and '10), of Pierantoni (1909 and '10), who succeeded in isolating and growing certain forms in pure culture, that has furnished the basis for a correct interpretation and for a comprehensive study of these bodies in the various groups of insects.

Such a study has been commenced by Dr. Buchner and the extensive paper before us considers primarily the intracellular symbionts of the hemiptera. There is a very full historical discussion which will be of great value to other students of the general subject, and which will serve to put the reader, be he botanist or zoologist, *en rapport* with the topic. Then follows a detailed discussion of the author's own investigations.

Of special interest are the data on the method of infection of the developing eggs by the organisms. This may take place in a diffuse manner, as in the cockroaches, or it may be very definitely localized, as in the aphids. In any event, we are concerned with a hereditary transmission of bacteria-like or yeast-like organisms.

Concerning the systematic position of the forms studied there is little definite to be said, though it is certain that the intracellular symbionts of insects, as we know them at present, do not represent a closely definable group. The forms in the cockroaches are apparently true bacteria and probably so also are those of the ants.

On the other hand, the multiplication by budding, the type of mycelial formation, the lack of structures comparable to spore of bacteria, the constant presence of a nucleus, and other characters in the other forms studied are suggestive of the yeasts, and it is here that most of the recent students of the subject are inclined to place them. Thirty-four species, some of them new, loosely grouped here, are described and figured.

It is obvious from Buchner's studies that these puzzling organisms are not to be regarded as parasites. So striking are some of the specializations and adaptations which their presence has brought about, that it is equally impossible to regard them as mere commensals. But certain as the author is that he is dealing with true symbionts, he is unable to explain, satisfactorily, the advantage which accrues to the host.

Dr. Buchner's work is of fundamental importance, but one must agree with him that it is but a beginning. With the foundation work done, the next few years should see wonderful advance in our knowledge of this difficult subject.

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BOTANICAL NOTES

Some Statistics as to the Flowering Plants

In this inquiry I have considered only the proper Flowering Plants, Anthophyta or "Angiospermae," and have given most of the numbers in thousands, for easier memorizing.

Number of species of Flowering Plants	±132,500
Dicotyledons	±108,800
Monocotyledons	± 23,700
In the Dicotyledons:	
Axiflorae	± 54,000
Calyciflorae	± 54,000
In these again:	
Axiflorae—apopetalae	± 29,000
Axiflorae—gamopetalae	± 25,000
Calyciflorae—apopetalae	± 33,000
Calyciflorae—gamopetalae	± 21,000
So there are:	
Of Apopetalous Dicotyledons	± 62,000
Of Gamopetalous Dicotyledons	± 46,000
Again, there are in Dicotyledons:	
Ovaries, superior	± 72,000
Ovaries, inferior	± 36,000
Those with superior ovaries are distributed as follows:	
In Apopetalous species	± 50,000
In Gamopetalous species	± 22,000
Those with inferior ovaries are distributed as follows:	
In Apopetalous species	± 14,000
In Gamopetalous species	± 22,000
In the Monocotyledons:	
With ovaries superior	± 12,000
With ovaries inferior	± 11,000
In Monocotyledons gamopetaly has not become established.	
So there are in the Flowering Plants:	
Of Apopetalous species	± 86,000
Of Gamopetalous species	± 46,000

And again there are:

With superior ovaries	± 84,000
With inferior ovaries	± 48,000

TWO BOOKS ON TREES

FROM the botanical garden and arboretum of the University of Michigan we have a little book of somewhat more than two hundred and seventy-five pages entitled "Michigan Trees: A Handbook of the Native and Most Important Introduced Species," by Charles H. Otis, curator. In its preparation the author has aimed to produce a book that would stimulate interest in the study of trees, having ultimately in view the betterment of forest conditions in the state. By means of keys ("summer" and "winter"), good pictures and clear descriptions it is made possible for any one of ordinary intelligence to find out what is the name and general relationship of any of the trees commonly found in Michigan. In order that it may be widely distributed the regents of the university have arranged to send one copy of the book free to every legal high school in the state, to every public library, nature study club, and finally to every resident of the state "who desires it." Surely the residents of Michigan, old and young, have no excuse hereafter for not knowing the trees growing about them.

The second book is Monograph 8, of the Geological Survey of Alabama, and is Part 1 of the "Economic Botany of Alabama," by Roland M. Harper, this part being devoted to the forests of the state (228 pp.). The book opens with a map of the state, in colors, showing geographical and forest regions. Starting with the remark that "Alabama has probably been more thoroughly explored by various kinds of scientists than has any other southern state," the author gives first of all a bibliography of Alabama forestry, and follows it with chapters on the natural regions, as the Tennessee Valley, Coal Region, Coosa Valley, Blue Ridge, Piedmont Region, Central Pine Belt, Black Belt, Southwestern Pine Hills, etc. In each region after geographical, geological and climatic details lists of trees are given, followed by a discussion of certain economic aspects. Then follow many half-tone reproductions of photographs of forests and forest matters. An interesting feature of these illustrations is that the exact dates when the photographs were taken are given. An unusually full index closes the report.

