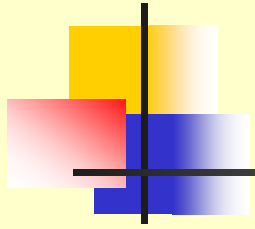


Status of the genera *Phytophthora* and *Pythium* in Argentina

H.E. Palmucci, S.M. Wolcan, P.E. Grijalba

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CIC, Research Center of Phytopathology, UNLP Argentina*





Stramenopila

Genera *Phytophthora* and *Pythium*

In order to have a more comprehensive vision of these fungi, a review and updating of recent progress in this matter in Argentina was carried out.



Materials and Methods

Information was taken from printed sources

- ***primary***: proceedings of national and international Scientific Meetings; Bulletins from National Institutions and Universities, Journals and books.
- ***secondary***: data bases and on ***line sources***.



Data bases

- AGRIS 1991-2001
- CABPESTCD 1973-1988
CABPESTCD 1989-1999/05
- CABPESTCD 2000/01-2001/02

On line sources



- EBSCO Journal Service (2008)

<http://web.ebscohost.com/>

- Cab, Biological Abstracts, Food Science & Tech. Abstracts (2008)

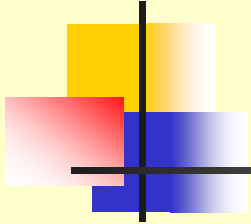
<http://web5.silverplatter.com/webspirs>

- Crossref - ScienceDirect (2008)

<http://www.sciencedirect.com/>

- Scopus (2008)

<http://www.sciencedirect.com/>



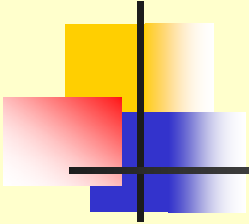
- Results of records of Plant Pathology Laboratories from 1920 to 1950 taken from Phytopathological Atlas of Argentina (Atlas Fitopatológico de Argentina = www.fitopatoatlas.org.ar)



Results

- Information was analyzed and categorized.
- An inventory was brought up to date about:
 - * number of species of both genera
 - * geographical distribution
 - * hosts affected
 - * races, sp. nov. described
 - * economic damages
 - * research topics

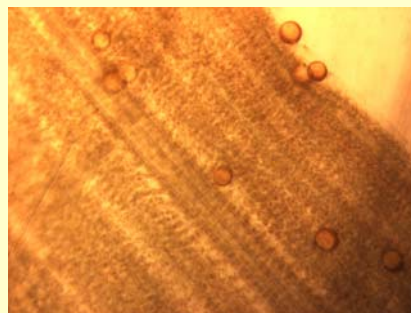
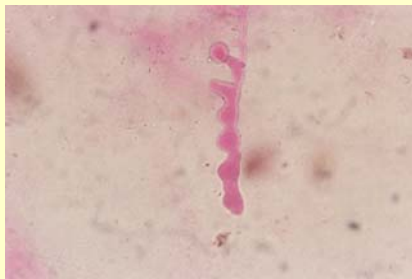
Pythium spp



More than 150 species in the world

The first species reported in Argentina was *Pythium ultimum* in 1937 infecting *Beta vulgaris* and *Brassica oleraceae*

To date: 17 *Pythium* species have been reported
on 235 hosts

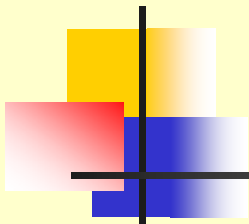




Genus *Pythium*

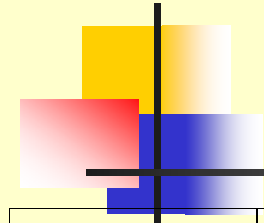
1. *P. acanthicum* Drechsler
2. *P. aphanidermatum* (Edson) Fitzp
3. *P. catenulatum* V.D. Matthews
4. *P. debaryanum* R. Hesse
5. *P. dissotocum* Drechsler
6. *P. graminicola* Subraman
7. *P. intermedium* de Bary
8. *P. irregulare* Buisman
9. *P. mastophorum* Drechsler
10. *P. oligandrum* Drechsler
11. *P. periplocum* Drechsler
12. *P. polymorphon* Sideris
13. *P. rostratum* E.J. Butler
14. *P. spinosum* Sawada
15. *P. torulosum* Coker & P. Patt.
16. *P. ultimum* Trow
17. *P. vexans* de Bary

The results were presented using tables, maps and graphics.



