ECOLOGICAL ASPECTS AND CROP OF *SUILLUS LUTEUS* (FUNGI, BOLETACEAE) IN *PINUS RADIATA* FORESTS IN THE REGION DEL BIO-BIO, CHILE

Aspectos ecológicos y cosecha de *Suillus luteus* (Fungi: Boletaceae) en bosques de *Pinus radiata* de la Región del Bío - Bío, Chile

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Abstract

Crop and ecological ospects of *Suillus luteus* (L. ex Fr.) S. F. Gray, growing in *Pinus radiata* D. Don forests in the Bio - Bio Region (the 8th Region) of Chile are given. The sites studied were three lots per stand found in the phytogeographic formations defined according to Pisano. Collections were made every fifteen days during a 15 month period. These collections were correlated in each locality to biotic factors (age and density of the plantings, human and animal action, and surrounding vegetation) as well as abiotic factors (soil types, wind and rainfall).

Monte Aguila presented the greatest crop of *S. luteus* / ha.

Resumen

Se hace un estudio de los aspectos ecológicos y producción de *Suillus luteus* (L. ex Fr.) S. F. Gray en plantaciones de *Pinus radiata* D. Don en la VIII Región de Chile. La investigación se efectuó en 3 parcelas por rodal, distribuidas equitativamente en 3 formaciones fitogeográficas definidas según el esquema de Pisano, donde se efectuaron recolecciones cada 15 días durante un período de 15 meses. Las recolecciones fueron relacionadas con los parámetros bióticos (edad y densidad de las planciones, acción humana y de animales, y vegetación circundante), y abióticos (tipos de suelos, temperatura, pH y humedad del suelo, energía incidente, vientos y precipitaciones) de cada localidad.

La localidad de Monte Aguila presentó la mayor producción de *Suillus luteus* por hectárea. Se dan recomendaciones sobre el período óptimo de recolección y modo de ejecutar la recolección.

Keywords: Fungi. Boletaceae. *Suillus*. Ecology. Edible fungi. *Pinus radiata*.

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INTRODUCTION

In the last decade the wild fungi growing in *Pinus radiata* D. Don forests have stimulated great economic interest. Edible chilean fungi are prized in Europe due to their wide culinary usage. *Suillus luteus* (L. ex Fr.) S. F. Gray is the most outstanding fungus of this type. It is a renewable natural resource, easily recognizable and also has great acceptence in the international market. The total export of brined *Suillus luteus* from the 8th Region of Chile amounted to US$ 240,000 in 1978 and nearly US$ 1.000,000 in 1979 (Cidere 1979). This fungus has become an important source of labor and sustenance for the rural population of this region.

Ecological and crop studies made on *S. luteus* are becoming increasingly important since, according to the National Forest Corporation of Chile (CONAF), out of approximately 800,000 ha reforested with *P. radiata* in Chile, 54.7% has been planted in the 8th Region. This represents 10.2% of the total area of this Region. Furthermore, *Suillus luteus* plays an important ecological role since it grows in ectomycorrhizal association with *P. radiata* (Trappe, 1962; Hepting, 1971; Chu-Chou, 1979).

The production of *Suillus luteus* in different stands of *Pinus radiata* D. Don in the 8th Region, Chile, will be evaluated. As well, the biotical and abiotic factors that control the abundance of this fungus, leading to possible management of *Suillus luteus,* will be investigated.

MATERIALS AND METHODS

Biogeographical background of the different localities studied[1] (see map).

Monte Aguila: (37º26'S; 72º15'W) is located within the "Formación de estepa con *Acacia caven*", with sandy soil of the Coreo type.[2]

Chaimávida: (36º15'S; 72º54'W) is located within the "Formación de los matorrales de la Cordillera de la Costa" with clay soil of the San Esteban type.

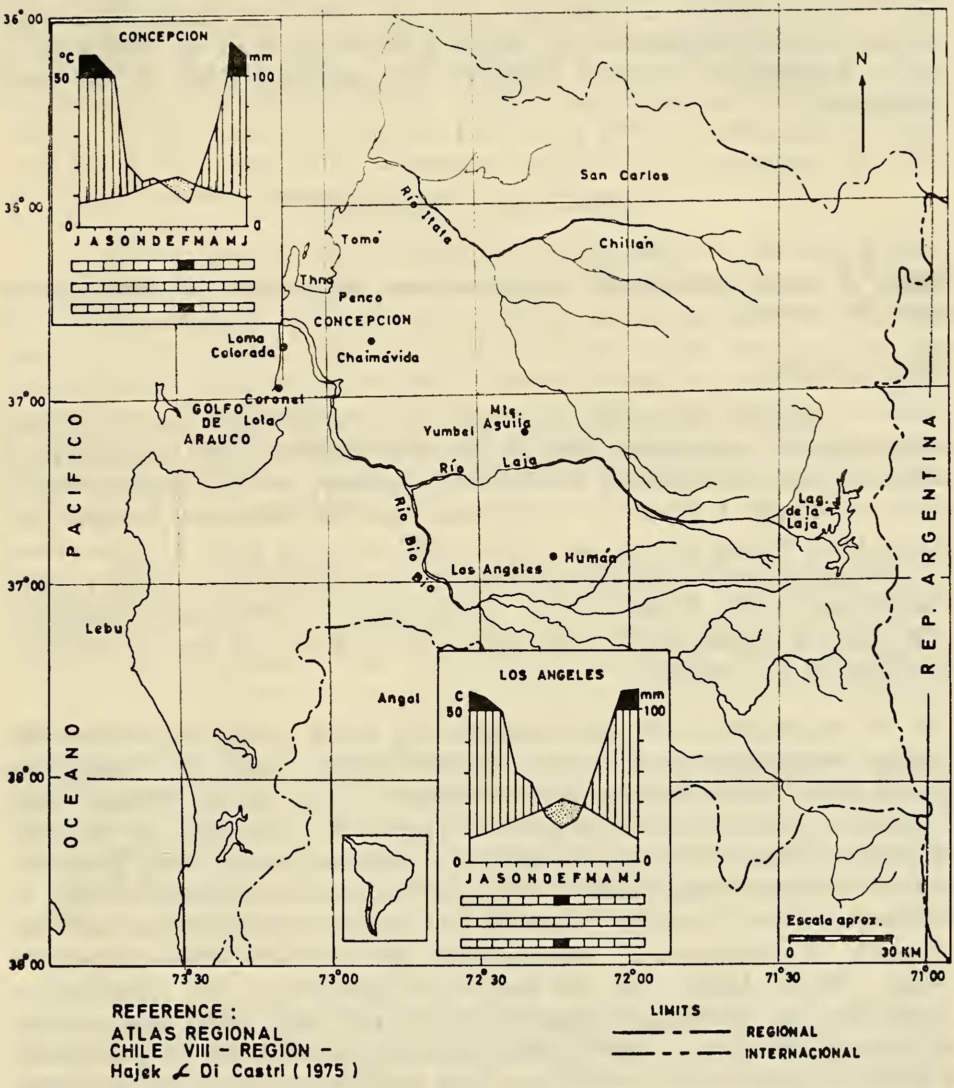
Lomas Coloradas: (36º50'S; 73º08'W) is located within the "Formación del matorral costero mesomórfico".

