

STATUS OF THE PYTHIACEAE (STRAMINIPILA) IN ARGENTINA

I. THE GENUS *PYTHIUM*

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Summary: The genus *Pythium* (Pythiaceae (Peronosporomycetes - ex Oomycetes), Kingdom Straminipila) includes important pathogens, affecting a wide range of hosts of economic value, causing damping-off and decline of herbaceous and wooded plants due to rootlets rot. In order to acquire a more comprehensive vision of *Pythium* in Argentina, a review and an updated report of recent progress in this matter was carried out since the first reports in the late XIX century till October 2009. Information was taken from printed and on line primary and secondary sources such as Proceedings of national and international Scientific Meetings, Bulletins from National Institutions and Universities, periodical Journals, books and data bases. The information was analyzed and categorized, thus updating the number of species of this genus, their geographical distribution, hosts affected, and symptoms. So far 18 species have been cited affecting, 247 hosts. The greatest number of hosts is affected by *P. ultimum* and *P. debaryanum*, followed by *P. irregulare* and *P. aphanidermatum*. The diversity of *Pythium* species in the world suggests that perhaps a wider variety of species, still not cited, could be present in Argentina. Projects dedicated to surveying the presence and identification of *Pythium* spp are necessary.

Key words: Pythiaceae, *Pythium*, Straminipila Kingdom, Oomycetes = Peronosporomycetes, Hosts, Argentina.

Resumen: Status de la familia Pythiaceae (Reino Straminipila) en Argentina. I. El género *Pythium*. El género *Pythium* (Pythiaceae (Peronosporomycetes-ex Oomycetes), Straminipila) incluye patógenos que afectan hospedantes de importancia económica, ocasionando damping off en pre y postemergencia de plántulas de almácigo y el declinamiento de plantas herbáceas y adultas por destrucción de las raíces absorbentes. Con la finalidad de conocer el estado actual de la información disponible sobre este género en Argentina, se llevó a cabo una revisión desde los primeros reportes a fines del siglo XIX hasta octubre de 2009. Se consultaron fuentes primarias y secundarias de información escrita y electrónica: presentaciones en congresos nacionales e internacionales, publicaciones periódicas nacionales e internacionales, boletines de instituciones y universidades, libros y bases de datos. La información obtenida fue categorizada y analizada permitiendo conocer el número de especies de este género, su distribución geográfica y por tipo de cultivos, relaciones hospedante-patógeno involucradas y la sintomatología observada. Se encuentran citadas 18 especies que afectan a 247 hospedantes. Un elevado número de hospedantes fueron afectados por *P. ultimum* y *P. debaryanum*, seguidos por *P. irregulare* y *P. aphanidermatum*. La diversidad de especies de *Pythium* en el mundo sugiere que un mayor número de especies podrían estar presentes en el país, siendo necesario su relevamiento e identificación.

Palabras clave: Pythiaceae, *Pythium*, Reino Straminipila, Oomycetes = Peronosporomycetes, hospedantes, Argentina.

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INTRODUCTION

The genus *Pythium* (Peronosporomycetes-ex Oomycetes) was previously considered a real fungus. Later, it was reclassified and relocated in the Straminipila Kingdom (Gunderson *et al.*, 1987; Patterson, 1989; Förster *et al.*, 1990, Dick, 2001), mainly due to the characteristics of the cellular wall composition – cellulose and beta glucans instead of chitin (Bartnicki-Garcia, 1969) - and the presence of heterokontes spores with two flagella (Van der Plaats-Niterinck, 1981) which allow the zoospores to swim in liquid media. So far, 160 species of *Pythium* have been described (Abad *et al.*, 2006; Abad, 2008).

Members of the genus *Pythium* are soil-inhabiting organisms that occur all over the world. They are, however, most commonly encountered in cultivated soils causing serious problems for various agronomically important crops. Some species are ubiquitous and occupy various ecological niches, being, most of them, saprotrophic and are present in different soil types and aquatic environments (Van der Plaats-Niterinck, 1981). Some others are important plant pathogens, with various degrees of pathogenicity, which can affect many different plants, or be host specific (Frezzi, 1956; Van der Plaats-Niterinck, 1981).

Plant pathogenic *Pythium* species can cause destructive diseases to thousands of plant species. They affect mainly seedbeds of different crops causing seed rot, seedling damping-off, and, occasionally, they cause root rot of different types of adult plants. Young or watery plant tissue is preferentially attacked. Soft, fleshy organs of vegetables in contact with the soil, such as cucurbit fruits, green beans, and potatoes, are sometimes infected by damping-off Oomycetes during extended wet periods (Frezzi, 1956; Van der Plaats-Niterinck, 1981).

The development of *Pythium* is favored by deficient soil drainage, high proportion of clay and poor air circulation among plants. The conditions of high humidity and free water facilitate the spread of zoospores. This characteristic of the fungus makes it responsible for important phytosanitary problems mainly in the intensive crops that utilize organic substrates or hydroponic systems (George & Biernbaum, 1990; Stanghellini & Rasmussen,

1994; Schnitzler, 2004; Hong & Moorman, 2005). The introduction of the inoculum in the crop may be due to infected soil, substrates, tools, irrigation water or seeds. Oospores are resistant to adverse temperatures and moisture and serve as the survival and resting stage of the fungus (Shokes & Carter, 1979; Pickett-Popoff & Panter, 1994; Martin & Loper, 1999; Sutton *et al.*, 2006).

In the last decade, developments in molecular (nucleic acid-based) diagnostic methods have made significant improvements in the detection of plant pathogens (Munford *et al.*, 2006) and phylogenetic studies have allowed a greater knowledge of the species and their populations (Briard *et al.*, 1995; Matsumoto *et al.*, 1999; Martin, 2000; Van de Peer *et al.*, 2000). Various authors (Guindon & Gascuel, 2003; Lévesque & De Cock, 2004; Paul *et al.*, 2008) have introduced modifications in the way the species are grouped, defining different clusters.

