REPRODUCTIVE PHYSIOLOGY OF *JUNIPERUS EXCELSA* M. BIEB.

1-POLLEN MIGRATION RATE

by

A. Khalique and Shahida Perveen*

Summary. *The pollen dispersal of Juniperus excelsa M. Bieb was studied on a single isolated tree. The pollen specimens were collected at the following distances from the source tree:* 3, 6, 12, 24, 48 *and* 96 *metres. The results showed that the pollen frequency at a distance of* 96 *metres is* 0.5% *of the source frequency. The standard deviation* (σ_D) *of the pollen dispersion distance was calculated from pollen counts as a measure of pollen dispersion. It was calculated according to SEWALL WRIGHT's formula* (*Wright,* 1962). *The value of* σ_D *is* 16.1 *metres.*

Introduction. *Juniperus excelsa* M. Bieb (Syn. *J. macropoda* Boiss., *J. polycarpos* C. Koch) is a wind pollinated species. Since it is dioecious, the incidence of pollination and frequency of seed setting depends solely upon the presence of a pollen source or at the rate of pollen migration from that source to the nearest female tree. The juniper forest of Baluchistan is basically an open type of forest where the trees are scattered and the male and female trees are spatially isolated from each other, the average number of trees per hectare have been estimated at hardly twenty eight (Khattak, 1976). The high frequency of empty seed reflects a problem associated with the frequency of pollen source or pollen migration. Karim (1974) has reported a similar state of affairs in this species, growing as open woods in parts of Iran and has suggested artificial pollination for solving the problem.

Review of Literature. Tree genes migrate via pollen or seed (Wright, 1962). Since pollen usually travels greater distances than seed, therefore pollen migration distance (D) is more critical than seed dispersion distance from genetical point of view. Wright (1952) investigated pollen dispersion of American trees and found that most of the pollen falls within about a hundred metres of the source tree. His data on Pinyon pine (*Pinus edulis* Engelm.) showed a rapid decrease in pollen dispersion with increasing distance. The pollen frequency at 92 metres was about one percent of the frequency of pollen at pollen source. The standard deviation of pollen distribution from the source (σ_D) was 16.8 metres. Besides, he also found that considerable pollen was trapped to leeward as well as windward and the distance of dispersion was as great or greater on calm than on windy days. Strand's (1957) conclusions were similar to Wright's. He found that pollen of *Pinus-sylvestris* L., and *Picea abies* (L.) Karst travelled relatively short distances in quantity and there was no relationship between wind velocity and dispersion distance. Wang *et al.* (1960) investigated *Pinus-elliottii* Engelm., pollen in Florida regarding seed orchard management and

[1] The authors are Plant Physiologist and Technical Assistant respectively at the Pakistan Forest Institute, Peshawar.

found a value of σ_D=69 metres and reported no correlation between wind velocity and dispersion distance. Wright (1962) has reviewed the pertinent literature in respect of pollen migration rates in forest trees and has described the standard methodology for pollen sampling and mathematical treatment of the dispersion data.

Material and Methods. *Source tree:* A single male tree of *Juniperus excelsa* M. Bieb growing in a small Botanical Garden of Islamia College, Peshawar was found to be an ideal point source for this study. The tree was about six metres tall, had full crown and was heavily flowering. Pollen shedding started on February 23 and continued till February 26, 1977. The weather data of this period is at Appendix.

Pollen sampling: Following Wright's methods (1962), four transects were established in four directions from the source tree; two of these transects were parallel to the average wind direction (NW and SE) while the other two were at right angles (NE and SW). Six sampling stations were established along each transect at 3, 6, 12, 24, 48 and 96 metres from the base of the source tree. The pollen sampler consisted of an unprotected vaseline-covered ordinary glass slide, fixed horizontally to a stick at a height of 1.2 metres above the ground level. The samplers were fixed on February 23 (at 8 a.m.) and collected after 36 hours on February 25 (at 8 p.m.). The slides were packed carefully in an airtight box and brought to the laboratory for counts.

The pollen counts were made directly from the exposed slides without coverslips by examining under low power of a microscope and an area of 0.339 cm^2 was counted on each slide.

Mathematical treatment of dispersion data: (after Batman, 1947 cf. Wright, 1962; Wang *et al.* 1960).

Standard deviation σ_D as a measure of pollen dispersion. The pollen dispersion distance is best expressed as a slope of a dispersion curve or as the standard deviation of dispersion distance (σ_D). To obtain the σ_D the pollen data were fitted to the curve represented by the formula:

(1) $y = y_o e^{-kD}$ where

y = frequency at a given distance D

y_o = frequency at station 0 or the source frequency

k = a constant relating to the decrease of dispersion rate with distance.

The logarithmic transformation of the curve is

(2) $\text{Log } y = \text{Log } y_o - (\text{Log}_{10} e)\, k\, D$ where

$\text{Log}_{10} e = 0.4343$

The variance (σ^2_D) is $2/k^2$, so that:

(3) $D = 2\sqrt{k}$

The number of pollen grains at a station was used as the weight in the regression calculation with the ordinary regression formula as suggested by SEWALL WRIGHT cf. Wright (1962).

Results. The pollen counts at varying distances from the source tree along four transects are given below in Table 1.

Table 1

Amount of pollen collected at varying distances from the source tree along four transects.

Distance in metres from the source tree	Transect number[1]				Total	Average
	1	2	3	4		
	.....Grains per 0.339 cm^2.....					
3	452	173	486	385	1496	374
6	105	67	65	1259	1496	374
12	53	48	38	53	192	48
24	44	43	21	12	120	30
48	10	8	14	8	40	10
96	2	3	2	1	8	2

1 (NW); 2 (SE); 3 (SW); 4 (NE).