Plots. The authors worked in *Pinus radiata* stands of different ages ((1–5; 6–10; 11–15; 16–20; 21 years old) and stages of exploitation, with three 33.3 m x 33.3 m (1,000 m²) plots per stand[3]. The plots were encircled with barbed wire and contained 800–2,500 trees/ha. In addition, observations were made near the stands.

[1] These sites are located in three phytogeographic formations defined according to the Pisano scheme (Pisano, 1956; Fuenzalida. 1965).

[2] The soils are named according to Int. Rec. Nat. (1964).

[3] The size of the plots were chosen based on previous outings carried out during 1978.



Collection methods. All localities were visited once every two weeks for 15 months. Based on methods by Peyronel (1956), Bohus and Babos (1960) and Kalamees (1968, 1971), carpophores present on non–humified litter were collected.

The collection was carefully and thoroughly carried out along specific pathways. The carpophores were weighed, counted and recorded immediately.

Climatic conditions, rainfall data, maximum and minimum temperatures and the temperature at 08:00 hrs.) were taken daily. The temperature underneath the non–humified litter was taken. According to the method of Zinke (1962) and Jackson (1964) the soil pH and soil moisture were taken biweekly. The soil pH was measured with a pHmeter. The incidence of energy was measured at 10:00, 11:00 and 12:00 A.M., with a quanto–radio–photometer LI 180 and the wind with an anemometer (Wilh. Lambrecht). Later, a study of the associated flora in the plots was made.

RESULTS AND DISCUSSION

Effect of biotic and abiotic factors on the frequency and development of *Suillus luteus*.

Abiotic factors

Rainfall. This in an important factor in the growth of the carpophores since it is converted directly into soil moisture. The fact that rainfall represents an essential factor in the growth of the carpophores is shown in graphs 1, 2 and 3. It is evident that the abnormal drought that affected the region during the fall of 1979 caused a delay and alteration in the formation of carpophores. On the other hand, the normal rainfall distribution in the region during 1980 produced a phenogram, frequency and crops of *Suillus luteus* that appear to be nearer to the normal fructification of this fungus.

Rainy season (April–September). It could be concluded from the studies completed that fall is the most important season for carpophore growth due to the high amount of rainfall (43% of the annual total) registered. The absolute minimum temperatures registered in fall were relatively (2 to 11º C for the different localities), facilitating fructification. In winter a large amount of rainfall was also registered (38–40% of the annual total), but the effects of low temperatures produced an interruption in fructification. Since it was the site most distant from the Ocean, Monte Aguila was the area most affected by low temperatures (–2ºC absolute minimum temperature). On the other hand, the localities of Loma Colorada and Chaimávida, which are close to the Ocean, showed a mean temperature of 11.5ºC and only occasionally registered minimum absolute temperatures under 0ºC for the season.[1]

Dry season (October–March). In spring, especialy during October due to the effects of rainfall (34 mm in Chaimávida and 14 mm in Loma Colorada[2], and the higher absolute minimum temperatures (2 to 16ºC), a reactivation in the fructification of *S. luteus* and pioneer mycorrhizal species was produced. This reactivation occurred especially in open grassy forests (with runing and/or thinning) and preferably located on clay soils. The south wind and relatively higher temperatures produced a drying effect which put a quick halt to the fruiting process.

1In these localities minimum temperatures under the litter of –0.5º C in August were occasionally registered.

2Normal rainfall for Concepción: 66.6 mm.

Light. An important role in the fruiting of some mycorrhizal species (Slankis 1971; Khan 1972; Manachere 1978), seems to be played by UV light. This condition would explain the absence of *S. luteus* in closed forests (non–pruned and/or non–thinned), due to the presence of an almost permanent twilight (107.29 – 158.59 u–einsteins m^{-2} seg^{-1}). In open forests where *S. luteus* is abundant, values of 2425.1 u–einsteins m^{-2} seg^{-1} during the day with 10/10 overcast sky and 3171.54 u–einsteins m^{-2} seg^{-1} on a clear day were registered.[1]

Wind. Due to the tremendous drying effect on the carpophores and surrounding habitat, the wind inhibited the fructification of *S. luteus* and other macroagaricales (especially during August to October with the south wind)[2]. Zinke (1962) reported that the wind influence on the distribution of needles, debris and branchs altering the soil characteristics is important. The needles and debris are located near the bases of trees; the branches, on the other hand, are found circling the tree forming a concentric ring where it is very common to find *S. luteus.* All of these factors affect the distribution of *S. luteus.*

