

FIRST TECHNICAL SESSION

Chairman: Richard F. Droege

SEX CONDITIONS IN WHITE ASH FRAXINUS AMERICANA L.¹

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Here in the Northeast, the most abundant and economically important American ash species is the white ash (*Fraxinus americana* L.). Any increase in our understanding of this species life cycle, especially the reproductive phases, will lead to more effective silvicultural treatment and tree improvement practices. Little information is available on the flowering and fruiting of white ash. To my knowledge no study has reported the flowering of white ash on a branch to branch, year to year basis.

Wright reported (8) considerable ecotypic variation within the species, *F. americana*, based on progeny tests. Variation occurred in seedling root growth, pubescence and the extent of frost damage. In addition., Wright observed variation in chromosome numbers within ecotypes. Variations in mature trees based on floral morphology, I feel, would be of similar interest.

Several conflicting reports of flowering conditions and sex ratios furnished additional incentive for study, For example, white ash is described by authorities as dioecious; however, at Maple, Ontario, in 1959, white ash "seed trees" were pointed out as "monoecious in that male and female flowers were present". This spurred a search for white ash with abnormal flowering. Similarly differing reports of sex ratios showed the need for investigation, These varied from reports of two females for every male, in 200 trees in and around Boston (1), to one female for every four males for 21 white ash found in Bartlett, New Hampshire (2). Wright stated, after five years' observation in the Philadelphia area, that the ratio is "probably" 1:1 (9).

A literature search showed the European species *F. excelsior* to exhibit dimorphism between sexes. If our American species could be demonstrated to exhibit these same trends, this would be noteworthy. The objectives of this study are then, as follows:

1. To investigate the flower conditions of white ash on a branch to branch and year to year basis.
2. To determine the sex ratio in natural stands of white ash
3. To determine the presence of sex dimorphism in natural white ash stands.

¹ This material is a portion of a thesis submitted to State University College of Forestry at Syracuse University in partial fulfillment of the requirements for the Master of Science degree.

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EXPERIMENTAL MATERIALS AND PROCEDURES

The areas chosen for this study were three forest stands of natural seedling origin. In each stand some prior attempt had been made to determine "seed trees". Many trees in two of the areas had previously been numbered and measured. In these areas the original numbers were retained. These records of seeding and flowering, in addition to the current observations, give a year to year depth to the study. The stands chosen were similar in that ash occurred in nearly pure, even-aged groups. Although some thinning had occurred in each stand, only a few white ash had been removed. In all areas the thinning tended to remove such species as aspen and birch rather than the dominant ash, thus simulating natural selection.

The areas differed, being widely separate.

1. Bartlett Experimental Forest is in northern New Hampshire
2. Beak and Skiff woodlot is located south of Syracuse, in central New York at the northern edge of the Allegheny Plateau.
3. Cooxrox Forest, near Stephentown Center, N. Y., is near the N. Y., Vt., Mass, border.

The study areas are at different elevations with different sites, Age differences range from 75-85 years for the Bartlett area. The Beak and Skiff trees are 55-60 years old, Cooxrox Forest trees ranged from 35-55 years. Because of the different ages at Cooxrox, three age groups were recognized. (These groups followed the pattern of land abandonment).

All individuals in each study area were observed, Those few individuals found to be of a different age, or widely separated from the main group, were excluded from the final data. I should explain the term "individual". This refers to a single stem and root system, a separate and distinct genotype. Individuals growing in a clump were separated by boring and digging at the root collar. Those arising from a cluster of seed are each treated individually. Those of spout origin are treated as one individual with one stem picked at random to represent the genotype.

The techniques used to observe sex conditions were as follows:

1. Forcing of numerous branches brought into the warm greenhouse in January, February and March, placed in crocks of water to force the buds into activity.
2. Sectioning dormant buds.
3. Field observations made during several periods of the year.

I believe this last method is the most reliable, Trees are climbed to observe flowers and seed from within the crown (some 50 to 80 feet above the ground), Field glasses are an additional aid. At times several adjacent trees could be observed from within one centrally located crown,

In females the peduncles (seed bearing bracts) persist for a number of years. Close examination of the twigs shows peduncle remnants are observable for as long as seven years. Males rarely show evidence of previous flowering unless the flower is attacked by a mite. These mite-galled flowers were found to persist for about four years.