SOUTHERN SYSTEMATIC BOTANY

TEN years ago Dr. John K. Small, head curator of the museum and herbarium of the New York Botanical Garden, brought out his "Flora of the Southeastern United States," covering the region south of the southern line of Virginia, Kentucky, Missouri and Kansas, and east of the 100th meridian. The book has proved so useful that the author has been encouraged to bring out a second edition. This has been done by the rewriting of 144 pages, and the addition of 53 pages of descriptions of additional species in the appendix, making nearly 200 pages of new matter in the whole book. Since the book contains about 1,400 pages the amount of revision is easily made out.

The same author's "Flora of Miami" (206 pp.) contains descriptions of the native gymnosperms and angiosperms of southern Florida. In looking it through one is as much struck by the absence of certain well-known genera as by the presence of others which are quite unfamiliar. Thus *Carex* is unrepresented, as are also *Ulmus, Populus, Brassica, Taraxacum, Rosaceae, Malaceae,* etc., while of *Ranunculaceae* there is but one species; *Salix,* one species; Mints, eight species; *Helianthus,* one species. Florida tourists should have this handy little book for use in the southern part of the state.

A third book by Dr. Small will also be of interest to Florida tourists. It bears the title "Florida Trees" (107 pp.) and is intended to be a handbook of the native and naturalized trees of the state. When we realize that "nearly one half of the trees known to occur naturally in North America north of Mexico and the West Indies grow naturally in the relatively small area of the state of Florida" the importance of this little book may be appreciated. By actual count there

are here included 365 species. Of these 15 species are gymnosperms; 10, palms; 23, oaks; with 43 species of *Crataegus*.

These three books are published by the author.

SHORT NOTES

A NEW edition of the "Guide to the Spring Flowers of Minnesota" (by Clements, Rosendahl and Butters) has just appeared, so broadened and extended as to include the plants that ordinarily blossom by the middle of June. Small but helpful figures of about 160 genera are now given in the text. The plan of these "Guides," of which half a dozen have been published, is to be highly commended.

ANNOUNCEMENT is made of the early appearance of a book on "Rocky Mountain Flowers," by F. E. and E. S. Clements. It is to be "an illustrated guide for plant-lovers and plant users" and is to contain twenty-five colored plates, and about as many uncolored. An examination of some of the colored plates indicates that they will be highly artistic as well as botanically accurate. The volume is bound to be one that will appeal strongly to those who "summer" in the Rocky Mountains.

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SPECIAL ARTICLES

THE APPLICABILITY OF THE PHOTOCHEMICAL ENERGY-LAW TO LIGHT REACTIONS IN ANIMALS

IT has been pointed out by Loeb that tropistic light reactions in animals should follow the law of Bunsen and Roscoe. This law states that in a light reaction the effect is proportional to the simple product of intensity and time. It was first proved to be true for the formation of hydrochloric acid from chlorine and hydrogen and for the blackening of silver chloride under the influence of light. Later it was found to apply to the phototropic curvature (Fröschel, Blaauw) of plants, as well as to the human eye, though within rather narrow limits (Bloch, Charpentier). For light reactions in animals it has frequently been stated that they do not follow this simple law. A large number of forms seem to react to changes of intensity only, the effect in this case being proportional to the amount of change per unit of time. This is particularly true of the stimulating and inhibitory reflexes of the locomotor apparatus, as shown by a large number of investigators.

It occurred to me that it might be possible to get proof for the applicability of the energy-law by using a reaction which did not involve the locomotor organs. The eye movements of *Daphnia* seemed to afford a suitable object for the study of this question. These movements were first observed by Radl and his observations were confirmed and extended by myself some years later. The spherical eyeball containing a number of radially arranged ocelli is capable of rotation and held in position by several thin muscles inserted at its periphery. The eye shows a definite normal position with regard to light, a certain axis of the sphere having to be placed in such a direction that the ocelli on all sides of this axis get an equal amount of illumination. The muscles keep the eye in this position and one can cause rotating movements of the eyeball, by shifting the position either of the source of light or of the animal. The eye will always maintain its fixed position to the source of light, no matter whether the body of the animal follows the eye or not. An unequal state of tension of the eye muscles seems to cause locomotor movements, which tend to restore the normal relative position of eye and body. By fixing the animal on a slide it can be prevented from moving and the eye movements may be observed at leisure. Instead of shifting the position of the light the eye can be placed in a position of equilibrium between two sources of light and eye movements can be caused by increasing or decreasing the intensity of either of them. This shows these movements to be a function of the intensity of illumination.

In order to test the energy law, it is necessary to combine different light intensities with different times of exposure. If the product of time and intensity, *i. e.*, the amount of radiant energy brought to bear on the eye, is the same, the eye will always give the same