theories lead to a shifting forward of the direction of attraction between two relatively moving bodies, a phenomenon exactly analogous to the aberration of light.

The effect of this aberration on the planetary orbits was first discussed by Laplace. He found that the resulting tangential acceleration of the planets had no effect on the longitude of perihelion, but introduced secular perturbations in the semi-major axis and eccentricity of the orbit and in the mean longitude of the planet in the orbit.

According to Jenneck,[3] calculations based upon Laplace's theory and upon the unexplained secular variations of the semi-major axis of the moon's orbit give as the lower limit of possible values for the velocity of propagation of gravitation about 10^8 times the velocity of light. Chazy[4] makes the following statement:

> Si l'on admet comme résultat des observations que l'accroissement séculaire de la longitude ne peut dépasser 2″ pour la Terre et 0.5″ pour Mercure, et si l'on cherche à expliquer par l'hypothèse précédente [Laplace's hypothesis] une accélération de la Lune de 2″ au plus par siècle, on obtient trois limites inférieures de la vitesse V_1 [velocity of propagation of gravitation] voisines respectivement de 6 millions, 600 millions et 30 millions de fois la vitesse de la lumière.

Sulaiman introduces, in effect, a slight modification of Laplace's theory in changing the magnitude of the attracting force (which Laplace kept unchanged from the Newtonian law) by the factor $\left(1-\frac{v}{D}\right)^3$, v being the radial velocity and D the velocity of propagation of gravitation, assumed by Sulaiman to be nearly equal to the velocity of light. The net result of this change is to introduce an advance of the perihelion close to the desired value in the case of Mercury. However, nothing is accomplished toward removing the objectionably large secular perturbations of Laplace's theory; on the contrary, the perturbation of the eccentricity is doubled.

To be specific with regard to this last point, calculations based upon Sulaiman's formulae (calculations which he apparently has not carried out) give for the secular logarithmic perturbations, in one earth year, of the semi-major axis and eccentricity, respectively, of Mercury's orbit the values .009643 and .01275. Tisserand,[5] quoting Newcomb's "Fundamental Constants of Astronomy," gives in the case of the eccentricity the discrepancy between Newtonian theory and observation (reduced here to a period of one year) as $(-4.3 \pm 2.5) \times 10^{-8}$—of opposite sign from the change predicted by Sulaiman's formula. In the case of the eccentricity of Venus, Earth and Mars, Newcomb and Sulaiman agree as regards sign; but to bring the values calculated from Sulaiman's formula into agreement with Newcomb's figures, it is necessary in using Sulaiman's formula to give D values ranging from 6×10^4 times the velocity of light (Mars) to 2×10^6 in the case of the earth.

The absurd size of Sulaiman's perturbations may be realized from the fact that the above calculated perturbation in Mercury's eccentricity is equivalent to an absolute yearly increase of .0026 in the eccentricity. As the eccentricity increases this of course does not remain constant; but taking it as a constant for the sake of illustration, Mercury's eccentricity would in 300 years reach unity and the planet would go off in a parabolic orbit!

Sulaiman's theory, in so far as it relates to gravitation, would seem, then, to founder on the same rock as Laplace's mathematically analogous theory and the modified forms of LeSage's physically similar theory. Neither are valid unless to the velocity of propagation of gravitation is assigned enormous values from 10^5 to 10^8 that of light; and aside from the objections to this, if this is done in Sulaiman's case, the desired advance of the perihelion is reduced to a negligible value and the theory accomplishes nothing in gravitational phenomena.

I take this opportunity to make acknowledgment of my indebtedness to Professor H. P. Robertson, of Princeton University, who suggested this investigation and gave valuable assistance in the pursuit of it.

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[3] *Enc. d. Math. Wiss.*, Band V–1, p. 49.
[4] Chazy, "La Théorie de la Relativité," vol. 2, p. 134.
[5] Tisserand, "Mécanique Celeste," vol. 4, p. 535.

LAST CALL FOR CULTURE METHODS

THE committee of American zoologists, commissioned to compile and issue a compendium of culture methods for invertebrate animals, desires to express its appreciation of the cordial cooperation already received and to issue a last call for further contributions.

The committee met in Pittsburgh on December 26 and went over the large number of valuable manuscripts already received, making note of others promised and of the many gaps still remaining. The month of June, 1935, has been set as the latest date for the receipt of further contributions. It is the hope of the committee that the volume containing these contributions may be ready for the printer in September.

