line from a heterogeneous mixture of small types differing gametically among themselves. Here we have a real explanation compatible with the belief that to be inherited variations must have affected the germ cell structurally—a view to which the author apparently adheres.

Mendel's original investigations are briefly discussed by the author, but all of the numerous, recent contributions along this line are left untouched. Of course the immense amount of labor necessary to compile a book of seven hundred pages in a new subject would necessitate the work being actually behind the date of the preface, but one would like to see more notice taken of the many valuable investigations of contemporary biologists. A more extended consideration of late cytological and Mendelian research would have changed materially the author's treatment of atavism, prepotency and the determination of sex.

The work as a whole, however, brings together an enormous number of facts along diverse lines, and, though largely zoological, will undoubtedly prove of great value as a reference basis for a course of lectures on the subject, even if the new facts, which are continually being contributed in such profusion, make it of less value as an ironclad text-book.

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Mushrooms, Edible and Otherwise. By M. E. HARD, M.A. Large octavo. Pp. xii + 609, with 504 half-tone figures from photographs, many of them full-page plates. Distributed by The Ohio Library Co., Columbus, Ohio.

Under the above title Mr. Hard has given us an exceedingly interesting and valuable book upon a subject in which every one is interested, whether he is a botanist or not. The book is intended primarily for the beginner and a chapter including such subjects as, Why Study Mushrooms? Mushrooms and Toadstools, How to Preserve Mushrooms, etc., and An Analytical Key, is written in words so simple and yet so accurate that even the beginning student will gain a ready hold upon the group and will not be encumbered with a load of useless and unscientific data. As the late Dr. Kellerman states in the introduction, "The author does not write for the specially educated few, but for the mass of intelligent people—those who read and study, but who observe more." Thus the work is intended to appeal more especially to the people at large, but there is also much good in it for the college student of mycology. The generic and specific descriptions, and the great range of forms depicted in word and picture, are so nicely worked out that the book is one of the very best of the American publications of its kind. Without doubt this is the finest and most carefully arranged set of half-tone figures of American Agarics to be found in a single book.

A little more than one half (349 pages) of the book is devoted to the Agarics, the remainder being divided between the Polyporaceæ, Hydnaceæ, Phelephoraceæ, Clavariaceæ, Tremellini, Gasteromycetes, Ascomycetes, and a chapter each on the Myxomycetes, Recipes for Cooking Mushrooms, and How to Grow Mushrooms. These chapters are characterized by the same interesting style and excellent illustrations.

The author is determined that every one shall come to know mushrooms, first from the practical side to be able to identify the edible ones, and finally to know them from a more scientific standpoint, and then to be led to the broader study of mycology as a whole. The student of this book will unconsciously be led along this very path. As one turns the pages of the book he is delighted almost beyond expression, and he feels that Mr. Hard has rendered a great service to science in general and to mycology in particular in giving us this excellent work.

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SPECIAL ARTICLES

NOTES ON THE FIRST GENERATION HYBRID OF ŒNOTHERA LATA ♀ × O. GIGAS ♂

DURING the summer of 1907 three offspring of *Oenothera lata* ♀ × *O. gigas* ♂ were reared to maturity in the garden at the Station for

Experimental Evolution and observations upon the somatic chromosomes of these plants were embodied in a report read at the Seventh International Zoological Congress.

The peculiar combination of parental vegetative characters in each of these hybrids, associated with a certain fixed number of somatic chromosomes, suggested the desirability of repeating the cross upon a much larger scale in hopes of throwing some light upon the behavior of chromosomes in inheritance and of determining, if possible, whether number, size and shape of chromosomes are regularly associated with the inheritance of certain definite external characters.

In a previous note *O. gigas* was reported to have double the number of chromosomes found in *O. lamarckiana*, with evidence to suggest that the number may vary within a limited range among individuals of the species.[1] Gates[2] later sustained the count of 28 for *gigas* from observations of the germ-cells. In an earlier paper he reported 14 chromosomes for *lata*.[3] The few individuals of this species which I have examined have given 14 and 15 chromosomes with considerable, though not conclusive, evidence that a single plant had 16.[4] The number for each individual however remained constant.

