat or concave.
  Sculpture absent (excepting incremental lines) . . . . *Fartulum*.
  Sculpture not absent.
    Sculpture of raised spiral ridges only . . . . *Elephantulum*.[2]
    Sculpture not of raised spiral ridges only.
      Sculpture of raised spiral ridges and axial rings...*Elephantanellum*.
      Sculpture of axial rings only.
        Axial rings strong and distantly spaced . . . . *Caecum*.
        Axial rings slender and closely spaced . . . . *Micranellum*.

Fartulum Carpenter, Cat. Mazatlan Shells, 525. 1856.

Shell smooth, excepting microscopic incremental lines. Type *Caecum laeve* C. B. Adams.

The genus *Fartulum* is represented by four species in our Northwestern waters, of which three are undescribed. Of these, *F. orcutti* Dall is the smallest and has the aperture slightly contracted. It is also somewhat laterally compressed, which lends the aperture an oval outline. The other three species are circular in section. Of these, *F. occidentale* is the largest. This has scarcely an indication of a lateral spur to the plug, while in *F. hemphilli* and *F. bakeri* a well developed claw-like spur is present. *Fartulum hemphilli* is always larger in equivalent stages and lighter colored than *F. bakeri*.

[2] Since the early whorls are coiled in planorboid fashion, and the adolescent and adult stages are simply portions of the solutely coiled part, it is proper to refer to the sculpture that coincides with the incremental lines, that is parallels the aperture, as *axial*, and that at right angles to this as the *spiral*. The latter, therefore, coincides with the long axis of the adolescent and adult shell. This nomenclature is used in conformity with that employed in all my former papers on Gastropods.

TABLE I

ADDITIONAL DATA PERTAINING TO THE ABOVE FARTULUMS

	Cat. No. U. S. N. M.	Height in mm.	Diameter in mm.	Type locality
Fartulum orcutti, Dall.........	60927 Type	2.1	0.7	San Diego.
Fartulum occidentale, sp. nov..	152166 Type	3.1	0.9	San Pedro.
Fartulum hemphilli, sp. nov....	340728 Type	3.1	0.7	San Pedro.
Fartulum bakeri, sp. nov......	340729 Type	2.5	0.6	San Pedro.

Fartulum orcutti Dall is the most abundant species on the West Coast; thousands of specimens have been examined. It ranges from San Pedro to Lower California. *F. occidentale* Bartsch is also abundant, and ranges from San Pedro to Lower California. *F. hemphilli* Bartsch is rather rare, and occurs from San Pedro to Lower California. *F. bakeri* Bartsch is very abundant, ranging from San Pedro to Lower California.

Elephantanellum, gen. nov.

Surface of shell marked by raised ridges which coincide with the long axis of the shell; annulations strongly developed; operculum thin, corneous, concave. Type *Caecum hexagonum* Cpr.

The genus *Elephantanellum* has a number of representatives in the more southern waters of the Pacific. From north of San Diego, only a single species is known, **Elephantanellum carpenteri,** sp. nov. This is a large thin shell, in which the segments of all stages are marked by very fine spiral sculpture and a little stronger incremental lines, while the last portion of these stages bears well developed annuli. These increase in number in succeeding stages. The type, Cat. No. 340726, U. S. N. M., comes from San Diego and measures: length, 4.8 mm.; diameter, 0.9 mm. We have seen it from various stations from San Pedro south to Lower California.

Caecum Fleming, Edinb. Encycl. 7: 97. 1817.

Brochus Brown, Ill. Rec. Conch. Great Britain, 124–125, in part. 1827.
Cornuoides Brown, Ill. Rec. Conch. Great Britain, 125, in part. 1827.
Odontina Zborzewski, Mem. Soc. Nat. Mosc. 3: 310. 1834.
Odontidium Philippi, Moll. Sci. Utr. **1**: 102. 1836.
Anellum Carpenter, Cat. Mazatlan Shells, 319. 1856.

Surface of the adult shell marked by numerous axial annulations. Operculum thin, corneous, concave. Type *Dentalium trachea* Montagu.

Five species of *Caecum* are known living on our Pacific shores north of San Diego. Four of these are undescribed. Some of the unnamed forms have at times been listed under names bestowed by Carpenter and Adams upon species occupying a more southern habitat. Three of these five species, *Caecum californicum*, *C. dalli* and *C. grippi* are robust forms and are much larger than the other two, *C. licalum* and *C. diegense*. *Caecum californicum* is larger than *C. dalli* and *C. grippi* and has about forty strong annuli, separated by narrow spaces, while *C. dalli* and *C. grippi* are of about the same size; the former has about twenty annuli on the last segment, while the latter has only about fifteen. While the annuli are of almost the same width, the spaces between them are much wider in *C. grippi* than in *C. dalli*. *Caecum licalum* has about eighteen broad annuli, while in *C. diegense* about twenty narrow slender rings are present.

TABLE 2

ADDITIONAL DATA PERTAINING TO THE ABOVE CAECUMS

	Cat. No. U. S. N. M.	Height in mm.	Diameter in mm.	Type locality
Caecum dalli, sp. nov.	340724 Type	2.5	0.7	San Diego.
Caecum grippi, sp. nov.	206961 Type	2.3	0.7	San Diego.
Caecum licalum, sp. nov.	340725 Type	2.2	0.5	San Diego.
Caecum diegense, sp. nov.	340726 Type	2.0	0.4	San Diego.
Caecum californicum Dall	15719 Type	2.8	0.8	San Diego.

Caecum californicum Dall is the most abundant West American *Caecum*. It is known from many stations from Monterey, California, to Lower California. *C. dalli* Bartsch is known from many stations from San Diego to Lower California, *C. licalum* Bartsch from San Pedro and San Diego. *C. diegensis* Bartsch has only been reported so far from the littoral zone at San Diego. *C. grippi* Bartsch was dredged in 15–20 fathoms off San Diego.

Micranellum, gen. nov.

Surface of the shell marked by closely spaced, slender, axial annulations; operculum thin, corneous, concave. Type *Caecum crebricinctum* Carpenter.

Seven species of *Micranellum* are known living in northwestern America. Five of these have the plug at the truncated apex forming an attenuated, obliquely placed spur, the base of which is narrower than the diameter of the plug. Of these three—*Micranellum pedroense, catalinense,* and *profundicolum*—have the anterior portion of the adult shell bulbously expanded, while in the other two, *M. barkleyense* and *oregonense,* the diameter does not increase at the anterior termination. Of those with the bulbously expanded anterior portion, *M. pedroense* has very fine closely spaced annulations, there being about a hundred present in the adult segment of the shell, while in *M. catalinense* and *profundicolum* the annuli are less numerous and more pronounced, there being about seventy-five in the last segment. The shell of *M. catalinense* is shorter and stouter than that of *M. profundicolum.* The two species which lack the bulbous anterior expansion, *M. barkleyense* and *oregonense,* are distinguished from each other at once by their great difference in size, *M. barkleyense* being both longer and thicker than *Micranellum oregonense.*

Two of the seven species, *M. rosanum* and *crebricinctum,* have the spur of the plug expanded basally to cover the entire width of the plug. Of these, *M. rosanum* is easily distinguished from *M. crebricinctum* by being much longer and having the annuli much more distinct than *M. crebricinctum.*

TABLE 3

Additional Data Pertaining to the Above Micranellums

	Cat. No. U. S. N. M.	Height in mm.	Diameter in mm.	Type locality
Micranellum pedroense, sp. nov	346723 Type	5.3	1.5	San Pedro.
Micranellum catalinense, sp. nov	211331 Type	4.5	1.3	Off Santa Rosa Island.
Micranellum profundicolum, sp. nov	209960 Type	5.5	1.3	Off San Diego.
Micranellum barkleyense, sp. nov	211589 Type	6.2	1.6	Barkley Sound, Vancouver Id.
Micranellum oregonense, sp. nov	216413 Type	4.6	1.2	Forrester Island, Alaska.
Micranellum rosanum, sp. nov.	211859a Type	6.9	1.2	Off Santa Rosa Island.
Micranellum crebricinctum Carpenter	14930 Type	6.2	1.3	San Diego.

Micranellum pedroense Bartsch is a shallow water form known to range from San Pedro to San Diego. *M. catalinense* is a deep water species, known from about 50 fathoms from Santa Rosa and Catalina Islands. *M. profundicolum* is a deep water form known from 55 to 199 fathoms off San Diego. *M. barkleyense* has so far been recorded only from Barkley Sound in 8 to 32 fathoms, *M. oregonense* only from shallow water, at Forrester Island, Alaska, and *M. rosanum* only from a station off Santa Rosa Island in 48 fathoms. *M. crebricinctum* Carpenter is a shallow water species abundantly distributed from Monterey to Lower California.

Turbonilla (Chemnitzia) **engbergi**, sp. nov.

Shell small, elongate conic, thin, semitransparent, bluish white. Nuclear whorls decollated. Postnuclear whorls moderately rounded, appressed at the summit, marked by broad, slightly protractively slanting axial ribs, of which fourteen occur upon all of the remaining turns, except the last, on which there are sixteen. These ribs are a little broader than the spaces that separate them, and they become slightly flattened and weaker toward the summit. The intercostal spaces are deeply depressed pits, which terminate somewhat posterior to the summit of the succeeding turn, leaving a broad, smooth band at the suture. Suture strongly constricted. Periphery of the last whorl well rounded, not crossed by the strong axial ribs. Base short, well rounded, marked by incremental lines only. Aperture subquadrate, posterior angle obtuse; outer lip thin; inner lip slightly sinuous, decidedly obliquely inserted, the inner edge having a decidedly protractive slant; parietal wall devoid of callus.

The type and another specimen, Cat. No. 334489, U. S. N. M., were collected by Dr. C. C. Engberg at San Juan Island, in the Gulf of Georgia. The type has almost 8 whorls remaining and measures: altitude, 3.7 mm.; diameter, 1.1 mm. Four additional specimens from the same station are in Dr. Engberg's collection.

This species occurs considerably farther north than any heretofore known *Chemnitzia*.

Odostomia (Amaura) **engbergi**, sp. nov.