The committee is receiving articles on culture methods and lesser notes on the "tricks of the trade" from those who have had experience. These will be as-

sembled for publication over their authors' signatures. Conciseness is essential and, as stated in a former notice in these columns,[1] "the committee reserves the right to condense and combine" where necessary.

Any one who has developed or improved methods of culturing invertebrate animals and wishes to assist in making this volume as complete as possible is cordially invited to communicate with the committee's secretary, Miss Mary E. Davis, Comstock Hall, Ithaca, N. Y., or with any member of the committee.

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PAUL S. GALTSOFF
PAUL S. WELCH
JAMES G. NEEDHAM, *Chairman.*

CHEMICAL COMPOSITION OF LARGE AQUATIC PLANTS

THE general investigations relating to the productivity of Wisconsin lakes have included studies of the chemical composition of the larger aquatic plants. Since these plants serve as a source of food, not only for strictly aquatic forms such as oligochetes, mollusks, insect larvae and fish but also for such animals as ducks and deer, their food value was regarded as an important item in these chemical studies.

Four papers dealing with the organic as well as the inorganic content of some of the larger aquatics were published by Schuette[1] between 1921 and 1929, which indicated the general food value of the forms that were analyzed. It is interesting to note that the chemical results published by Gortner[2] in a recent number of SCIENCE for the large aquatics of Minnesota lakes are in reasonably close agreement with those obtained by Schuette. The greatest difference is found in the Potamogetons, where the Wisconsin material yielded a somewhat smaller percentage of crude protein and a larger percentage of nitrogen-free extract than that from the Minnesota lakes. Birge and Juday[3] found that the percentage of crude protein varied with the stage of maturity of these plants, while Harper and Daniel[4] noted that the percentage of nitrogen varied with the character of the soil on which they grew; thus these two factors are probably responsible for the more marked differences noted in the Potamogetons.

With respect to the annual yield of large aquatic plants, Rickett[5] estimated the crop in Lake Mendota at 2,000 kilograms per hectare (1,800 pounds per acre), dry weight, in the zone occupied by them and 1,780 kilograms per hectare (1,580 pounds per acre) in Green Lake. Similar studies have been made on a dozen lakes in northern Wisconsin; while a report on this work has not been completed, the data indicate that the crop of large aquatics in them is much smaller, especially in those with soft water.

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CONCERNING THE TASTE OF HEAVY WATER

IN discussing the recent press reports of the drinking of heavy water by Professor Hansen, of Oslo, the present writers could not account for the "dry burning sensation" said to have been experienced by Professor Hansen—assuming that it had been due to the water. Accordingly, it was decided to make a personal test.

In order to make the experiment as objective as possible, a third person in a different room prepared the samples to be tasted. Each of us was then given two identical watch glasses, one containing one cubic centimeter of ordinary distilled water, and the other the same amount of pure heavy water, especially prepared for biological experiments. One of us kept each sample in his mouth for a short time to make sure of its taste, and then spat it out. The other repeated the same procedure, but swallowed the water. Neither of us could detect the slightest difference between the taste of ordinary distilled water and the taste of pure heavy water. It might be mentioned in this connection that one cubic centimeter of water is not too small an amount to taste properly, since both of us could detect plainly the characteristic "flat" taste of distilled water in both cases. It may be concluded, therefore, that pure deuterium oxide has the same taste as ordinary distilled water.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE CHOICE OF KILLING FLUIDS APPROPRIATE FOR CYTOLOGICAL RESEARCH

THE increasing use of cytological investigations by workers in the fields of physiology and pathology indicates that we have reached a point in biology where we are ready to use cytomorphological methods as an important adjunct to the study of function.

One of the writers pointed out a quarter of a cen-

[1] SCIENCE, 77: 427–428, 1933.
[1] *Trans. Wis. Acad. Sci.*, 20: 529–531, 1921; 23: 249–254, 1927; 24: 135–139 and 141–145, 1929.
[2] SCIENCE, 80: 531–533, 1934.
[3] *Wis. Geol. & Nat. Hist. Sur. Bull.*, 64: 215, 1922.
[4] *Bot. Gaz.*, 96: 186–189, 1934.
[5] SCIENCE, 52: 641–642, 1920; *Trans. Wis. Acad. Sci.*, 20: 521–527, 1921; 21: 381–414, 1924.