The striking differences in the number of chromosomes of *lata* and *gigas*, associated with marked differences in external characters, caused the progeny of a cross between individuals of these two species to become a subject of particular interest. Seeds for the first generation offspring of *O. lata* ♀ × *O. gigas* ♂ were secured from guarded pollinations through the kindness of Dr. G. H. Shull. The hybrids arising therefrom were the progeny of a single pair of parents; the pistil parent in this case being a mutant which arose from a culture of pure-bred *lamarckiana* and the pollen parent a pure-bred *gigas*. Seventy-seven young rosettes were transferred to the experimental garden early in May, fixations having previously been made of the root tips of 50 of this number for the study of somatic chromosomes.

By sowing seeds in the greenhouse early in February and transplanting rosettes to the garden as soon as danger of frost is past, *lata*, like *lamarckiana* and others, may readily be brought to flower the first season. *Gigas*, on the contrary, is strongly biennial and even when subjected to the same conditions as *lata* from seed-sowing to maturity only a small percentage can be expected to flower and ripen seeds the first season. Consequently, the fact that 44 of these hybrids were annuals is of considerable apparent significance. It is, however, unsafe to conclude that this is a manifestation of an hereditary character, inasmuch as the majority of those remaining in the rosette stage were subjected to slightly different environmental conditions, having been transplanted to the garden 9 days later than the majority of those which proved to be annuals, and transferred to somewhat richer soil. Designating the two plots as east and west gardens, 47 young rosettes were transplanted to the former May 1 and 3 on May 10. Of the first lot, 37 came to flower during the season, 3 died and 7 have gone into the winter as rosettes.

Twenty-seven rosettes were transferred to the west garden May 10, of which 5 came to flower during the season, though very much later than the majority of those of the same class in the east garden.

The somatic chromosomes of 40 of these hybrids (25 of which were annuals) have been carefully studied and the remaining 10 will be included in the final publication to appear shortly. To insure accuracy of chromosome counts, none was considered conclusive unless sustained by 10 or more perfectly clear figures distributed through 2 or

[1] "A Preliminary Note on the Chromosomes of *Œnothera lamarckiana* and One of its Mutants, *O. gigas*," SCIENCE, N. S., 26: 151–2, August 2, 1907.

[2] "The Chromosomes of *Œnothera*," SCIENCE, N. S., 27: 193–5, January 31, 1908.

[3] "Pollen Development in Hybrids of *Œnothera lata* × *O. lamarckiana* and its Relation to Mutation," *Bot. Gazette*, 43: 81–115, 1907.

[4] "Chromosomes of the Somatic Cells of the *Œnothera*," SCIENCE, N. S., 27: 335, February 28, 1908.

more (usually 3 to 6) separate fixations from each plant. In every case but one, referred to later, the number remained constant for each individual throughout the several fixations. Corroborative evidence was also secured in a number of the exceptional forms by a study of tapetal cells. Hundreds of figures were carefully examined to determine whether individuality in size and shape of chromosomes could be recognized, but no evidence whatever was secured to demonstrate that any such differences exist.

In the majority of these hybrids the exact number of somatic chromosomes has been determined with certainty; but owing to the fact that a few of the intermediates and several of the *gigas*-like hybrids yet require the study of more sections to settle the question of one or two chromosomes more or less, it will be necessary for the present to group them merely under the heads of *lata, gigas* and intermediate. The identifications are based both on chromosomal and vegetative characters. While these groupings are sufficient in the main for all classes, II. and III. can well be further subdivided with respect to external characters.

CLASS I., *lata,* is represented by 2 individuals appearing as true *lata* in every point, indistinguishable from *lata* mutant from earliest seedling stage, and having *lata* number of chromosomes—15. Both annuals.

CLASS II., *gigas,* consists of 6 plants having *gigas* number of chromosomes (30 in each case so far definitely counted). Two of the 6 plants were annuals; one resembled *gigas* far more strongly than any other hybrid coming to flower in the garden, yet hardly to be classed as a good typical *gigas.* The second annual resembled the individuals of Class III. in a few, and pure *gigas* in the majority, of its vegetative characters. A peculiar exceptional circumstance is connected with the microscopic study of this plant. Fixations of root-tips, prepared April 3, gave an intermediate number of chromosomes. Another dated April 11 showed the *gigas* number with equal clearness, while a third was poorly fixed and gave no hint to settle the question. A fourth fixation of tapetal cells was made in August and clearly demonstrated the higher number. It therefore seems probable that the first fixation was taken from a member of Class III., and the confusion arose from an error in labeling. It is upon the basis of this conclusion that I have included this plant within Class II. rather than III.

