

MORPHOLOGY AND PHENOLOGY OF PINUS LAGUNAE M.-F. Passini

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Pinus lagunae (Passini, 1987) was described, (Robert-Passini, 1981), as "a tree with an upright trunk, 12-15 meters high, leaves principally 3, sometimes 2 per fascicle, grey green; stomates on each surface; two resin ducts. Conelets slightly pedunculate, cones globular or sub-globular." It is found in the Sierra de La Laguna, in the far southern tip of the Lower California Peninsula. This study describes the morphology and phenology of *Pinus lagunae*.

METHODS

Several morphological characteristics were studied in growing trees in various localities: La Laguna, San Antonio, San Juanito on the eastern slope, experimental plot (1 hectare), Palo-Extraño, La Chuparrosa and San Francisquito (Tab. 1).

Tab. 1. - Geographic origin of the trees

Site	Longitude	Latitude	Elevation	N° of Trees
La Laguna	110°58'	23°33'	1700 m	1-2-3-13
Picacho	110°01'	23°34'	1900 m	4
San Antonio	109°58'	23°32'	1950 m	5
Palo-Extraño	109°57'	23°31'	1650 m	14-15-16
Experimental	109°56'	23°31'	1750 m	6-7
San Juanito	109°55'	23°31'	1400 m	8
La Chuparrosa	109°55'	23°31'	1725 m	9
San Francisquito	109°57'	23°29'	1400 m	10

For each tree, the height and diameter of the trunk, the height of the first sensitive branch, the length of growth units in 1982, 1983, 1984 (4 terminal branches from the main and lateral axis) were measured. Number of needles (300 to 1300 fascicles by tree), needle length (20 needles from each main and lateral axis) were measured. Height, weight, number of fertile scales, number of two seed scales were noted for 30 mature cones by tree. The length, width of seeds and seed wall thickness were measured (20 seeds by tree).

A phenological study of trees from the two localities of La Laguna and plot experimental was made.

Moreover, four lots of seeds from La Laguna were put to germinate in november and december 1984, in april and may 1985, in identical conditions (tin foil covered Petri boxes, kept moist with distilled water, temperature 25 - 2°C).

RESULTS

Trunk and branches. Pines can grow from 3 to 21 meters. The pine height and the height of the first needle clad branches in La Laguna are significantly different when compared to heights of the experimental plot. No significant difference is found between diameter of trees in the two localities. La Laguna pines, growing 6.7 to 8 meters apart, are not so tall as those of the experimental plot, but have a more widespread habit. On the contrary, the more closely packed trees on the experimental site (3 to 5 meters apart) have a taller trunk and a sparser crown. Finally, pines in southern and south westerly localities are not so tall as those growing in the afore mentioned localities.

In 1983, the average branche length growth was 6, 9 - 2,3 cm and 6,3 - 1,5 cm in 1984. The difference between 1983 and 1984 is not significant in any locality.

However, the difference between length from one locality to another is significant (Tab. 2). In particular, branches from trees in La Chuparrosa and San Juanito revealed far less growth than pine branches from La Laguna. Three localities: La Chuparrosa, San Juanito and San Francisquito, have a south westerly exposure, therefore with more sun and also drier soil.

Tab. 2. - Length of growth units: comparison of La Laguna pines with other localities pines

Site or N° of trees	1983-	Significance*	1984	Significance*
La Laguna	6,9 ± 2,3		6,3 ± 1,5	
4	6,1 ± 0,7	ns	7,8 ± 1,3	ns
5	3,6 ± 0,3	ns	4,6 ± 0,5	0,05
6	4,9 ± 0,1	ns	5,5 ± 0,0	ns
7	6,0 ± 0,6	ns	2,6 ± 0,7	ns
8	5,0 ± 2,1	ns	3,9 ± 1,1	0,05
9	4,1 ± 0,4	ns	3,3 ± 0,4	0,001
10	4,0 ± 0,0	0,05	2,4 ± 0,0	0,001

* Student-test

Foliage characteristics. No significant difference appears between year to year length of needles from fascicles of the main axes:

Year	Length in cm	Number of fascicles
1982	4,5	480
1983	5,5	820
1984	5,5	820

However, a comparison of average needle lengths of the pines of San Francisquito and La Chuparrosa with those of La Laguna reveals a significant difference. A positive correlation exists between growth unit lengths (x) and needle lengths (y) for 1982 and 1983 on the one hand, and for 1984 on the other.