Shell elongate ovate, yellow, a little paler toward the tip. Nuclear whorls eroded in all the specimens seen. Postnuclear whorls narrowly tabulatedly shouldered at the summit, quite strongly rounded, marked by very fine slightly slanting lines of growth and equally fine spiral striations, the combination, when viewed under the microscope, giving to the surface a cloth-like texture. Suture strongly marked. Periphery of the last whorl inflated, strongly rounded. Base strongly rounded. Aperture narrowly ovate; posterior angle very obtuse; outer lip thin; inner lip short, very oblique, somewhat sinuous, reflected over the base and appressed to it except at the extreme tip, which alone is free; a strong fold is present on the inner lip a little anterior to its insertion; parietal wall covered by a thin callus.

The type and three additional specimens, Cat. No. 334492, U. S. N. M., were collected by Dr. Engberg off San Juan Island, Gulf of Georgia. The type has a little more than 5 whorls and measures: altitude, 7 mm.; diameter, 3.4 mm. Eight additional specimens from the same station are in Dr. Engberg's collection.

Odostomia (Amaura) **sanjuanensis,** sp. nov.

Shell elongate ovate, wax yellow. Nuclear whorls decollated. Postnuclear whorls narrowly tabulatedly shouldered, moderately rounded, marked by regular retractively slanting lines of growth and fine spiral striations, which give to the surface a cloth-like texture when subjected to high magnification. In addition to this sculpture, the surface of the shell is marked by strong incremental lines and more or less irregular and irregularly distributed spiral threads, which produce a malleated pattern. Suture strongly marked. Periphery of the last whorl well rounded. Base moderately long, well rounded, marked like the spire. Aperture obliquely ovate; posterior angle obtuse; outer lip thin; inner lip very obliquely retractively slanting, somewhat flexuose and provided with a strong fold at its insertion; parietal wall covered by a thin callus.

The type, Cat. No. 334491, U. S. N. M., was collected by Dr. C. C. Engberg near San Juan Island, Gulf of Georgia. It has $5^1/_2$ whorls and measures: altitude, 7.2 mm.; diameter, 3.5 mm. Another specimen from the same locality is in Dr. Engberg's collection.

Odostomia (Amaura) **washingtonia,** sp. nov.

Shell moderately large, broadly elongate conic, pale horn colored. Nuclear whorls too eroded to permit of description. Postnuclear whorls strongly tabulatedly shouldered at the summit, moderately rounded, marked by decidedly retractively slanting lines of growth and numerous very finely incised spiral striations. Sutures conspicuously marked by the tabulated summit. Periphery of the last whorl inflated, strongly rounded. Base short, inflated and strongly rounded, marked like the spire. Aperture rather large, almost subquadrate, slightly oblique; posterior angle obtuse; outer lip thin; inner lip flexuose, reflected over the base, but not appressed, the axis being decidedly protractively slanting. A strong columellar fold is present at the umbilical chink. Parietal wall covered by a thick callus.

The type, Cat. No. 334490, U. S. N. M., was collected by Dr. C. C. Engberg at San Juan Island, Gulf of Georgia. It has 7 whorls and measures: altitude, 8.7 mm.; greater diameter, 4.2 mm. The decidedly turreted outline of this shell, together with its broadly conic shape, will distinguish it at once from any of the other West Coast Amauras.

Alaba catalinensis, sp. nov.

Shell elongate conic, milk white, early whorls well rounded, the succeeding turns a little less so. All whorls polished, appressed at the summit, and marked by fine retractively slanting lines of growth. Beginning with the second turn, varicial thickenings make their appearance; these are very feeble on the early whorls, but increase steadily in strength until on the last turn they form decidedly raised sinuous ridges. The last whorl, too, shows well marked malleations. Aperture oval; posterior angle obtuse; inner lip curved and reflected, but not appressed to the base; parietal wall covered by a thick callus.

The type, Cat. No. 213369, U. S. N. M., was collected by Dr. S. S. Berry in 40 fathoms, off Catalina Island, California. It has ten and a half whorls and measures: length, 5.3 mm.; diameter, 1.9 mm. It is at once distinguished from the other two West American species by the absence of incised spiral lines.

Cyclostremella concordia, sp. nov.

Shell very small, planorboid, hyaline, semitransparent. Early whorls eroded in all the specimens seen. Yhe last two whorls curve suddenly to the deeply channeled suture on the upper surface; the rest gradually, evenly rounded. Periphery of the last whorl well rounded, Base openly umblicated. The entire surface of spire and base is marked by rather strong, irregularly developed incremental lines and more or less equal and equally spaced fine spiral lirations. The intersections of these two sculptural elements give to the surface of the shell the characteristic beaded sculpture of the genus. Aperture very broadly ovate, almost subcircular, the narrower portion being at the posterior angle; peristome thin, not reflected; parietal wall covered by a thin callus. Operculum thin, corneous, paucispiral.

The type and two additional specimens, Cat. No. 340862, U. S. N. M., were collected by Professor Carl C. Engberg at Olga, Washington. The type measures: altitude, 1 mm.; diameter, 2 mm. Two additional specimens from the same locality are in Professor Engberg's collection. The Museum also has specimens from Friday Harbor, Washington.

This species has been known from the last named locality under the names of *Skenia*, and *Skeniopsis planorbis* Fabr.

It is easily distinguished from its nearest neighbor, *Cyclostremella californica* Bartsch, by its smaller size, more robust form and weaker sculpture.

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.—*Deposits of manganese ore in Nevada.* J. T. PARDEE and E. L. JONES, JR. U. S. Geol. Survey Bull. **710-F**. Pp. 34 (109–242), pl. 1, figs. 2. 1920.

The report describes between twenty and thirty deposits rather generally distributed over the State of Nevada, from which about 25,000 tons of manganese ore were produced during the war. Under the head of "Deposits formed by replacement of country rock by carbonate or silicate minerals that have become partly or completely oxidized," are described the Siegel mine, near Schellbourne, and several deposits elsewhere, that show a characteristically cavernous texture in the oxidized zone and are dense below it, where they consist largely of carbonate and silicate of manganese. Like the metalliferous quartz lodes of the surrounding region, to which these bodies are closely related, their origin is ascribed to solutions ascending from intrusive magmas.

Deposits formed by replacement of country rock by oxide minerals, as typified by the Three Kids deposit near Las Vegas, consist largely of somewhat porous but not cavernous masses of wad and other soft oxides. The origin of the manganese is obscure in these and in several bodies near Golconda that are classified as silicate and carbonate lenses in metamorphic rocks.

Minerals of special interest mentioned in the report are alabandite, a sulfide of manganese which is found rather plentifully in the Siegel mine, and exceptionally bright colored rhodonite that is abundant in the O'Brien and Tucker deposit near Golconda. J. T. P.

GEOLOGY.—*Deposits of manganese ore in Costa Rica and Panama.* J. D. SEARS. U. S. Geol. Survey Bull. **710-C**. Pp. 31 (61–91), pl. 1, figs. 28. 1919.

During the war the Geological Survey investigated deposits of ore of metals used in the manufacture of ferro-alloys, pig iron, and steel, and made estimates of tonnage available as substitutes for foreign ores. This paper describes forty deposits of manganese oxide in the

Province of Guanacaste, on the Pacific Coast of Costa Rica, and two recently discovered deposits in Panama. The Costa Rican deposits are widespread, but most of them are either of low grade or of small extent, and in October, 1918, ore was being produced at only three localities. Development of ore bodies of any reasonable size could be done at low cost, but only one other group of prospects seems promising. The two deposits examined in Panama are northeast of the Canal Zone on the Atlantic side, and the ore in sight was estimated at 25,000 to 30,000 tons. An assay of the ore from one deposit showed 55 per cent of manganese. J. D. S.

GEOLOGY.—*Peat in the Dismal Swamp, Virginia and North Carolina.* C. C. OSBON. U. S. Geol. Survey Bull. 711-C. Pp. 19. (41–59), pls. 3. 1919.

The peat deposits of the Dismal Swamp lie in shallow basins that originated in an extensive depression of the Columbia group of formations. The Dismal Swamp covers approximately 2,200 square miles, of which a little more than 700 square miles has been permanently drained to a depth of 3 feet or more by Dismal Swamp Canal and smaller ditches. Much of the drained land is farmed. In the remaining 1500 square miles peat deposits ranging in depth from 1 foot to 20 feet are found. The thickest beds lie in the region east and northeast of Lake Drummond, where peat 18 feet deep was exposed by comparatively recent excavations. The peat in this area is black and low in inorganic impurities and is probably the best in the swamp. In general, the depth of the peat gradually decreases toward the edge of the swamp, where the peat finally merges into the sands of the adjoining areas. It is estimated that the average thickness of the peat is 7 feet. On the assumption that the uncultivated area of the Dismal Swamp is 1,500 square miles, that about one-half of this area is covered with peat averaging 7 feet in depth, and that 200 tons of dry peat per acre-foot may be obtained, then the total available peat in the Dismal Swamp is 672,000,000 tons. R. W. STONE.

TECHNOLOGY.—*The MacMichael torsional viscosimeter.* WINSLOW H. HERSCHEL. Journ. Ind. and Eng. Chem. 12: 282. 1920.

The MacMichael viscosimeter contains a pendulum hanging at the center of a motor-driven cup. Near the upper end of the pendulum is a disk graduated from zero to 300, on which readings may be made of deflections up to 600 M (MacMichael degrees). On adjusting the speed of the instrument used in these tests, as directed by MacMichael, it was found that a speed of 114 revolutions per minute was required to give a deflection of 10 M with water at 20° C. One series of tests gave for viscosities over 0.15 poise, the equation

$$\text{absolute viscosity in poises} = \mu = 0.0042\,(M - 17) \qquad (1)$$

while a second series with variable speed gave

$$M = 1.95\,\mu\,n + 0.000833\,\gamma\,n^2 \qquad (2)$$

where n is the speed in r. p. m., and γ is the density in g/cm^3. These two equations are not exactly equivalent, the difference being at least partly due to the fact that the torsion wire was removed and replaced between the two series of tests. The method of fastening the wire in the pendulum does not permit an accurate adjustment of its length. For this and other reasons the above equations are not intended for application to all instruments with medium-sized wires. Each instrument should be calibrated by the operator with liquids of approximately the same density as those to be tested. Water is objectionable on account of its high density and the small deflection. The Bureau of Standards is prepared to certify to the viscosity of calibrating liquids having a viscosity not exceeding 20 poises. W. H. H.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

146TH MEETING

The 146th meeting of the Washington Academy of Sciences was held at the Cosmos Club on Thursday, April 15, 1920. Dr. VERNON KELLOGG, Chairman of the Division of Educational Relations, National Research Council, delivered an address on *Europe's food in war and armistice.*

147TH MEETING

The 147th meeting was held at the Cosmos Club on May 20, 1920. Dr. E. B. ROSA, of the Bureau of Standards, delivered an address entitled *Economic importance of the scientific work of the government.* This has since been published.[1]

148TH MEETING

The 148th meeting was held at the Cosmos Club on June 15, 1920. Dr. W. VAN BEMMELEN, Director of the Magnetic and Meterological Observatory of Batavia, delivered an illustrated address entitled *The volcanoes of Java.*

Java, the most important, though not the largest island of the Malay Archipelago, is chiefly of volcanic nature. It possesses about 50 volcanoes, with their lateral cones, of which about 20 are more or less active. They may be called the rulers of the island, since the climate, weather, agriculture, and soil are largely dependent on them. The fertile alluvial plains have been formed by their "ejecta" and "efflata."