The third plant under this head (biennial) was characterized in early seedling and rosette stages by whitish markings, so conspicuous in *albida* at corresponding stages of development. It differed markedly from the latter, however, in shape of leaf. The three remaining biennials differ considerably from one another, but equally pronounced differences have been noted among individuals of pure *gigas.* The members of this class, however, form the least homogeneous group of the three with respect to external characters.

CLASS III. is represented by 32 individuals, 21 of which were annuals. A portion of these had 22, others 23 and some possibly 21 chromosomes, although evidence is not yet complete in regard to the last. With respect to vegetative characters, the plants of this group fall readily into 3 subdivisions:

1. Consists of a single individual, remarkable for its narrow leaved, *gigas* type of foliage, utterly unlike that of *lata.* A single lateral flowering branch produced a few buds and flowers which were noted as "intermediate."

2. Is composed of those individuals which may be classed as true intermediates and includes 12 of the 21 annuals of Class III. The main features characteristic of this group are as follows: resembled *lata* in imperfect unfolding of petals, scarcity of pollen produced, sterility of pollen and shape of first buds; resembled *gigas* in size of corolla (with several exceptions), and various parts of flower, in red tinting of sepals (particularly in latter part of the season), and in general vigor of the plant.

3. Is in many respects the most interesting of all. It is composed of those individuals of class III. that have long slender buds, flowers with smooth petals and yield a moderate abundance of pollen. It may again be properly subdivided into *a* and *b*; the former consisting of three plants attaining the height of

lamarckiana and being indistinguishable from it in manner of branching and large number of flowers produced. A fourth member of this group bloomed late in the season and did not attain its full stature. The buds of these peculiar hybrids might have been classed as stout *lamarckiana* or slender *gigas*. The sepals remained conspicuously yellow, attaining near the end of the season a faint tint of red, like extracted *latas* of this cross. The foliage resembled *gigas*.

The second half of this group consisted of four plants somewhat resembling the first in size and branching habits but, in three of the four individuals, distinguished from it by the deep red color of the sepals—strikingly resembling *rubrinervis* in this regard. The fourth plant had less deeply colored sepals and possibly should be placed in a subdivision of its own.

The appearance among the offspring of *O. lata* × *O. gigas* of plants with pronounced *lamarckiana* characters is puzzling. The combination of these with equally pronounced *gigas* characters, further associated with the intermediate number of chromosomes, precludes the possibility of the pistil parent having been accidentally fertilized by *lamarckiana* pollen. MacDougal[5] succeeded in fertilizing *lata* with its own pollen for the first time on record, and obtained seed which "gave rise to a progeny which showed only the constitutents usually found in a progeny of this plant when fertilized by *lamarckiana*."

Study of the pollen of these hybrids is as yet in the initial stages, but some interesting observations have already been made.

Pollen grains of *O. lamarckiana*, *O. lata*, *O. nanella*, *O. rubrinervis* and *O. cruciata* are, so far as I have observed from the cultures growing at the station this summer, characteristically 3-lobed as figured by Gray[6] for *Œnothera*. Limiting observations to the first two forms mentioned, ordinarily about 1 in 1,000 grains has been found to have 4 or more lobes, although as high as 15 per cent. has been observed in normal, typical individuals. Seven representatives of pure *gigas* were examined and the 3-lobed grain was found to occur as rarely in this species as the 4 and 4 + grains in *lamarckiana*. Four-lobed grains prevailed for most individuals of *gigas*, although these were commonly found mixed with 5-, 6-, 7- and even 8-lobed grains, usually decreasing in frequency with the increase in the number of lobes. A further interesting point brought out was the fact that certain individuals showed these extra lobes in all stages.

The study of the pollen of the hybrid progeny of *O. lata* × *O. gigas* was therefore of absorbing interest.

Class I. (two extracted *latas*) showed 3-lobed pollen with an exceptional extra-lobed grain, as is characteristic for a *lata* mutant.

Class II., composed of two adults with *gigas* number of chromosomes gave each 4 and 4 + grains with an exceptional 3-lobed individual as is characteristic for pure *gigas*.