SPECIES	HOST	SYMPTOMS	PROVINCE	REFERENCES
<i>P. aphanidermatum</i> (Edson) Fitzp.	<i>Pisum sativum</i>	Root rot	Cba.	Frezzi, 1956
	<i>Fragaria vesca</i>	Root rot	Cba.	Frezzi, 1956
	<i>Beta vulgaris</i>	Damping off	Cba.	Frezzi, 1956
	<i>Capsicum annuum</i>	Root rot and necrosis stem Damping off	Cba, Sal.	Frezzi, 1956
	<i>Cereus aethiops</i>	Root rot and necrosis stem	Cba	Frezzi, 1956
	<i>Citrullus lanatus</i>	Fruit rot Brown	Cba.	Frezzi, 1956
	<i>Cucumis melo</i>	Fruit rot	Cba.	Frezzi, 1956, 1977
	<i>Cucúrbita .máxima</i>	Fruit rot	Cba.	Frezzi, 1956, 1977
	<i>Cucúrbita pepo</i>	Root rot	Cba.	Frezzi, 1956
	<i>Euphorbia marginata</i>	Root rot	Cba.	Frezzi, 1956
	<i>Medicago sativa</i>	Damping off	B A.	Frezzi, 1977
	<i>Melia azedarach</i>	Root rot, Damping off	Cba.	Frezzi, 1956
	<i>Morus alba</i>	Damping off	Cba.	Frezzi, 1956
	<i>Phaseolus vulgaris</i>	Root rot and necrosis stem , fruit rot	Cba.	Frezzi, 1956
	<i>Euphorbia pulcherrima</i>	Stem and root rot	Bs As.	Palmucci and Grijalba, 2007