In contrast with the intricate features found in mountain folding, in the realm of the volcanoes, such geometrical patterns are met with as the straight line, the circle, and the oval. The reason for this is that the causes which produced them were simple, just as in the case of the geometrical line. It is, therefore, comparatively easy to understand their life story. Javanese volcanoes are especially instructive in this regard.

In 1883, Mt. Krakatoa gave the world an interesting lesson in volcanology, when by its terrible eruption two of its secondary cones were blown up and a lateral cone rent asunder. Careful soundings have been made in the newly-formed basin, the bottom of which is 280 meters below sea level, whereas previously the central cones, Perbuwatan and Danan, rose to altitudes of about 250 meters and 450 meters, respectively. The return of the flora and fauna has been studied.

[1] This JOURNAL, 10: 341–382. June 19, 1920.

It is a well-known fact that a lava mountain has often been formed by magma squeezed out of the earth's interior in a comparatively quiet way. An interesting instance of this occurred in 1919, when, in a crater of Mt. Galungun, a flat dome 400 meters in diameter and 100 meters in height was built up in a period of three weeks.

Mt. Merapi, now 3,000 meters high, built up repeatedly a heap of lava blocks in its crater, alternately with severe eruptions. The present lava cone began to form in 1883, and has now attained a height of 300 meters. It fills the crater completely, and red-hot blocks are being hurled over its rim and fall down the slopes of the mountain.

One of the most terrible volcanoes of Java is Mt. Kloot, because it has a crater-lake which has been repeatedly thrown out by the explosions of the crater furnace. Thirty-eight million tons of water, mixed with volcanic ash and erosion products of the ravines, flow down to the plains as a terrible mud-stream. This happened four times in the course of the nineteenth century, and again in 1901 and 1919. Soundings with a maximum thermometer in 1916 revealed no indication of a rise in temperature, and the native official who visited the lake weekly reported no activity. Shortly after the 1919 eruption an attempt was made to drain the lake, so as to prevent the formation of the destructive mud-stream in case of a future eruption. The boring of a tunnel, at the level of the crater bottom, through the crater wall, has been started, notwithstanding the tremendous difficulties involved.

Another dangerous crater lake is that of Mt. Idjen, the most easterly of Java's volcanoes. Its water is of great acidity, containing in solution about 6 per cent of hydrochloric acid and about 2 per cent of sulfuric acid, besides many other chemical compounds. The acid stream which drains this lake is neutralized by another containing lime. However, when the lake overflows, the neutralization is insufficient and the acid water does much damage in the coastal plain. A sluice has been built to remedy this evil. Layers of sulfur are found in the crater walls, and natives cross the lake in canoes to dig out the sulfur. In 1916 soundings were made in the lake and its temperature was investigated by means of a bathothermograph of new design, by which water pressure and temperature were registered simultaneously. In the central pool, 260 meters in depth, concentrated acid at a temperature of about 100° C. was encountered. The work had to be discontinued, however, owing to the loss in the pool of both the thermographs and the maximum thermometer. When new instruments had been made by Dr. J. Boerema, of the Batavia Observatory, renewed activity of the crater prevented the resumption of the work.

149TH MEETING

The 149th meeting was held in the auditorium of the New National Museum, October 23, 1920, at 8.15 p. m., the occasion being an address by Dr. E. B. Rosa, of the Bureau of Standards, entitled *A reorganized Civil Service.* The address was published in the last number of this

JOURNAL (pp. 533–558). It was discussed by Col. W. B. GREELEY, Chief of Forest Service; Dr. GEORGE OTIS SMITH, Director of the U. S. Geological Survey; Dr. F. G. COTTRELL, Director of the Bureau of Mines; Hon. MARTIN MORRISON, President of the Civil Service Commission; and Mr. LEWIS MERIAM, Assistant Director of the Institute for Government Research.

WILLIAM R. MAXON, *Recording Secretary.*

BIOLOGICAL SOCIETY

608TH MEETING

The 608th meeting was held at 8.30 p.m., March 6, 1920, in the lecture hall of the Cosmos Club, with Vice-President VERNON BAILEY in the chair and 50 persons present. The minutes of the meetings held on February 7 and February 21 were read and approved. On recommendation of the Council, Mr. TRACEY I. STORER, of the Museum of Vertebrate Zoology, Berkeley, Calif., and Miss PENELOPE BROWN, East Falls Church, Va., were elected to membership.

Under the heading of *Brief notes and exhibition of specimens*, Dr. M. B. WAITE exhibited the panicled buds of *Paulownia tomentosa*, calling attention to the rather unusual feature of naked buds, without winter scales or special protection. This is an example, as has already been pointed out, of a tropical tree which had adapted itself physiologically rather than structurally, in spreading northward, to more severe conditions.

Prof. A. S. HITCHCOCK gave a brief account of his itinerary in his winter's investigation in British Guiana and the biological conditions prevailing there, and the opportunities for collecting and study, as yet difficult to use to full advantage.

Regular Program

W. P. TAYLOR: *The birds and mammals of Mount Ranier National Park.*

Mr. Taylor spoke on the birds and mammals of Mount Ranier, his communication being illustrated by sixty-four stereopticon slides illustrating features of the flora, glaciers, scenery, and more especially the birds and mammals of Mount Ranier National Park. Half a dozen of the latter were posture studies of mounted birds or mammals in their natural surroundings, prepared by Prof. W. T. SHAW of the State College of Washington. All the remainder were from life, being taken principally by W. L. FINLEY of Portland, Oregon, W. T. SHAW and J. B. FLETT of the National Park Service. Especially noteworthy were the photographs of the Cony, Marmot, Chipmunk and Black-tailed Deer. (*Author's abstract.*)

Mr. Taylor's paper was discussed by Prof. A. S. HITCHCOCK.

D. R. CRAWFORD: *The life history of the spiny lobster.*

The spiny lobster (*Panulirus argus*) is of considerable economic importance. The value of the catch brought into Key West in 1918 was $58,000. The fishermen employ wire traps and the bully net, which is a modified dip net, the hoop of which is set at right angles to the pole.

The spawning season is in the spring from the latter part of February to the first half of May. The act of spawning was observed at the biological station. The female remains in an upright position, and the seminal vesicle is scraped off by using the fifth pair of dactyls just before the eggs are extruded. The eggs are all laid in about six hours. They are carried on the last three pairs of pleopods, but it is not known how they are attached. The incubation period was observed to be eighteen days. The eggs change in color from red to gray as the yolk material is absorbed. The eggs were hatched at Key West in McDonald jars and the first larva or phyllosome was recovered.

The female molts from seven to ten days after the eggs hatch and mating occurs while the shell is still soft. The copulation act follows *Astacus* in details more closely than *Homarus* or *Cambarus*, the female lying on her back with the male standing over her.

The molting act was observed, the shell splitting along the sides of the carapace and rising upward and forward as the cephalothorax is withdrawn. The shell hardens in from eighteen days to three weeks to the extent that it cannot be indented by the fingers. (*Author's abstract.*)

The paper was illustrated by lantern slide views of lobster houses, eggs, larvae, and adult lobsters. Mr. WALDO SCHMIDT discussed the paper, showing by means of a map the distribution of the larvae of the spiny lobster off the southern California coast.

609TH MEETING

The 609th meeting was held March 20, 1920, in the lecture hall of the Cosmos Club. Dr. A. D. HOPKINS called the meeting to order at 8 p.m., with 47 persons present. The minutes of the 608th meeting were read and approved. Upon the recommendation of the Council, Miss K. G. SYMMONDS of Washington was elected to active membership.

Under the heading of *Brief notes and exhibition of specimens*, Dr. R. W. SHUFELDT exhibited a specimen of the Moloch (*Molochius horridus*), a lizard from Australia. It is fairly common and feeds upon ants, especially upon a certain malodorous form which infests houses. These lizards are sometimes encouraged to live in houses to keep the houses free from the worse evil. Thousands of ants may be eaten by the lizard at a meal.

Dr. L. O. HOWARD commented upon the severe cutting back of the sycamore trees on a portion of Eleventh Street, said to be done on account of a blight. Dr. M. B. WAITE further remarked that the blight of sycamore was common in the District, causing long shoots. It is not known that the cutting of the trees back in such drastic manner will control the blight, yet the trees will endure the treatment and develop symmetrical leafy tops.

Mr. THOMAS E. SNYDER exhibited a photograph of a nest of an ant. The nest is similar in external appearance to the nests of some termites which build above ground.

Regular Program

F. L. SCRIBNER: *The lure of Rock Creek Park.*

A brief history of the development of Rock Creek Park was given and its main geographical features described. Then a very extended series of colored lantern slides was shown, making a tour of the park. Many general views were shown of the roads, bridges, and plant associations, in different seasons, and also portraits of some of the individual blossoms or clusters.

Mr. Scribner's paper was discussed by Prof. A. S. HITCHCOCK, Dr. R. W. SHUFELDT, and Dr. M. B. WAITE. In response to a question, Mr. SCRIBNER said that some of the pictures referred to as showing extreme detail were taken by a miniature focusing camera, whose plates were about one and one-half inches in length.

THOMAS E. SNYDER: *The lead cable borer.*

With but few exceptions injury to metal by insects is accidental; the metal blocks the emergence of an adult or is in the path of a burrowing larva. Lead is the metal most commonly injured but tin, zinc, quicksilver, etc., are also damaged. Bullets, roofing, piping and lining of tanks are some of the large variety of products damaged.

