chemicals supposedly to try to gain an insight into the chemical composition of the material. Perhaps their silence on this matter, as contrasted with their relative multiloquence on the pedigree culture data, is indicative of a capacity to judge the comparative importance of the facts, rather than a crafty masking of inefficiency.

E. M. EAST

NEW OCCURRENCE OF THE BELT TERRANE IN MONTANA

No occurrence of the Belt Terrane in central Montana has been reported east of the Little Belt Mountains which were mapped in 1892-97 by Weed and Pirsson in Folio 56 of the United States Geological Survey.

Recently the writer has discovered over 100 feet of the top of the Belt Terrane in the Big Snowy Mountains. These mountains are about thirty miles long and are located east of the Little Belts, from which they are separated by a pass several miles broad called Judith Gap. The Big Snowies are the result of an anticlinal fold and contain no igneous rock, thus differing from all the rest of the outlying ranges in Montana. The summit of the uplift was reached at Half Moon Pass in the eastern part of the range, and the exposure of the Belt Terrane is on the south side of this pass in the canyon of Swimming Woman Creek.

The exposure of the Belt consists of dark gray, reddish and greenish shale or fissile slate. The rock is hard and highly fractured. Veinlets of iron stained quartz and calcite containing small amounts of gold and copper fill some of the fractures and joints in the strata. The Belt Terrane is exposed over an area of possibly two or three hundred acres. The Belt is overlain by more than 1,000 feet of Cambrian strata at the base of which is a quartzitic basal conglomerate. The walls of Swimming Woman Canyon are composed of the Cambrian and the hard Devonian and Mississippian limestones. There is an angular unconformity of a few degrees between the basal Cambrian quartzite and the Belt Terrane, but the Belt shows no evidence of extensive erosion. No fossils were seen in the Belt rocks.

The Big Snowy Mountains have never been mapped geologically, and the discovery of Belt strata in them extends the known area containing Algonkian strata forty miles farther east than hitherto reported.

O. W. FREEMAN

STOCKTON, CALIF.

THE SCALES OF THE FOSSIL FISH EOBRYCON

OWING to the remarkable distribution of the Characinid fishes in the neotropical and ethiopian regions and consequent questions as to their origin and migrations, any scrap of information concerning fossil forms is of value. In 1898 Dr. A. S. Woodward described and figured *Tetragonopterus avus* from the Tertiary of São Paulo, Brazil. He considered that it might belong to the subgenus *Hemibrycon*, which is now considered a quite distinct genus. However, in 1907 Jordan made it the type of a new genus *Eobrycon*. In 1920 Dr. Eigenmann sent me a specimen, lacking the head, for examination. I found that the scales were exactly those of *Salminus*, and I think the fish must be placed in that vicinity. In his very excellent work on the fishes of western South America, just published by the Carnegie Museum, Dr. Eigenmann, in accordance with most ichthyologists, neglects to use or refer to the finer characters of the scales. I venture to predict that the time will come when scale-characters will be considered more valuable for generic diagnosis among the Characidæ or Characinidæ than the presence of an adipose fin or the completeness of the lateral line. More valuable because more constant and characteristic of natural divisions.

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SCIENTIFIC BOOKS

LOFTFIELD ON STOMATA[1]

NOT since the appearance of Lloyd's "Physiology of Stomata" in 1908 has there appeared in America a book which has taken up the problems involved in the behavior of stomata on the broad and comprehensive scale, and as

[1] "The Behavior of Stomata." By J. V. G. Loftfield. Publication No. 314, Carnegie Institution of Washington. Pp. 104; 54 figures in text, 16 plates with 27 figures. Washington, D. C., 1921.

possibly related to agricultural and industrial practices, as does this publication. For many years there has been a growing demand for more accurate information regarding the inter-relations of stomatal activity and environmental conditions. This situation became particularly critical a few years ago in connection with studies of smelter smoke injury in various parts of the continent and that stimulus finally culminated in the investigations which Dr. Loftfield has reported in this book. Many field and garden crop plants were included in the investigations.

The author, using the methods of Lloyd with some modifications, in the first portion of the work brings out some rather striking results. The daily march of stomatal movement varies considerably from day to day, in fact is seldom identical on two successive days. He states that such variations are due to changes in water-content and weather. In nearly all cases stomatal opening is correlated with light under favorable conditions, but in some cases light seems to play little or no part as a control. An outstanding feature of this portion of the work is the report that some plants, such as the potato, tend to maintain open stomata at night under optimum conditions of water-content, and that the behavior of stomata in upper and lower surfaces is usually quite different. In general the stomatal movements of each plant follow a regular course under optimum conditions, a course which is modified as conditions depart from the more favorable.

Part II brings us face to face with the complex inter-relations of environmental and internal factors as related to stomatal behavior. The author seems particularly emphatic in his statements that no ordinary atmometer or evaporimeter yet devised can be used to measure at all accurately the effect upon the plant of all of the factors concerned in evaporation. This may come as a shock to some of the enthusiasts in the field of "atmometry." Wind was found to cause increases of transpiration unlike the increases of evaporation measured by atmometers.