The aim of our work was to carry out a revision of the findings of the genus *Pythium* affecting cultivated plants registered so far in Argentina.

MATERIAL AND METHOD

The information was taken from: a) printed and electronical primary sources such as Proceedings of National and International Scientific Meetings, Bulletins from National Institutions and Universities and periodical Journals, and b) printed and electronical secondary sources such as 'Atlas e Índice de Enfermedades de Plantas Cultivadas y Nativas Explotadas de Argentina' (Nome *et al.*, 2009) and data bases, such as CAB and Biological Abstracts.

In this review only the records of *Pythium* spp. affecting plants were taken into account. Species from water, soil, animals and man were discarded for the present review.

Information was analyzed and categorized. An inventory was brought up to date about number of species of *Pythium*, geographical distribution in the country and natural and cropped affected hosts.

RESULTS

According to the result of this review, the first species reported in Argentina was *Pythium ultimum*

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in 1937 infecting *Beta vulgaris* and *Brassica oleraceae* (Frezzi, 1947). The most important research was carried out by Frezzi, who studied, between the years 1937 and 1956, the only 17 species known in the country till the finding of *P. tracheiphillum* by Kiehr *et al.*, 2000. Frezzi (1956) mentions a group which he calls *Pythium cf. ultimum* (latin: *conferre* = close to), in which he places those unconfirmed strains like *P. ultimum* without sexual structures. *P.cf. ultimum* was found causing damping off on *Nicotiana tabacum* (Buenos

Aires province), on *Pinus* sp (Mendoza and Santa Cruz), on *Cedrus* sp. (Mendoza), on *Prosopis alba* (Córdoba) and *Picea excelsa* (Tierra del Fuego).

To date 18 identified species have been reported in Argentina on 248 host-pathogen relations (Table 1).

Pythium ultimum and *P. debaryanum* are the species that affect the greatest number of hosts, followed by *P. irregulare* and *P. aphanidermatum*. Other species affect 1 to 9 hosts (Table 1 and Fig. 1).

Table 1: *Pythium* spp. cited in Argentina: host pathogen relations, symptoms and localities where they were recorded. Records of unidentified *Pythium* species are presented under *Pythium* spp.

Species	Hosts	Symptoms	Proviences ¹	References
<i>P. acanthicum</i> Drechsler	<i>Arachis hypogaea</i>	Fruit rot and root	Cba	Tello <i>et al.</i> , 2002
	<i>Citrullus lanatus</i>	Fruit and root rot	Cba	Frezzi, 1956
<i>P. aphanidermatum</i> (Edson) Fitzp	<i>Allium cepa</i>	Asymptomatic or root rot	BA	Kiehr <i>et al.</i> , 2002
	<i>Amaranthus caudatus</i>	Root, collar and fruit rot	Ctes	Noelting & Sandoval, 2003
	<i>Allium schoenoprasum</i>	Root and basal rot	Ctes	Colombo <i>et al.</i> , 2005
	<i>Beta vulgaris</i>	Damping off	Cba	Frezzi, 1956
	<i>Capsicum annuum</i>	Root rot and necrosis stem / Damping off	Cba, Sal, Ctes	Frezzi, 1956, Colombo <i>et al.</i> , 2005
	<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
	<i>Cucurbita maxima</i>	Fruit rot, basal rot	Cba, Ctes	Frezzi, 1956, Colombo <i>et al.</i> , 2005
	<i>Cucurbita pepo</i>	Root rot	Cba	Frezzi, 1956
	<i>Euphorbia marginata</i>	Root rot	Cba	Frezzi, 1956
	<i>Euphorbia pulcherrima</i>	Root and stem rot	BA	Palmucci & Grijalba, 2007
	<i>Fragaria vesca</i>	Root rot	Cba	Frezzi, 1956
	<i>Medicago sativa</i>	Damping off	BA	Frezzi, 1977, Ostazeski & Hijano, 1986
	<i>Melia azedarach</i>	Root rot, Damping off	Cba	Frezzi, 1956
	<i>Morus alba</i>	Damping off	Cba	Frezzi, 1956
	<i>Ocimum basilicum</i>	Basal rot	Ctes	Colombo <i>et al.</i> , 2005
	<i>Phaseolus vulgaris</i>	Root rot and necrosis stem , fruit rot	Cba	Frezzi, 1956
	<i>Pisum sativum</i>	Root rot	Cba	Frezzi, 1956
	<i>Solanum melongena</i>	Basal rot	Ctes	Colombo <i>et al.</i> , 2005
<i>P. catenulatum</i> V.D. Matthews	<i>Capsicum annuum</i>	Damping off, root rot	Cba	Frezzi, 1956
	<i>Cyamopsis tetragonoloba</i>	Damping off, root rot	Cba	Frezzi, 1956
	<i>Solanum lycopersicum</i>	Damping off	LP	Frezzi, 1956
	<i>Solanun melongena</i>	Damping off	LP	Frezzi, 1956
<i>P. debaryanum</i>	<i>Alternanthera</i> sp	Root rot	Tuc	Frezzi, 1956

