being given in classrooms as part of the regular curriculum. Most of the specimens are of natural history subjects local to the Chicago area. Teachers may obtain loans of this material upon written or telephoned request, to the extent that previous loans make compliance with their requests possible.

ACCORDING to *The Experiment Station Record,* an Agricultural Machinery Development Board set up early in 1942 has established a National Institute of Agricultural Engineering at Askham Bryan, near York. The nucleus of the institute is the Institute of Research in Agricultural Engineering, transferred from Oxford by the university with its director, S. J. Wright, continuing in charge. Temporary housing in the new location will be provided in buildings belonging to the Yorkshire Council for Agricultural Education, but eventually it is intended to build permanently on a near-by site. The main functions of the new institute will be to act as a general clearing house for information about agricultural machinery and its use, to carry out tests or demonstrations of new or improved implements and to undertake experimental and demonstration work on the better utilization of existing equipment.

DISCUSSION

PREDETERMINATION OF SEX[1]

IN the past the sex of the offspring from any mating has been a matter of chance. Despite the fact that thousands of techniques have been suggested no method of sex control has stood the scrutiny of unbiased investigation.

The advent of this century contributed a major advance in understanding the mechanism behind this chance distribution of the sexes. The unbalanced condition of one or more chromosome pairs in one sex furnished the mechanism whereby the distribution of sex in a population was random with a mean approximating equality for the two sexes. The extension of the gene balance concept to our knowledge of sex determination did not alter the random nature of the sex distribution, it refined our understanding of how the randomness came about. No man-controlled environmental circumstance was found to affect the ratios of the gametes or the sex after their fusion.

Sex-linked lethals gave students of inheritance the first positive means of controlling the sex of specified progeny. The control was directional in that it reduced the numbers of males. But it was positive and could be duplicated to any interested person's satisfaction. At first this genetic control changed the sex ratio from the 50:50 distribution to $33\frac{1}{3}$ males to $66\frac{2}{3}$ females. But the introduction of one or more lethal genes in each of the sex chromosomes with prevention of crossing over soon showed that the sex control could be made practically perfect, no males to 100 per cent. adult females. This directional genetic control of the adult sex ratio had become an accomplished fact.

Gowen and Gowen[2] demonstrated another genetic control of sex. The presence of a homozygous gene pair in the third chromosome of *Drosophila melanogaster* controlled the embryological development of the sex-differentiating organs. Besides normal males and females, individuals with a mixture of male and female organs appeared in the progeny. Inheritance control of sex even to the organ arrangement was evidently a function of this gene. But the path over which the gene worked was also learned. The gene controlled the maturation division of the parent female in such a manner that diploid and fractionally diploid eggs, instead of the haploid eggs, were produced.

Gershenson[3] in *Drosophila obscura* analyzed another case in which the genotype affects the maturation division. In this case the male instead of the female is the responsible agent. Male genotypes carrying this inheritance in their sex chromosomes have nearly 100 per cent. female progeny (96 per cent. females to 4 per cent. males) without regard to the females to which they are bred. The possible mechanism through which this inheritance may work has been further clarified by Sturtevant's and Dobzhansky's[4] observation that at maturation of this genotype the sex chromosome undergoes equational division at each meiotic division, the Y degenerates and the autosomes behave normally.

These cases furnish understandable mechanisms for shifting a normal sex ratio of 1 male to 1 female to that of all females. The other end of the sex control question, the production of all male progeny, has not been possible as yet. It is the purpose of this paper to present such a case where genotypic control leads to a progeny of 100 per cent. males.

In crosses intended for homozygosis studies, Mr. Nelson observed a pair mating of *Drosophila melanogaster* which produced 136 males and no females. The male progeny of this cross were able to transmit

[1] Journal Paper No. J–1054 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 714.

[2] Marie S. Gowen and John W. Gowen, *Am. Nat.*, 56: 286–288, 1922; John W. Gowen, SCIENCE, 68: 211–212, 1928; John W. Gowen, *Am. Nat.*, 65: 193–213, 1931.

[3] S. Gershenson, *Genetics*, 13: 488–507, 1928.

[4] A. H. Sturtevant and Th. Dobzhansky, *Genetics*, 21: 473–490, 1936; A. H. Sturtevant, *Proc. Nat. Acad. Sci.*, 23: 360–362, 1937.

the male-producing characteristic to certain of their daughters without regard to the characteristics of the mates to which they were bred. In something over 500 matings, covering a period of 8 generations from the original parent, no failures in finding the expected male-producing genotype have occurred.

