

# NOTES ON THE ECOLOGY OF AMERICAN LOTUS IN SOUTHERN ILLINOIS

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## INTRODUCTION

American lotus, *Nelumbo lutea* (Willd.) Pers., was selected as one of several aquatic plants to be used in experimental plantings in strip-mine ponds in southern Illinois. Fruits were scarified prior to planting and germinated in the laboratory as a control to field planting. Interest was aroused in the germination and ecology of these plants, and the following data resulted from experiments and observations completed subsequently.

The community studied is located in Crab Orchard Lake, five miles east of Carbondale, Illinois. Fruits for germination experiments were collected from Colp City Reservoir.

The American lotus commonly occurs from Florida to Texas, north locally to Ontario, Minnesota and Iowa (Fernald, 1950:641). A common inhabitant of quiet waters, it appears readily in artificial impoundments. Possessing a high degree of local dominance, it soon establishes pure stands in bays and estuaries. As areas completely covered by lotus are difficult to navigate, it is often considered a weed, and efforts have been made in some localities to eradicate the plant.

Martin and Uhler (1939:84) reported that the plant is of little or no use as waterfowl food, but rather, often chokes out valuable food plants.

## METHODS

As the dormancy of lotus is due to the impermeability of the ovary wall, any method of reducing this impermeability without harming the embryo will speed germination. Scarification by abrasion or cracking the ovary wall produces germination in a short time, but the results are not uniform. Immersion in concentrated sulfuric acid ( $H_2SO_4$ ) proves to be the most feasible. Immersion in the acid for 2 hours is suitable, but fruits so treated require from 48 to 72 hours for initial germination whereas fruits treated for 5 hours germinate within 24 to 36 hours. Using 5 hours' immersion, germination success for a total of 300 fruits was 95%.

Fruits were weighed and volume measured every 2 hours for a 24-hour period to determine the rate of water absorption. Fruits were weighed on a single-beam laboratory balance, and volume was determined by a simple water displacement method. All figures for volume and weight were averaged from a sample of 100 fruits used in this experiment.

In the control experiment, 100 unscarified fruits were placed in water and measured daily for 15 days for volume and weight.

Seedlings were grown in the laboratory in a 10-gallon aquarium. Sand, under seven inches of water, was used in the aquarium.

In obtaining data in the field, 6 quadrats, each of 144 sq. ft., were used. To obtain annual productivity per acre, stalks were clipped at the rootstocks and air dried for three days.

#### RESULTS

##### *Germination and development.*—

Prior to germination, the fruit of American lotus is oval to spherical, rather uniform in size, averaging 12 mm. in breadth and 14 mm. in length. The average weight is 1.03 gms. and the average volume 0.837 ml. The specific gravity is 1.23. Hall and Penfound (1944:753) reported the water content of the cotyledons to be 7%. Following scarification the fruits no longer retained the oval appearance, but were distorted considerably. They were apparently as hard as before, however. The weight, volume, and specific gravity had changed but little (Table 1). When placed in water, all but a few fruits sank.

After 2 hours, 60% of the fruits were floating. All fruits remained distorted, some bearing little resemblance to their original form. The ovary wall was no longer hard and could be crushed easily by hand. Both weight and volume had increased considerably and continued to increase until germination (Table 1).

The rate of water absorption was most rapid during the first 2 hours (Fig. 1), gradually leveling off at the end of the 24-hour period. The distortion and swelling of the fruits resulted in an increase in volume that was proportionally greater than the increase in weight at the onset of water absorption. This resulted in a low specific gravity accompanied

by floating and would provide a suitable method for the natural dispersion of the species.

After 24 hours, 5% of the fruits were beginning to split along the longitudinal axis. Although some of the fruits were (20%) still flaccid, the majority were fully turgid. Final measurements were taken at 24 hours. The fruits had swollen to 15 by 19.7 mm. The average amount of water imbibed during the 24-hour period was 0.934 gms.; the average volume increase was 1.003 mls. per fruit.

One hundred percent germination of the 100 fruits used in the experiment required 108 hours (Fig. 2). Average germinating time for the 100 fruits was 59.7 hours.

In the control experiment, neither volume or weight of the unscarified fruits changed during the period of 15 days (Table 2).

Ohga (1926:755) working with the Indian lotus, *N. nucifera*, the only other species in the genus, observed that the fruits were capable of germinating on oxygen-free media. Attempts to germinate *N. lutea* in oxygen-free media during this study yielded similar results. Ohga (*op. cit.*) found that the fruits of *N. nucifera* had an internal air pocket, containing 0.2 cc. of gas, 18.33% of which was oxygen, an amount sufficient for germination. *N. lutea* fruits possess a similar structure.

*Ecology.*—Adult plants are found on muddy banks a few inches above water level to a depth of more than six feet, although an ideal depth seems to be about three feet. Toward the interior of the community competition was all intraspecific.

TABLE 1.—Physical Reactions of Fruits of *Nelumbo lutea* to Acid Scarification.