Species	Hosts	Symptoms	Proviencas ¹	References
R. Hesse	<i>Antirrhinum majus</i>	Root rot	Cba	Frezzi, 1956
	<i>Arachis hypogaea</i>	Fruit and seed rot, root rot	Cba	Frezzi, 1956, 1960
	<i>Arachis pusilla</i>	Root rot	Cba	Frezzi, 1956
	<i>Ageratum sp</i>	Root rot	Cba	Frezzi, 1956
	<i>Brachichiton acerifolius</i>	Damping off	Cba	Frezzi, 1956
	<i>Brassica napus</i>	Root rot	Cba	Frezzi, 1956
	<i>Caesalpinia gilliesii</i>	Damping off	Cba	Frezzi, 1956
	<i>Capsicum annum</i>	Damping off	ER	Frezzi, 1956
	<i>Calendula officinalis</i>	Damping off	Tuc	Frezzi, 1956
	<i>Carica papaya</i>	Damping off	Cba	Frezzi, 1956
	<i>Celosia cristata</i>	Damping off	Cba	Frezzi, 1956
	<i>Cercis siliquastrum</i>	Damping off	Cba	Frezzi, 1956
	<i>Cicer arietinum</i>	Root rot	Chu	Frezzi, 1956
	<i>Citrullus lanatus</i>	Brown Fruit rot, damping off cottony leak	Cba	Frezzi, 1956
	<i>Clarkia sp</i>	Damping off	Tuc	Frezzi, 1956
	<i>Cucumis melo</i>	Damping off, fruit rot	Cba	Frezzi, 1956
	<i>Cucumis sativus</i>	Damping off	Cba	Frezzi, 1956
	<i>Cucurbita máxima</i>	Stem and fruit rot	Cba	Frezzi, 1956
	<i>Erythrina crista galli</i>	Root and stem rot in potted plant	Cba	Frezzi, 1956
	<i>Eucalyptus sideroxylon</i>	Damping off	Cba	Frezzi, 1956
	<i>Gaillardia pulchella</i>	Root rot	Cba	Frezzi, 1956
	<i>Gysophila paniculata</i>	Damping off	Cba	Frezzi, 1956
	<i>Helianthus annuus</i>	Root and base stem rot	Cba	Frezzi, 1956
	<i>Hordeum vulgare</i>	Root rot ,Damping off	Fsa	Frezzi, 1956
	<i>Ipomea batatas</i>	Root and fruit rot	Cba, Ctes, BA	Frezzi, 1956, Colombo et al. 1993
	<i>Lathyrus cicera</i>	Root rot	Cba	Frezzi, 1956
	<i>Lathyrus odoratus</i>	Root rot	Cba	Frezzi, 1956
	<i>Lathyrus pubescens</i>	Root rot	Cba	Frezzi, 1956
	<i>Lathyrus tingitanus</i>	Root rot	Cba	Frezzi, 1956
	<i>Ligustrum lucidum</i>	Damping off	Cba	Frezzi, 1956
	<i>Limonium sp</i>	Root and stem rot	Cba	Frezzi, 1956
	<i>Luffa cylindrica</i>	Damping off	Cba	Frezzi, 1956
	<i>Solanum lycopersicum</i>	Damping off	Cba, LP, Tuc, Mis, Juj	Frezzi, 1956
	<i>Matthiola sp</i>	Damping off	Tuc	Frezzi, 1956
	<i>Medicago sativa</i>	Damping off	Cba	Frezzi, 1956, Ostazeski & Hijano, 1986
	<i>Melilotus indicus</i>	Root rot	Cba	Frezzi, 1956
	<i>Morus alba</i>	Damping off	Cba	Frezzi, 1956
	<i>Nicotiana tabacum</i>	Damping off	Tuc	Delle Coste, 1945
	<i>Parthenium argentatum</i>	Damping off	Cba	Frezzi, 1956
	<i>Phaseolus vulgaris</i>	Fruit rot, stem and root rot	Cba, Chu	Frezzi, 1956
	<i>Pinus excelsa</i>	Damping off	RN	Frezzi, 1956
	<i>Pinus halepensis</i>	Damping off	Cba, ER, LR	Frezzi, 1956
	<i>Pinus pinea</i>	Damping off	SL	Frezzi, 1956
	<i>Pinus radiata</i>	Damping off	RN	Frezzi, 1956
	<i>Pyrus sylvestris</i>	Damping off	RN	Frezzi, 1956
	<i>Pisum sativum</i>	Root rot, damping off, seed rot	Cba	Frezzi, 1956
	<i>Prosopis alba</i>	Damping off	Cba	Frezzi, 1956
	<i>Salvia splendens</i>	Damping off	Cba	Frezzi, 1956
	<i>Schinus molle</i>	Damping off	Cba	Frezzi, 1956
	<i>Solanun melongena</i>	Damping off	LP	Frezzi, 1956

