at the end of the ungulate sequence. The Tillodontia are shifted from a position following the rodents to the end of the Insectivora sequence. In the Ungulata we note the disappearance of the artificial Diplarthran group, and an arrangement modified from that of Schlosser, into five orders (1) Subungulata (Hyracoids, Arsinoitheres, Proboscideans and Sirenians), (2) Notoungulata (Toxodonts, Typotheres, Entelonychia and Astrapotheres), (3) Pyrotheria, (4) Artiodaclyta and (5) Mesaxonia (Protungulata = Condylarthra, Perissodactyls, Ancylopoda = Chalicotheriidae, Amblypoda and Litopterna). Numerous changes and additions within each of these larger groups have been occasioned by the paleontological contributions of the last twenty-five years, and with most of them paleontologists in this country will be in agreement, at least as to relative position, although many will be disposed to assign higher rank to some of the groups.

This reviewer is much in sympathy with Weber's conservative attitude as to the scope of taxonomic groups, but would not be disposed to go so far in reducing their rank in several instances. The Multituberculates might at least be granted ordinal rank if indeed they should not be raised to higher standing. A forthcoming article by Granger and Simpson will discuss the evidence on this point. On the other hand, Chalicotheriidae are now generally regarded as a family of Perissodactyla, although Abel has adduced some plausible arguments for maintaining their separate ordinal rank. The substitution of Protungulata for the customary term of Condylarthra is open to criticism, as also the association of Amblypoda with the Mesaxonia group instead of with the Subungulata.

The new edition of *Die Saeugethiere* is cordially commended as a very thorough and up-to-date revision of this most useful text-book.

W. D. MATTHEW

Der Sauerstoff im Eutrophen und Oligotrophen See. By AUGUST THIENEMANN. Bd. IV of Thienemann's "Die Binnengewässer," E. Schweizerbart'sche Verlags-buchhandlung, Stuttgart, 1928. 175 pages, 41 figures.

LIMNOLOGISTS have been making quantitative studies of the dissolved oxygen in lakes for more than three decades, because it is such an important factor in the environment of aquatic organisms. These investigations have yielded an extensive literature on the subject, and the present volume gives a summary and general discussion of the more important results that have been obtained.

Two types of lakes are considered, namely, eutrophic and oligotrophic. Eutrophic lakes are characterized by a marked decrease in the quantity of dissolved oxygen in the lower water (hypolimnion) during the summer period of stagnation; in many lakes belonging to this class only a trace of oxygen or none at all is found in this stratum in late summer. Oligotrophic lakes possess an abundance of oxygen in the lower stratum throughout the summer.

One of the outstanding features of the volume is the development of a formula for the computation of the total oxygen deficiency in eutrophic lakes; the author has made computations for several well-known lakes in order to illustrate his formula. The second chapter deals with the variations that take place in the dissolved oxygen content of lakes during the different seasons of the year; special emphasis is placed upon the changes that take place in the lower water in eutrophic lakes during the summer period of stratification. The variations which are found in the oxygen content of lakes in different years are considered in the third chapter; these annual variations are attributed chiefly to variations in the climatic factor.

In the fourth chapter the author presents the results that have been obtained on lakes that are broken up into bays and separate basins; in several instances cited the different basins of lakes differ very widely in character. The oxygen relations that have been found in the thermocline (mesolimnion) of eutrophic and oligotrophic lakes are discussed in the fifth chapter. In eutrophic lakes there is usually a marked decrease in the quantity of oxygen in the thermocline, but in oligotrophic lakes there is usually very little change in the amount in this stratum.

In the sixth and final chapter the author discusses the causes for the differences in the oxygen relations between eutrophic and oligotrophic lakes. These differences are dependent upon such factors as differences in mean depth, the ratio of the volume of the epilimnion to that of the hypolimnion, the shape of the lake basin and the quantity of organic matter produced by the lake. The bibliography includes fifty-eight titles.