Treatment	Av. wt., gms.	Av. vol., mls.	Specific gravity
none			
A—Five hrs. in conc. H <sub>2</sub> SO <sub>4</sub>	1.03	0.84	1.23
B—Treatment A, plus 2 hrs. in water	0.96	0.83	1.16
C—Treatment A, plus 4 hrs. in water	1.34	1.44	0.93
D—Treatment A, plus 6 hrs. in water	1.42	1.64	0.87
E—Treatment A, plus 8 hrs. in water	1.56	1.71	0.92
F—Treatment A, plus 10 hrs. in water	1.64	1.74	0.95
G—Treatment A, plus 12 hrs. in water	1.68	1.80	0.92
H—Treatment A, plus 14 hrs. in water	1.73	1.78	0.96
I—Treatment A, plus 16 hrs. in water	1.78	1.83	0.96
J—Treatment A, plus 18 hrs. in water	1.83	1.81	0.98
K—Treatment A, plus 20 hrs. in water	1.85	1.83	1.00
L—Treatment A, plus 22 hrs. in water	1.88	1.85	1.00
M—Treatment A, plus 24 hrs. in water	1.90	1.84	1.02
	1.90	1.84	1.03

TABLE 2.—Comparison of the Original and Final Physical Measurements of the Fruits of *Nelumbo lutea*.

Treatment	Control		Experimental	
	Weight, gms.	Volume, ml.	Weight, gms.	Volume, ml.
none				
Five hrs. in conc. H <sub>2</sub> SO <sub>4</sub>	1.03	0.87	1.03	0.84
Twenty-four hrs. in water	omitted	omitted	0.86	0.83
Fifteen days in water	1.03	0.87	1.90	1.84
	1.03	0.87	100% germination	

Over 55,000 leaves per acre were determined in the community studied. Of these, 17% were erect. Erect leaves formed a large percentage of the total in the center of the community where intraspecific competition was most severe. Near the periphery of the community in deeper water, few or none of the leaves were erect. Even in aquaria, small leaves became erect when the surface of the water was covered by other leaves.

Leaves grew as large as 75 cm. in diameter, with an average dia-

meter of 46 cm. (18.1 inches). The surface area of an average leaf was 1.78 square feet.

Foliage cover was 95% in the greater part of the community, decreasing around the periphery in deeper water. By the elevation of some leaves, and the overlapping of many of the surface leaves, a foliage area of 98,000 square feet per acre was obtained in the area studied. This was more than twice (2.25) the surface area of the water.

In late July, during the peak of the flowering season, 8,500 flower

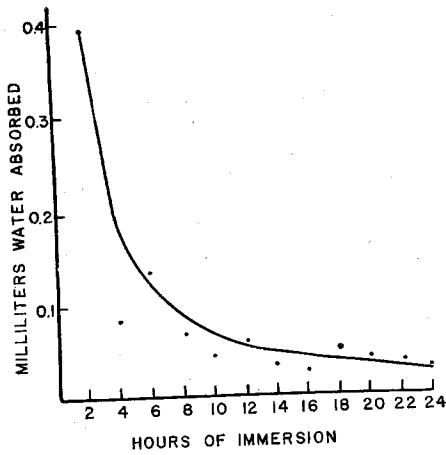


FIG. 1.—Amount of water absorbed by fruits of *Nelumbo lutea* during 24-hour period.

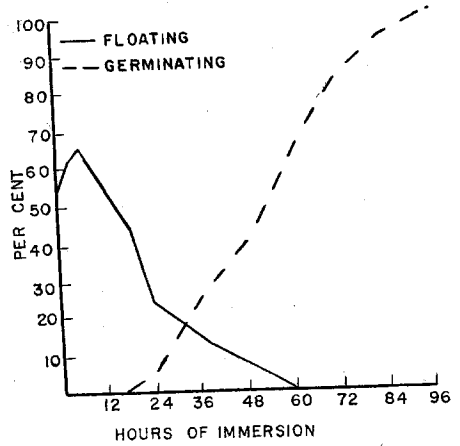


FIG. 2.—Comparison of germination rate of fruits of *Nelumbo lutea* to number floating, an indication of specific gravity.

stalks per acre were present, showing a 1:6.5 ratio of flower stalks to leaves. With an average of 20 fruits per capsule, a production of nearly 200,000 fruits (almost 400 lbs.) would be realized per acre. As this was measured only once, in the latter part of July, and the plants produce flowers all season (although apparently at a lower rate toward the end of the season), the fruit production per acre could easily be as high as 500 to 600 lbs. Considering the fact that most of the reproduction in the communities is of a vegetative nature, the number of fruits successfully germinating and maturing in nature must be exceedingly low (Meyer, 1930:225).

Cuttings in late July showed the annual productivity of vegetative material to be approximately 6.5 tons air-dry weight per acre. The rate of growth was so rapid, that after three weeks the areas that had been clipped were no longer distinguishable. The deposition of such

large amounts of organic matter in the shallow, lentic habitats in which lotus grows should prove to be a great impetus to succession in these habitats. Although no efforts were made to study directly the importance of lotus in succession, the large annual productivity, as well as the slow rate of decomposition of the stems and leaves, would seem to indicate that the lotus plays an important part in this succession.

#### SUMMARY

1. Immersion of *N. lutea* fruits in concentrated  $H_2SO_4$  for 5 hours was found to be the most feasible method of scarification, assuring initial germination within 24 to 35 hours, and yielding 95% germination.
2. Absorption of water by fruits is rapid at first, gradually tapering off until germination.
3. The average amount of water absorbed during the 24-hour period

following scarification was 0.934 gm. (90.7% of the dry fruit weight); the average volume increase was 1.003 mls. (119% of the dry fruit volume).

4. Fifty-five thousand leaves per acre were recorded, 17% of which were elevated; an average of 8,500 flowers per acre was determined, calculated to yield more than 400 lbs. of fruit per year.

5. An annual productivity of 6.5 tons air-dry weight per acre was calculated.

6. Lotus probably plays an important role in the succession of the areas in which it grows.

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