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	<i>Solanum tuberosum</i>	Brown fruit rot	Cba, SF	Frezzi, 1956
	<i>Thuja sp</i>	Damping off	Cba	Frezzi, 1956
	<i>Thuja occidentalis</i>	Damping off	Cba	Frezzi, 1956
	<i>Zinnia sp</i>	Damping off	Cba	Frezzi, 1956
<i>P. dissotocum</i> Drechsler	<i>Gladiolus communis</i>	Root necrosis	Sal	Frezzi, 1956
	<i>Solanum lycopersicum</i>	Damping off	Juj	Frezzi, 1956
	<i>Morus alba</i>	Damping of	Cba	Frezzi, 1956
<i>P. graminicola</i> Subraman.	<i>Maranta arundinacea</i>	Root rot in potted plant	Cba	Frezzi, 1956
	<i>Saccharum officinarum</i>	Root rot	Tuc	Vazquez de Ramallo, 1985
<i>P. intermedium</i> de Bary	<i>Capsicum annuum</i>	Damping off	Cba	Frezzi, 1956
	<i>Solanum lycopersicum</i>	Damping off	Tuc	Frezzi, 1956
	<i>Morus alba</i>	Damping off	Cba	Frezzi, 1956
	<i>Piptadenia rigida</i>	Damping off	Mis	Frezzi, 1956
<i>Pythium irregulare</i> Buisman	<i>Alternanthera sp</i>	Root rot	Tuc	Frezzi, 1956
	<i>Arachis hypogaea</i>	Fruit and seed rot	Cba	Frezzi, 1956, 1960, Tello et al., 2002
	<i>Avena sativa</i>	Root rot, seedling blight	Cba	Frezzi, 1956
	<i>Camellia thea</i>	Root and fruit rot	Mis	Frezzi, 1977
	<i>Cupressus lusitanica</i>	Damping off	Tuc	Frezzi, 1956
	<i>Cynara scolymus</i>	Root rot	Cba, BA	Frezzi, 1956, Carranza, 1979
	<i>Daucus carota</i>	Damping off brown rot and forking	Cba	Frezzi, 1956
	<i>Dianthus caryophyllus</i>	Damping off	Tuc	Frezzi, 1956
	<i>Eruca sativa</i>	Damping off	Cba	Frezzi, 1956
	<i>Erythrina crista-galli</i>	Root necrosis	Cba	Frezzi, 1956
	<i>Eucalyptus occidentales</i>	Damping off	Cba	Frezzi, 1956
	<i>Foeniculum vulgare</i>	Damping off	Cba	Frezzi, 1956
	<i>Gaillardia aristata</i>	Damping off	Tuc	Frezzi, 1956
	<i>Gypsophila sp</i>	Damping off	Tuc	Frezzi, 1956
	<i>Hordeum vulgare</i>	Root and fruit rot	Cba	Frezzi, 1956
	<i>Lactuca sativa</i>	Damping off	Cba	Frezzi, 1956
	<i>Lupinus sp.</i>	Damping off	Cba	Frezzi, 1956
	<i>Solanum lycopersicum</i>	Damping off	Tuc	Frezzi, 1956
	<i>Medicago sativa</i>	Damping off	Cba	Frezzi, 1956
	<i>Nicotiana tabacum</i>	Damping off	Cba	Frezzi, 1956
	<i>Petroselinum crispum</i>	Damping off	Cba	Frezzi, 1956
	<i>Phaseolus vulgare</i>	Root rot	Cba	Frezzi, 1956
	<i>Phoenix dactylifera</i>	Damping off	SL	Frezzi, 1956
	<i>Pinus halepensis</i>	Damping off	Cba	Frezzi, 1956
	<i>Pisum sativum</i>	Root rot	Cba	Frezzi, 1956
	<i>Solanum melongena</i>	Damping off	Tuc	Frezzi, 1956
	<i>Sorghum vulgare</i>	Root rot	Cba	Frezzi, 1977
	<i>Thuja sp.</i>	Damping off	Cba	Frezzi, 1956
	<i>Thuja occidentales var. compacta</i>	Damping off	Cba	Frezzi, 1956
	<i>Tragopogon porrifolius</i>	Root rot	Cba	Frezzi, 1956
	<i>Trifolium repens</i>	Damping off	Cba	Frezzi, 1956
	<i>Zinnia sp</i>	Damping off	Cba	Frezzi, 1956
<i>P. mastophorum</i> Drechsler	<i>Brassica oleracea var. capitata</i>	Damping off	Cba	Frezzi, 1956
	<i>Petroselinum crispum var vulgare</i>	Damping off	Cba	Frezzi, 1956

Species	Hosts	Symptoms	Proviencias ¹	References
<i>P. oligandrum</i>	<i>Antirrhinum majus</i>	Root rot	Cba	Frezzi, 1956
Drechsler	<i>Carthamus tinctorius</i>	Root rot	Cba	Frezzi, 1956
	<i>Citrullus lanatus</i>	Brown fruit rot (cottony leak)	Cba	Frezzi, 1956
	<i>Malus domestica</i>	Root rot	Mza	Frezzi, 1956
	<i>Malus sylvestris</i>	Root	Mza	Feldman & Pontis, 1960
	<i>Matthiola sp</i>	Root rot	Cba	Frezzi, 1956
	<i>Phaseolus acutifolium</i> var. <i>latifolium</i>	Root rot, necrosis in stem	Cba	Frezzi, 1956
	<i>Pisum sativum</i>	Root rot	Cba	Frezzi, 1956
	<i>Santolina chamaecyparissus</i>	Root rot	Cba	Frezzi, 1956
<i>P. periplocum</i>	<i>Citrullus lanatus</i>	Brown Fruit rot,	Cba	Frezzi, 1956
Drechsler	<i>Phoenix dactylifera</i>	Damping off, root rot and stem necrosis	SL	Frezzi, 1956
<i>P. polymorphon</i>	<i>Cupressus horizontales</i>	Root rot in potted plant	Cba	Frezzi, 1956
Sideris	<i>Solanum lycopersicum</i>	Damping off	Tuc	Frezzi, 1956
	<i>Trifolium pratense</i>	Damping off	Cba	Frezzi, 1956
<i>P. rostratum</i>	<i>Solanum lycopersicum</i>	Damping off	Cba	Frezzi, 1956
E. Buttler	<i>Pinus halepensis</i>	Damping off	Cba	Frezzi, 1956
	<i>Trifolium repens</i>	Damping off	Cba	Frezzi, 1956
<i>P. spinosum</i>	<i>Arachis hypogea</i>	Fruit rot	Cba	Frezzi, 1960
Sawada	<i>Gypsophila sp</i>	Damping off	Tuc	Frezzi, 1956
	<i>Solanum melongena</i>	Damping off	Tuc	Frezzi, 1956
<i>P. torulosum</i>	<i>Piptadenia rigida</i>	Damping off	Mis	Frezzi, 1956
Coker & P. Patt				
<i>P. tracheiphilum</i>	<i>Lactuca sativa</i>	Root rot	BA	Kiehr et al., 2000
Matta				
<i>P. ultimum</i> Trow	<i>Acacia decurrens</i> var. <i>dealbata</i>	Damping off	ER	Frezzi, 1956
	<i>Albizia julibrissin</i>	Damping off	Cba	Frezzi, 1956
	<i>Allium cepa</i>	Damping off	BA	Kiehr et al., 1996
	<i>Antigonium sp</i>	Root rot	Tuc	Frezzi, 1956
	<i>Antirrhinum majus</i>	Root rot	Cba	Frezzi, 1956
	<i>Apium graveolens</i> var. <i>dulce</i>	Damping off	Cba	Frezzi, 1956
	<i>Arachis hypogaea</i>	Fruit, seed and root rot	Cba	Frezzi, 1956; 1960, Tello et al., 2002
	<i>Begonia sp.</i>	Root rot	Cba	Frezzi, 1956.
	<i>Begonia imperiales</i> var. <i>maculata</i>	Root rot	Cba	Frezzi, 1956
	<i>Beta vulgaris</i>	Damping off	Ctes	Frezzi, 1956; Mazanti, 1972
	<i>Beta vulgaris</i> var. <i>cicla</i>	Damping off, root rot	Cba	Frezzi, 1947, 1956
	<i>Brachychiton populneum</i>	Damping off	Cba	Frezzi, 1947, 1956
	<i>Brassica oleracea</i> var. <i>botrytis</i>	Damping off	Cba, Ctes	Frezzi, 1947, 1956; Mazanti, 1972
	<i>Caesalpinia gilliesii</i>	Damping off	Cba	Frezzi, 1956
	<i>Cannabis sativa</i>	Root rot	BA, Cba	Di Fonzo, 1945 2; Frezzi, 1956
	<i>Carica papaya</i>	Root rot, seedling	Ctes	Frezzi, 1956; Mazanti, 1972
	<i>Capsicum annum</i>	Damping off	Sal, RN	Frezzi, 1956; Bergna, 1963
	<i>Cattleya spp</i>	Black rot	BA	Jauch, 1952 2
	<i>Celosia plumosa</i>	Damping off	Cba	Frezzi, 1956