C. JUDAY

UNIVERSITY OF WISCONSIN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PHOTOGRAPHIC METHOD OF MEASURING PITCH*

HISTORICALLY there have been five methods used in psycho-physics and physics for determining the frequency of vibration of sound waves in speech and music: (1) Measurements made from graphic or photographic records of sound waves, involving the use of tambours, or such light levers as the Miller

* The term "pitch" is here used in the physical sense.

phonodeik,[1] Dorsey phonelescope[2] or Lapp undulagraph.[3] (2) Stroboscopic methods, notably the Seashore tonoscope,[4] where a manometric flame, neon tube or light lever gives a flash of light for every vibration of sound, illuminating rows of holes on a disc or drum. Knowing the number of equidistant holes in each row on the drum, it is possible to determine the number of holes passing a given point per second. When the number of flashes per second is the same as the number of holes per second, those holes are seen as stationary dots due to retinal lag. (3) A combination of resonator and light lever,[5] the light vibrating and photographing when the resonator responds to a tone. (4) The method of beats. (5) Lissajous' method.

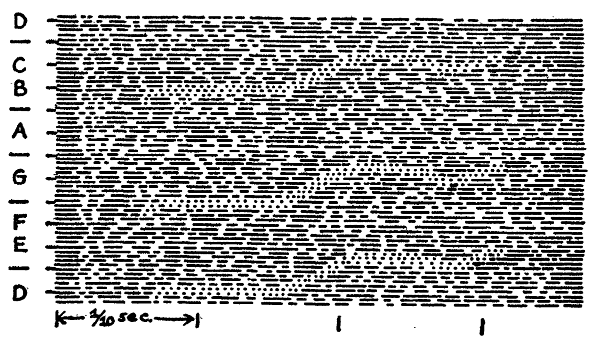
The first of these five is an expensive and laborius task, a record of five minutes of singing requiring film costing about fifty dollars, with the measuring and graphing of the waves requiring from one hundred to three hundred hours, depending upon the desired detail of the measures. The stroboscopic methods, while serving many purposes, do not give a continuous record of the rate and form of important patterns of singing and speaking, to say nothing of the time this method requires to transcribe a song accurately. The third technique requires one resonator for each frequency, and it would require sixty of them to cover an octave in as fine units as are necessary in studies of speaking and singing. The fourth and fifth methods are dependent upon comparing two constant frequencies, which in speaking and singing rarely exist.

The method here proposed is in a sense a combination of methods one and two above. Instead of photographing the sound wave and then measuring it, the sound wave is at once measured and graphed on photographic film. The cost of the film is about one fifth that of method one above, while the labor of measurement and graphing is almost eliminated. This is accomplished by using the same synchronizing effect as in stroboscopy. The vibrating light passes through the equally spaced apertures of the rows on the stroboscopic disc or drum, being photographed on film at the other side.

If the film is stationary, and each flash of light meets a hole in the revolving disc or drum at the same position every time, dots will be photographed. The frequency of vibration is the same as the number of holes in this row passing a given point per second. Other rows of holes which do not meet the flashing light at the same place each time will distribute the light instead of concentrating it upon one point on the film, with dashes instead of dots resulting on the photograph.

To achieve these results, a slit which is placed between the vibrating light and the revolving disc permits each flash of light to meet one and only one dot in every row of holes. The slit is thus cut so as to be as wide as the separation distance of the holes. In the particular optical system now used there are two flashes of light for every complete vibration. To make the slit one half the size would destroy the results, since the two dots are not always one half the width of the slit described above—the relationship of these two dots varying according to wave form.

With a moving instead of a stationary film, another factor must be taken into account, namely, the speed of the film. In this case the row of holes which photographs as dots will not be the one which synchronizes with the flashing light. When the positions of two successive holes in a row on a rotating member, at two flashes of light, are the same distance apart as the film has traveled, each flash strikes the same spot on the film and therefore photographs as a dot. The same row can be used to measure two different frequencies, depending on whether the film is moving in the same or opposite direction to the holes.



A here is 870 dv. and the half step units are those of the tempered scale. The first tone actually is located at *F*-sharp. The dots seen above and below are not sound wave analyses, but merely are due to mechanical synchronizations at ratios other than 2:1 (flashing light with number of holes). The tones here sung by Galli-Curci have twice as many vibrations as there are holes in the strobophotographic disc.

An example of the results with a moving film is presented in the accompanying illustration, a graph of Galli-Curci's voice on two short notes photographed from a photograph record. The original photograph has been inked in order to make a zinc etching.

[1] "The Science of Musical Sounds," p. 78, Macmillan, 1916.

[2] *Journal of the Optical Society of America* and *Review of Scientific Instruments*, 6: 279, May, 1922.

[3] *Journal of the Optical Society of America* and *Review of Scientific Instruments*, 7: 661–664, August, 1923.

[4] *University of Iowa Studies in Psychology*, 6: 1–12, 1914.