High temperatures. The highest temperatures were registered during the dry season (October–March). This dryness inhibited the fructification of *S. luteus* in spite of the fact that high temperatures are favorable to the appearance of the carpophores (Binyamini, 1980) and mycorrhizal activity (Theodorou and Bowen, 1971). Nonetheless, occasional rains registered in summer caused the fructification of *S. luteus* in clay soil (Chaimávida locality). These carpophores were more voluminous and of a better quality than the fall carpophores. The optium growth of *S. luteus* occurred in fall, since the maximum rainfall was registered during this season (43% of annual total). The mean temperatures oscillated between 11 to 14ºC in the different localities and the soil absolute maximum temperatures varied from 12 to 26ºC in Loma Colorada, 9.5 to 27ºC in Chaimávida and 7 to 17ºC in Monte Aguila.

Low temperatures. The low winter temperatures (soil minimum absolute –0.5ºC in Chaimávida and Loma Colorada, and –2ºC in Monte Aguila), have detrimental effects on the appearance of *S. luteus* and other mycorrhizal fungi *(Russula, Amanita)* producing the rupture of the carpophores and an interrupcion of mycelial activity.

Soil moisture. The soil moisture is closely related to the soil type and the amount of rainfall registered. In sandy soil *S. luteus* was absent from October to April due to the low soil moisture, since these soils are very permeable. The clay soil, with greater capacity of retention of water, allows the appearance of *S. luteus* during the dry season after a 3–4 day period of rain. This actually occurred in summer 1980 in Chaimávida,

[1]These measurements represent extreme values registered from March 1979 until August 1979.

[2]Values of 0,2 – 1,5 km/hr in non pruned forests and 0,3 – 9 km/hr in pruned forests, and 0,4 – 20 km/hr in pruned and thinned forests were registered, in the different stands.

where the rainfall registered caused *S. luteus, Tricholoma fagnani, Lactarius deliciosus* and *Russula sardonia* to appear.

These species grow more quickly than in autum because of the high temperatures. The good quality of the fungus would lead one to suggest emphasizing a summer production of *S. luteus* through artificial irrigation in clay soils.[1]

Soil pH. The pH in *Pinus radiata* forests oscillates (see graphs 1, 2, 3), but there is a tendency towards acidity of pH 4–6, which is optimal for the growth of Agaricales (Bohus and Babos, 1960; Theodorou and Bowen, 1969; Manachere, 1978). The fine debris near the base of the trees is more acidic (pH 4.30 to 5.20) than in the periphery (pH 5.40 to 6.30) where large branches and larger debris predominate. These pH values are relatively constant under normal rainfall conditions, but in the dry season the soil pH tends to be higher (especially in the case of sandy soil where it may reach pH 8). The higher pH decreases mycorrhizal activity (Theodorou and Bowen, 1969; Bowen and Theodorou, 1973) and would favor bacterial and animal activity (Manachere, 1978).

Biotic factors

Pine plantations

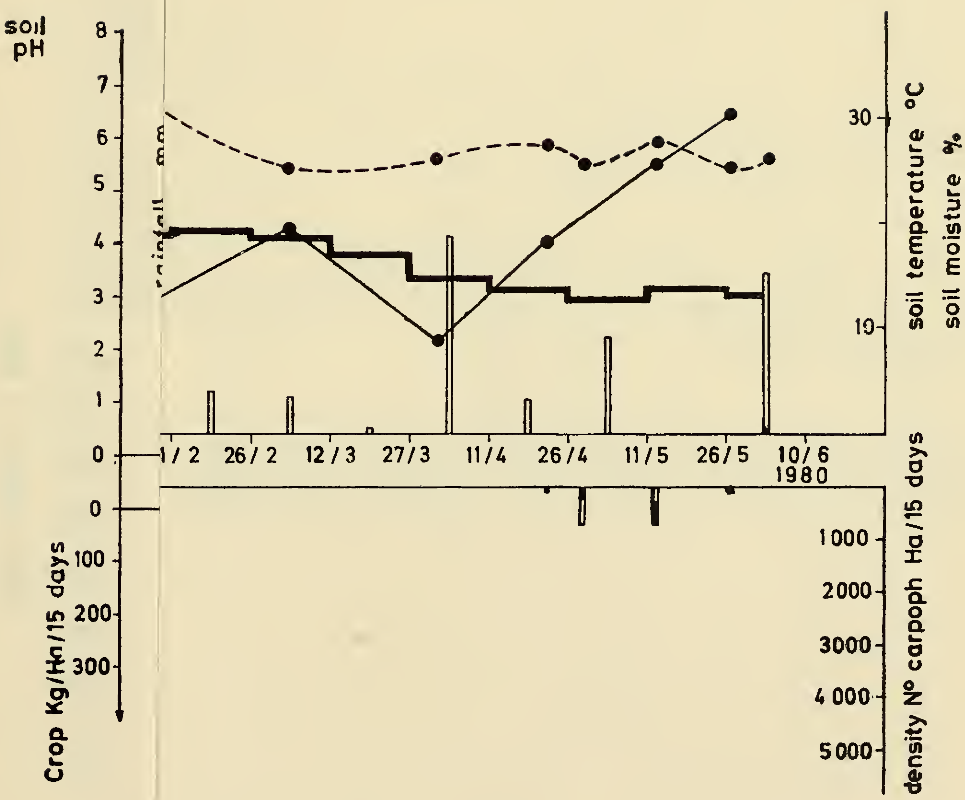
Age. Arboreal foliage plays an important role in the transmission of electromagnetic radiation (Odum, 1972). The foliage prevents (according to the age and management of the forests) the transmission of light and heat to the floor. In closed plantations *S. luteus* and other mycorrhizal fungi are non–existent, probably because of the absence of UV light.