One of the most serious cases of direct injury to metal by insects is that done to tubular lead telephone fuses by the beetle *Dermestes vulpinus* Fab. The purpose of the fuse is to protect apparatus from high currents; it melts or "blows" and "grounds" the high current. By eating through the lead (alloy) tape of the fuses, the insects necessitate replacement, as if blown out.

A much more extensive and serious type of injury is that caused to the lead sheathing of aerial telephone cables in California by the beetle *Scobicia declivis* Lec. This beetle normally breeds in recently felled cordwood piled for fuel, "powder posting" the wood. Another abnormal habit is to bore through the staves of wine casks. This beetle attacks the cable in the summer where it lies in contact with the metal suspension ring, which affords it a leverage in boring. The hole allows moisture to penetrate the insulation and numerous widely separated "short circuits" are caused all at once during the fall rains. A high percentage of "wire trouble" is caused by this beetle.

No remedy has as yet been found. Chemical repellants, various different types of suspension rings and hard tin and antimony alloys have proved ineffective. Infested cordwood should be burned before the middle of April. (*Author's abstract.*)

Mr. Snyder's paper was discussed by Dr. L. O. HOWARD.

610TH MEETING

The 610th regular meeting was held in the lecture hall of the Cosmos Club, April 3, 1920, at 8 p.m. President HOPKINS called the meeting to order with forty-two persons present. The minutes of the 609th meeting were read and approved. Upon recommendation of the Council, Mr. EMERSON STRINGHAM of the U. S. Patent Office was elected to membership.

Regular Program

R. W. SHUFELDT: *Observations on the cervical region of the spine in chelonians.*

A series of lantern slides was shown which presented photographs of the cervical vertebrae of an adult specimen of *Amyda cartilaginea* from Japan; a photograph of a drawing by Dr. Shufeldt showing the lateral view of the skull of *Amyda ferox* and different views of its leading cervicals; and, finally, sagittal sections of the neck of the young *Amyda ferox*, showing the leading vertebrae of the cervical region in that chelonian. These sections were furnished by Dr. C. JUDSON HERRICK, Director of the Hull Laboratory of Anatomy of Chicago University, and were made expressly for Dr. Shufeldt's demonstrations from material supplied by him. Various authorities were cited, as Günther, Claus, Sir Richard Owen, Hay, Boulenger, Raynolds, and others, who in their writings contended that chelonians generally possessed but eight cervical vertebrae in the neck, and that the bone found in this region of the spine, between the atlas and third vertebrae, was not a vertebra but an independent bone, which they designated as the "odontoid bone." Dr. Shufeldt, in partial agreement with Professor Huxley, contended that this so-called "odontoid bone," inasmuch as it possessed an odontoid process in *Amyda ferox*, and was developed in the notochord, as in the case of the axis vertebra in other vertebrata, was, in fact, the second vertebra of the neck in chelonians, notwithstanding the fact that, for some reason or other, its processes had, in time, disappeared. It had not, however, lost its usual articulations with the atlas and the third cervical vertebrae. This point having been demonstrated, it gave chelonians *nine* cervical vertebrae instead of eight, as usually stated in works upon the osteology of those animals. (*Author's abstract.*)

Dr. Shufeldt's paper was discussed by Mr. J. W. GIDLEY.

W. C. KENDALL: *Trout of the Great West.*

The ancestral Salmonids were marine forms which gradually acquired an anadromous habit, and some of them later a permanent fresh water abode. They had invaded every accessible region suitable to their existence, which their present distribution and the structure of the various species indicate must have been during a time of free intercommunication of oceans, and comparatively uniform conditions in those portions of all seas in which they lived. The latest period when free intercommunication and comparatively uniform conditions existed was during the Tertiary. Paleontology and recent faunas indicate that it could not have been prior to the Tertiary.

The ancestral Salmonids may have occupied the Pacific, Arctic, and Atlantic Oceans, or may have been restricted to the Arctic. Changes which were evidently initiated as early as the Miocene may have pushed some Arctic ancestors southward into the Pacific, if they did not already occur there. It is well established that in the Pliocene the Pacific was cut off from the Arctic by land connections between Alaska and Siberia. The Salmonids were then actually segregated into two groups, Pacific and Atlantic, with no possible means of intercommunication. With the closing of the Arctic-Pacific gateway, two independent lines of development began.

The original ancestral forms doubtless occupied a northern zone, the southern limit of which was a temperature barrier. The advancing glacial conditions pushed the zone southward and formed a northern border-barrier beyond which no aquatic animal could pass.

The evolution of the environment was accompanied by evolution of the occupant, with the very evident result that there now exist groups of fishes adapted to different environmental conditions. Authorities have indicated that the different environmental conditions are most clearly defined by range of temperature. The different groups of Salmonids are most clearly determined by range in number of scales and vertebrae.

The Pacific Salmonidae, with the exception of the chars, which are probably of Atlantic origin, are sharply defined from the Atlantic Salmonidae by cranial characters. The changing environmental conditions and the indirect barrier of distance, which had preceded the Pacific-Arctic separation, had effected a partial segregation and modification of the ancestral form, which the previously mentioned land barrier and the glacial period carried on to the results manifested by present distribution of more or less differentiated forms.

It is a well known fact that, as a rule, northern fishes are characterized by smaller scales and more numerous vertebrae than those of the south.

The present conditions necessary to the existence of the trouts indicate that the trouts were evolved in and synchronously with the changes of environmental conditions, culminating in those of the present time. As the environmental zone and its subordinate zones moved northward with the recession of the glacial conditions, the occupants of the respective subordinate zones entered accessible fresh waters.

It could not have been until the recession of the glacial conditions that the marine trout were able to permanently occupy inland waters, so as northern waters became accessible they were occupied by trout. Inasmuch, however, as all regions were not provided with accessible fresh waters, the present faunas represent only those which were derived from the respective subordinate zones reaching the outlet of the inland region at the time of accessibility. Such outlets may have been accessible to one or two zones, and not to remaining zones. The trout of present inland isolated waters indicate by their structure from which zones they were populated and by what routes they probably reached these waters. (*Author's abstract.*) The paper was illustrated by maps, diagrams, and photographs of the trouts discussed.

611TH MEETING

The 611th regular meeting was held April 17, 1920, at 8 p.m., in the lecture room of the Cosmos Club. Dr. A. D. Hopkins called the meeting to order with 80 persons present. The minutes of the 610th meeting were read and approved, and on the recommendation of the Council, Mr. Raymond A. St. George of East Falls Church, and Miss Patty Thumb Newbold of the Bureau of Plant Industry, were elected to membership.

The following informal communications were presented: Dr. Alexander Wetmore exhibited a lantern slide prepared by Dr. M. W. Lyon, Jr., former Recording Secretary, showing mounted portions of (1) the beef tape worm and (2) the fish or broad tape worm. The latter is a rare parasite of man in this country, though common in the region surrounding the Baltic Sea. Most specimens taken in this country are from immigrants from that region, though the species is apparently established in the Great Lake Region. The specimen exhibited had an entire length of 6.250 millimeters. (See Lyon, *Journal of the American Medical Association* 74: 655.)

Mr. W. P. Taylor reported a third mammal seen upon the summit of Mount Ranier, 7000 feet above timber line. A black bear, probably lost during a snow storm, was wandering upon the summit.

Dr. Paul Bartsch stated that a new subgenus of *Teredo* had been discovered in Dutch Guiana, especially important as infesting greenheart wood, formerly supposed to be immune, making long burrows 4 to 5 feet long. Prof. A. S. Hitchcock brought out the fact that the greenheart wood in question was that of British Guiana and valuable for marine construction, not that of Dutch Guiana, which is not valuable.

Dr. R. W. Shufeldt showed lantern slides of an insect which he found infesting sycamore trees, commonly known as beech blight. The insect occurs in immense numbers and is covered with white fibers. It is hard to combat mechanically or with sprays. A predaceous caterpillar tangles them in a web and feeds upon them.

Dr. Alexander Wetmore read a letter from Mr. George Haley, Teacher for the Bureau of Fisheries at St. Pauls Island, Alaska, addressed to the Bureau. It was stated that native song birds were becoming very scarce, as the Aleutian Wren, the Rosy Finch, and the Pribilof Snowflake. Only the Alaskan Longspur, a summer migrant, seems to be holding its own.

Regular Program

Dr. H. M. Smith: Address of the retiring President, *Some biological problems in the Yellowstone Park.*

The speaker mentioned the unrivalled facilities afforded by the park for the study of wild animals and the many thousands of visitors who in recent years are becoming acquainted with its biological and other attractions. The anticipated large increase in visitors in the next few years will create a situation that demands attention, especially because of the heavy drain that will be made on the game fishes. The speaker had made two official trips to the park, the last in 1919, and brought to the notice of the society some of the practical biological problems confronting the government authorities—problems that particularly concern the fishes but are not restricted thereto.

After alluding to the origin of the fish life in the park, to the limited number of native species (ten), and to the successful introduction of five trouts of America and Europe, the speaker discussed the following: (1) *The problem of keeping out obnoxious fishes.* The introduction of predatory fishes like the pikes, pike perches, and basses would be unwise and might be a calamity to the trouts and grayling. Two plantings of black bass in 1893 and 1895 were, fortunately, unsuccessful, but in waters where the black bass were said to have been deposited the speaker found a great abundance of yellow perch (*Perca flavescens*), whose introduction was apparently without official record or sanction. (2) *The problem of food for the native and introduced trouts.* There is a scarcity of food for adult trouts in Yellowstone, Lewis, and Shoshone lakes; cannibalism prevails; and the fish are driven at times to a diet consisting almost exclusively of caddisflies caught singly at the surface. It is proposed to introduce small cyprinid and other non-predatory fishes in the expectation that the lakes may support a more numerous supply of trouts. (3) *The problem of parasitism of the native trout.* The tapeworm parasite that, in its larval stage, infests a large proportion of the redthroat trout (*Salmo lewisi*) in Yellowstone Lake, passes its adult stage in the white pelican. The trout could be freed from the parasite by the eradication of the pelican, and the intensity of the parasitism might be reduced by diminishing the number of pelicans and by providing other fish on which the pelicans and trout could in part subsist. This problem merges into the next. (4) *The problem of the pelicans.* The pelicans present a double problem: responsibility for the parasitism of the trout and destruction of large numbers of trout. The speaker's census of the pelicans in the park in 1919 indicated not over 1,300 adult and young birds. The consumption of fish by pelicans was regarded as not inordinately large, in proportion to the size of the waters and the abundance of the redthroat trout, which is the chief food of the pelicans. The statement of Mr. Ernest T. Seton before the Biological Society on January 24, 1920, that the Yellowstone Park pelicans eat only diseased trout and therefore do no harm was controverted. The extermination of the pelicans was not advocated by the speaker, who had recommended to the park authorities that the birds be kept under close observation and their number be reduced by destroying a part of their eggs, after it had developed that they were taking an unduly large toll of trout and were counteracting the government's fish-cultural work. (5) *The problem of maintaining the fish supply in the park.* The fishes are the only wild vertebrates in the park whose deliberate and general killing by visitors is allowed and encouraged. The maintenance of the fish supply in the smaller waters against yearly increasing destruction constitutes a serious practical problem. The restrictions on fishing now imposed—size and string limits—may have to be extended, but, in the opinion of the speaker, the situation for the present may best be met by increasing the abundance of fish by artificial means rather than by further curtailing the anglers.