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<i>Ceratonia siliqua</i>		Damping off	Cba	Frezzi, 1956
<i>Chorisia speciosa</i>		Damping off	Ctes	Frezzi, 1956; Mazanti, 1972
<i>Chorisia insignis</i>		Damping off	Cba, Tuc	Frezzi, 1956
<i>Chorisia sp.</i>		Damping off	Cba	Frezzi, 19472
<i>Cicer arietinum</i>		Root rot	Cba	Frezzi, 1956
<i>Citrullus lanatus</i>		Fruit rot, cottony leak	Cba	Frezzi, 1956
<i>Clarkia sp.</i>		Damping off	Tuc	Frezzi, 1956
<i>Coffea arabica</i>		Root rot	Tuc	Frezzi, 1956
<i>Coleus sp.</i>		Root rot	Cba	Frezzi, 1956
<i>Cucumis sativus</i>		Fruit rot	Cba	Frezzi, 1956
<i>Cucurbita máxima</i>		Root rot	Cba	Frezzi, 1956
<i>Cupressus horizontales</i>		Damping off	ER	Frezzi, 1956
<i>Cyamopsis tetragonoloba</i>		Damping off	Cba	Frezzi, 1956
<i>Delphinium sp.</i>		Damping off	Tuc	Frezzi, 1956
<i>Dianthus caryophyllus</i>			BA	Carrera, 1955 2
<i>Emerus marginatus</i>		Damping off	Cba	Frezzi, 1956
<i>Eucalyptus globulus</i>		Damping off	BA, Cba, Ctes	Frezzi, 1947, 1956; Sarasola & Rocca de Sarasola, 1959; Mazanti, 1972; Merlo, 1981
<i>Eucalyptus leucoxylon</i>		Damping off	Cba	Frezzi, 1956
<i>Eucalyptus robusta</i>		Damping off	Cba	Frezzi, 1956; Sarasola & Rocca de Sarasola, 1959
<i>Eucalyptus viminalis</i>		Damping off	BA, Cba, Ctes	Frezzi, 1947, 1956; Sarasola & Rocca de Sarasola, 1959; Merlo, 1981
<i>Euphorbia marginata</i>		Root rot , damping off	Cba	Frezzi, 1956
<i>Euphorbia splendens</i>		Stem and root rot	Cba	Frezzi, 1956
<i>Fraxinus americana</i>		Damping off	Cba	Frezzi, 1956
<i>Gomphrena sp</i>		Root rot	Cba	Frezzi, 1956
<i>Gossypium sp.</i>		Damping off	Cba	Frezzi, 1956
<i>Gossypium herbaceum</i>		Damping off	Cha	Bonacic Kresic & Ojeda, 1998.
<i>Gysophila sp</i>		Damping off	Cba	Frezzi, 1956
<i>Hibiscus esculentus</i>		Stem and root rot, seedling	Ctes	Frezzi, 1956; Mazanti, 1972
<i>Hordeum vulgare</i>		Damping off	Fsa	Frezzi, 1956
<i>Ipomoea batatas</i>		Brown fruit rot, root rot, postharvest rot	BA, Cba	Frezzi, 1956, Mitidieri, 1990
<i>Jacaranda acutifolia</i>		Damping off	Cba, Ctes	Frezzi, 1947, 1956
<i>Jacaranda mimosifolia</i>		Seedling	Ctes	Mazanti, 1972
<i>Lathyrus cicera</i>		Root rot	Cba	Frezzi, 1956
<i>Lathyrus pubescens</i>		Root rot	Cba	Frezzi, 1956
<i>Lepidium sativum</i>		Root rot	Cba	Frezzi, 1956
<i>Lilium candidum</i>		Collar sof rot, rot necrosis	Tuc	Frezzi, 1956
<i>Linum usitatissimum</i>		Damping off	Cba	Frezzi, 1956
<i>Lolium multiflorum</i>		Root rot	BA	Frezzi, 1977
<i>Lotus corniculatus</i>		Damping off	BA	Frezzi, 1956
<i>Luffa cilindrica</i>		Damping off	Cba	Frezzi, 1956
<i>Matthiola sp.</i>		Root rot ,	Cba, Tuc	Frezzi, 1956
<i>Medicago sativa</i>		Damping off	Cba, BA	Frezzi, 1956, Ostazeski & Hijano, 1986
<i>Melia azedarach</i>		Damping off, root rot	Cba	Frezzi, 1956