Class III. (hybrid number of chromosomes), pollen of seven individuals studied each gave a mixture of 3- and extra-lobed grains. The proportions have not yet been ascertained, but it is clear that the former are usually considerably in excess of the latter.

The sterility of *lata* is due not only to the scarcity of pollen produced, but to the large percentage of bad grains. The amount yielded by any form was found to vary with the individual, with the flower of the individual, and with the anther of the flower. Even the most fertile forms produce a surprisingly large percentage of bad pollen, and some of the above hybrids, notably certain members of Class III., subdivision 3, have been found to have as high as 90 per cent., although pollen was produced in moderate abundance. Inasmuch as *lata* yields but very little pollen, mostly bad, and *gigas*, while producing a considerably larger quantity, has in most instances a low percentage of good grains, it is not at all surprising that it was utterly impossible to artificially self-pollinate the majority of these

[5] "Mutations, Variations and Relationship of the *Œnothera*," by D. T. MacDougal, A. M. Vail and G. H. Shull. The Carnegie Institution of Washington, Papers of Station for Experimental Evolution No. 9.

[6] Gray's "Lessons and Manual of Botany," revised edition, 103, fig. 316.

hybrids, although attempts were persistently repeated throughout the summer. However, a few seeds were obtained from individuals having respectively *lata, gigas,* and intermediate number of chromosomes and the plants derived from these will form the chief subject of study for the coming year.

To summarize briefly:

The first generation offspring of *O. lata* ♀ × *O. gigas* ♂ fall into three main groups with respect to external characters and number of chromosomes; namely, *lata, gigas*-like and intermediate. Considering external characters only, the latter two should be further divided and subdivided.

Numbers of chromosomes are closely associated with external characters in the first and last, and probably also in the second group.

Pollen grains of two parental forms differ in number of lobes and these are inherited.

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December 7, 1908

MUCOR CULTURES

IN the study of the Mucoraceae for several years, some interesting facts concerning the development or rather the non-development of zygospores were observed. The experiments were made with the common *Mucor stolonifer* Ehrenberg. The media used were bread, pumpkin, orange, cornmeal, decoction of horse manure with gelatine, Pasteur's solution with gelatine, Hamaker culture medium.[1] The cultures were made with sterilized and unsterilized media. The spores for inoculation were taken from plants grown in the laboratory, from specimens collected for the herbarium, and from specimens sent to us by friends. In one thousand cultures not one zygospore was discovered.

In addition to the cultures, five hundred specimens of this species found growing spontaneously in different places were also examined but not one zygospore was observed.

Besides these experiments, many cultures were made and many specimens examined, a record of the exact number of which, however, was not kept. It is a conservative estimate to say that five hundred observations of this kind were made. This makes a grand total of two thousand observations without a single zygospore.

Experiments were also made to determine the development of this Mucor under anaerobic conditions. The media used for these experiments were orange, bread and Hamaker culture medium. All were sterilized. In giving the results of these experiments below, the word cornmeal will be used for the Hamaker medium. Cornmeal is the principal constituent of the medium. The material for inoculation was kindly furnished by Dr. Niewland, of Notre Dame University.

Small wide-mouthed bottles were used for the cultures. The medium was placed in the bottles and the bottles then closed with cotton and all sterilized. After inoculation, the bottles were placed into Novi jars and the jars filled with gas. The jars with the bottles were then set aside for observation. The following results were obtained.

In Hydrogen.—On orange, mycelium developed but few sporangiophores, no zygospores; on bread, no development; on cornmeal, no development.

In Nitrogen.—On orange, mycelium and few sporangiophores, no zygospores; on bread, about the same result; on cornmeal, about the same result.

In Carbon Dioxide.—On orange, mycelium well developed but few sporangiophores; on bread, mycelium profusely developed, many sporangiophores, no sporangia, no zygospores; on cornmeal, no development.

It seems that the absence of oxygen is not a necessary condition for the growth of zygospores.

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[1] Hamaker, SCIENCE, XXIII., 710, 1906.

THE BOTANICAL SOCIETY OF AMERICA

A UNION OF THE BOTANICAL SOCIETY OF AMERICA, THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY AND THE AMERICAN MYCOLOGICAL SOCIETY

THE third annual meeting of the federated societies (the fifteenth of the Botanical Society