The address was concluded by an account of the fish hatching carried on in the park by the Bureau of Fisheries, and attention was drawn to the great debt that the country and the park owe to fish culture and fish acclimatization for making the park a veritable anglers' paradise, affording probably better and more varied trout fishing than can be had elsewhere in the United States. Some of the advantages of artificial propagation over natural propagation were pointed out.

Numerous colored lantern slides of streams and lakes in the park served to indicate the extraordinary attractions among which fishery investigations and fish culture are conducted; and there were shown also colored views of geysers and hot springs in some of which collections of sediment and algae had been made. Among some of this material that had been obtained for and examined by Dr. N. A. Cobb there were nematodes representing undescribed species—the first recorded from a hot spring. (*Author's abstract.*)

612TH MEETING

The 612th meeting was held in the lecture hall of the Cosmos Club, May 1, 1920. Dr. T. S. PALMER presided, calling the meeting to order at 8 o'clock with 30 persons present. The minutes of the 611th meeting were read and approved. Upon recommendation of the Council Dr. J. N. ALDRICH of the National Museum and ERIC D. REID of the Fish Division, National Museum, were elected to membership.

Under the heading of *Brief notes and exhibition of specimens*, Dr. R. W. SHUFELDT, having collected all the salamanders known to occur in the District of Columbia except the Cave Salamander, exhibited lantern photographs of six of them. He exhibited two specimens of the spotted trumpet leaf (*Sarracenia variolaris*) in full bloom, from near Orlando, Florida. The specimens have been accepted by the Botanical Gardens.

Dr. T. S. PALMER mentioned the tendency of animals in semi-domestication or protection to breed earlier than in the wholly wild state. Thus bison in the west have been born in April, where in the wild state they are born in June. Pelicans in Florida normally have two breeding seasons, May and November. Recently, under protection, the birds arrive earlier and begin to breed in September.

Dr. C. D. MARSH stated that loco weed is now common in New Mexico and Arizona. The stand is quite heavy for that plant. The plant periodically recurs, since the seeds are practically water proof and withstand several seasons of moderately dry weather but a few wet seasons will cause them to germinate.

Regular Program

Prof. A. S. HITCHCOCK: *Floral aspects of British Guiana.*

An account was given of Prof. Hitchcock's recent trip to British Guiana for the purpose of studying the grasses and collecting the flowering plants and ferns. The work was cooperative between the U. S. Department of Agriculture, the Gray Herbarium, and the New York Botanical Garden. About three and one-half months were spent in the colony, from October to February. The geographical features of British Guiana and the meteorological conditions, especially as to their ecological relations, were described, also the distribution of population, the general conditions of living, and the commercial products. Prof. Hitchcock also described his itinerary, illustrated his remarks with photographs of plants observed and botanical conditions. In answer to questions it was brought out that Prof. Hitchcock's sample of sugar cost ten cents per pound, and that mosquitoes occur everywhere but not so abundantly as in our north. Malaria occurs.

A. A. DOOLITTLE, *Recording Secretary.*

613TH MEETING

The 613th meeting was called to order by Past President PALMER at 8.20 p.m., May 15, 1920, in the lecture hall of the Cosmos Club, with 47 persons present. The minutes of the preceding meeting were read and approved.

Under the head of general notes Dr. PALMER referred to the recent meeting of the American Society of Mammalogists and the wealth of material presented in papers on 20 topics. Then followed remarks by Dr. WETMORE on a collection of bones taken by H. E. ANTHONY from Porto Rican deposits and submitted to him for identification. Several species proved to be new and the collection as a whole tends to fill gaps in the known distribution of birds.

Regular Program

ALEXANDER WETMORE: *Use of powder down feathers in birds.* This paper will appear in full in *Condor.*

W. P. TAYLOR: *Habits of the kangaroo rat in Arizona.*

The big kangaroo rat (*Dipodomys spectabilis*), the large rounded mounds of which are so conspicuous a feature in many localities in the southwestern United States, is found to be of considerable economic importance. Its habit of food storage is of particular interest, as it hoards large quantities of the seeds or crowns of several kinds of grama grasses and needle grasses, including some important forage species. Although considerable information on the life history and habits of the animal has been acquired, further investigations are necessary, if a thorough understanding of its relation to its environment is to be gained. Discussed by Messrs. WETMORE, GOLDMAN and MARSH.

E. A. GOLDMAN: *The elk of the Jackson's Hole region in Wyoming.*

Forage conditions were very adverse in Jackson Valley and the winter unusually long and severe. There was some starvation of elk at certain outlying points, but the main herd wintered fairly well through feeding carried on by the Biological Survey and the State of Wyoming. An emergency purchase of hay by the Biological Survey undoubtedly saved the lives of thousands of elk. Discussion by Drs. SHUFELDT and MARSH.

E. A. GOLDMAN, *Recording Secretary, pro tem.*

SCIENTIFIC NOTES AND NEWS

A general plan to coordinate the work of the various associations interested in changes in the executive departments of the Federal Government was set on foot on October 5, when JOHN T. PRATT, former Secretary of War STIMSON, HERBERT HOOVER, PAUL M. WARBURG, M. O. LEIGHTON and C. T. CHENERY met and decided to call a meeting of representatives of all interested organizations on October 14. A general plan will be submitted by the National Committee on Governmental Economy.

The following educational courses are being given at the Bureau of Standards: H. L. CURTIS: *Advanced electricity and magnetism.* L. B. TUCKERMAN: *Theory of functions.* L. H. ADAMS: *Physical chemistry.* I. C. GARDNER: *Optical instruments and lens design.*

At the regular meeting of the Board of Surveys and Maps on October 12, the committees on Coordination, Highway Maps, and Hydrographic Charts made complete reports, which are being prepared for distribution.

The National Academy of Sciences has purchased the block bounded by B, C, Twenty-first, and Twenty-second Streets, N. W., near the Lincoln Memorial. The site will be used for the erection of a home for the Academy and the National Research Council. Funds for the building have been allotted by the Carnegie Corporation of New York.

The representatives of the various organizations constituting the Federated American Engineering Societies met in Washington on November 18–19.

The Grass Herbarium of the U. S. National Museum has recently received from the Berlin Botanic Garden two consignments of grasses, consisting of 100 specimens from Africa and South America, and 126 specimens nearly all of which were types of species described from South America, chiefly the Andean region, by Dr. PILGER. In proportion to its size, the collection is the most valuable ever received by the Herbarium.

The mounted skeleton of an extinct Pleistocene wolverine from a cave near Cumberland, Maryland, has recently been added to the paleontological exhibits at the National Museum.

At a meeting at the Chemists' Club in New York City on October 15, Dr. C. L. ALSBERG, Chief of the Bureau of Chemistry, and Dr. F. G. COTTRELL, Director of the Bureau of Mines, presented the Government's arguments in favor of the bill concerning patents by Federal employees (H. R. 9932 and S. 3223).[1] Representatives of the chemical industries opposed the bill but offered no substitute to accomplish

[1] See this JOURNAL **10**: 400, 425. 1920.

what Messrs. Alsberg and Cottrell deemed very desirable and necessary objects, namely, the development of inventions and discoveries which are made by employees incidentally to the regular work of the scientific bureaus, as well as the protection of such inventions against unfair exploitation to the detriment of the public.

The U. S. Department of Agriculture has become a member of the American Engineering Standards Committee. This committee consists of representatives from the five large engineering societies, the Army, the Navy, and the Department of Commerce, and several organizations dealing with safety codes and fire protection. Messrs. A. T. Goldbeck, of the Bureau of Public Roads, D. J. Price, of the Bureau of Chemistry, and E. H. Clapp, of the Forest Service, have been appointed to represent the Department of Agriculture.

An "Industrial Alcohol and Chemical Division" and a "Permit Division" were established on October 15 in the prohibition unit of the Bureau of Internal Revenue, to divide and handle the work of the former Division of Technology. Mr. J. M. Doran has been appointed head of the Industrial Division, and Dr. A. B. Adams will be in charge of the Permit Division.

The publication and information work of the Department of Agriculture has been reorganized, and Mr. Harlan Smith has been appointed Director of Information to have general supervision of all these activities both in Washington and in the field.

Dr. C. L. Alsberg, chief of the Bureau of Chemistry, U. S. Department of Agriculture, was elected president of the Association of American Dairy Food and Drug Officials at the recent convention of the Association at St. Louis.

Dr. Henry M. Ami, who has been since January, 1917, at the British Embassy in Washington in charge of matters concerning war metals, minerals, etc., returned to Ottawa in September to resume his paleontological and geological work with the Geological Survey of Canada.

Mr. William B. Brown, associate physicist, of the aëronautic power plants section of the Bureau of Standards, has resigned to become instructor in physics at the Ohio State University, Columbus, Ohio.

Mr. J. P. Cockey has been appointed research associate at the Bureau of Standards by the Super Cement Company, Limited, and will study methods of using oil in connection with portland cement.

Dr. Whitman Cross, of the U. S. Geological Survey, has been appointed Honorary Associate in Petrology at the National Museum, succeeding the late Dr. J. P. Iddings.