Species	Hosts	Symptoms	Proviencias ¹	References
	<i>Melilotus albus</i>	Damping off	Cba	Frezzi, 1956
	<i>Peltophorum dubium</i>	Damping off	Cba, Ctes	Frezzi, 1947, 1956; Mazanti, 1972
	<i>Peperonia spp</i>	Root rot	Tuc	Frezzi, 1956
	<i>Petroselinum crispum</i>	Damping off	Cba	Frezzi, 1956
	<i>Phaseolus vulgaris</i>	Necrosis de vainas y granos, root rot	Cba	Frezzi, 1956
	<i>Picea excelsa</i>	Damping off	RN	Frezzi, 1956
	<i>Pinus canariensis</i>	Damping off	Cba, Ctes	Frezzi, 1947, 1956; Mazanti, 1972
	<i>Pinus contorta var. latifolia</i>	Damping off	RN	Frezzi, 1956
	<i>Pinus halepensis</i>	Damping off, root rot	Ctes, Cba, LR,ER	Frezzi, 1947, 1956; Mazanti, 1972
	<i>Pinus halmintonii</i>	Damping off	Cba	Frezzi, 1956
	<i>Pinus longifolia</i>	Damping off	Ctes	Frezzi, 1947, 1956; Mazanti, 1972
	<i>Pinus pinaster</i>	Damping off	Cba,Ctes	Frezzi, 1947, 1956; Mazanti, 1972
	<i>Pinus pinea</i>	Damping off	BA, Cba	Frezzi, 1947, 1956
	<i>Pinus radiata</i>	Damping off	Cba, RN	Frezzi, 1947, 1956
	<i>Pinus sylvestris</i>	Damping off	Ctes, RN	Frezzi, 1956; Mazanti, 1972
	<i>Pinus spp</i>	Damping off	Mza	Schiel & Vitoria, 1946
	<i>Pisum sativum</i>	Root rot	BA, Cba	Frezzi, 1956
	<i>Prunus persica</i>	Damping off	Cba	Frezzi, 1956
	<i>Raphanus sativus</i>	Damping off	Cba, Ctes	Frezzi, 1947, 1956; Mazanti, 1972
	<i>Salvia splendens</i>	Damping off	Cba	Frezzi, 1956
	<i>Senna corymbosa</i>	Damping off	Cba	Frezzi, 1956
	<i>Sesbania marginata</i>	Damping off	Cba	Frezzi, 1956
	<i>Solanum lycopersicum</i>	Damping off	Cba, Ctes, Tuc, Mis, Juj	Frezzi, 1947, 1956, Mazanti, 1972
	<i>Solanum melongena</i>	Damping off	Cba, Tuc	Frezzi, 1947, 1956
	<i>Sorghum vulgare</i>	Root rot	Cba, SF	Frezzi, 1977
	<i>Spinacea oleracea</i>	Damping off	Cba, Ctes	Frezzi, 1947, 1956; Mazanti., 1972
	<i>Thuja sp</i>	Damping off	Cba	Frezzi, 1956
	<i>Thuja occidentalis var. aureovariegata</i>	Damping off	Cba	Frezzi, 1956
	<i>Thuja occidentalis var. compacta</i>	Damping off	Cba	Frezzi, 1956
	<i>Triticum vulgare</i>	Root rot	Cba	Frezzi, 1977
	<i>Viola tricolor</i>	Damping off	Tuc	Frezzi, 1956
<i>P. vexans</i> de Bary	<i>Begonia sp</i>	Root rot	Cba	Frezzi, 1956
	<i>Begonia rex</i>	Root rot	Cba	Frezzi, 1956
	<i>Celosia cristata</i>	Damping off	Cba	Frezzi, 1956
	<i>Celosia plumosa</i>	Damping off	Cba	Frezzi, 1956
	<i>Citrullus lanatus</i>	Brown fruit rot	Cba	Frezzi, 1956
	<i>Dianthus chinensis</i>	Root rot	Cba	Frezzi, 1956
	<i>Eucalyptus teritiformis</i>	Damping off	Cba, Ctes	Frezzi, 1956; Merlo, 1981
	<i>Piptadenia rigida</i>	Damping off	Mis	Frezzi, 1956
<i>Pythium spp</i>	<i>Allium cepa</i>	Damping off	Mza	Gatica & Oriolani, 1997
	<i>Apium graveolens</i>		BA	Varaschin & De Souza, 2003