[5] E. E. F. D'Albe, "The Optical Analysis of Sound," *Proc. Opt. Conv.*, 894–898, 1926.

This method is susceptible to as many variations in devices as was the stroboscopic principle applied to the measurement of pitch, depending upon the particular needs of the research.

MILTON METFESSEL

PSYCHOLOGICAL LABORATORY,
STATE UNIVERSITY OF IOWA

SPECIAL ARTICLES

THE INFLUENCE OF MINUTE DOSES OF IODINE AND IRON ON GROWTH OF RATS FURNISHED VITAMIN A FREE DIET

IN a series of experiments recorded elsewhere, the writers have shown that while thyroid extract and iodine will produce rapid metabolism resulting in small animals, minute doses of the iodides or desiccated thyroid prove beneficial to rats on a *normal* diet and induce bone growth and increased weight. Certain preliminary experiments having shown *slight* beneficial results with sodium iodide on rats receiving vitamin A free diet, it was decided to combine minute quantities of iron with the iodine in an attempt to partially replace vitamin A.

The combination was chosen since the old-fashioned remedy, syrup of the iodide of iron, formerly so much used in anemia, has recently been displaced by the more fashionable although less esthetic *raw* and cooked liver. The peculiarity of the situation is that investigators have apparently given themselves over to a debauch in the field of vitamins and utterly forgotten that all important vitamin-containing foodstuffs are composed of combinations of chemicals. Analyses of the iron, sodium, calcium, phosphorus and manganese, and in some cases the copper of these "*vitamin rich*" substances, have been available for years.

The writers believe that the benefit ascribed to the "vitamins" is really due to minerals and that these minerals, acting as catalyzers, make available the proteids, carbohydrates and fats supplied with them.

One feature has been neglected in connection with discussions of the remarkable freedom from illness of those Greenland Eskimos subsisting entirely on a carnivorous diet.

The whales, seals, walruses and bears of the far north secure their food almost entirely from the water, devouring the fish which in turn depend upon minute organisms living on a diet rich in certain minerals.

The raw liver, flesh and oil of the mammals mentioned and of the codfish, which form a considerable part of the diet of the Eskimos, are rich in iodine, iron, manganese and minute quantities of other minerals such as zinc and copper. Recent investigations by Miss Sommer and Dr. Lipman, of the University of California, indicate the significance to plants of as little as one part in two millions of either zinc or boron.

In a series of two experiments just completed (August 1) we have utilized fifty-seven rats, placing some of them at the age of one month on diets deficient in vitamin A and later using small quantities of iodide of iron to bring about a restoration to normal condition. In the first *preliminary* experiment, we used nineteen Albino rats from the original stock purchased at the Wistar Institute; in the second experiment we found it desirable to use thirty-eight Agouti rats developed from an extremely vigorous and resistant strain produced by our animal husbandry department.

In both experiments the rats were divided into four lots. The first lot received Sherman diet No. 380 plus cod-liver oil. The second lot received Sherman diet No. 380 plus 0.01 mgm of irradiated ergosterol daily. The third lot, also on Sherman diet No. 380, received in addition to 0.01 mgm of irradiated ergosterol 0.0003 grain of iodine and 0.0001 grain of iron in the form of dilute syrup of the iodide of iron. The fourth lot received Sherman diet No. 380, ergosterol to supply vitamin D and in addition a daily allowance of 0.0005 grain of iodine and 0.000165 grain of iron.

In the preliminary experiment it was noted that several rats on the deficient diet were benefited and in some cases permanently cured of their xerophthalmia. Complete growth was not resumed, however.

In the second experiment we were able to bring the deficient animals up to a point where they followed closely the average weight of the positive controls for a period of fourteen weeks.

For six weeks they remained at an average weight of twenty grams above the negative controls, fluctuating around the maximum for over three weeks. The experiment lasted twenty-four weeks.

In the absence of adequate proteid, carbohydrate and fat, we could not hope to find that minerals acting purely as catalyzers would be able to keep the animals up to normal growth. It is reasonable to suppose, however, that in the experiment that we are now running, in which we will add dextrose to the deficient diet, our minerals will show up to even greater advantage.

F. E. CHIDESTER
(*In charge, Purnell Grant*)
A. G. EATON
G. P. THOMPSON

DEPARTMENT OF ZOOLOGY,
WEST VIRGINIA UNIVERSITY
EXPERIMENT STATION