The value of σ_D was calculated for pollen dispersion from average values of pollen counts at varying distances from the source tree. According to the formula (1) the regression equation is:

$$\text{Log } y = 2.705284 - 0.038179\ D.$$

The value of σ_D is 16.15 metres.

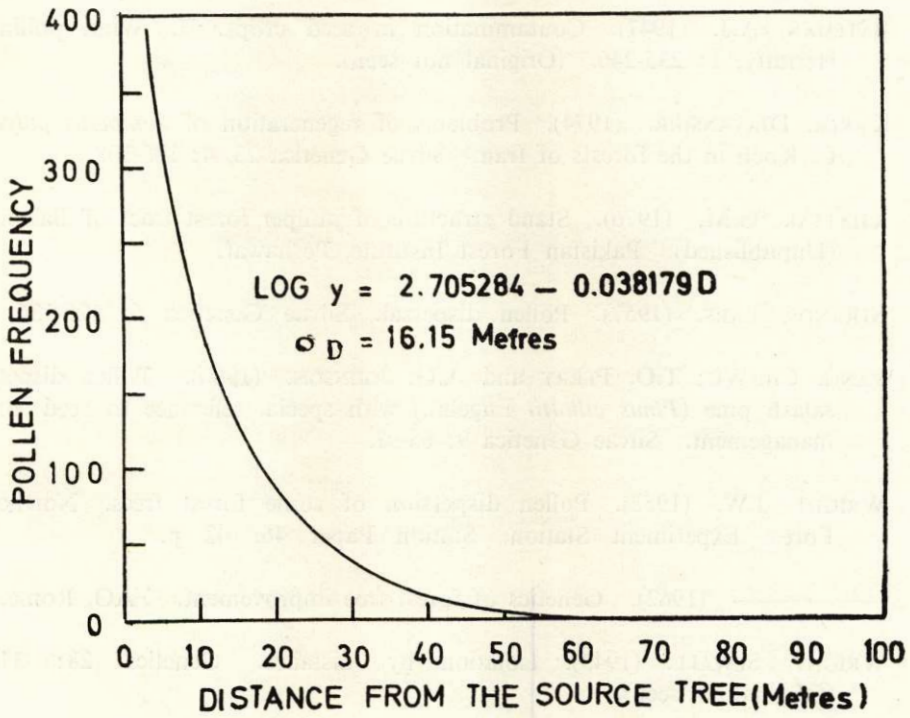

Fig. 1. Pollen frequency curve showing pollen collected at varying distances from the source tree. Standard-deviation of the pollen dispersion distance (σ_D) was computed from the pollen data as a measure of pollen dispersion.

Discussion. It is evident from the data in Table 1; that pollen frequency decreases rapidly with increase in distance from the source tree. For instance the pollen frequency at a distance of 96 metres is just 0.5% of the source frequency (Figure 1). This indicates that juniper pollen travels relatively very short distance in quantity and most of it falls within 30 metres from the source tree. The standard deviation of pollen dispersion distance was 16.1 metres. Wright (1953) has suggested that 2 σ_D can function as an effective isolation barrier for the management of slash pine seed orchards, from the risk of extraneous pollen. Similarily, it appears reasonable to presume that female trees isolated by more than 2 σ_D from the male trees are liable to be sterile merely because of Ineffective pollination.

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References

1. BATEMAN, A.J. (1947). Contamination in seed crops. II. Wind pollination. Heridity, 1: 235-246. (Original not seen).

2. KARIM, DJAVANSHIR. (1974). Problems of regeneration of *Juniperus polycarpos* C. Koch in the forests of Iran. Silvae Genetica 23, 4: 106-108.

3. KHATTAK, G.M. (1976). Stand structure of juniper forest tract of Baluchistan. (Unpublished). Pakistan Forest Institute, Peshawar.

4. STRANDS, LARS. (1957). Pollen dispersal. Silvae Genetica 6: 129-136.

5. WANG, CHI-WU; T.O. PERRY and A.G. JOHNSON. (1960). Pollen dispersal of salash pine (*Pinus elliottii* Engelm.) with special reference to seed orchard management. Silvae Genetica 9: 65-92.

6. WRIGHT, J.W. (1952). Pollen dispersion of some forest trees. Northeastern Forest Experiment Station. Station Paper 46. 42 p.

7. ———— (1962). Genetics of forest tree improvement. FAO, Rome, Italy.

8. WRIGHT, SEWALL. (1943). Isolation by distance. Genetics 28: 114-138. (Original not seen).

Appendix

Daily weather data at Pakistan Forest Institute (Watershed Management Station) during juniper flowering period Feb. 21-26, 1977 *at Peshawar.*

Date	Temperature (°C)		Humidity (%)	Evaporation (mm)	Wind[1] at 2.44 m (Km./day)	Sunshine duration		Rain (mm)
	Maximum	Minimum				Hrs.	Min.	
Feb. 21	22.2	4.4	75	14.26	50.00	10	—30	0
Feb. 22	22.8	5.0	69	3.94	49.9	8	—10	0
Feb. 23	24.0	5.0	65	2.86	82.0	3	—30	0
Feb. 24	17.8	4·4	76	1.64	49.0	11	—50	0
Feb. 25	23.8	4.4	76	4.04	32.0	8	—40	0
Feb. 26	23.9	11.1	87	3.68	170.0	9	—10	0

[1] Anemometer's height is 2.44 metres from the ground level.