The Earliest Fresh-Water Arthropods: Charles Schuchert, Peabody Museum, Yale University. If the eurypterids and limulids arose in the fresh water we can explain why they and the terrestrial scorpions do not pass through a crustacean stage. It may well be that the trilobites retaining the nauplius stage do not give rise to these stocks. We may look for this ancestral stock in one still more primitive, which seems to have permanently invaded the rivers of the land either in Proterozoic time or in Walcott's Lipalian time.

Observations upon Tropical Fishes and Inferences from their Adaptive Coloration: W. H. Longley, Goucher College, Baltimore. The observations here presented undermine many speculative explanations of animal coloration in terms of natural selection.

Report of meetings of the National Research Council and of its Executive Committee.

Address by Lieut. Colonel George O. Squier, on Scientific Research for National Defense as Illustrated by the Problems of Aeronautics.

Research Grants from the Trust Funds of the Academy.

Report of the Autumn Meeting.

We may summarize the articles in Volume 2 of the *Proceedings* as follows: Mathematics, 20; Astronomy, 29; Physics and Engineering, 23; Chemistry, 15; Geology and Paleontology, including Mineralogy and Petrology, 33; Botany, 9 (see also Genetics); Zoology, including General Biology, 20 (see also Genetics); Genetics, 10; Physiology and Pathology, 13; Anthropology, 10; Psychology, 4; a total of 186 articles.

The division of these articles between members of the Academy and non-members is 63 and 123, respectively.

The list of institutions which have contributed three or more articles is as follows: Harvard, 31; Carnegie Institution, 29, divided as follows: Solar Observatory 19, Marine Biology 3, Station for Experimental Evolution 3, all other departments 4; University of Chicago, 12; Johns Hopkins University, 11; University of California, 7; Yale University, 7; Princeton University, 5; Maine Agricultural Experiment Station, 5; Brown University, 5; Massachusetts Institute of Technology, 5; U. S. Geological Survey, 4; University of Illinois, 4; Smithsonian Institution, 4; Rockefeller Institution for Medical Research, 4; Observatorio Nacional Argentine, 3.

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NOTES ON METEOROLOGY AND CLIMATOLOGY

EVAPORATION MEASUREMENT

Loss of moisture from plant and animal surfaces and from the soil interests the plant physiologists, plant and animal ecologists, and students in agriculture and forestry; but evaporation from a free water surface appeals to irrigation and hydraulic engineers. On this account, a type of instrument satisfactory to the one group will not meet the requirements of the other. Although the rate of evaporation depends primarily on temperature, wind-velocity, humidity, it is a function of the nature of the atmometer as well. For instance, the size, shape, material and color of the pan, the height of the projecting rim, and sediment, color and depth of the water, and the nature of the evaporating surface, affects strongly the evaporation. This being the case, Dr. B. E. Livingston says:[11]

> The ratio of the rate of the evaporation from one kind of atmometer pan to that from another kind remains constant only for some single set of surrounding conditions. Thus the evaporation rate from any atmometer varies with the relation between the internal complex of conditions (nature of the instrument) and the external complex (the surrounding conditions of the atmosphere). . . . The exposure of several evaporating surfaces must be alike if their readings are to be comparable.

The readings of one instrument, therefore, can not be reduced to terms of another.

Although many evaporation observations of various sorts have been taken in the United States,[12] this lack of comparability prevents

[11] *Mo. Weather Rev.*, 43, pp. 126–131, 1915, "Atmospheric Influence on Evaporation and Its Direct Measurement."

[12] T. Russell, "Depth of Evaporation in the

the construction of an accurate chart using these data. It is pleasing, on this account, that Dr. Livingston is distributing standardized porous clap cup atmometers, and that the Weather Bureau has adopted a standard evaporation tank. For special purposes at a given locality any type of atmometer which fills the need is best. Thus, to determine the evaporation from a reservoir surface, several floating pans are used; for the study of evaporation as affecting plant transpiration, some form of water-impregnated paper or a porous clay surface is to be chosen; and for soil evaporation, a box or pan of moist soil is logical.

The porous clay cup atmometer, first suggested by Babinet in 1848, modified by Livingston, Shive and W. L. Tower and again by Livingston, is, in its present form, a spherical clay cup 50 mm. in diameter or a clay plate 77 mm. in diameter attached to a bottle of distilled water.[13] Capillary attraction keeps the cup full of water; and, when it rains, the water is prevented from entering the instrument by means of an ingenious mercury stopper in a bend of the feeding tube. This instrument is adapted especially to studies of plant and animal evaporation. The effect of the sun can be measured by exposing a black and a white bulb side by side. Frequent standardization is necessary, although washing reduces the need. It can not be operated in freezing weather; but this is no drawback for most plant studies. The atmometer is so compact and inconspicuous that it can be exposed with safety almost anywhere.