Density. The arboreal density has an identical effect as does age on the density and growth of *S. luteus* due to the arboreal cover effect. *S. luteus* seems to have a maximum crop in forests of 5 to 20 years with a density of 2,500 to 800 trees/ha, respectively.

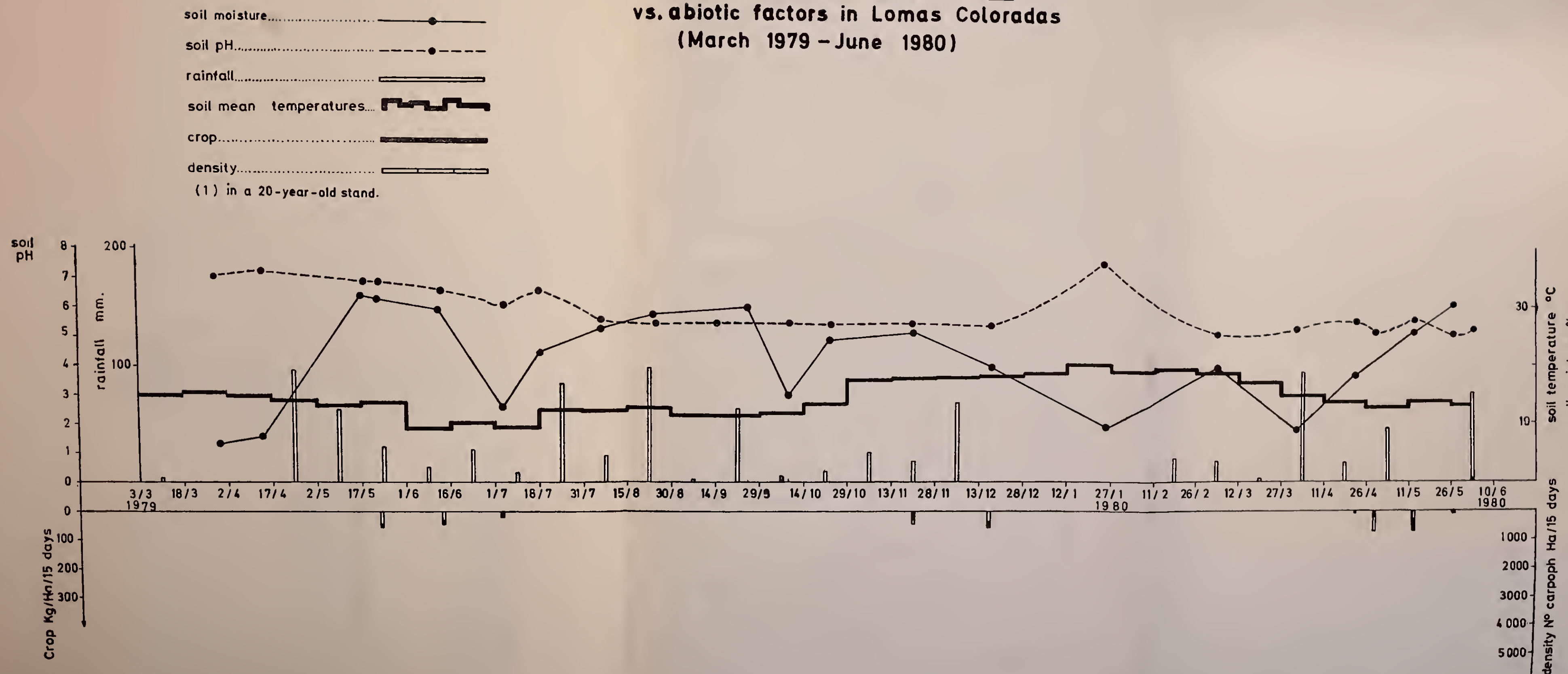
Pruning and thinning. These practices are important in mature forests because they increase the crop of *S. luteus.* Crops of this fungus and other ectomycorrhizal macroagaricales are low in forests not subjected to these management practices. Mycorrhizal Cortinariaceae such as *Cortinarius, Inocybe* and *Astrosporina* were dominant in pine stands which were neither pruned nor thinned.

