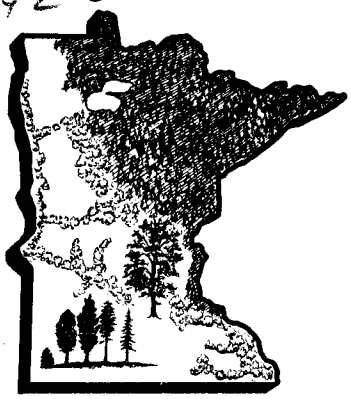

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CONE SCALE MOVEMENTS OF JACK PINE (Pinus banksiana Lamb.)[1/]

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Resin on cone-scale tips generally has been considered (1, 2) as an adhesive and/or vapor barrier responsible for keeping serotinous jack pine cones closed at maturity. After the "resin bond" is melted or broken, scale movement is considered to be a hygroscopic function, i.e. moisture closes the cone and drying opens it. Tubeuf (3) and Radais (4) suggested that in addition to resin the growing together of "epidermal hairs" between overlapping scales also may be responsible for cone closure. However, the latter characteristic is not restricted to serotinous cone species of pine. Nonserotinous cones, i.e. cones that open at maturity, are also found on jack pine.

The objectives of this study were to test the following hypotheses in regard to both cone types:

1. The mechanism of scale movement is hygroscopic in nature.
2. Scale movement in serotinous cones is inhibited by resinous substances.
3. The union of overlapping scales is characterized by "epidermal hairs" and associated resinous substances.

Cones were collected in central Minnesota from trees bearing either all serotinous or all nonserotinous cones.

Scale movement in response to treatments was followed by cone weight loss, primarily moisture, with time and four visible classes of cone opening as follows: completely closed, scale separation, half open, and fully open.

In the first experiment the response of cone types to a temperature approximating the maximum that might be expected under field conditions, i.e. 41°C (106°F) was studied. The results (Fig. 1) suggested that some unknown factor was inhibiting both weight loss and scale movement of the serotinous cones.

In the second experiment, cones of both types were extracted for resinous substances for five days in a 1:2 alcohol-benzene mixture followed by air drying for 15 hours at room temperature. At the end of this treatment all cones were half open. After water soaking these cones at room temperature for one day, all cones had reclosed to the "scale separation" point. The cones were then oven dried at 41°C. The results of this experiment (Fig. 2) indicated that the mechanism of scale movement in both cone types is hygroscopic in nature and very similar, but is normally inhibited in serotinous cones by alcohol-benzene soluble substances.

In a third experiment 220 serotinous cones were first compressed by means of a small pulp press. Half of the compressed cones were then soaked in water at room temperature for one day and the other half left dry. The results showed that compressing serotinous cones separated the scales without damage to the hygroscopic opening mechanism. The dry cones opened no farther than the scale separation stage. The separated scales of the water-soaked cones opened completely within two days of air drying at room temperature. Therefore, once

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the scales of serotinous cones have been separated, the limiting factor in scale movement under drying conditions appears to be the quantity of water contained in the cone scales.

Microscopic examination of scale unions of both cone types showed them to be very similar in appearance. The unions showed up as dark brown lines which consisted of relatively long, narrow cells and a brown colored refractory substance. These cells may be the "epidermal hairs" described in the literature and the brown refractory substance primarily resin. However, alcohol-benzene also removes other substances besides resins, e.g. waxes, fats, and possibly some so called wood gums (5). Therefore, resin alone was not established as the factor responsible for keeping serotinous cones closed. The possibility that "epidermal hairs" of serotinous cones is alone responsible for continued closure appears unlikely from the results of this study.