Mr. Hubert M. Freeman, associate physicist of the radio section, Bureau of Standards, has resigned to accept a position with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

Mr. VICTOR R. GAGE, mechanical engineer, of the aëronautic power plants section of the Bureau of Standards, has resigned to accept a position in the Department of Experimental Engineering, Cornell University, Ithaca, New York.

Mr. C. W. GILMORE, of the Division of Paleontology, National Museum, through the courtesy of Mr. O. H. REINHOLT, of the Treasury Department, was enabled to visit the cave recently discovered in the limestone rocks in the vicinity of Keedysville, Maryland. It was hoped that the remains of extinct animals might be found, but none were discovered. Though not as extensive as the Luray caverns, the cave contains several lofty rooms and passages, decorated with various forms of stalactitic incrustations.

Dr. ALES HRDLICKA, of the U. S. National Museum, is delivering a course of lectures on man's antiquity and on the origins of the more important existing races and nations, at the American University, 1907 F Street.

Dr. CARL O. JOHNS, chief of the color laboratory at the Bureau of Chemistry, U. S. Department of Agriculture, resigned in November to become director of a newly-established department of general research for the Standard Oil Company of New Jersey.

Dr. ADOLPH KNOPF, formerly of the U. S. Geological Survey, has been appointed associate professor of physical geology and petrology at Yale University, New Haven, Connecticut.

Mr. J. O. LEWIS, chief petroleum technologist of the Bureau of Mines since 1918, resigned on November 15 to take up private work as petroleum technologist. Mr. A. W. AMBROSE, superintendent of the Bureau's experiment station at Bartlesville, Oklahoma, has been appointed to succeed Mr. Lewis.

Mr. S. K. LOTHROP has returned to Washington after spending the summer at the British Museum and other English institutions. Mr. Lothrop will resume his studies on the Central American pottery in the division of American Archeology of the National Museum.

Major LAWRENCE MARTIN, of the General Staff Corps, U. S. Army, is giving the inaugural series of the Gilman Memorial Lectures on Geography, at Johns Hopkins University, Baltimore. The general subject of the series is *Geographic factors affecting foreign trade.*

Mr. T. W. NORCROSS, assistant chief engineer of the Forest Service, U. S. Department of Agriculture, since 1913, has been appointed chief engineer of the Service to succeed O. C. MERRILL, who resigned recently to accept the secretaryship of the Federal Power Commission.

Mr. SAMUEL R. PARSONS, associate physicist, of the aëronautic power plants section, Bureau of Standards, has resigned to accept a position as instructor in physics at the University of Michigan, Ann Arbor, Michigan.

Mr. Albert B. Peck, associate physicist of the cement, sand and stone section, of the Bureau of Standards, resigned on September 15, to become assistant professor in the Department of Mineralogy, University of Michigan.

Mr. H. Pittier, of the U. S. Department of Agriculture, who is at present in Venezuela, will accompany a party of Swiss engineers who are expected in Venezuela in January for the purpose of investigating doubtful points of the Venezuela-Colombia boundary as recently arbitrated by the King of Spain. The Commission will traverse the territory extending from a point on the Rio Meta to the headwaters of the Guainiia in the Rio Negro basin, a region which has probably never been visited by naturalists.

Mr. Daniel H. Simpson has resigned from the chemical staff of the Bureau of Standards to accept a position in the sales department of the Edison Electric Appliance Company, Inc., of Chicago, Illinois.

Messrs. E. N. Turnquist, physicist, and G. G. Sward, physical chemist, have been appointed research associates at the Bureau of Standards by Sears, Roebuck and Company of Chicago, to study the methods of standardization of mechanical devices and commercial articles on a physical and chemical basis.

Mr. H. M. Westergaard has been appointed a research engineer at the Bureau of Standards by the American Concrete Association, to investigate the properties of flat-slab concrete and tile structures.

Mr. G. M. Williams, associate engineer of the cement, sand and stone section of the Bureau of Standards, has resigned to accept a position as professor of civil engineering at the University of Saskatchewan, Saskatoon, Saskatchewan.

Dr. Sadao Yoshida, of the Department of Pathology, Osaka Medical College, Dr. T. Minowa, now at Cold Spring Harbor, Long Island, and Prof. Hiko Matsumoto, of Sendai University, visited Washington in October.

JOURNAL
OF THE
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Vol. 10 December 19, 1920 No. 21

BOTANY.—*The history of kidney cotton.* Frederick L. Lewton, U. S. National Museum.[1]

It is often difficult to determine the botanical identity of the cultivated forms of an important plant like cotton, on account of the extensive transport of seed from one country to another which has taken place, the changes brought about in these forms while adjusting themselves to the new conditions, and the results of natural or artificial crossing. In the case of cotton the meagre and incomplete descriptions of cotton plants usually given in books of travel, and found even in many botanical works, make it extremely difficult to trace the origin and distribution of a large number of distinct species and varieties. The type of cotton, however, known as kidney, chain, or stone cotton, in which the seeds of each cell adhere firmly together in the form of a kidney-shaped mass, instead of lying separated from one another enveloped in more or less cotton lint, has such a unique and constant character in its clusters of seeds that its identification in even very incomplete descriptions is a comparatively easy matter.

What appears to be the earliest account of this species was given by Jean de Lery[2] in his history of a voyage made to the land of Brazil in 1557, which was written in French and published in 1578. Under the name of John Lerius, his history was translated and reprinted by Purchas[3] in the fourth book of his "Pilgrimes." In this account Lerius tells of the Bom-

[1] Received October 30, 1920.

[2] Lery, Jean de. *Histoire d'un voyage fait en la terre du Bresil, autrement dite Amerique*, ed. 1, 208. 1578.

[3] Purchas, Samuel. *Purchas his Pilgrimes*, ed. 3, 4: 1333. 1625.

basin cotton shrubs with seeds "close joined and verie much pressed together after the form of a man's kidnie." He says it was known to the barbarians by the name of *ameniiou*, a name which is still used in practically the same form by the Tupi tribes of Brazil. L'Obel,[4] in 1576, endeavored to improve on the pictures of the Levant cotton published some years earlier by Fuchsius and by Matthiolus, by adding a figure of a cluster of seven seeds arranged in a kidney-shaped mass. He must have become familiar with the seed arrangement in Brazilian kidney cotton through material brought to Europe by traders or explorers, and thought that this was true of all cottons.

The earliest accurate description and illustration of kidney cotton seems to be that given in 1675 by Giacomo Zanoni,[5] who calls it "Bambagia arborea di Pernambuco." His figure is reproduced on the opposite page. This cotton, undoubtedly a native of Brazil and Guiana originally, was soon spread over the tropical regions of the world bythe aerly Portuguese navigators, and became thoroughly established in Africa, India, Siam, the Philippines, and many other countries. Sir Hans Sloane tells in 1696 of kidney cotton having been brought to Jamaica from Brazil by James Lancaster after the defeat of Pernambuco in 1594.

Julius Philip Benjamin von Rohr carried on in the island of St. Croix, between 1786 and 1790, a most extensive series of cotton experiments, an account of which he published in 1791 and 1793 under the title "Anmerkungen über den Cattunbau zum nuzen der Daenischen Westindeschen Colonien." He grew and examined as many kinds of cotton as he could obtain by travel in the West Indies and South America, and by the help of friends in other parts of the world. He made notes on the character and behavior of these cottons, recorded their yields, and carried out extensive breeding experiments and fertilizer tests. Rohr describes under the names Guiana cotton, Brazil cotton, and Porto Rico cotton, three types in

[4] L'Obel, Matthias de. *Plant. seu Stirp. Hist.*, 370. 1576.

[5] Zanoni, Giacomo. *Istoria Botanica*, 40–44. *Pl. 16.* 1675.

Fig. 1.—The earliest illustration of a plant of kidney cotton. From Giacomo Zanoni, Istoria Botanica, pl. 16. 1675.

which the seeds adhere together. The following are descriptions, condensed from Rohr, of three types of cotton which have their seeds adhering together in clusters:[6]

"*Guiana cotton*, the seed very black and rough like fine chagrin, those of each lock adhere together in the form of a long, narrow pyramid. The kind most prized in Europe on account of its whiteness, strength and length. Known in Europe as Cayenne, Surinam, Demerara, Berbice and Essequibo. Planted all over Guiana. This is the kind seen and described by all writers and travelers in this region. It does not do so well in the West Indies. Yields two harvests yearly. In Martinique called *coton á pierre*, in Jamaica, kidney cotton, also link cotton. Grows 10 to 12 feet wide if the ground is good. Nine to eleven seeds in each lock.

"*Brazil cotton*, the seed black and rough like those of Guiana cotton. The seed of each lock adhere together in the form of a short, broad pyramid. Only found in Brazil, imported into St. Croix by Dr. Peter Duncan. Seven and not over nine seeds in each lock. I have often found the seeds of the Guiana cotton in commerce, but never those of the Brazilian. After growing the Brazilian cotton in St. Croix, I saw no evidence of its changing into the Guiana kind.

"*Porto Rico cotton*, the seed in each lock adhere together in the form of a long, narrow pyramid, and are entirely covered with 'filz.' I have known this kind for a long time. Very much like the Guiana cotton in growth, size, shape of the tree and all its parts. It only bears with me once a year. For the planter the only distinguishing character is the entirely fuzzy seed. The wool is as hard to take off as that of the Guiana cotton."

The eccentric American botanist C. S. Rafinesque, in his "Sylva Telluriana," published in 1838, proposed Latin binomial names for the cottons described by Rohr.[7] For the Guiana and Brazil cottons he proposed the name *Gossypium guyanense* and distinguished them as varieties *verum* and *braziliensis*. For Rohr's Porto Rico cotton he proposed *Gossypium rohrianum*.

F. R. de Tussac, a French colonist who settled in the Island of Santo Domingo, and eventually lost his fortune there, pubished in 1808 to 1827 his "Flore des Antilles." In this work, devoted mainly to the botany and agriculture of the islands of Santo Domingo (Hayti), Martinique and Guadeloupe, the

[6] ROHR, JULIUS PHILIP BENJAMIN VON. *Anmerkungen über den Cattunbau zum nuzen der Daenischen Westindischen Colonien.* 1: 38–39, 45, 72–80, 120–121. 1791.