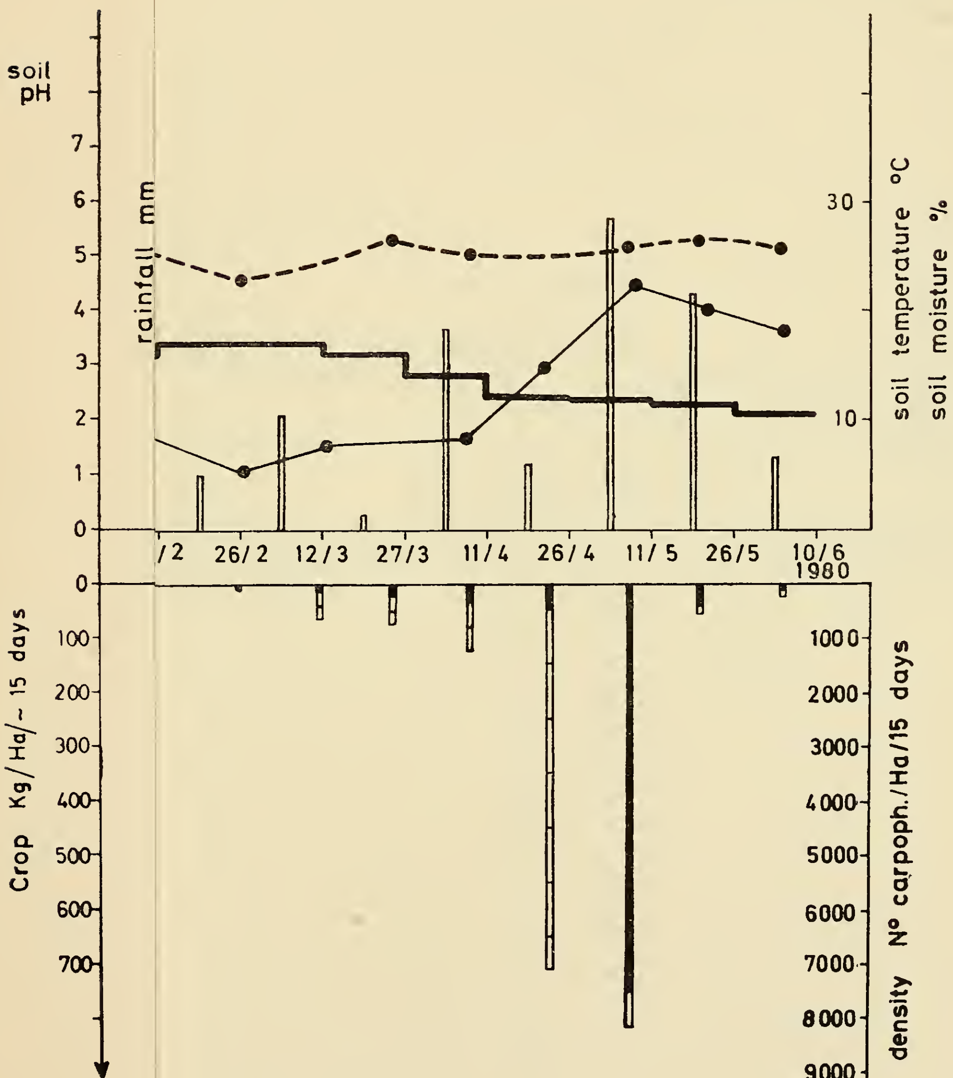
Flora in the plots. In plantings with a poor herbaceous stratum mixed with blackberry (see appendix), an important increase in the crop of *S. luteus* was produced. In addition, in forests with *Rubus ulmifolius*

[1]In summer, young carpophores of *S. luteus* (velum enclosed) as much as 10 cm in diam. pileus, absence of parasite and with a more pleasant smell and odor similar to *Boletus edulis* L. ex Fr.

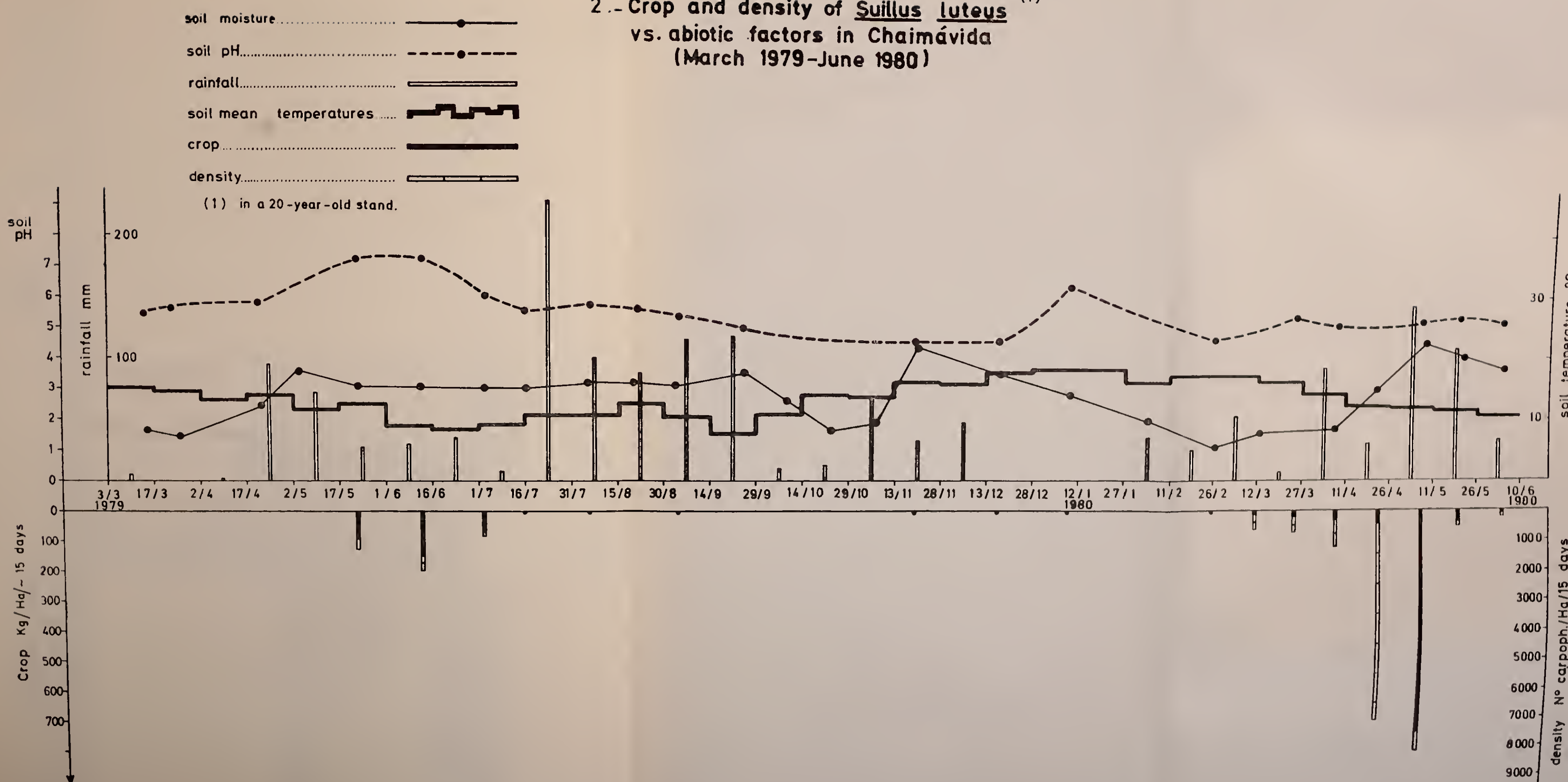

soil pH
8
7
6
5
4
3
2
1
0
0
100
200
300
Crop Kg/Ha/15 days
1/2
26/2
12/3
27/3
11/4
26/4
11/5
26/5
10/6
1980
30
19
soil temperature °C
soil moisture %
1000
2000
3000
4 000
5 000
density Nº carpoph Ha/15 days