The equation differs according to whether the branche belongs to a main growth axis :

$$y = 3.37 + 0.31 x r = 0.54 \text{ DL} = 25$$

or to a lateral axis :

$$y = 3.37 + 0.32 x r = 0.55 \text{ DL} = 26.$$

The growth is therefore greater on the main axis than on lateral axis.

Mature pines have commonly 3 needles per fascicle, a smaller number has 2 needles per fascicle, and a few four needles, one needle per fascicle are uncommun. In all mature trees, in 1983, there are 91% three needles per fascicle and merely 8%, in 1984. Therefore, the number of two or three needles fascicles varies from year to year. Moreover, there is a higher percentage of two needles per fascicle in San Francisquito than in La Laguna (Tab. 3).

Tab. 3. - Comparison of needle lengths and number of needles per fascicle of La Laguna pines and other localities pines

Site or N° of trees	Needle length (mm)		Percent 2 needles/ fascicle					
	1983	S*	1984	S*	1983	S*	1984	S*
La Laguna	6,3 ± 1,1		5,8 ± 0,8		3%		4%	
6	4,1 ± 0,3	0,05	4,6 ± 0	0,05	7	ns	8	ns
7	6 ± 0,2	ns	5,1 ± 0,3	ns	0	ns	6	ns
8	4,6 ± 1	ns	5,1 ± 0,3	ns	2	ns	7	ns
9	4,6 ± 0,4	0,01	4,4 ± 0,3	0,01	15	ns	25	ns
10	4,6 ± 0	0,05	4,3 ± 0	0,05	22	0,01	48	0,01

* Student-test (S-significance)

A positive correlation (logarithmic) links up the annual growth unit and the percentage of three needle fascicles.

Lagunae pine needles have ventral and dorsal stomatal lines : from one line to three lines on the dorsal surface, and four to six lines on the ventral surface. The ratio between surface lines (FV) and dorsal surface lines (FD) is slightly higher in localities south of the Sierra de La Laguna (San Francisquito and San Juanito). But no positive correlation appears neither between FV/FD and needle length nor FV/FD and percentage of needles per fascicles.

The needles grow longer in June and are fully grown in october or november, they are a three year life span.

Cones and seeds characteristics. The pedoncule of the seed cones are 0,2-1,2 cm long. They are decidues. A mature seed cone is 3-6 cm long (mean length 3,9±0,5 cm). The scale number is about 9. Only median and upper scales bear seeds. In all the cones, 63% of scales have 2 fertile seeds and 37% one seed. The seed cones from San Francisquito are smaller than those of La Laguna and have fewer two seed scales (Tab. 4).

Tab. 4- Cone characteristics, comparison of pines of La Laguna with those of Palo-Extraño (14,15,16), experimental plot (6,7) and San Francisquito (10)

Site or N° of trees	Number	Cone length (cm)	S*	2 seeds scale	S*
La Laguna	228	4,3 ± 0,5		6,6 ± 3,2	
14	31	1,5 ± 0,6	0,001	5,5 ± 2,6	ns
15	13	3,9 ± 0,4	ns	6,9 ± 2	ns
16	21	4,4 ± 0,4	0,001	6,4 ± 2,5	ns
6	21	4,3 ± 0,5	ns	8,6 ± 2,2	0,001
7	31	4,6 ± 0,5	0,05	6,9 ± 3,1	ns
10	23	3,2 ± 0,3	0,001	4,3 ± 1,6	0,001
Mean		3,9 ± 0,5		6,2 ± 1,2	

* Student-test (S-significance)

Pinus lagunae has large seeds coffee coloured or light brown mottled with dark brown. Mean length seed of all the localities are 12,9 ± 1,3 mm long, 7,6 ± 0,5 mm width. The shell seeds have 0,5 ± 0,2 mm thick. Seeds from La Laguna are significantly longer than all of Palo-Extraño, experimental plot, and San Francisquito. Moreover, certain trees of this localities produce seeds with thinner shelles than those of La Laguna (Tab. 5).