Geographical distribution

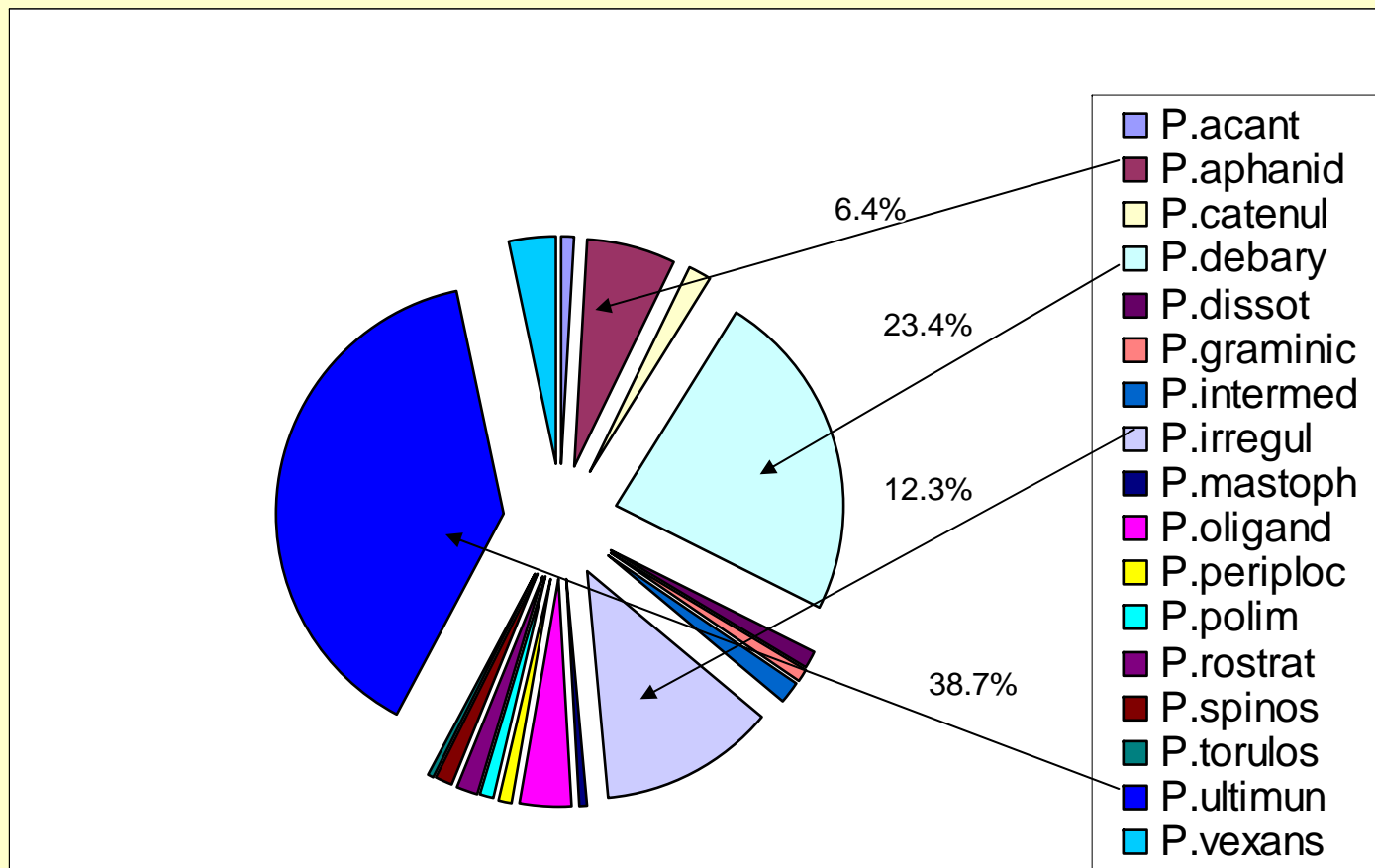


	Juj	Sal	Tuc	Cat	SE	Mis	Cha	Ctes	ER	SF	Fsa	Cba	Mza	LR	SL	SJ	BA	LP	RN	Chu	SC	Neu	TF IM	Prov/sp
<i>P. acanthicum</i>												X												1
<i>P. aphanidermatum</i>		X										X					X							3
<i>P. catenulatum</i>												X						X						2
<i>P. debaryanum</i>	X		X			X		X	X	X	X	X		X	X		X	X	X	X				14
<i>P. dissotocum</i>	X	X										X												3
<i>P. graminicola</i>												X												1
<i>P. intermedium</i>			X			X						X												3
<i>P. irregulare</i>			X									X			X		X							4
<i>P. mastophorum</i>												X												1
<i>P. oligandrum</i>												X	X											2
<i>P. periplocum</i>												X			X									2
<i>P. polymorphon</i>			X									X												2
<i>P. rostratum</i>												X												1
<i>P. spinosum</i>			X									X												2
<i>P. torulosum.</i>						X																		1
<i>P. ultimum</i>	X	X	X			X		X	X		X	X	X	X			X		X		X		X	14
<i>P. vexans</i>						X		X				X												3
<i>sp/provinces</i>	3	3	6	-	-	5	-	3	2	1	2	16	2	2	3	-	4	2	2	1	1	-	1	

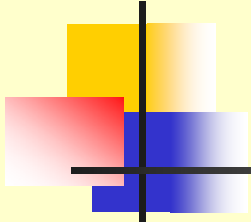
Groups of crops affected by the different *Pythium* spp

<i>Pythium</i> spp	HOSTS	HORTICULTURAL CROPS	ORNAMENTAL CROPS	FOREST CROPS	FRUIT CROPS	FODDER CROPS	OLEAGINOUS/ INDUSTRIAL CROPS	CEREALS	PALMS
<i>P. acanthicum</i>	2	1					1		
<i>P. aphanidermatum</i>	15	9	3	2		1			
<i>P. catenulatum</i>	4	4							
<i>P. debaryanum</i>	55	14	23	9	3	2	3	1	
<i>P. dissotocum</i>	3	2	1						
<i>P. graminicola</i>	2		1				1		
<i>P. intermedium</i>	4	2		1	1				
<i>P. irregulare</i>	29	11	8	5		2	2	1	
<i>P. mastophorum</i>	2	2							
<i>P. oligandrum</i>	8	3	3		1		1		
<i>P. periplocum</i>	2	1							1
<i>P. polymorphon</i>	3	1		1		1			
<i>P. rostratum</i>	3	1		1		1			
<i>P. spinosum</i>	3	2	1						
<i>P. torulosum.</i>	1			1					
<i>P. ultimum</i>	91	20	25	33	2	3	7	1	
<i>P. vexans</i>	8	1	5	2					

Percentage of *Pythium* species found in Argentina



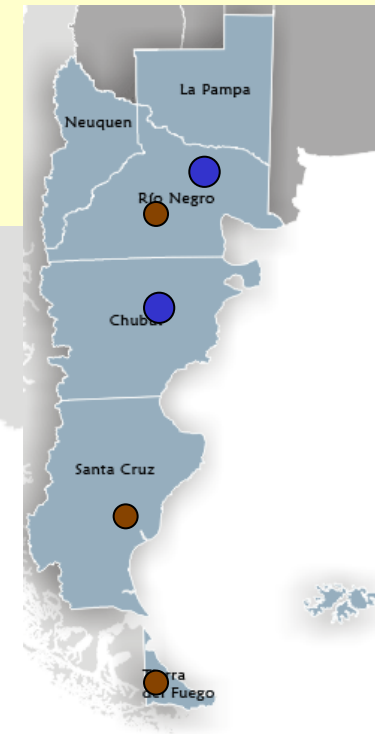
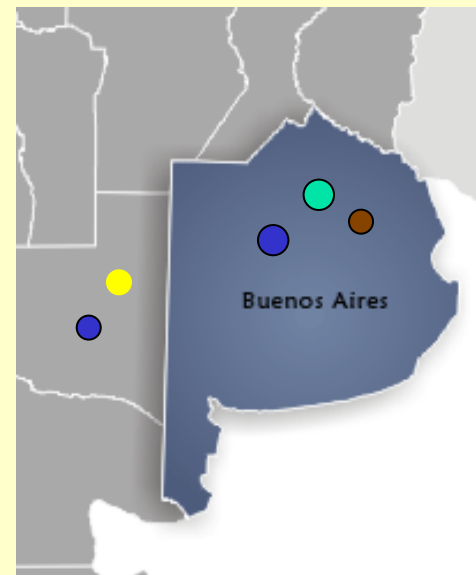
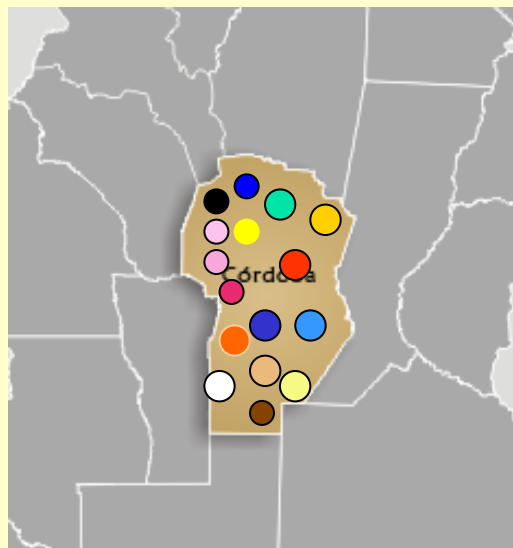
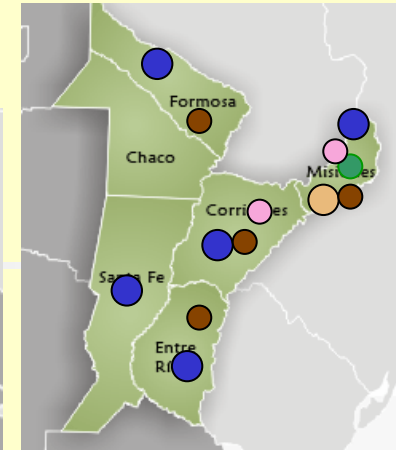
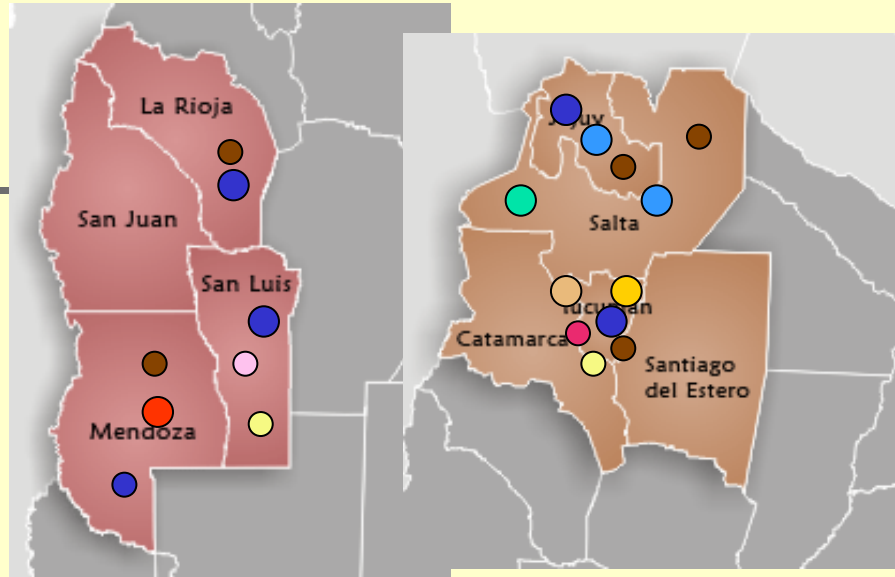
Species most affecting the hosts