1.- Crop and density of <u>Suillus luteus</u> (1) vs. abiotic factors in Lomas Coloradas (March 1979 - June 1980)

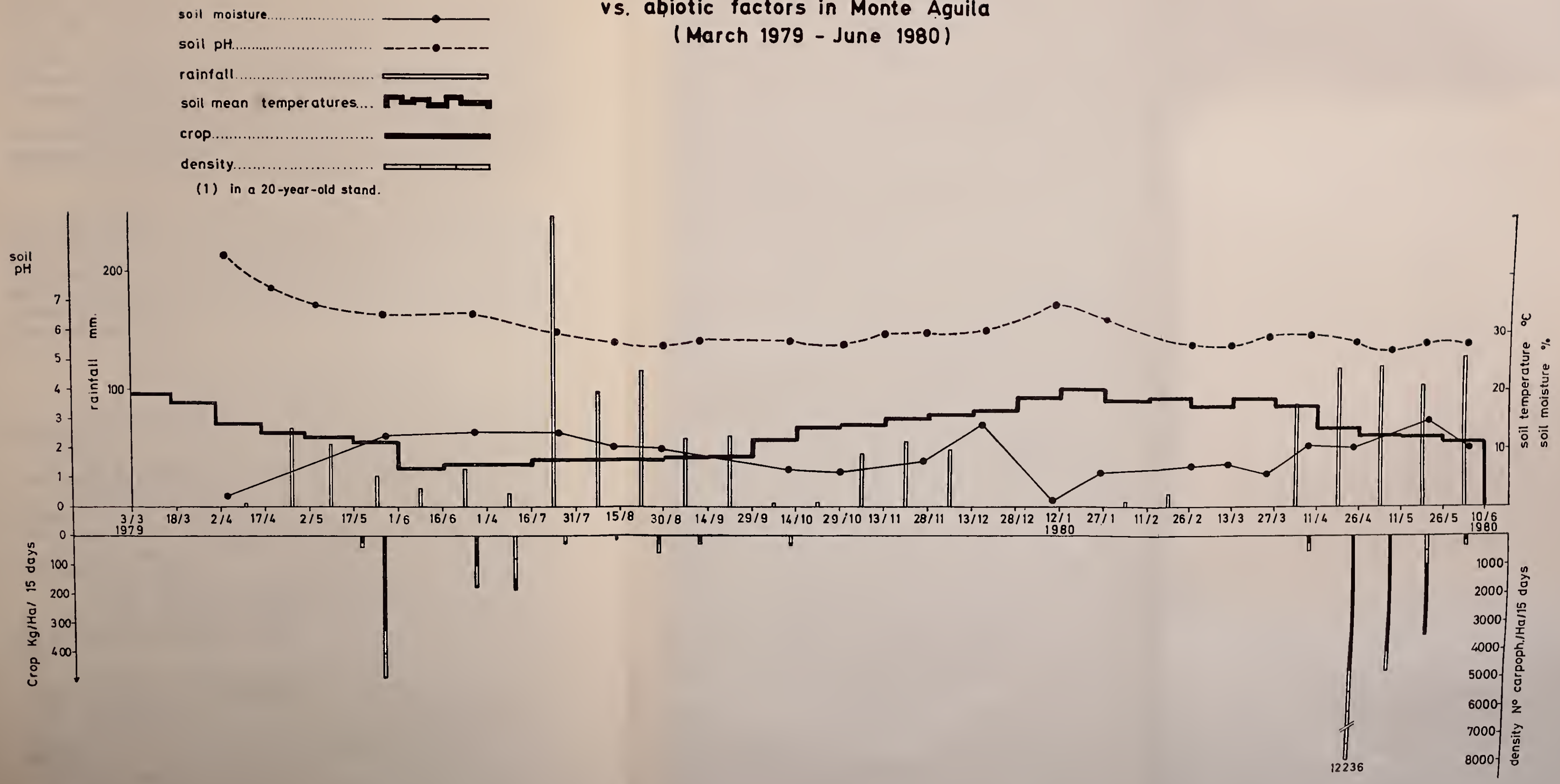



soil pH
rainfall mm
soil temperature °C
soil moisture %
Crop Kg/Ha/~ 15 days
density N° carpoph./Ha/15 days
/2
26/2
12/3
27/3
11/4
26/4
11/5
26/5
10/6
1980
0
1
2
3
4
5
6
7
10
30
100
200
300
400
500
600
700
1000
2000
3000
4000
5000
6000
7000
8000
9000

2.- Crop and density of *Suillus luteus* [1] vs. abiotic factors in Chaimávida (March 1979–June 1980)



3.- Crop and density of Suillus luteus [1] vs. abiotic factors in Monte Aguila (March 1979 - June 1980)



and/or *R. constrictus* it is easy to find early and later carpophores of *S. luteus*. This is probably due to the greater humidity conserved by the scrub cover. Also, in stands with a good development of a herbaceous stratum, a decrease in the crop of *S. luteus* and other mycorrhizal fungi is produced. Spores may arrive, but grass roots may inhibit germination (Bowen and Theodorou, 1973). Malajczuk and Lamont (1981) show that certain grasses, which are endotrophic, are toxic to ectomycorrhizal fungi.