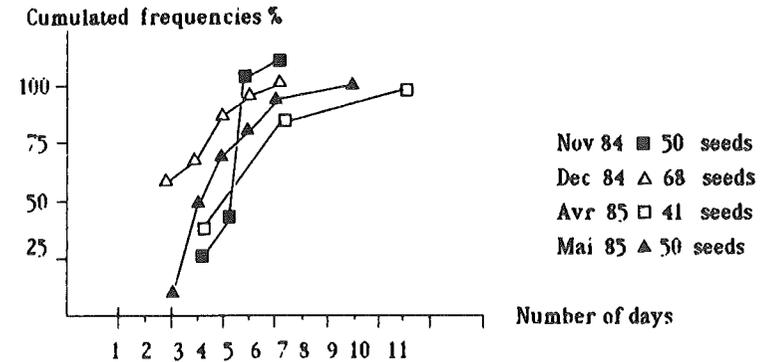
Tab. 5.- Seed characteristics

Site or N° of trees	Seed length (mm)	S*	Seed width (mm)	S*	Thickness shell (mm)	S*
La Laguna	13,8 ± 1,3		7,9 ± 0,9		0,7 ± 0,2	
14	12,4 ± 0,5	0,001	8,4 ± 0,5	0,02	0,6 ± 0,2	ns
15	13,1 ± 0,7	0,02	7,4 ± 0,6	0,02	0,6 ± 0,1	ns
16	15,0 ± 1	0,001	8 ± 0,5	ns	0,4 ± 0,1	0,001
7	13,1 ± 0,7	0,02	7,4 ± 0,6	0,02	0,5 ± 0,1	0,001
10	11,5 ± 0,4	0,001	7,3 ± 0,6	0,001	0,3 ± 0,1	0,001
Mean	12,9 ± 1,2		7,6 ± 0,5		0,5 ± 0,15	

* Student-test (S-significance)

Germination. The four lots of seeds from La Laguna proved to have a high germinative capacity: 90% germination within a five day response delay (Fig 1). These seeds, as those of *Pinus catarinae* (Passini, 1981), display no dormancy period. The mean number of cotyledons is 12,3 (150 germinations).

Fig. 1. - Seed germination



In the mountain, seeds germinate from September onwards and germination percentage is also very high. Seeds were sown on the spot, in the forest, but only 30% of the initial plantlets survived after six months. March had the heaviest losses.

Phenology. The vegetative buds, that enter in dormancy in November, become active in late March. At bud bursting time, the bud, 1-2 cm long, swells at the base and the scales open up. The terminal bud stretches and lengthens during April, forming an inflorescence which will be fully developed at the end of May. Male branches grow will not begin until after pollination, at the end of June.

Female strobili can be seen as from late April onwards. Their scales are open mid May. In 1985, pollination began towards 20th May and carried on until 10th June. A slight delay in the dehiscence of male inflorescences was observed in La Laguna, compared with those in Palo-Extraño.

All the trees observed, in 1985, in the collecting localities of La Laguna and the experimental plot flowered. Male inflorescences, generally abundant, were on the lower branches. On the contrary, female strobili developed in the upper part of the tree, although some were occasionally found on the lower branches. Two trees, three meter tall, about 30 years old (age determined by number of verticils) only bore female strobili.

Seed cones begin growing in March during the second year, they are ripe in August. In late August, early september, the hanging cones open and let fall their ripened seeds. Heavy late summer hurricanes often speed up the process, hurling cones and seeds to the ground.

Small mammals, such as *Peromyscus truei*, the "raton de los pinos", and many birds feast upon these seeds. The birds include *Paloma serrana* and *Melanerpes formicivorus* which build up large stocks of these seeds inside dead tree trunks.

CONCLUSION

In this study, carried out in Sierra de la Laguna, from October 1984 to July 1985 (Pinel, 1985), it appears that morphological characteristics, especially the number of needles per fascicle, vary throughout the *Pinus lagunae* formation. Apart from varying number of needles per fascicle from one specimen to another in La Laguna, previously indicated by Passini (1981), it was noted that the number of needles per fascicle increases with altitude, between 1 400 and 1 700 m. Also, the positive correlation between annual growth unit and the percentage of three needles per fascicle has to be noted. We also draw attention to the fact that very long needles (longer than the average needle length of *Pinus cembroides* Zucc., Zavarin & Snajberk, 1986)) are to be found at La Laguna, and shorter needles in southern collection localities.

Characteristics of description type : three needles per fascicle, ventral and dorsal stomatal lines, average number of cotyledons (12,6) were confirmed. But the average height of trees is greater than that given in the description. Moreover, considerable variation was noted at the San Francisquito locality which is further south than that of La Laguna : the trees, there, are smaller, but at present, our studies do not enable us to say whether this variation affects all the trees of the locality.

Two types of seeds were found : a thin shell seed of 0.2 to 0.5 mm and a medium thick shell 0.5 to 0.9 mm. This study enable us to conclude that two varieties of *Pinus lagunae*. Further studies will specify their relations and ecological requirements.

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