The Weather Bureau standard is a galvanized open pan four feet in diameter and ten inches deep, which is kept clean and filled with water to a depth of more than seven inches. The top of the pan is some sixteen inches above the ground. With the evaporating pan go anemometer, rain-gauge, and maximum and minimum thermometers. When set up, the whole station is surrounded with a substantial wire fence. By means of a still well, and a micrometer, the depth of the water is read every day at about 7 A.M. local time. All water surface atmometers are subject to the disadvantages (1) of wind action which changes the form of the surface and may blow some of the water out, (2) of the splash of raindrops, and (3) of the interference of animals, birds and insects. Furthermore, the water caught in the standard eight-inch rain-gauge is not necessarily the same as that caught in the tank. With all these errors, it seems a mistake to carry the refinement of measurement to the thousandth of an inch.[14]

While the results of the porous-cup observations and those from the evaporation pans can not be used together, each in the course of time will yield data sufficient for the construction of the first reasonably accurate evaporation maps of the United States.

EXTENSIONS OF THE WEATHER BUREAU SERVICE

Out of the $81,210 increase in the appropriations for the Weather Bureau for the current fiscal year, $50,000 has been designated for extensions of the service. The largest item, $30,000 is to be applied for the increase in weather reports from the West Indies and Central America. It is probable that some 10 new stations will be established, and that closer cooperation between the Weather Bureau and the meteorological services of Cuba and the British colonies will be effected. If these plans are carried out there will be about twice as many stations in this region reporting twice daily to the Central Office during the hurricane season, June 1 to November 30. The shipping using the Panama Canal will be most benefited. During, and for a few years after the Spanish-American War, the Weather Bureau maintained a service almost as extensive as that now planned.

$10,000 is to be used for more complete organization of the weather observation work

United States," *Mo. Weather Rev.*, 16, 235–239, 1888. B. E. Livingston, "A Study of the Relation between Summer Evaporation Intensity and Centers of Plant Distribution in the United States," *Plant World*, 14, 205–222, 1911.

[13] Science, N. S., XLI., pp. 872–874, 1915.

[14] Kadel, B. C., "Instructions for the Installation and Operation of Class 'A' Evaporation Stations," Circular L, Instrument division, 1915, W. B. No. 559, 8vo, 26 pp.

in Alaska. Juneau is to become a regular Weather Bureau station and climatological section center. Not only will the climate of Alaska become more fully known but also it is thought that the general weather and storm forecasts for the United States will be helped.

Another $10,000 is to be used in extending the river and flood and the frost-warning services.

The Weather Bureau has recently announced a new civil service examination designed principally for college graduates who are competent to carry on scientific investigation. The initial salary is $1,260 a year.

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SPECIAL ARTICLES

EXPERIMENTS WITH THE FOUCAULT PENDULUM

1. *Introductory.*—In view of the relatively large angular velocity of the earth, it should be possible to exhibit this rotation by aid of the Foucault pendulum in a few minutes, and this in such a way that reasonably accurate quantitative results may appear. As the pendulum partakes of the rotation of the earth it is not feasible to attach mirrors to the bob, even if this were useful. It is equally clear that the combination of a horizontal pendulum and a Foucault pendulum at its end, or of a large pivoted balance beam with two identical pendulums at its ends will lead to no solution of the problem. In the following note I shall give the results of an optic and of an electric method which I recently had occasion to test and which may interest the reader. A few remarks will also be made on an earth inductor pendulum.

2. *Apparatus.* The question is obviously solved if the swing of the pendulum is regarded with a distant telescope with an ocular micrometer, sighting in the plane of vibration. The equivalent objective result may be obtained if as in Fig. 1, a lens L (not too strong) is placed near the pendulum. The string at rest C is to be at the conjugate focal distance u to the distance v of the screen S from the lens. The string must be strongly illuminated by a Nernst burner N, or sunlight, or the like, and the arc of vibration ab or $cd = D$ must not be so large as to seriously throw the image m of the string at S out of focus. A lens of focal distance of about 60 cm., for a swing D (double amplitude) not larger than 30 cm., does very well. If S is about at 6 meters u will be somewhat short of 70 cm. The pendulum bob should obviously be heavy (3–6 kg.) and the string long (4–5 meters) so that vibration may be slow (period 4 seconds or more), air currents ineffective and observation at S easy.

The vibration is started with the arc ab in the direction of the optical center of L, or otherwise the lens is so placed. In this case the image of the string is stationary at m on the screen. Of course lateral vibration and rotation of the bob around the string as an axis must be scrupulously avoided. This is easily done by letting the bob fall from a lateral hitching cord with one hand after all vibration has been checked by the loose fingers of the other hand, and the image is at m.

The image m soon begins to vibrate right and left more or more fully on the screen S and after the earth has rotated over the angle θ, the point c is replaced by the elongations dd' and the point m has expanded into the elongations at a distance x apart. With a swing of $D = 36$ cm. originally, the distance x increases to nearly 5 cm. in 5 minutes, or about 1 cm. per minute with the dimension of pendulum and lens given above. The rate falls off because the arc D diminishes.

3. *Equation.*—Fig. 1 shows that if θ is the angle of rotation, for the distance x between the elongations at the screen S and the double swing of pendulum $cd = D$, and if the constant $k = u/v$, approximately

$$(1) \qquad \theta' = \frac{u - D/2}{v}\frac{x}{D} = (k - D/2v)x/D,$$

remembering that the angles θ' at c remain small and are initially nearly the same as θ at the center. Furthermore with the same approximation

$$(2) \qquad \theta = \theta'(1 + D/2u) = k(1 - D^2/4u^2)(x/D).$$

Hence after reduction if the rates per hour be dotted