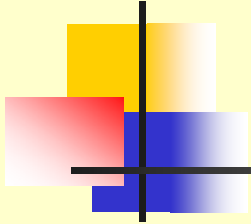
<i>P. ultimum</i>	<ul style="list-style-type: none">• Horticultural crops• Ornamental crops• Industrial crops• Forest crops
<i>P. debaryanum</i>	<ul style="list-style-type: none">• Horticultural crops• Forest crops <p>(Fruit rot in <i>Cucurbitaceae</i> in post harvest <i>Ipomea batata</i>, <i>Arachis hypogea</i>)</p>
<i>P. irregulare</i>	<ul style="list-style-type: none">• Ornamental crops• Horticultural crops <p><i>Arachis hypogea</i>, <i>Nicotiana tabacum</i></p>
<i>P. aphanidermatum</i>	<ul style="list-style-type: none">• Horticultural crops <p>(Fruit rot in <i>Cucurbitaceae</i>)</p>

Regional maps show the distribution of *Pythium* spp

<i>Pythium</i> spp	
<i>P. acanthicum</i>	Blue
<i>P. aphanidermatum</i>	Green
<i>P. catenulatum</i>	Yellow
<i>P. debaryanum</i>	Dark Blue
<i>P. dissotocum</i>	Light Blue
<i>P. graminicola</i>	White
<i>P. intermedium</i>	Orange
<i>P. irregulare</i>	Light Orange
<i>P. mastophorum</i>	Black
<i>P. oligandrum</i>	Red
<i>P. periplocum</i>	Light Pink
<i>P. polymorphon</i>	Yellow
<i>P. rostratum</i>	Orange
<i>P. spinosum</i>	Pink
<i>P. torulosum</i>	Green
<i>P. ultimum</i>	Brown
<i>P. vexans</i>	Pink



Phytophthora spp



This genus includes more than 100 species in the world

The first plant disease caused by *Phytophthora* in Argentina was reported at the end of 1800's.

Up to date 18 species have been determined on 180 hosts.



Genus *Phytophthora*

- 
-
1. *P. austrocedrae* Gresl. & E.M. Hansen
 2. *P. boehmeriae* Sawada
 3. *P. cactorum* (Lebert & Cohn) J. Schröt
 4. *P. cambivora* (Petri) Buisman
 5. *P. capsici* Leonian
 6. *P. cinnamomi* R.D. Rands
 7. *P. citricola* Sawada
 8. *P. citrophthora* (R.E.Sm .& E.H. Sm.) Leonian
 9. *P. cryptogea* Pethybr. & Laff
 10. *P. drechsleri* Tucker
 11. *P. gonapodyides* (H:E. Petersen) Buisman
 12. *P. infestans* (Mont.) de Bary
 13. *P. medicaginis* E.M. Hansen & D.P. Maxwel
 14. *P. megasperma* Drechsler
 15. *P. nicotianae* Breda de Hann
 16. *P. nivea* Thaxter
 17. *P. palmivora* (E.J. Butler) E.J. Butler
 18. *P. sojae* Kufm. & Gerd.

