hundred pages, clearly printed on good paper, and substantially bound in convenient format. The experience of a veteran text-book maker and user shows in every feature of this book's construction.

The new book is "affectionately inscribed" to the author's "old students whose youthful enthusiasm was a constant inspiration" during a long period of service as teacher, as an effort to further aid them, though they are now gone from his classrooms and laboratories. Professor Comstock may rest assured that his greeting will be quite as affectionately returned, and that his latest effort will be as gratefully received by his many scattered students, mostly now no longer youthful, as were his earlier efforts to instil in them that love of nature and passionate interest in learning to know nature's works which have been for so many years beautifully characteristic of their beloved mentor. These old students will be greatly helped by this effort in their attempts to carry on to new students the Comstock tradition. And American entomology has not had, nor will ever have, any finer tradition.

Vernon Kellogg

SPECIAL ARTICLES

"PHYSICAL CONSTANTS" PERTAINING TO THE OCEAN

An important object of the science of physics is description of the behavior of different substances. Expression in mathematical form of such descriptions requires the use of one or more "physical constants," such as the coefficient of elasticity, conductivity, etc. Constants thus obtained are generally regarded as intrinsic, or peculiar to the substance. The extensive list of "physical constants" already determined bears witness to the achievements of physics, and constitutes fundamental quantitative data of the science.

Application of the methods of physics to terrestrial phenomena taking place on a correspondingly immense scale, has likewise resulted in physical laws or descriptions capable of expression in mathematical form. But the corresponding "physical constants" cannot be evaluated by means of experiments necessarily limited to much smaller dimensions. The influence of the enormous magnitudes involved in many terrestrial phenomena can be determined only by observing the phenomena as they take place in nature. It is impossible, for example, to determine in detail the motion of the water particles in the convective circulation of even a limited part of the sea. But this would be necessary in order to resolve the water mass into sufficiently small portions to justify the assumption, made in laboratory experiments, of flow in plane layers. Even if this resolution of the complex motion into its elements were possible, there would still be the impracticable task of summing up the effects of the correspondingly complex and irregular system of forces in order to obtain the resultant effect. The only recourse is to observe the system as a whole under the actual conditions of the sea. For example, a decade ago, the Swedish physicist, V. W. Ekman, applied the classical hydrodynamical equations to certain ocean current observations, but replaced the viscosity coefficient by a constant representing the integrated effect of the complex system of frictional forces. The value of this constant is thousands of times greater than the coefficient of viscosity of sea-water. A generation ago, a German mathematician, Zöppritz, developed an elaborate mathematical theory of ocean currents, but used laboratory values of the physical constants. Consequently his theory disagreed widely with subsequent objective knowledge. Such results emphasize the fact that physical constants are dependent not only upon the nature of the substances, but also upon the corresponding external conditions, and must therefore be determined under the conditions prevailing where they are to be used.

Progress in laboratory investigations is continually demonstrating the variability of quantities originally regarded as physical constants. Further refinement often requires the substitution of a variable, dependent upon additional conditions, for constant quantities of earlier formulæ. This is also true in cosmic and terrestrial physics. Continuous and highly refined observations on the sun have demonstrated the variable nature of the "solar constant." The so-called constants of heat conductivity, diffusion, viscosity, etc., pertaining to the ocean also vary with the conditions, though they are all thousands of times larger than the corresponding laboratory values.

For example, to determine the upwelling velocity in the southern California coastal region the author applied the classical equation[1] for the diffusion of salts in a medium moving with the velocity W, to seasonal observations of ocean salinities at a series of depths, and obtained the value 40 in C.G.S. units for the diffusion constant μ^2, while a Norwegian investigator, Jacobsen, obtained values varying from 0.3 to 11.4 for different regions of the sea near Denmark. The laboratory value for the diffusion coefficient of ocean salts in water is only .0000125. The upwelling velocity in the southern California region was also determined by applying to serial ocean temperatures Fourier's equation for the flow of heat in a moving medium. The conductivity constant for this ocean region was found to be 30, while the laboratory value of the coefficient of conductivity of sea-water is only .0012.

The values of such constants found under the simple conditions of laboratory control are known to depend upon the temperature of the fluid. This is in turn an index of the complex molecular activity. In the ocean, the corresponding variable factor is the rate of interchange of small parts of the water in the ever present alternating convective circulation.

Complicated as those phenomena are, encouraging results have already come from quantitative studies, not only in oceanography, but also in other geophysical investigations.

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[1] Ocean temperatures, their relation to solar radiation: quantitative comparisons of certain empirical results with those deduced by principles and methods of mathematical physics by George F. McEwen, 1919, Semicentennial Publications of the University of California, 1868–1918, pp. 336–421, 19 figs. in text.

THE DIFFERENTIAL STAINING OF PLANT PATHOGEN AND HOST

THE well-known difficulty experienced in staining to differentiate pathogen from host tissues in phytopathological studies needs no comment. In order to obviate this difficulty the writer has tried numerous combinations of stains and finally a method was hit upon which gives uniformly satisfactory results from the histological point of view. It is not intended for cytological studies although even for these there may be possibilities in the method.

The comparatively short time required to complete preparations, and the fact that students not yet expert in microtechnique can in most cases obtain good mounts, decided the question of publication.

STAINS

1. Magdala red. A 2 per cent. solution in 85 per cent alcohol.
2. Licht grün. A 2 per cent. solution in clove oil to which has been added a few drops of absolute alcohol.

METHOD

1. Dissolve paraffin in xylol and wash in absolute alcohol.
2. Wash in 95 per cent. and 85 per cent. alcohols.
3. Stain with Magdala red 5 to 10 minutes.
4. Remove surplus stain and wash in 95 per cent. alcohol.
5. Stain with Licht grün in clove oil for 1 to 3 minutes.
6. Wash in absolute alcohol, or in carbol-turpentine.
7. Clear in xylol and mount in Canada balsam.

The time factors may require slight modifications in some cases but a microscopic examination of the slide will enable the worker easily to determine the variation required. As a rule the staining with Licht grün is very rapid and if overstaining occurs the red becomes tinged with purple although this may