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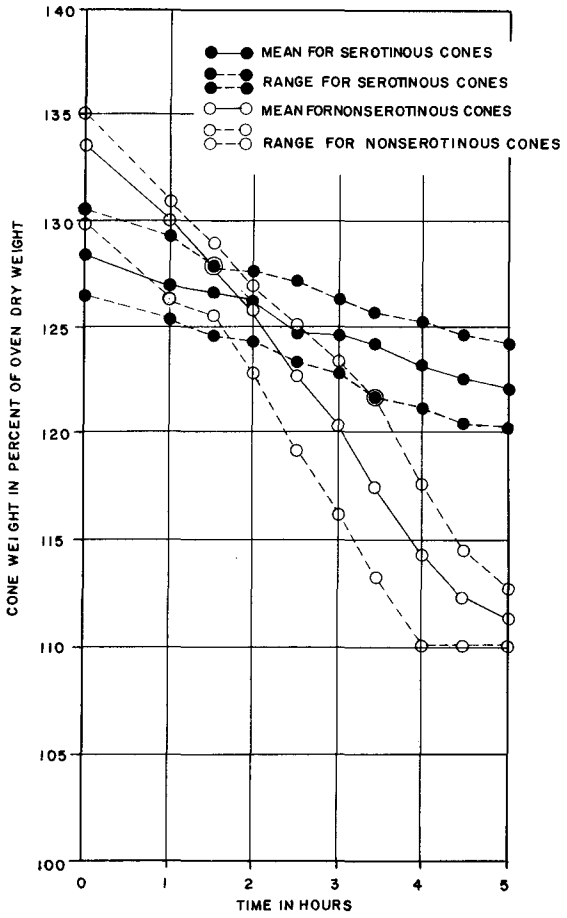

FIGURE I. WEIGHT LOSS AFTER DRYING AT 106°F OF TEN SEROTINOUS AND TEN NONSEROTINOUS JACK PINE CONES. ALL SEROTINOUS CONES REMAINED COMPLETELY CLOSED THROUGHOUT THE TEST PERIOD. AT THE END OF FIVE HOURS AT 106°F ALL NONSEROTINOUS CONES WERE HALF OPEN.

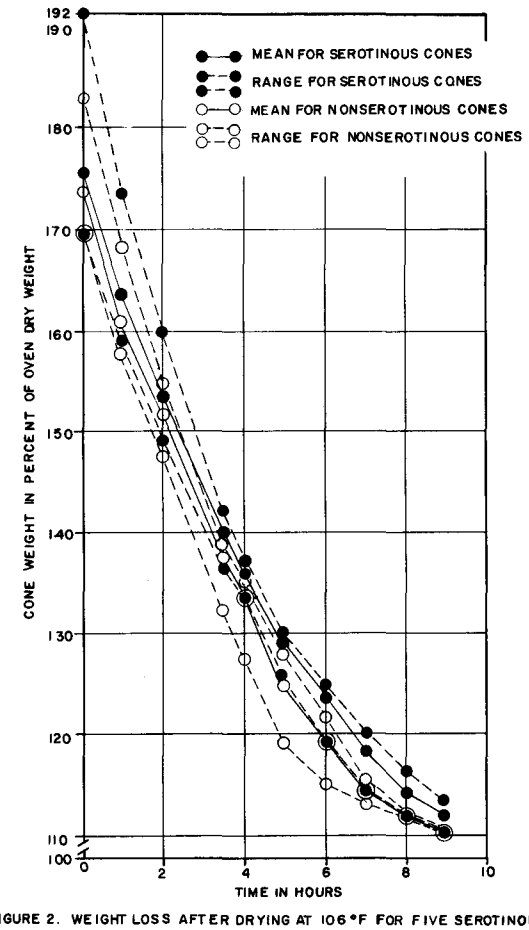

FIGURE 2. WEIGHT LOSS AFTER DRYING AT 106°F FOR FIVE SEROTINOUS AND FIVE NONSEROTINOUS JACK PINE CONES PREVIOUSLY WATER SOAKED. PRIOR TO SOAKING THE CONES WERE TREATED WITH ALCOHOL-BENZENE WHICH RESULTED IN SCALE SEPARATION IN ALL CONES. AT THE END OF NINE HOURS AT 106°F ALL CONES WERE COMPLETELY OPEN.

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