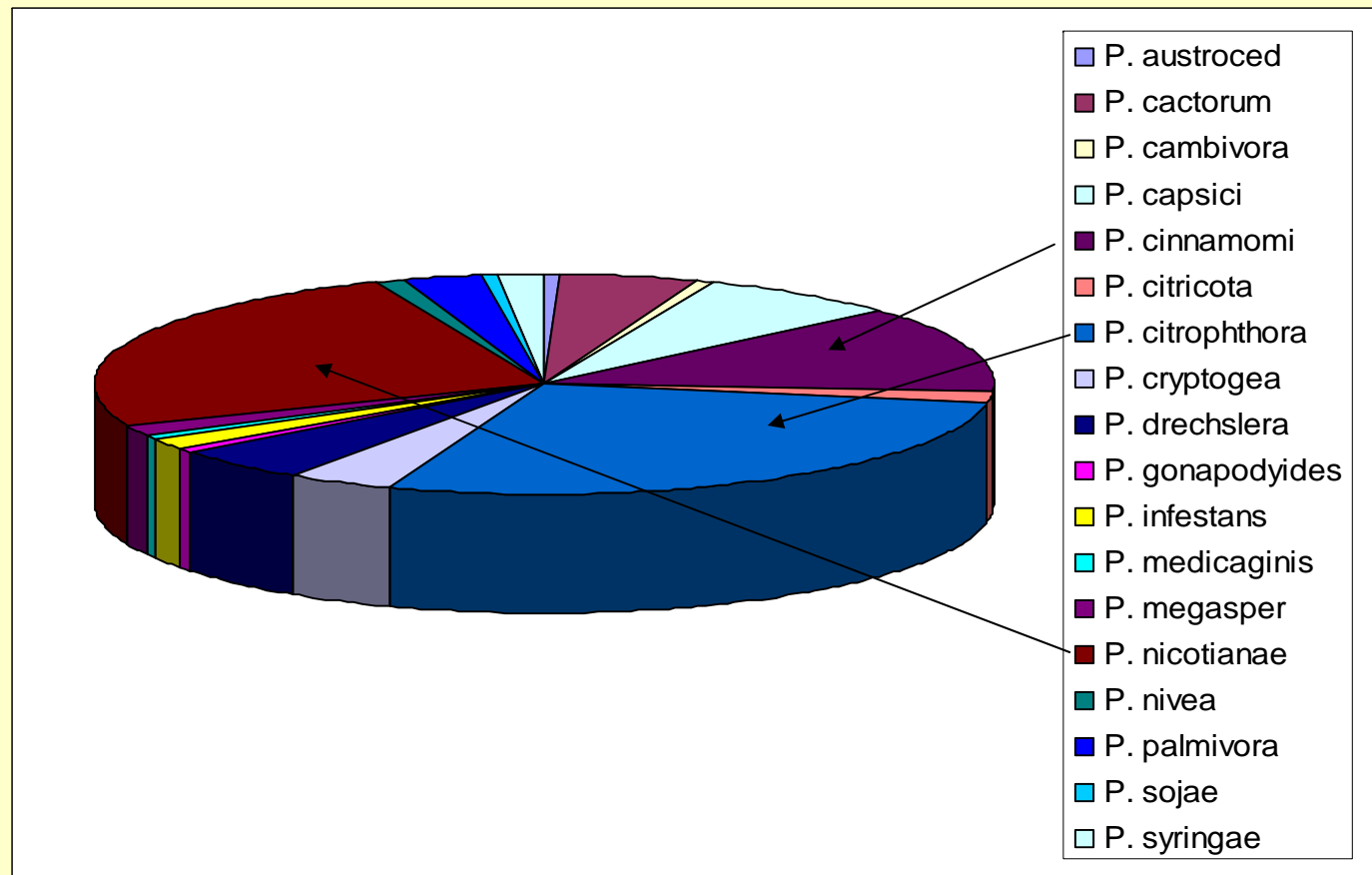
Results for *Phytophthora cinnamomi*

HOST	CROP	SYMPTOMS	PROVINCE	REFERENCES
<i>P. cinnamomi</i> R.D. Rands	<i>Azalea sp</i>	Root rot	BA	Frezzi, 1977
	<i>Calycanthus floridus</i>	Root and stem rot	CbA	Frezzi, 1977
	<i>Casuarina sp.</i>	Stem and collar canker	BA	Frezzi, 1977
	<i>Casuarina cunningamiana</i>	Root and basal stem rot, cankers	ER	Palmucci et al, 2008
	<i>Cupressus sp</i>	Root rot	Cba	Frezzi, 1977
	<i>Echeveria sp</i>	Root rot	Cba	Frezzi, 1977
	<i>Eucalypts rostrata</i>	Root rot and died	Cba	Frezzi, 1977
	<i>Iresine sp</i>	Root rot	Cba	Frezzi, 1977
	<i>Juglans regia</i>	crown rot	Juj	Alcoba et al, 2005
	<i>Ligustrum lucidum</i>	Root rot	Cba	Frezzi, 1950, 1977
	<i>Persea americana</i>		Cba, Sta, Juj, Tuc	Frezzi, 1952, 1977; Alcoba et al., 2005
	<i>Phaseolus lunatus</i>	Seed and fruit necrosis	Cba	Frezzi, 1950; 1977
	<i>Pinus radiata</i>	Root rot	Cba	Frezzi, 1950; 1977.
	<i>Pittosporum tobira</i>	Root rot	Cba	Frezzi, 1977
	<i>Platanus orientalis</i>	Root rot	BA	Frezzi, 1950; 1977
	<i>Prunus persica</i>	Root and crown rot	BA	Frezzi, 1977
	<i>Rhododendron sp</i>			
	<i>Salix caprea</i>			
	<i>Schinus molle</i>			
	<i>Sedum sp</i>			
<i>Spiraea cantoniensis</i>	Root rot	Cba	Frezzi, 1950; 1977	
<i>Rubus idaeus</i>	Root and crown rot	BA	Paganini, 2004	
<i>Thuja sp</i>				
<i>Vaccinium corymbosum</i>	Root and crown rot	Sta, Tuc.	Hongn et al, 2003; Hongn, 2005; Wright et al, 2005	