[7] RAFINESQUE, C. S. *Sylva Telluriana* 16, 19. 1838.

author describes one indigenous and four introduced species of cotton. Of one of the latter he speaks as follows:

"The culture of another species, which differs but little from the preceding, has been adopted by some colonists, it is called the Stone cotton, *Cotonnier pierre* (*Gossypium lapideum* Tussac), or cotton of Cayenne. In this species the seeds are strongly united together and form a little block which is easily separated from the wool. This is composed of very long and very strong filaments, and on this account it gains in weight what it loses in fineness."[8]

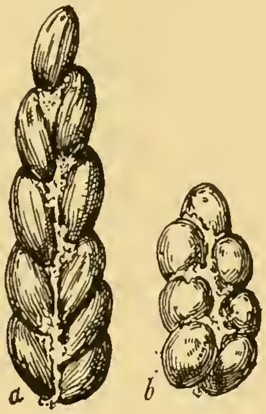

Fig. 2.—Seed clusters of two varieties of kidney cotton which were distinguished by Rohr (1791) and named by Rafinesque (1838).

a. The Guiana variety: Gossypium guyanense verum Raf.

b. The Brazilian variety: G. guyanense brasiliense Raf.

Original drawing from photograph of seeds planted in Arizona, 1908.

From the settlements of the Portuguese in India, and the activities of the East India Company in bringing seed from South America for planting on the coast of Coromandel and in Bengal before 1780, kidney cotton became thoroughly established in India, as shown by specimens in European herbaria collected by Dr. Hove as early as 1787. It thus attracted the attention of W. Roxburgh, who, in his "Hortus Bengalensis" of 1814, catalogs a species of *Gossypium* as *G. acuminatum*, but gives no description.[9] In Roxburgh's "Flora Indica," however, which appeared in 1832, he gives enough description to show that he intends this name for kidney cotton, the specific name "acuminatum" being chosen because of the "much pointed" capsules.[10] Roxburgh believed this cotton to be uncultivated and a native of northwestern India.

John Vaupell, an Englishman who traveled throughout Guzerat in western India in 1838, published[11] two years later an account of the cottons of that region, and mentions having found several

[8] Tussac, F. R. de. *Flore des Antilles* **2**: 67. 1818.

[9] Roxburgh, W. *Hortus Bengalensis* 51. 1814.

[10] Roxburgh, W. *Flora Indica* **3**: 186. 1832.

[11] Vaupell, John. *Cottons of Guzerat*, Trans. Agric. Hort. Soc. Bombay. 1840.

unusual cotton plants growing in a temple yard at Sidhpoor. He planted seeds of these near Bombay, and obtained plants which he described as a new species under the name *Gossypium imbricatum*, from the imbricate arrangement of the seeds. In the meantime, however, John Graham, the superintendent of the botanical gardens of the Agri-Horticultural Society of Western India, in Bombay, published "A Catalogue of the Plants Growing in Bombay and its Vicinity," in which he described[12] under the name *Gossypium vaupellii* the cotton brought from Sidhpoor in Guzerat by Vaupell.

Two or three years before the names proposed by Graham and by Vaupell for this type of cotton were published, there appeared the "Flora of Jamaica" by James Macfadyen, founded largely on the work of Sir Hans Sloane. Under the name *Gossypium brasiliense*, Macfadyen gives a much better description of the kidney cotton than those appearing in earlier works, and says that "In the time of Sloane as well as in that of Edwards it was known by the name of Brazilian cotton."[13]

Since 1814 the following names have been published as applying solely to kidney cotton:

Gossypium lapideum Tussac, Fl. Antill. **2**: 67. 1818.
Gossypium acuminatum Roxb. Hort. Beng. 51, nomen nudum. 1814; Fl. Ind. **3**: 186. 1832.
Gossypium arboreum Vell. Fl. Flum. **7**: *pl. 49*. 1827. Not L. 1753.
Gossypium brasiliense MacFad., Fl. Jam. **1**: 72. 1837.
Gossypium perenne Blanco, Fl. Filip., ed. 1, 537. 1837.
Gossypium guyanense Raf. Sylva Tell. 16. 1838.
Gossypium vaupellii Graham, Cat. Plants Bombay and Vicinity, 15. 1839.
Gossypium imbricatum Vaupell, Trans. Agric. Hort. Soc. Bombay. 1840.
Gossypium conglomeratum Wiesner, Die Rohstoffe des Pflanzf., ed. 2, **2**: 236. 1903.

Of these, Tussac's name, although antedated by that of Roxburgh, is the first name which was associated with a description sufficiently clear to identify the species intended.

[12] Graham, John. *A Catalogue of the Plants Growing in Bombay and Its Vicinity* 15. 1839.

[13] Macfadyen, James. *Flora of Jamaica* 1: 72. 1837.

Until such time as the Guiana and Brazilian forms shall be considered as constituting two distinct species, the scientific name of kidney cotton should be *Gossypium lapideum* Tussac.

PETROGRAPHY.—*Platinum in meteoric irons: a correction.*

Through a misreading of Dr. Mingaye's notes it was stated in the issue of this JOURNAL for June 4 last,[1] with reference to the Yenberrie iron: "This is the first reported case of platinum in an Australian meteorite." As a matter of fact platinum has become one of the well-recognized constituents of meteorites and has been detected by Dr. Mingaye himself in those of Barrata, Cowra, Delgate, Gilgoin, Molong, and Mount Dyrring.

GEO. P. MERRILL.

[1] This JOURNAL, **10**: 315. 1920. Note *a* to Table I.

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.—*The Mule Creek oil field, Wyoming.* E. T. HANCOCK. U. S. Geol. Survey Bull. 716-C. Pp. 19 (35-53), pl. 1, fig. 1. 1920.

The bulletin discusses an area containing two well-developed anticlines about 30 miles S. S. E. of the Black Hills, near the east edge of Wyoming in Niobrara County. Upper Cretaceous beds from the top of the Niobrara formation down into the Mowry shale are exposed, a stratigraphic thickness of about 1600 feet. The subsurface section, compiled from records of drill holes in this and adjacent areas, includes about 2700 feet of beds and extends 398 feet into the top of the Mississippian. Structure is represented by contours at 100-foot intervals. The two anticlines described lie along the general trend of the Hartville uplift, which connects the Front Range with the Black Hills, and strike nearly due north. The length of one anticline is about 4 miles, of the other more than 7 miles; the widths range from 2 to 5 miles or more. The dips average from 5° to 15°, reaching a maximum of 26°. No faults are noted. Active production in the field began early in 1919. The producing wells average 125 to 150 barrels and the total production of the field early in 1920 exceeded 1000 barrels a day, of a paraffin oil of low specific gravity. Tests on one of the anticlines had been unsuccessful when the report was prepared. The writer lays much stress as a possible oil horizon on what he calls the Newcastle sandstone, about 175 feet above the Lakota sandstone and 50 feet below the Mowry shale. In the discovery well he believes the productive sand is in the Lakota sandstone about 435 feet below the Newcastle sandstone. Testing for possible deeper sands had been carried into the "Red beds" (Spearfish formation, Triassic?) with the ntention of going still deeper. M. I. GOLDMAN.

SCIENTIFIC NOTES AND NEWS

The American Ornithologists' Union met in Washington on November 9–11.

The seventh revised edition of the Smithsonian Physical Tables, after considerable delay due to printing difficulties, appeared in October. It contains about 100 more pages and 170 more tables than the sixth revision.

An Advisory Board on the subject of highway research, under the chairmanship of Dean MARSTON of Iowa State College, has been organized by the Engineering Division of the National Research Council. Money will be provided for a salaried technical director of the Board who will give his whole time to the work. The U. S. Bureau of Public Roads will coöperate in this work.

A cryogenic laboratory for the study of liquefied gases, including hydrogen and helium, is being installed at the Bureau of Mines. The laboratory will be under the direction of Dr. R. B. MOORE.

Contracts were let in November for the construction of five reinforced concrete buildings for the new Naval experimental and research laboratory to be established at Belleview, D. C., on the east bank of the Potomac River, south of Washington. The laboratories are to cost about $650,000. The funds are provided from a war appropriation authorized by Congress on the recommendation of the Naval Consulting Board.

An illustrated lecture on *The stereographic method as applied to photographic mapping and the apparatus used in connection therewith* was given in the auditorium of the Interior Department on Saturday, November 13, by Mr. N. SANDOR, of Jena, Germany, a representative of the International Stereographic Central, under the auspices of the Topographic Branch of the U. S. Geological Survey.

Mr. H. D. FOSTER has been appointed research associate at the Bureau of Standards by the Hollow Building Tile Association.

Dr. RALPH E. HALL, formerly of the Geophysical Laboratory of the Carnegie Institution of Washington, has resigned from the Firestone Rubber Company, of Akron, Ohio, to accept a position with the Koppers Company, manufacturers of by-product coke ovens, at Pittsburgh, Pennsylvania.

Mr. ELMER D. MERRILL, Director of the Philippine Bureau of Science, spent two weeks in Washington during November.

Mr. HARRY S. MULLIKEN, a consulting and metallurgical mining engineer of New York City, has been appointed technical assistant to the Director of the Bureau of Mines.

Dr. Hideyo Noguchi of the Rockefeller Institute for Medical Research, New York City, gave a lecture at the National Museum at 4 p. m., Wednesday, November 17, on *Recent studies of yellow fever.* The lecture was given under the auspices of the Army Medical School.

Messrs. Charles Resser and R. S. Bassler of the National Museum have prepared an exhibit of fossil plants, arranged biologically, in the paleobotanical hall of the Natural History Building. This is the first systematic exhibition of its kind in the Museum.

Mr. Bert Russell, formerly of the Patent Office, left the service of Prindle, Wright and Small of New York City on December 1, to accept a position with R. F. Steward, chemist and patent attorney, of Washington.

Messrs. P. S. Smith of the U. S. Geological Survey, and E. A. Holbrook and O. P. Hood of the Bureau of Mines, have been appointed by the Secretary of the Interior to serve on the American Engineering Standards Committee, of which the Department has become a member.

Mr. Nelson R. Wood, for over thirty-two years a taxidermist in the National Museum, died on November 8, 1920.