THE STUDY OF SEX CONDITIONS

In 1961, branches were collected from all study areas for forcing and grafting. Branches were brought down or shot down with a rifle. In the greenhouse, detailed daily records were kept on bud break., flower expansion and flower structures. All inflorescences were given particular attention to observe stamens on female trees, pistils among males or any bisexual tendency such as non-functional or rudimentary flowers. No abnormal sex conditions were noted among the more than 1500 inflorescences observed in the greenhouse. Dormant floral buds of white ash are not easily discerned from vegetative buds until April when differential swelling occurs. No reliable way was found to locate floral buds, thus the attempt to study sex conditions from sectioned dormant buds was disappointing,

Of the more than 145 trees observed to flower in the field:

- 1.No hermaphroditic flowers have been noted.
- 2.No individual tree was observed to produce both male and female flowers.
3. No change of sex was noted for any individual from one year to another. Female trees, which had been reported or observed to bear seed or retained peduncle from earlier seed crops, continued to produce female flowers, Male trees, observed to be male or retain staminate flowers, continued to produce males and were never found to bear seed or peduncle remnants.
- 4.These results concur with the accepted dioecious nature of white ash.

Sex Ratio Determination

From periodic observations throughout the years 1960-1962, sufficient information was obtained to estimate the sex ratio for each stand, The sex ratio estimate was based on my own observations of flowers, flower remnants and seed (as seen from within the crown) and from the severed branches forced in the greenhouse, Out of 201 study trees, 56 failed to flower, These included 11 trees apparently suffering from ash dieback and 12 trees of otherwise poor crown vigor. On the basis of those poor vigor trees which did flower, there is no reason to believe that the nonflowering individuals represent a disproportionate number of either sex.

The determinations at the Bartlett study area were 16 males, 22 females and 25 nonflowering individuals. At the Beak and Skiff woodlot 21 males and 15 females were found along with 28 of undetermined sex. I observed 38 males, 33 females and three trees that did not flower at the Cooxrox study area. In total, 75 males and 70 females were observed, This most likely represents a 1:1 ratio for the areas studied.

Sex Dimorphism

From the literature available, several dioecious tree species are known to exhibit sexual dimorphism. For example, juniper, ginkgo, poplar and poplar clones (3) (4) (5). Rohmeder averaged the growth values for male and female *F. excelsior* in terms of height and volume. The mean male value always exceeded the comparable female value. This difference, however, was not apparent by individual comparison, as some females exceeded an individual male (6) (7).

To determine if different growth values exist in white ash for males and females, all the individuals in the three study areas were measured for total height and diameter. Individuals were then grouped into cells by age³, sex, crown class and study area.

The crown position of each tree was noted as dominant, co-dominant, intermediate or suppressed. The suppressed group was later discarded as most of these individuals failed to flower.

Individual tree heights and diameter values were averaged by sex for each study area. In all but two of 18 cases (cells) the mean male values exceeded the mean female values. A "t" test was used to determine if these differences between male and female mean values are significant. A significant difference between sex growth values could be shown in only four of the 18 cells.

An analysis of variance for each stand, for height and diameter data, demonstrated no significant differences between sexes.

If the greater mean male values represent a real, but small difference between sexes, a larger sample size would be required to demonstrate this to be statistically significant.

To achieve a larger sample, the data from all three stands are pooled on the assumption that the stands represent random samples of the natural white ash population. This analysis allows the partitioning of variation into that attributable to sexes, crown classes, stands (which could represent site and age factors) and random variation (error). The difference between sexes in this case, however, is not statistically significant. In spite of this present lack of statistical evidence, I still feel that slight differences between sexes in the stand (perhaps in the entire species) do exist. It seems that a new design or grouping of more homologous stands would demonstrate these slight differences statistically.

SUMMARY

The flowering of white ash was studied in three natural stands located in the Northeast over a two-year period. No evidence of abnormal flowering could be observed in any of the 1500 inflorescences scrutinized. In the study areas a branch by branch survey of individuals with questionable or unknown flowering records showed that only normal inflorescences developed and the sex remained unchanged from one year to another,

Although the three natural stands used in this study represent a limited sample of the white ash population, the sex ratio appears to be 1:1. Of the 201 individuals studied, 75 were male, 70 female and 56 were of undetermined sex. There is no reason to suspect that these 56 represent a disproportionate number of either sex,

Individuals could not be grouped as male and female by any characteristic other than floral anatomy. Sex dimorphism is suggested, however, by the slight, rather consistent differences between the averaged male and female height and diameter values. These differences could be proven statistically significant in only four of the 18 cases. It is felt that if these small differences represent a real dimorphic trend, larger or more homologous samples will be necessary to demonstrate statistical significance.

³ An age difference greater than plus or minus five years was present only in the Cooxrox area. Here the age groups were pooled for statistical analysis because of the few individuals in each age-class cell.

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