THE GENUS *PERONOSPORA* IN THE IBERIAN PENINSULA, ESPECIALLY IN NORTHERN SPAIN AND ANDORRA

by

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Resumen

GUSTAVSSON, A. (1991). El género Peronospora en la Península Ibérica, con especial mención al norte de España y Andorra. *Anales Jard. Bot. Madrid* 49(1): 3-38 (en inglés).

Tomando como base los datos extraídos de la literatura y el trabajo de campo realizado por el autor durante los años 1989 y 1990, en las provincias de Gerona, Lérida, Huesca, Navarra, Cantabria, Vizcaya, Asturias, León, Burgos, La Rioja y Principado de Andorra, se presenta un balance del nivel de conocimientos que para el género *Peronospora* se tiene ahora de la Península Ibérica. Tras este estudio se ha incrementado con 36 el número de especies de *Peronospora* y el número de táxones huéspedes en más de 50; de modo que el total de especies de *Peronospora* conocidas para España es de 80 y hasta 100 el de huéspedes. Para Andorra son siete las especies de *Peronospora* y el mismo número de las de huéspedes. De especial interés es el hallazgo en este Principado de *Lathyrus laevigatus* como nuevo huésped de *Peronospora senneniana,* originalmente descrito de esta región en *Lathyrus niger* por González Fragoso y Saccardo. Sobre la base única de los datos bibliográficos se relacionan para Portugal 55 especies de *Peronospora* y alrededor de 66 especies de diferentes huéspedes.

Palabras clave: *Peronospora,* Península Ibérica, catálogo.

Abstract

GUSTAVSSON, A. (1991). The genus Peronospora in the Iberian peninsula, especially in northern Spain and Andorra. *Anales Jard. Bot. Madrid* 49(1): 3-38.

Field studies were carried out during 1989 and 1990 in Gerona, Lérida, Huesca, Navarra, Cantabria, Vizcaya, Asturias, León, Burgos, La Rioja, and Andorra. There were earlier about 43 *Peronospora* species known from Spain on about 53 host species. The new investigations have increased this number by 36 *Peronospora* species on 55 hosts, and, after this investigation, we thus know of about 80 species on just over 100 hosts in the studied region. Of special interest is *Peronospora senneniana* on *Lathyrus laevigatus,* found in Andorra, originally described from this region on *Lathyrus niger* by González Fragoso and Saccardo. For comparison the literature records for Portugal are given. There are 55 *Peronospora* species on about 60 host species known from this country.

Key words: *Peronospora,* Iberian peninsula, catalogue.

INTRODUCTION

The Swedish mycologist G. LAGERHEIM reported in 1890 localities for *Peronospora* on *Rubia peregrina, Atriplex halymus, Polycarpon tetraphyllum,* and

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Beta maritima, all found by him in 1889 in Portugal and new for this country as *Peronospora* hosts. The first three plant species are also reported as new hosts to *Peronospora*. Lagerheim's report seems to have been the first one for *Peronospora* in the Iberian peninsula but has been unknown to most later authors. LUCAS & SOUSA DIAS mention his work in 1976, but it seems to have been unknown to, e.g., GÄUMANN in his monograph in 1923.

During the years 1910-1982 there are several reports about *Peronospora* in Portugal by TRAVERSO & SPESSA (1910), SOUSA DA CAMARA (1929, 1936), COSTA & SOUSA DA CAMARA (1953), SOUSA DA CAMARA & OLIVEIRA (1944), SOUSA DA CAMARA & *al.* (1936), LUCAS (1957), LUCAS & SOUSA DIAS (1976), LUCAS & *al.* (1979, 1982), SOUSA DIAS & LUCAS (1962, 1974, 1980), SOUSA DIAS & SOUSA DA CAMARA (1953).

Important contributions to our knowledge of the Spanish *Peronospora* flora were given by GONZÁLEZ-FRAGOSO in 1917 and 1924 and by LÁZARO E IBIZA in 1920. Unamuno has written several papers during the years 1927-1941 (UNAMUNO, 1927, 1930a, 1930b, 1933, 1935a, 1935b, 1941) and is the most prolific Spanish author in this field. BENITO MARTÍNEZ's paper was written in 1930.

From 1946 on the contributors have been LOSA ESPAÑA in 1946, DOMÍNGUEZ-GARCÍA TEJERO in 1950, DURRIEU in 1964 and 1966, JØRSTAD in 1962 (Mallorca and Menorca), and IZQUIERDO TAMAYO in 1966.

MATERIAL AND METHODS

After suggestions from Dr. E. Descals, Instituto de Estudios Avanzados de las Islas Baleares, CSIC, Mallorca, and Dr. Josep Girbal, Universitat Autónoma de Bellaterra, Barcelona, I started the field work for this paper in the Pyrenees in June 1989 and continued for a year later in a wider area of northwest Spain and Andorra. Dr. Girbal took part in the field work during the first days, and I have been assisted by my wife, Mrs. Ingrid Gustavsson the whole time. We have collected 275 *Peronospora* specimens, which includes several *Peronospora* species new to Spain (indicated by * below) and also plant species new to science as hosts of these fungi –see below. The material is deposited in the herbarium of the Real Jardín Botánico, CSIC, in Madrid (MA).