Groups of crops affected by the different *Phytophthora* spp

<i>Phytophthora</i> spp	HOSTS	VEGETABLE CROPS	ORNAMENTAL CROPS	FOREST CROPS	FRUIT CROPS	FODDER CROPS	OLEAGINOUS/ INDUSTRIAL CROPS	CEREAL CROPS	PALMS
<i>P. austrocedrae</i>	1	-	-	1	-	-	2	-	-
<i>P. cactorum</i>	9	-	-	-	7	-	2	-	-
<i>P. cambivora</i>	1	-	-	1	-	-	-	-	-
<i>P. capsici</i>	13	10	1	-	2	-	-	-	-
<i>P. cinnamomi</i>	23	1	9	10	3	-	-	-	-
<i>P. citricola</i>	3	-	-	3	-	-	-	-	-
<i>P. citrophthora</i>	50	6	10	16	17	-	-	-	1
<i>P. cryptogea</i>	7	2	2	1	1	-	1	-	-
<i>P. drechslera</i>	9	2	6	1	--	-	-	-	-
<i>P. gonapodyides</i>	1	-	-	1	-	-	-	-	-
<i>P. infestans</i>	3	3	-	-	-	-	-	-	-
<i>P. medicaginis</i>	1	-	-	-	-	1	-	-	-
<i>P. megasperma</i>	3	-	-	-	3	-	-	-	-
<i>P. nicotianae</i>	45	8	16	6	11	-	4	-	-
<i>P. nivea</i>	2	2	-	-	-	-	-	-	-
<i>P. palmivora</i>	5	-	-	-	2	-	1	-	2
<i>P. sojae</i>	1	-	-	-	-	1	-	-	-
<i>P. syringae</i>	3	-	-	1	2	-	-	-	-