Plants tend to show much less response to wind than do atmometers, but with a sudden high wind they often reveal greater response. All attempts to correlate evaporation from atmometers and from free-water evaporimeters with transpiration failed, and led the author to state that "Until an atmometer is devised which responds in the same manner and degree to each of the factors concerned, the ratio of transpiration to evaporation is meaningless." His work tends to support the contention that there is no warrant for the view that lack of agreement between stomatal movement and "relative transpiration" based upon evaporation from the porous-cup atmometer indicates that stomata are non-regulatory.

A reduction of light intensity to less than half (as measured by the "solio" photometer) is commonly necessary to produce any effect upon the stomata of plants growing in the open. When stomata are closing they are affected by decrease in light more rapidly than when they are opening. Stomata may open at night as a result of moonlight or a strong artificial light of much less intensity than one per cent. of the solar maximum. They open more readily toward morning than before midnight. This part of the work, on the whole, leaves one with a sense of incompleteness and confusion, although it serves to reopen many long debated problems, and to contribute many additional data to indicate that it will be many years yet before we are provided with an adequate and comprehensive body of dependable facts and principles relative to the effects of habitat factors and plant development upon stomatal behavior.

The concluding part of the book records some interesting studies of the effect of stomatal movement upon transpiration, a favorite topic for ecological investigations. The author presents data which lead him to conclude that stomata *do regulate the water-loss from plants*, and so to question seriously the value of the work of Lloyd. He demonstrates the reasons for this notable lack of agreement and points out that Lloyd's evidence that stomata are non-regulatory is vitiated by his use of potometers to measure the water-loss of field plants. However, a careful perusal of the present text leaves the reaction that Loftfield's "evidence" upon the basis of which he summarily disposes of the potometer method is rather meager, especially as compared to that presented by Lloyd.

The author's opinion as to the regulatory rôle of stomata is nicely put in the concluding

statement: "Although the factors concerned in evaporation have great influence upon evaporation, this influence is definitely controlled by the stomata. When the stomata are wide open or nearly wide open, transpiration is the result of the action of the factors of evaporation alone, since the stomata in nowise interfere with the action. As the stomata close, the influence of the factors is lessened, but until closure has reduced the apertures to fifty per cent. or less, stomatal regulation is still largely overshadowed by the control exerted by them. When closure is almost complete, the regulation of water-loss by the stomata is very close and the effect of the factors overshadowed by the effect of even very small changes of the opening." This is, of course, quite different from the conception of "regulation" of some physiologists when they have attempted to compare the stomata-transpiration complex with the mechanism which rather effectively controls or "regulates" the speed of an engine under a variation of load.

The plates showing the features of the stomata in various plants under various conditions should receive special mention. The micro-photographs are arranged radially in such a manner as to show the condition of the stomata in upper and lower epidermis, especially the degree of opening, at each hour of a twenty-four hour day, together with curves for sunlight, temperature and humidity plotted toward the center of the circular figure. This commendable method enables one to compare readily the condition of the stomata in upper or lower epidermis at different hours of day or night and as related to the light, temperature and humidity values.

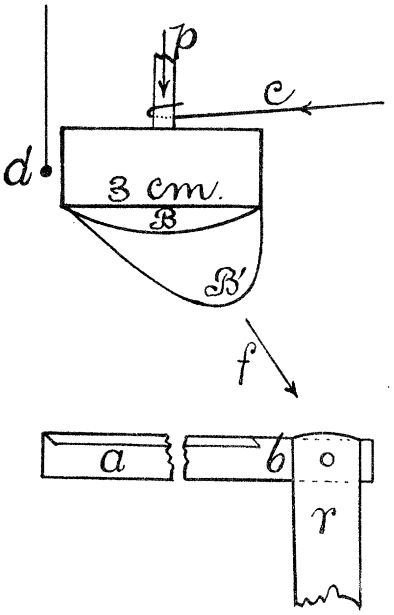
Loftfield's book is very stimulating, on the whole. It must be in the hands of every investigator working on problems in which stomatal behavior is involved.

RAYMOND J. POOL

SPECIAL ARTICLES

SPARKLESS SPARKS[1]

1. The endeavor to take away all the internal pressure (measured by the U-tube interferometer as in the preceding paper) from the soap bubble by charging it electrostatically, does not usually succeed unless the bubble is well anchored; otherwise the lower end is apt to break apart and fly off along the lines of force. A wide blower (say 3 cm. in diameter) as in the figure, with but a small segment of bubble *B* projecting, is satisfactory. The initial pressures are thus reducible to .04 mm. of Hg, so that with flattish bubbles I have actually obtained negative pressures within, on charging.



The charged bubble usually takes an oblique oval figure, *B'*, being drawn out along the incidental lines of force *f*. This expansion, on very slowly increasing the potential, reaches a maximum, after which the bubble suddenly, in fact spasmodically, jerks back from *B'* to *B*, remaining intact. With the same bubble a succession of 10-40 spasms may be easily obtained, at the end of which the bubble bursts. A pitch ball, *p*, near the metallic holder shows a definite but only very slight diminution of obliquity at each spasm. An adapted aluminum electroscope (right angled strip of aluminum, say 8 inches long, .03 mm. thick, flexible at *b*, appressed against a hacksaw blade and clutched by the hard rubber stem *r*) placed below *B'*, indicates a marked increment of potential, even at the least spasm of the bubble, from the beginning up to the maximum. With each such case, therefore, there is partial discharge, an outrush or ions, or an intermittent current. A few of the lines of force break loose and slide off.

[1] Advance note, from a Report to the Carnegie Institution of Washington, D. C.