Other fungi, the saprophytic fungi *Mycena pseudoalnicola* Sing. and *Collybia subhybrida* Sing., seem to play an important role in the appearance of *S. luteus*. These saprophytic fungi fruit in patches with the first rains. Later on *S. luteus* grows abundantly in these patches.

Anthropogenic and domestic animals action. In addition to the effects of pruning and thinning, man and domestic animals, especially cattle, hogs, and horses play an important role when they trample and generally disturb the litter or soils. These actions alter or injure the growing carpophores or mycelia. These alterations produce a reduction in the density and growth of *Suillus*, which may oscillate in extreme cases between 60 to 100% since this fungus prefers non–disturbed ecosystems (Slipp and Snell, 1944).

CONCLUSIONS AND RECOMMENDATIONS

The optimal season for collection of *S. luteus* in the Bío - Bío area is April to June at the onset of persistent rainfall (see graphs 1, 2, 3 and table 1).

Monte Aguila was the locality with the greatest crop (more than 1,200 Kg/ha/season 1980).

Chaimávida also presented a large crop (approximately 1,000 Kg/ha/season 1980). In this locality the crop was havested throughout most of the year.

Loma Colorada presented the smallest crop of the 3 localities (152 Kg/ha/season 1980).

In sandy soils the collection can be made only until October.

In open forests (those pruned or thinned) located in clay soils (i. e. Chaimávida) with *Rubus ulmifolius* and/or *R. constrictus* it is possible to collect *Suillus luteus* in summer after a more or less intense rainfall.

In winter *S. luteus* is absent due to low temperatures and great rainfall, but other mycorrhizal macroagaricales more adapted to these conditions are dominant.

The greatest *S. luteus* crop was observed in young nonpruned stands up to 10 years of age and in pruned and thinned stands up to 20 years of age.

The collection must always be carried out along permanent paths in order to reduce the injury to carpophores or the mycelium.

S. luteus is a dominant species in non–disturbed habitats.

S. luteus crop may be increased by irrigation in stands located in clay soils.

Table Nº I

SUMMARY OF THE CROP AND CLIMATE CONDITIONS*

Crop (density)	Kg[1] (Nº carpoph.) /Ha/ season		Kg (Nº carpoph.)/Ha/ month Maximum		Dormancy period winter		Climate conditions	1979				1980	
Locality	1979[2]	1980[3]	1979	1980	1979	1980		Summ.	Fall	Wint.	Spr.	Summ.	Fall
Monte Aguila	746.1 (9965)	1276.4 (18442)	347 - June (5353)	504 - Apr. (12742)	Jul.-Aug.	Jun.-Aug.	rainfall mm	2	249.7	505.5	157.4	14.6	562.6
							soil tºC means	18.2	11.6	8.0	14.3	18.4	12.7
Chaimávida	388.7 (6171)	907.3 (19044)	155.9 - June (1995)	747.2 - May. (8874)	Jul.-Aug.	Jun.-Aug	rainfall mm	4.4	236.1	666.4	170.4	117.0	448.0
							soil tºC means	14.9	11.2	9.9	14.5	17.0	12.0
Lomas Colorada	163.2	105.4	55 - May.	71.2 - May.	Jul.-Aug.	Jun.-Aug	rainfall	4.2	228.1	427.7	124.7	37.7	419.7
							soil tºC means	15.8	12.1	11.5	15.3	18.6	13.5

[1]Fresh weight (water % of the carpophores 86–92%)
[2]March to December
[3]January to June
[4]Only March included.

*In a 20–years–old stand.

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REFERENCES

Atlas Regional, 1976. Chile. VIII Región. Concepción. 23 pp., 1 mapa.

Binyamini, N., 1980. Succession of Israeli agaric flora. Nova Hedwigia 32: 185–198.

Bouh, G. & M. Babos, 1960. Coenology of terricolous macroscopic fungi of deciduous forests. Bot. Jahrb. Syst., 80(1): 1–100.

Bowen, G. & C. Theodorou, 1973. Groth of ectomycorrhizal fungi around seeds and roots. *In* Marks & Kozlowski (eds.). Ectomycorrhizal their ecology and physiology. New York, London, pp. 107–150.

Chu–Chou, M., 1979. Mycorrhizal fungi of *Pinus radiata* in New Zealand. Soil Biol. Biochem., 11: 557–562.

Cidere Bío - Bío, 1979. 13ª Memoria anual. Concepción. 24 pp.

Fuenzalida, H., 1965. Biogeografía económica de Chile. Texto refundido. Corfo. Santiago. pp. 228–267.

Hajek, F. & F. Di Castri, 1975. Bioclimatología de Chile (Manual de consulta). 6, 1, 107 pp. Dirección de Investigación Vice–Rectoría Académica. Universidad Católica de Chile.

Hepting, G., 1971. Diseases of forests and shade trees of the United States. USDA Forest Serv. Handb. 386: 1–658.

Instituto de Recursos Naturales, 1964. Suelos. Publ. 2. Descripciones proyecto aerofotogramétrico. Chile. OEA, BID, Santiago.

Jackson, M. L., 1964. Análisis químico de suelos. Barcelona. 662 pp.

Kalamees, K., 1968. Mycoenological methods based on investigations in the Estonian forests. Acta Mycol., 4(2): 327–335.

Kalamees, K., 1971. Some methodological aspects of Mycoenology. Estonian Contr. Int. Biol. Programme (Tartu), 2: 33–46.

Khan, A. G., 1972. Mycorrhizae and their significance in plant nutrition. Biologia (Lahore). Special suppl. 42–72.

Malajczuk. N. & B. Lamont, 1981. Specialized roots of symbiotic origin in heathlands. *In* Specht, R. (ed.) Heathlands and related shrublands of the world. B. Analytical studies. Amsterdam. pp. 165–182.