ERRATA

VOL. 9, 1919

P. 668, second column, line 20....	For Frederick B. LaForge	read Laurence LaForge

VOL. 10, 1920

P. 15, line 4......	For *drymifolia*	read *drimyfolia*
P. 35, line 25......	For Wostor	read Wooster
P. 327, line 14 f. b.	For quenstedticerds	read Quenstedticeras
P. 339, line 15 f. b.	For COLVILLE	read COVELL
P. 413, Legend, Fig. 1..............	For Reflection	read Refractive
P. 498, line 6.... .	For March 13	read February 28
P. 578, lines 28 and 33.............	For Ranier	read Rainier
P. 587, lines 28–30	This should read	"consisting of 100 specimens from Africa and 126 from South America, the latter being types of species described by Dr. Pilger, chiefly from the Andean region."

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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

AUTHOR INDEX

24160

SUBJECT INDEX

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Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, aims to present a brief record of current scientific work in Washington. To this end it publishes: (1) short original papers, written or communicated by members of the Academy; (2) short abstracts of current scientific literature published in or emanating from Washington; (3) proceedings and programs of meetings of the Academy and affiliated Societies; (4) notes of events connected with the scientific life of Washington. The JOURNAL is issued semi-monthly, on the fourth and nineteenth of each month, except during the summer when it appears on the nineteenth only. Volumes correspond to calendar years. Prompt publication is an essential feature; a manuscript reaching the editors on the twelfth or the twenty-eighth of the month will ordinarily appear, on request from the author, in the issue of the JOURNAL for the following fourth or nineteenth, respectively.

Manuscripts may be sent to any member of the Board of Editors; they should be clearly typewritten and in suitable form for printing without essential changes. The editors cannot undertake to do more than correct obvious minor errors. References should appear only as footnotes and should include year of publication.

Illustrations will be used only when necessary and will be confined to text figures or diagrams of simple character. The editors, at their discretion, may call upon an author to defray the cost of his illustrations, although no charge will be made for printing from a suitable cut supplied with the manuscript.

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* Volume I, however, from July 19, 1911, to December 19, 1911, will be sent for $3.00. Special rates are given to members of scientific societies affiliated with the Academy

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Tuesday, January 6. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Tuesday, January 6. The Botanical Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, January 7. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Thursday, January 8. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program:

Celebration of the 300th meeting:

F. W. Clarke, W. F. Hillebrand, H. W. Wiley: Early history of the Society.

R. S. McBride: Review of the past ten years.

Saturday, January 10. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Tuesday, January 13. The Institute of Electrical Engineers, at the Cosmos Club, at 8.00 p.m.

Tuesday, January 13. The Washington Academy of Sciences, at the Carnegie Institution, at 8.15 p.m. Program.

Presidential address: F. L. Ransome: *The functions and ideals of a national geological survey.*

Annual meeting for reports and election of officers.

Wednesday, January 14. The Geological Society, at the Cosmos Club, at 8.00 p.m.

Thursday, January 15. The Entomological Society, at the Cosmos Club, at 8.00 p.m.

Saturday, January 17. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

Program of papers on aeroplane investigations, in charge of H. C. Dickinson.

Tuesday, January 20. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Wednesday, January 21. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

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Vol. 10 JANUARY 19, 1920 No. 2

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Tuesday, January 20. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m. Program:

GERARD FOWKE: *The exploration of caves in the Ozark region, Missouri.*

Wednesday, January 21. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Thursday, January 22. The Chemical Society, at the Cosmos Club, at 8.00 p.m.

Saturday, January 24. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, January 28. The Geological Society, at the Cosmos Club, at 8.00 p.m. Program:

F. E. MATTHES: *Physiographic history of the Yosemite.*
G. R. MANSFIELD: *Stratigraphy and structure in southeastern Idaho.*
W. T. HEOM, JR.: *The structure of the so-called Poplar Dome in northeastern Montana.*

Thursday, January 29. The Washington Academy of Sciences, at the Cosmos Club, at 8.15 p.m.

Saturday, January 31. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

Presidential address: W. J. HUMPHREYS: *A bundle of meteorological paradoxes.*

Tuesday, February 3. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Tuesday, February 3. The Botanical Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, February 4. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Thursday, February 5. The Entomological Society, at the Cosmos Club, at 8.00 p.m.

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Saturday, February 7. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Tuesday, February 10. The Institute of Electrical Engineers, at the Cosmos Club, at 8.00 p.m.

Wednesday, February 11. The Geological Society, at the Cosmos Club, at 8.00 p.m.

Thursday, February 12. The Chemical Society, at the Cosmos Club, at 8.00 p.m.

Saturday, February 14. The Philosophical Society, at the Cosmos Club, at 8.15 p.m.

Tuesday, February 17. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Wednesday, February 18. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Thursday, February 19. The Academy.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Thursday, February 19. Joint meeting of the Academy with the Geological Society, at the Cosmos Club, at 8.15 p.m. Program:

Alfred H. Brooks: *The application of geology to war.*

Friday, February 20. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, February 25. The Geological Society, at the Cosmos Club, at 8.00 p.m.

Thursday, February 26. The Chemical Society, at the Cosmos Club, at 8.00 p.m.

Saturday, February 28. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

E. D. Williamson: *Elastic properties of the earth.*

L. H. Adams: *The nature of the interior of the earth.*

C. G. Peters: *Calibration of precision end standards.*

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Thursday, March 4. The Entomological Society, at the Cosmos Club, at 8.15 p.m.

Saturday, March 5. The Biological Society, at the Cosmos Club.

Tuesday, March 11. The Chemical Society, at the Cosmos Club, at 8.15 p.m.

Wednesday, March 10. The Geological Society, at the Cosmos Club, at 8.15 p.m.

Saturday, March 13. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

S. DUSHMAN: *Chemical and physical researches at low pressures.*

Tuesday, March 16. The Anthropological Society.

Wednesday, March 17. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Thursday, March 18. The ACADEMY, at the Cosmos Club, at 8.15 p.m. Program:

J. W. FEWKES: *American archaeology; its history and technique.*

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Saturday, March 20. The Biological Society

Monday, March 22. The Board of Managers of the ACADEMY.

Wednesday, March 24. The Geological Society.

Thursday, March, 25. Joint Meeting of the ACADEMY and Chemical Society, at the Cosmos Club, 8.15 p.m. Program:

EDGAR T. WHERRY: *Soil reaction and plant distribution.*

Saturday, March 27. The Philosophical Society, at the Cosmos Club.

Thursday, April 1. The Entomological Society.

Saturday, April 3. The Biological Society.

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Tuesday, April 6. The Anthropological Society.

Tuesday, April 6. The Botanical Society, at the Cosmos Club at 8.00 p.m. Program.

A. S. HITCHCOCK: *A botanical trip to British Guiana.*

Wednesday, April 7. The Society of Engineers, at the Cosmos Club, at 8.15 p.m. Program:

N. C. GROVER: *The future of hydroelectric power.*

Thursday, April 8. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program:

C. E. MANGELS: *Food dehydration.*

J. M. DORN: *Industrial alcohol.*

Saturday, April 10. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

H. C. DICKINSON: *Physical laboratory methods applied to aircraft engine performance at high altitudes.*

M. D. HERSEY: *Old and new problems of aeronautic instruments.*

Tuesday, April 13. American Institute of Electrical Engineers, Washington Section.

Wednesday, April 14. The Geological Society, at the Cosmos Club, at 8.00 p.m. Program:

A. E. FATH: *Fault systems in the mid-continent field in Oklahoma.*

J. B. MERTIE, JR.: *The Salt Chuck palladium mine near Kasaan, Alaska.*

ARTHUR KEITH: *Structure of the Taconic Range in Vermont.*

Thursday, April 15. The ACADEMY, at the Cosmos Club, at 8.15 p.m. Program:

VERNON KELLOGG: *Europe's food in war and armistice.*

Saturday, April 17. The Biological Society, at the Cosmos Club.

[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 the month.

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Vol. 10 APRIL 19, 1920 No. 8

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Tuesday, April 20. The Anthropological Society.

Wednesday, April 21. The Washington Society of Engineers.

Thursday, April 22. The American Meteorological Society.

Friday and Saturday, April 23 and 24. The American Physical Society at the Bureau of Standards.

Saturday, April 24. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

W. H. Souder and C. G. Peters: *Physical properties of dental materials.*

H. A. Marmer: *Results of recent tidal investigations.*

Wednesday, April 28. The Chemical Society, at the Interior Department, at 8.15 p.m. Program:

W. A. Noyes: *The foundations for chemical development.*

Saturday, May 1. The Biological Society.

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Thursday, May 6, to Saturday, May 8. The American Pharmaceutical Association.

Saturday, May 8. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

F. B. Silsbee: *Physics of the high-tension magneto.*

C. Nusbaum: *The magnetic reluctivity relationship as a criterion of the structure of an eutectoid carbon steel.*

Wednesday, May 12. The Geological Society, at the Cosmos Club, at 8.00 p.m. Program:

Lithology of the Bend Series and contiguous formations of north-central Texas:

M. I. Goldman: *Lithology.*

P. V. Roundy: *Micro-Paleontology.*

Thursday, May 13. The Chemical Society, at the Cosmos Club, at 8.00 p.m.

Thursday, May 20. The Academy, at the Cosmos Club, at 8.15 p.m. Program:

E. B. Rosa: *The economic value of scientific research by the Government.*

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E. B. Rosa: *The economic value of scientific research by the Government.*

Saturday, May 22. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

H. L. Curtis and C. E. Mendenhall: *Foreign laboratories and societies.*
W. P. White: *Three methods of promoting precision in thermostats.*

Thursday, May 27. The Chemical Society, at the Cosmos Club, at 8.00 p.m.

Saturday, May 29. The Biological Society.

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Tuesday, June 15. Joint meeting of the ACADEMY and the Geological Society, at the Cosmos Club, at 8:15 p.m. Program:

W. VAN BEMMELEN: *The volcanoes of Java.* (Illustrated.)

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Saturday, October 23. The ACADEMY, in the Assembly Hall of the National Museum at 8.15 p.m. Program:

E. B. ROSA: *A reorganized civil service.*

Saturday, October 23. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

W. BOWIE: *The Pan Pacific Scientific Conference.*

P. V. WELLS: *The 1920 meeting of the British Association for the Advancement of Science.*

[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 the month.

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E. F. MUELLER and T. S. SLIGH, JR.: *The hypsometer as a precision instrument.*
T. S. SLIGH, JR.: *Thermostatics.*

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