The daughters with the genotype for all male progeny produce all male offspring without regard to the mates with which they are bred. The males give no phenotypic expression of this inheritance. The male-producing genotype is thus without effect on the adult males which carry it. The inheritance is sex-limited in its action in that it affects only the females which have it, acting as a dominant.

This case completes the span for the genetic control of sex. Genotypes, which may be genetically controlled, have now been established for the most divergent sex ratios possible, 100 per cent. female in one progeny and 100 per cent. male in the other. Many problems of sex differentiation and distribution are, of course, left, but in the sense of establishing means for sex control through specific agencies under man's guidance, the problem of the predetermination of sex may be said to be solved.

JOHN W. GOWEN
RONALD H. NELSON

PEDIGREED PINE FOR NAVAL STORES PRODUCTION

IN the fall of 1941 the U. S. Forest Service started a project concerned with the development of an extra-high-yielding strain of naval stores pine. Efforts were directed toward the selection of naturally superior individuals and the working out of methods for their propagation. The undertaking has precedent in the notable success achieved with other tree species yielding special products. It is well known, for example, that the average output of rubber latex from *Hevea* has been greatly increased as a result of careful selection, controlled breeding and the propagation of superior clones. High-yielding strains of *Cinchona,* from which quinine is obtained, were similarly developed.

The naval stores belt was thoroughly scouted for outstanding trees—trees which for no apparent reason produced exceptional yields of oleoresin. Emphasis was placed on slash pine (*Pinus caribaea* Morel.), since this species normally yields more gum than longleaf pine (*P. palustris* Mill.), the other commercially important producer of naval stores. Of the thousands of trees inspected, twelve of the most promising were selected for further study. During the summer of 1942 the yields of these trees were accurately determined by weighing the gum produced each week. In connection with each of the twelve, equally precise data were also obtained on the yields of from fifteen to fifty control trees of the same species, age, size, growth rate and general appearance growing under similar conditions on the same site. Comparisons made near the end of the season show that the majority of the trees under test produced from two to three times as much gum as the average of their respective control groups. Because of the care used in selecting and checking the test trees, it is probable that the superiority of at least some of them is due largely to hereditary factors. In the meantime, the search continues for additional outstanding individuals.

Vegetative propagation was chosen as the most promising method for speeding up the production of planting stock having the same characteristics as the superior trees selected in the present study. The advantages and possibilities of this method and its importance in the field of forest tree genetics have been discussed by Schreiner.[1] Research in vegetative propagation, directed chiefly toward the rooting of cuttings, was started in November, 1941. Cuttings from young slash pine were used exclusively in the initial exploratory experiments. It was soon found that with proper treatment, better than 90 per cent. of this material could be rooted within five weeks from the time of planting.[2] Work was then started on cuttings from older trees, large enough to work commercially, and for which gum yield records were available. This type of material proved much more difficult to root. Thousands of cuttings from mature trees, collected at 15-day intervals, were tested during the winter, spring and summer of 1942. The material was cut and handled in different ways, given a total of 175 chemical treatments, and planted in 40 different environments provided in greenhouse and nursery. Results with the winter and spring collections were discouraging; none rooted or even calloused, and all eventually died. The first successful rooting of cuttings from mature slash pine was observed on August 19 for material collected and planted on June 20.

To date, roots have been observed only on cuttings given rather complex chemical treatments. The two most promising treatments seem to be: (1) a 24-hour treatment in a solution containing 50 ppm traumatic acid,[3] 10 ppm vitamin B_1, all essential mineral elements and 5 per cent. sugar, followed by a dust treatment with commercial Hormodin No. 2 just previous to planting; and (2) a 24-hour treatment in a solution

[1] E. J. Schreiner, *Jour. For.*, 37: 1, 61–62, 1939.

[2] H. L. Mitchell, *Naval Stores Review*, 52: 7, 10–12, 1942.

[3] Traumatic acid has been tentatively identified as 1 decene – 1, 10, dicarboxylic acid (J. English, J. Bonner and A. J. Haagen-Smit, SCIENCE, 90: 2336, 329, 1939). That used in these experiments was made available through the courtesy of Merck and Company.