Manachere, G., 1978. Morphogenese des carpophores de Basidiomycetes supérieurs. Rev. Mycol. (Paris), N. S. 42: 191–251.

Odum, E., 1972. Ecología. 3ª ed. México. 639 pp.

Peyronel, B., 1956. Considerazioni sulle micocenosi del suolo e sui metodi per studiarle. Allionia 3: 85–109.

Pisano, E., 1956. Esquema de clasificación de las comunidades vegetales de Chile. Agronomía (Santiago), 2(1): 30–33.

Slankis, V., 1971. Formation of ectomycorrhizae of forest trees in relation to light, carbohydrates and auxins. Hacskaylo, E. (ed.). Mycorrhizae. USDA Forest Serv., Misc. Publ. 1189: 1–255.

Slipp, A. W. & W. Snell. 1944. Taxonomic–ecologic studies of the Boletaceae in northern Idaho and adjacent Washington. Lloydia, 7(1): 1–65.

Theodorou, C. & G. C. Bowen, 1969. The influence of pH and nitrate on mycorrhizal associations of *Pinus radiata* D. Don. Austral. J. Bot., 17(1): 59–67.
associations of *Pinus radiata* D. Don. Austral. J. Bot., 17(1): 59–67.

Theodorou, C. & G. C. Bowen, 1971. Influence of temperature of the mycorrhizal association of *Pinus radiata* D. Don. Austral. J. Bot., 19: 13–20.

Trappe, J., 1962. Fungus associates of ectotrophic mycorrhizae. Bot. Rev. (Lancaster), 28: 538–606.

Zinke, P. J., 1962. The pattern of influence of individual forest trees on soil properties. Ecology, 43(1): 130–133.

APPENDIX

Floral Composition in the plots

1. *Trees*	Lomas Colorada	Chaimávida	Monte Aguila
A: *Aristotelia chilensis* (Mol.) Stuntz		X	
Crytocarya alba (Mol.) Looser		X	
Luma apiculata (DC.) Burret		X	
Nothofagus obliqua (Mirbel) Oerst.		X	
Peumus boldus Mol.	X		
Sophora macrocarpa J. E. Sm.		X	
I: *Pinus radiata* D. Don	X	X	X
Populus nigra L. cv. *Italica*			X
2. *Shrubs*			
A: *Baccharis linearis* (R. et P.) Pers.	X		X
Baccharis racemosa (R. et P.) DC.	X	X	
Berberis trigona Kunze et P. et E.	X		
Chusquea sp.		X	
Margyricarpus pinnatus (Lam.) O. K.	X		
Ribes punctatum R. et P.		X	
Schinus polygamus (Cav.) Cabr.	X		
I: *Lupinus arboreus* Sims	X		
Rosa eglanteria L.	X	X	X
Rubus constrictus P. J. Muell. et Lefevre	X	X	X
Rubus ulmifolius Schott		X	
Teline monspessulana (L.) C. Koch		X	
3. *Herbs*			
Dicotyledons			
A: *Acaena argentea* R. et P.		X	
Conyza chilensis Spreng.			X
Geranium berterianum Colla	X	X	
Geranium commutatum Steud.		X	
Oenothera stricta Ledeb. ex Link	X	X	
I: *Anthemis arvensis* L.	X		
Cirsium vulgare (Savi) Tenore	X	X	X
Crepis capillaris (L.) Wallr.	X	X	
Daucus carota L.	X	X	

	Lomas Colorada	Chaimávida	Monte Aguila
Echium vulgare L.	X		X
Hypericum perforatum L.		X	X
Hypochaeris glabra L.			X
Hypochaeris radicata L.	X	X	X
Lactuca serriola L.			X
Linum usitatissimum L.	X		
Lobelia tupa L.		X	
Ornithopus compressus L.	X		
Petrorhagia prolifera (L.) P. W. Ball et Heyw.	X		X
Plantago lanceolata L.	X	X	X
Prunella vulgaris L.		X	
Rumex acetosella L.	X		X
Rumex conglomeratus Murr.	X		
Sanguisorba minor Scop.		X	X
Senecio vulgaris L.	X		
Silene gallica L.	X		X
Sonchus asper (L.) J. Hill	X		
Trifolium arvense L.			X
Verbascum virgatum Stokes	X		X
Verbena bonariensis L.			X
Monocotyledons			
A: *Alstroemeria* sp.	X		
Bomarea salsilla (L.) Herb.		X	
A: *Chascolytrum subaristatum* (Lam.) A. N. Desv.	X		
Dioscorea reticulata Gay		X	
Herbertia lahue (Mol.) Goldbl.	X		
Hippeastrum chilense (L'Hérit.) Baker	X		
Nassella exserta Phil.		X	
Piptochaetium montevidense (Spreng.) Parodi	X		
Piptochaetium sp.		X	
Sporobolus poiretii (Roem. et Schult.) Hitch.			X
Stipa filiculmis Del.	X		
Stipa poeppigiana Trin. et Rupr.	X		
I: *Agrostis* sp.	X	X	
Aira caryophyllea L.			X
Avena fatua L.	X		X
Bromus mollis L.	X		
Briza maxima L.	X		

	Lomas Colorada	Chaimávida	Monte Aguila
Cynosurus echinatus L.	X		X
Cyperus laetus Presl.		X	
Cyperus vegetus Willd.	X		
Holcus lanatus L.	X	X	
Imperata sp.			X
Lagurus ovatus L.	X		
Paspalum dilatatum Poir.			X
4. *Climbers*			
A: *Cissus striata* R. et P.		X	
Muehlenbeckia hastulata (J. E. Sm.) Johnst.	X	X	
5. *Cryptogams*			
A: *Adiantum chilense* Kaulf.		X	
A: *Blechnum hastatum* Kaulf.		X	
I: Mosses		X	X

A: *Natural* I: *Introduced*