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Species	Hosts	Symptoms	Proviencias ¹	References
<i>Begonia sp.</i>			BA	Cipolla, 1948
<i>Beta vulgaris subsp. vulgaris</i>		Damping off, black root, seedling blight	BA	Jauch, 1951
<i>Brassica napus</i>		Damping off	BA	Monterroso & Delhey, 1995
<i>Citrus spp y rutaceas</i>		Damping off pre and post emergence	Ctes	Canteros, 2009
<i>Cucumis melo</i>		Root rot	Mza, SJ	Oriolani & Gatica, 1980
<i>Cucurbita máxima</i>		Damping off	SF	Bonasic Kresic & Campagnac, 1982
<i>Eucalyptus sp</i>			Tu	Carrera, 1955 2
<i>Eustoma grandiflorum</i>		Root and basal rot	Ctes	Obregón <i>et al.</i> , 2000
<i>Fragaria x ananassa</i>		Plant death	For, Ctes, SF	Scaglia <i>et al.</i> , 1984; Bonasic Kresic & Campagnac, 1982
<i>Fucsia magellanica</i>		Root and stem rot	BA	Palmucci & Grijalba, 2003
<i>Glycine max</i>		Damping off	ER, SF, BA, LP	Belmonte & Carrasco, 2006; Botta <i>et al.</i> , 1997
<i>Gossipium herbaceum</i>		Damping off	Cha, Ctes, SF	Campagnac, 1985
<i>Ilex paraguariensis</i>		Damping off, Root rot	Mis	Marchionatto, 1948; Rivera Flores, 1983
<i>Impatiens wallerana</i>		Root rot	BA	Wolcan & Grego, 2007
<i>Impatiens x hawkerii</i>		Crown and root rot	BA	Wolcan & Grego, 2007
<i>Lactuca sativa</i>		Damping off	Juj	Alcoba <i>et al.</i> , 2005
<i>Lavandula dentata,</i>		Root rot	BA	Wolcan & Grego, 2004
<i>Lavandula x intermedia</i>		Root rot	BA	Wolcan & Grego, 2004
<i>Nicotiana tabacum</i>		Damping off Rot during curate and conservation	Sal, Juj, Mis, Cha, BA	Castelló <i>et al.</i> , 1995; Catania, 1992, Carrera, 1972 2; Alcoba <i>et al.</i> , 2005; Dummel, 2008
<i>Ocimum basilicum</i>		Damping off Collar and root rot	Ctes	Colombo & Obregón, 2006
<i>Olea europea</i>		Wilt	BA, Mza	Goldenberg & Castronovo, 1960; Lucero <i>et al.</i> , 2005
<i>Pinus spp.</i>			Chu	Barroetaveña & Rajchenberg, 2005
<i>Pisum sativum</i>			Neu	Bergna, 1963
<i>Solanum lycopersicum</i>		Damping off, Collar and root rot	Ctes, Sal; Juj	Flores <i>et al.</i> , 2008, Colombo, 2009
<i>Triticum spp</i>		Damping off	LP, BA, SF	Pérez Fernández & Corro Molas, 2001
<i>Vaccinium corymbosum</i>		Root	BA	Wright <i>et al.</i> , 2005
<i>Zea mays</i>		Damping-off, stalk rot	Cba	Botta, 2001

¹BA: Buenos Aires; Cat.: Catamarca; Cba: Córdoba; Ctes: Corrientes; Cha: Chaco; Chu: Chubut; ER: Entre Ríos; Fsa: Formosa; Juj: Jujuy; LP: La Pampa; LR: La Rioja; Mza: Mendoza; Mis.: Misiones; Neu: Neuquén; RN: Río Negro; Sal: Salta; SF: Santa Fe; SJ: San Juan; SL: San Luis; TF: Tierra del Fuego e islas Malvinas; Tuc.: Tucumán

Córdoba province has the highest number of species and in Chaco and Catamarca no species were isolated (Table 2). *Pythium ultimum* occurs in most of the provinces and *P. mastophorum*, *P. rostratum*, *P. torulosum* and *P. tracheiphilum* only in one of them (Table 2). The high number of records in Córdoba province is due to the fact that the researcher Mariano Frezzi carried out most of his work in this province (Frezzi, 1947, 1956, 1960, 1977).

Different groups of crops are affected by the different *Pythium* species (Table 3). *Pythium ultimum* is the species that mostly affects ornamental, horticultural and forest crops.

The percentage of each host-*Pythium* sp. relationships in Argentina is shown in Fig. 1.

DISCUSSION AND CONCLUSIONS

Most of the work was carried out in Córdoba due to the existence of a group of researchers devoted to the study of pathologies that could be caused by *Pythium* and *Phytophthora*. Frezzi's work marked a turning point. He is considered a pioneer and important researcher in Argentine phytopathology. During his working life he produced the greatest number of studies which gave rise to two books about *Pythium* (Frezzi, 1956, 1977). He condensed an exhaustive morphological characterization of the species and also detailed drawings, which were later references of foreign papers (Frezzi, 1956). After his death no projects centred on this issue were carried out, and only new host-*Pythium* sp. relations and new localities were reported.