Percentage of *Phytophthora* species found in Argentina

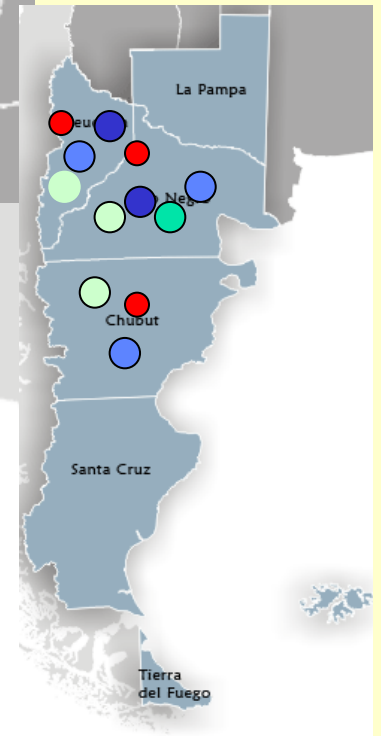
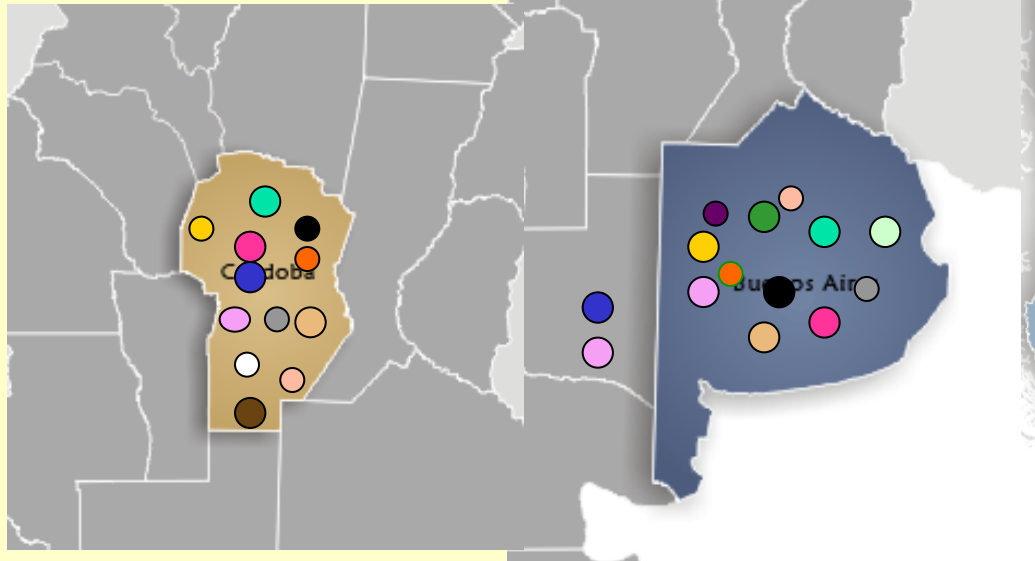
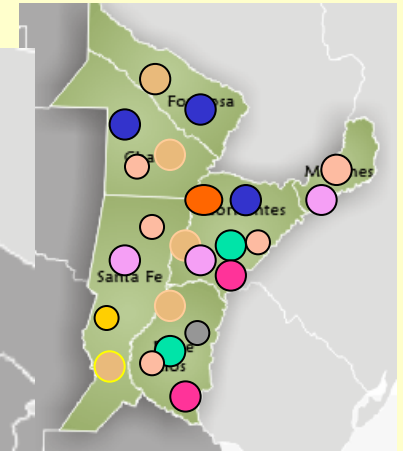
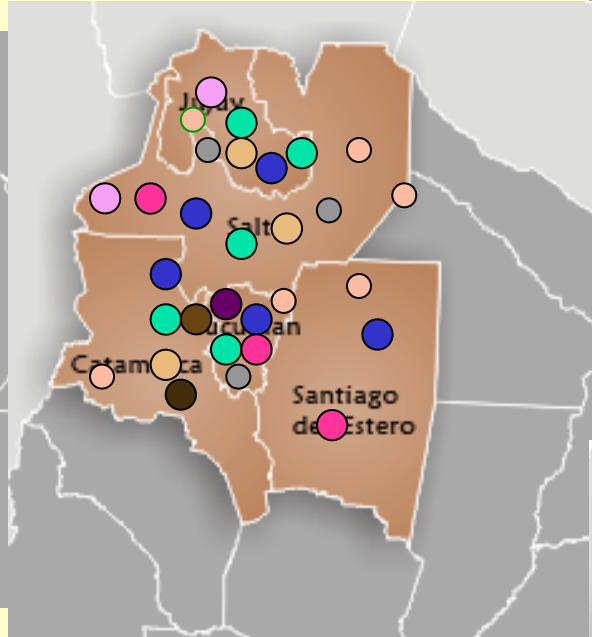
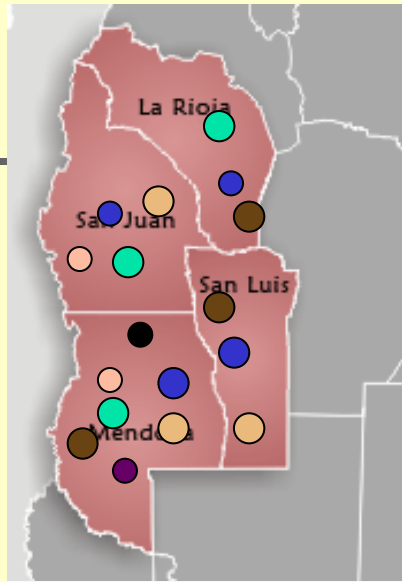


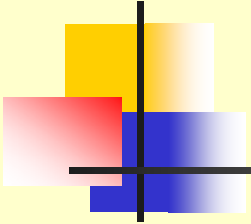
Geographical distribution of *Phytophthora* spp

<i>Phytophthora</i> spp	Juj	Sal	Tuc	Cat	SE	Mis	Cha	Ctes	ER	SF	Fsa	Cba	Mza	LR	SL	SJ	BA	LP	RN	Prov. /sp
<i>P. austrocedreae</i>																			X	1
<i>P. cactorum</i>	X	X	X	X				X	X			X	X	X		X	X		X	12
<i>P. cambivora</i>																			X	1
<i>P. capsici</i>	X	X	X	X	X		X	X			X	X	X	X	X	X	X	X	X	16
<i>P. cinnamomi</i>	X	X	X						X			X					X			6
<i>P. citricola</i>												X								1
<i>P. citrophthora</i>	X	X		X			X	X	X	X	X	X	X		X	X	X			13
<i>P. cryptogea</i>			X										X				X			3
<i>P. drechsleri</i>												X	X				X			3
<i>P. gonapodyides</i>																			X	1
<i>P. infestans</i>	X	X	X	X	X	X	X	X	X	X		X	X			X	X			14
<i>P. medicaginis</i>										X		X					X			3
<i>P. megasperma</i>								X				X					X			3
<i>P. nicotianae</i>		X	X		X			X	X			X					X			7
<i>P. nivea</i>																	X			1
<i>P. palmivora</i>			X	X				X				X	X	X		X				7
<i>P. sojae</i>		X	X			X			X	X		X					X	X		8
<i>P. syringae</i>																	X		X	2
<i>sp/Prov.</i>	5	7	8	5	3	2	3	7	6	4	2	12	7	3	2	5	13	2	6	

Regional maps showing the distribution of *Phytophthora* spp

<i>Phytophthora</i> spp	
<i>P. austrocedreae</i>	Blue
<i>P. cactorum</i>	Cyan
<i>P. cambivora</i>	Yellow
<i>P. capsici</i>	Light Green
<i>P. cinnamomi</i>	Grey
<i>P. citricola</i>	White
<i>P. citrophthora</i>	Tan
<i>P. cryptogea</i>	Purple
<i>P. drechsleri</i>	Black
<i>P. gonapodyides</i>	Red
<i>P. infestans</i>	Light Orange
<i>P. medicaginis</i>	Dark Blue
<i>P. megasperma</i>	Orange
<i>P. nicotianae</i>	Pink
<i>P. nivea</i>	Green
<i>P. palmivora</i>	Brown
<i>P. sojae</i>	Pale Pink





Most of the work done on *Pythium* and *Phytophthora* correspond to work of morphological identification and pathogenicity.

