Schools which have enough free time available are—Leland Stanford, Yale.

Schools permitting research but giving no time are—Colorado, Illinois, Michigan, Mississippi, Physicians and Surgeons (Columbia), Texas, Virginia.

In considering question five we find that a large majority is of the opinion that undergraduate research is justified by its educational value. The following medical schools answer affirmatively—California, Colorado, Cornell, Harvard, Illinois, Johns Hopkins, Leland Stanford, McGill, Michigan, Minnesota, Oregon, Rush, Virginia, Washington (St. Louis), Western Reserve, Wisconsin, Yale.

The schools which do not believe that undergraduate research is justified by its educational value—George Washington (Washington, D.C.), Maryland, Physicians and Surgeons (Columbia). The cause of the objection is the lack of time.

Mississippi, which gives only two years, is doubtful.

Reasons for favoring the proposition are given as follows:

*Illinois*—"Anything which stimulates a student to do independent thinking is justified." (Letter of Dean A. C. Eycleshymer.)

*Michigan*—"I know that those who have done some research are better students than those who have not." (Letter of Dr. V. C. Vaughan.)

*Rush*—"Because it is by all odds the most efficient pedagogic method." (Letter of Dr. J. M. Dodson.)

*Virginia*—"Where a man has the investigator's mind and is a sufficiently apt student to acquire his knowledge of the required subjects readily, such a man should be encouraged to do all the research possible and nothing in my judgment could be of greater educational value to this man." (Letter of Dean Theodore Hough.)

*Washington*—"We believe emphatically that undergraduate research is justified by its educational value to the student. In fact it is our belief, held generally in this school, that a piece of research may be of great value to a man in preparing him for the future. It is our opinion that the essential and most important object in medical education is to turn out men who will be lifelong (N. B.) students of medicine, and there is nothing more valuable in cultivating this spirit than the pursuit of first-hand knowledge along some line of interest." (Letter of Dr. G. Canby Robinson, dean.)

In view of these facts we conclude:

1. The vast majority of Class A medical schools approves of undergraduate research in theory.

2. Many medical schools approve of it in practise by conceding hours from their regular course which may be devoted to research.

3. The opportunity for undergraduate research has increased greatly since 1912.

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## SPECIAL ARTICLES

### COMPLETE REVERSAL OF SEX IN HEMP

THE writer has been investigating the sexual condition of hemp (*Cannabis sativa* L.) for a number of years and has obtained results so remarkable that he thought it advisable to present this preliminary note on certain phases of the problem before the completion of all the experiments and observations now in progress.

Common hemp was planted in the winter, when light conditions were very low, on shallow greenhouse benches heated mainly from beneath. Aside from these three special conditions, the environment was practically normal. Under the stated conditions, the hemp matures very early, sometimes having not more than two pairs of leaves before the terminal flower cluster appears and never being more than a few inches high.

The plants are staminate and carpellate and are decidedly dimorphic. The main sexual differences are as follows: Carpellate plant —broad flat crown of leaves, vigorous appearance but not so tall as the staminate plant, large root system, large leaf blades, carpellate flowers with the perianth a closed sheath and with no vestigial stamens, and a long period of life and growth. Staminate plant—slender habit and taller than the carpellate plant, delicate appearance, small root system, small

leaf blades, staminate flowers with 3–6 separate sepals and no vestige of the gynecium, and a very short life as compared with the carpellate plant.

Some staminate plants produce only pure staminate flowers, the expression being purely male, others at first produce besides staminate flowers some abnormal, intermediate flowers with structures differentiated as part ovulary and part stamen, or with normal stamens and a vestigial ovulary which usually has normal stigmas. Frequently ordinary stamens are produced ending in normal stigmas and occasionally a pure carpellate flower with the typical sheath-like perianth is developed. The staminate, intermediate plants exhibit various degrees of female expression but apparently in all cases have a strong tendency to become more and more staminate as the blooming period advances, so that at the end only normal staminate flowers are produced. The progression of the sexual state is from femaleness to maleness.

The carpellate plants usually produce nothing but carpellate flowers at first. Occasionally, however, there is a plant which will immediately begin to grow taller than the average carpellate plant and develop stamens in some of the flowers. These plants appear somewhat intermediate not only in floral development but also in vegetative characters. The vast majority, however, of the carpellate plants develop no such characteristics but begin to produce normal carpellate flowers and seeds and continue with the typical carpellate appearance. After the carpellate plants are well advanced in age, many of them begin to show a change in sex and develop stamens or staminate flowers. Some begin the reversal at a comparatively early period, others not until the very last flowers are produced. Some individuals produce only imperfect stamens, apparently with defective pollen and with indehiscent anthers; others produce normal staminate flowers with dehiscent anthers and apparently normal pollen. In these normal staminate flowers, the perianth consists of typical, separate sepals exactly similar to those in normal staminate flowers produced on staminate plants. The reversal from femaleness to maleness is, therefore, of every degree of intensity or completeness both in the number of flowers produced and in the degree of perfection of the sexual structures themselves.

A number of individuals appeared normally carpellate and produced 2 or 3 normal seeds at first and then gradually changed to the staminate condition until finally before they began to die of old age purely male sex was being expressed. Nothing but typical staminate flowers with dehiscent anthers was being produced. Femaleness had been changed to maleness. In one plot over 50 per cent. of the carpellate plants were finally reversed in their sexual state to a greater or less degree.

It is evident, therefore, that in these experiments we have a complete reversal of sex from female to male in a species characterized by an extreme dimorphism and this without any manipulation of the plants whatever except that they were grown out of season with a deficiency of light, and a shallow soil heated partly from below.

Female heredity is at first active and male heredity is latent, and finally male heredity is active and female heredity is latent. The change takes place in the vegetative body and is plainly caused gradually by an internal change of the physiological state or condition of the meristematic tissues from which the flowers are produced.

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