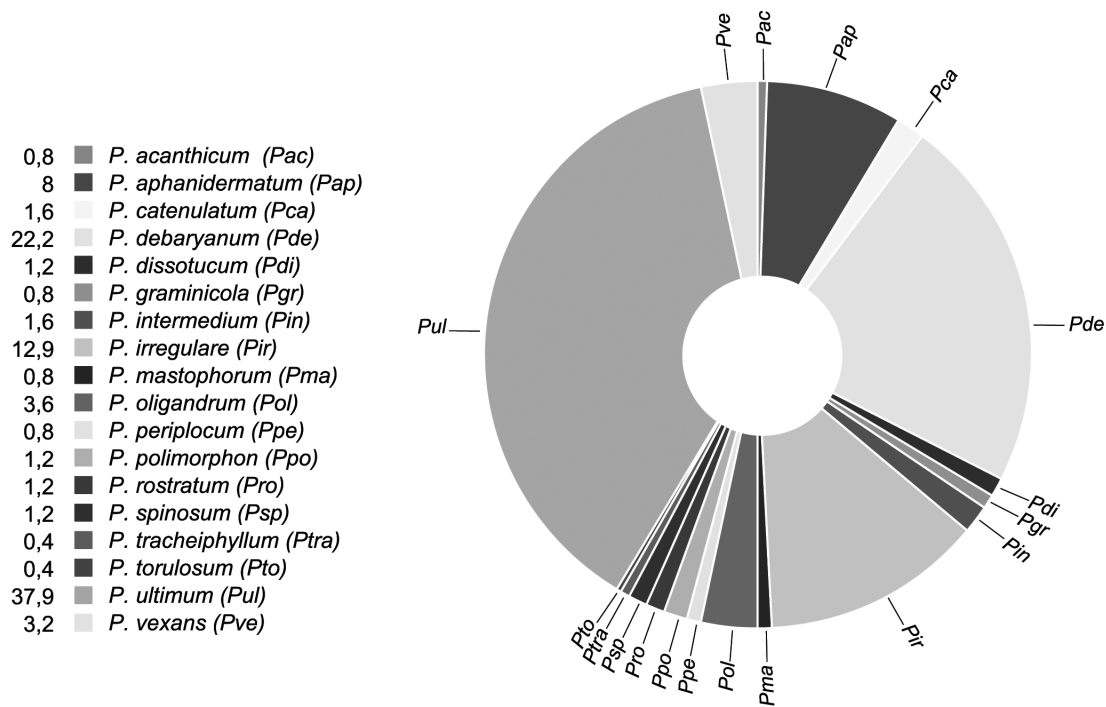


Fig. 1: Percentage of host-pathogen relations of *Pythium* species found in Argentina. *P. acanthicum* (Pac-0,8%), *P. aphanidermatum* (Pap-8%), *P. catenulatum* (Pca-1,6%), *P. debaryanum* (Pde-22,2%), *P. dissotucum* (Pdi-1,2%), *P. graminicola* (Pgr-0,8%), *P. intermedium* (Pin-1,6%), *P. irregulare* (Pir-12,9%), *P. mastophorum* (Pma-0,8%), *P. oligandrum* (Pol-3,6%), *P. periplocum* (Ppe-0,8%), *P. polimorphon* (Ppo-1,2%), *P. rostratum* (Pro-1,2%), *P. spinosum* (Psp-1,2%), *P. tracheiphylum* (Ptr-0,4%), *P. torulosum* (Pto-0,4%), *P. ultimum* (Pul-37,9%), *P. vexans* (Pve-3,2%).

Table 2: Distribution of *Pythium* spp. in geographical regions of Argentina.

Pythium spp.	Regions and Provinces																				Prov/ P.sp					
	NorthWest					NorthEastern					Central					West						Patagonia				
	Juj	Sal	Tuc	Cat	SE	Mis	Cha	Ctes	ER	SF	Fsa	Cha	Mza	LR	SL	SJ	BA	LP	RN	Chu		SC	Neu	TF		
<i>P. acanthicum</i>											X												1			
<i>P. aphanidermatum</i>	X							X				X					X						4			
<i>P. catenulatum</i>										X								X					2			
<i>P. debaryanum</i>	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						X												2			
<i>P. intermedium</i>					X	X					X												3			
<i>P. irregulare</i>					X	X					X			X			X						5			
<i>P. mastophorum</i>											X												1			
<i>P. oligandrum</i>										X	X		X										2			
<i>P. periplocum</i>											X			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. tonulosum.</i>										X													1			
<i>P. tracheiphylum</i>																	X						1			
<i>P. ultimum</i>	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			14			
<i>P. cf. ultimum</i>											X		X				X				X		5			
<i>P. vexans</i>						X					X												3			
<i>P.spp/province</i>	3	3	7	-	-	-	6	1	4	2	2	2	2	2	3	2	3	6	2	2	1	1	1			

Juj=Jujuy; Sal=Salta, Tuc=Tucumán; Cat = Catamarca; SE=Santiago del Estero; Mis =Misiones; Cha= Chaco; Ctes = Corrientes, ER=Entre Ríos; SF =Santa Fe, Fsa= Formosa; Cba =Córdoba, Mza =Mendoza, LR= La Rioja, SL= San Luis; BA =Buenos Aires; LP= La Pampa; RN= Río Negro; Chu =Chubut; SC= Santa Cruz; Neu =Neuquen; TF =Tierra del Fuego y Malvinas).

Table 3: Groups of crops affected by each species of *Pythium*.

<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>	20	12	5	2		1			
<i>P. catenulatum</i>	4	4							
<i>P. debaryanum</i>	55	14	25	8	1	2	4	1	
<i>P. dissotocum</i>	3	1	1	1					
<i>P. graminicola</i>	2		1				1		
<i>P. intermedium</i>	4	2		2					
<i>P. irregulare</i>	32	10	10	4		2	2	3	1
<i>P. mastophorum</i>	2	2							
<i>P. oligandrum</i>	9	3	3		2		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	1	1				1		
<i>P. tracheiphillum</i>	1	1							
<i>P. torulosum.</i>	1			1					
<i>P. ultimum</i>	93	18	36	24	2	4	6	3	
<i>P. vexans</i>	8	1	5	2					
P. spp/group*	247	74	87	46	5	11	16	7	2

*Total numbers of host-*Pythium* spp. relationships within each type of crop.

This revision allowed an updating of the situation of this genus, and associated hosts, locations and symptoms. So far 18 species have been cited affecting 248 hosts in Argentina. Taxonomic identification was always based only on morphological features and colony patterns on different media.

The great number and diversity of *Pythium* species in the world suggest that perhaps a wider variety of pathogenic *Pythium* species have not been yet identified in Argentina. Further studies with an extended range of hosts would be necessary to determine in detail the diversity of the *Pythium* population in different cropped areas. It is hoped that molecular and secuention techniques will allow a better knowledge of the diversity of *Pythium* species present in Argentina

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