In the crops with a greater economic importance in the country, like soybean and potato, the investigations included work on resistance, races and different control techniques.



Phytophthora sojae



First cited in 1970's by Hartwig

1989 to 1992 → Race 1

1993 to 1997 → race 1 (prevalent), race 4 reported (Santa Fe province), but 24% of the isolates presented virulence formulas that could not be classified as previously described

During 1997-1998 → 53 % isolates race 1, but an increasing variability in pathogenicity was observed

P. sojae is a highly variable pathogen in Argentina and so far many new races have been detected that will be reported for the first time in Argentina (Barreto et al., unpublished).



Phytophthora infestans

Resistance

Lorenzo Lamattina et al. (IIB).Universidad Nacional del Mar del Plata. Biochemical and molecular studies related with host defence.

Micheletto-S; Andreoni-M; Huarte-MA

Vertical resistance to late blight in wild potato species.

Argentinian wild diploid *Solanum* species as sources of quantitative late blight resistance

Races and Mating type

Calderoni, 1966 → race 1,4

Bazán y Segura (1968) → races 3 and 4.

Van Damme y Ridao (1994) → Mating type **A1 y A2** and different virulence formulas (e.g.: 1,4 - 1,3,4,7,11)

Chemical control

Mantecon-JD; Escande-AR AD: Exp. Balcarce, INTA, Argentina
Effectiveness of systemic and non-systemic fungicides..

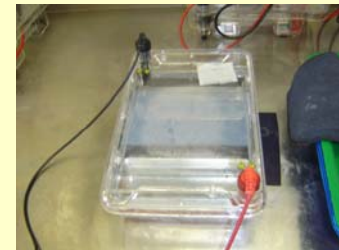
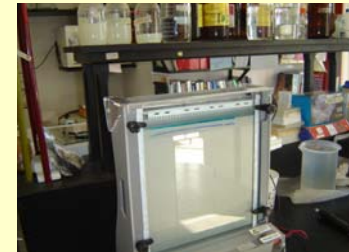


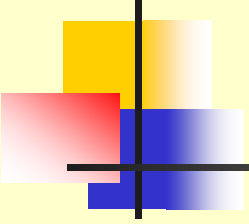
***Phytophthora* sp. nov. described**

- ***Phytophthora austrocedrae* sp. nov.**, a new species associated with *Austrocedrus chilensis* mortality in Patagonia (Argentina) 2007. Greslebin et al.

Molecular Characterization

- Before 2000 taxonomic identification = morphological and physiological characterization.
- Since 2000 some of the diagnoses were complemented with molecular techniques (e.g.):
 - *P. sojae* on soybean
 - *P. infestans* on potato
 - *P. palmivora* on olivo
 - *P. austrocedrae* on *Austrocedrus chilensis*
 - *P. nicotianae* on dieffembachia
 - *P. cinnamomi* on casuarina





Frezzi, Mariano J.

- Argentine pathologist from Cordoba province.
- Considered a referent by Argentine researchers.

Frezzi, M.J. 1956. *Especies de Pythium fitopatógenas identificadas en la República Argentina*. Rev. de Investigaciones Agrícolas. Vol. 10 (2): 113-241. Eds. INTA.

Frezzi, M.J. 1977. *Especies del género Pythium y Phytophthora fitopatógenas identificadas en Argentina*. Boletín. Eds., Serie Didáctica 2. Inst. de Cs Agronómicas. UNCb. 96pp.

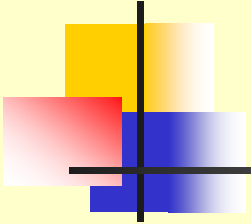
Frezzi, M.J. 1950. *Las especies de Phytophthora en la Argentina*. Rev. investig. agric. Vol. 4 (1): 47-133. Eds. INTA.



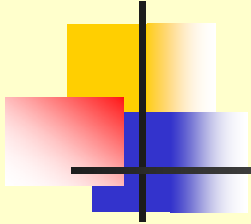
Conclusions

This revision allowed an updating of the situation of these genera. The hosts, location and symptoms. 17 species of *Phythium* and 18 of *Phytphtora* have been cited.

1. A wider variety of pathogens have not even been diagnosed
2. It is necessary for the different teams to join forces and effort to research these pathologies.
3. All this information will be used as the basis for a Survey of *Phytophthora* and *Pythium* in Argentina integrating morphological and molecular methods.



- **This complete work (including the tables) will be published next year in the magazine of the Argentine Botanic Society (www.botanicargentina.com.ar)**
- **Now we have to confirm: 1) the validity or not of the host-pathogen relations cited. 2) The existence of living isolates and we have form a good collection**



MUCHAS GRACIAS

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