My field work is of course very incomplete concerning the area I have studied, and it only deals with part of Spain and with Andorra. To get the view of *Peronospora* in the Iberian peninsula as complete as possible I have also borrowed herbarium specimens from Madrid and Barcelona (BCB Mycotheca). As I have not been collecting material in Portugal, I only very briefly mention literature records from that country in this paper.

RESULTS

A simple way to obtain a general view of the Iberian *Peronospora* species including the results of my investigations is as follow, organized by host families as in my monograph (cf. GUSTAVSSON, 1959b).

Species on *Liliaceae*

Peronospora destructor (Berk.) Casp.

On *Allium cepa*.—I have not had the opportunity to search for this species, which seems to be quite common in onion fields in different countries. LÁZARO E IBIZA (1920) writes "Sobre las cebollas, región septentrional". GONZÁLEZ-FRAGOSO (1924) reports it as common in various parts of Spain and also refers to a collection by Lagerheim from Portugal. It has also been reported from this country by other authors (LUCAS & SOUSA DIAS, 1976).

Species on *Urticaceae*

Peronospora debaryi Salmon & Ware

On *Urtica urens*.—It has been found once in Spain (Barcelona, 1914, MA) by GONZÁLEZ-FRAGOSO (1924), whose collection is mentioned by DURRIEU (1966). I have examined this collection but did not find any *Peronospora* in it, which could mean that the infection was so weak that it can no longer be found on this old material. Concerning reports from Portugal about *Peronospora* on *Urtica urens* and *U. membranacea* Poiret (= *U. dubia* Forskål) (SOUSA DA CAMARA, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944) see discussion by CONSTANTINESCU (1985).

Species on *Polygonaceae*

Peronospora rumicis Corda

On *Rumex acetosa*.—It has been reported in Portugal (LUCAS & *al.*, 1982) but I do not know of any findings from Spain. In Scandinavia, where I have had most of my experience with *Peronospora*, this species is more easily found in the western parts of Sweden and in Norway –closer to the Atlantic Sea– and it should be investigated if this is the case also in the Iberian peninsula.

* **Peronospora polygoni** Thüm.

On *Polygonum aviculare*.—It is new for Spain. My three collections are all from Gerona (Urtx, Bolvir, and Isóvol). There is also a report from Portugal (SOUSA DA CAMARA & OLIVEIRA, 1944), where the fungus is presented as new to this country.

* **Peronospora polygoni-convolvuli** A. Gust.

On *Polygonum convolvulus*.— My three localities are the first published from this area. They are all from Huesca (Samper, Jaca, and Santa Cilia de Jaca). J. Girbal found one locality in Gerona (Sant Martí de Llémena) in 1990 (BCB Mycotheca).

Species on *Chenopodiaceae*

Peronospora schachtii Fuckel
[*P. farinosa* (Fr.) Fr. –see GUSTAVSSON (1959b: 32) and compare BYFORD (1967)]

On *Beta maritima* and *B. vulgaris*.—There are literature reports concerning this species on *B. vulgaris* in Spain by LÁZARO E IBIZA (1920) –also quoted by GONZÁLEZ-FRAGOSO (1924)– "región meridional", and DOMÍNGUEZ-GARCÍA TEJERO (1950) (Adra and Madrid). J. Luque found it in 1990 in Barcelona (Prat de Llobregat) (BCB Mycotheca).

The reports from Portugal are more numerous. LAGERHEIM (1890) found it on *Beta maritima*, and it was later on found on the same host also by other authors (LUCAS & SOUSA DIAS, 1976). Reports of infections on *B. vulgaris* are quite common (LUCAS, 1957; LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1979, 1982; SOUSA DA CAMARA & OLIVEIRA, 1944; SOUSA DA CAMARA & *al.*, 1936).

Peronospora chenopodii Schlecht.

On *Chenopodium album*.—It seems to be a very common species in different parts of Europe, also in the Iberian peninsula. LÁZARO E IBIZA (1920) gives the Spanish distribution as "región central". GONZÁLEZ-FRAGOSO quotes this and reports it also from Sevilla (1924). This collection is from 1913 (MA). UNAMUNO (1941) has found it in Valladolid (Valladolid, 1930) –"Localidad nueva y segunda cita sobre este huésped para la flora española" and in Galicia (Celanova, 1931, MA) (cf. UNAMUNO, 1933). There are also collections made by Unamuno in Galicia (Orense, Isla del Miño, 1931, MA) and in Cuenca (Puente Vadillos, 1932, MA). I have found the fungus in Gerona (Puigcerdá, Bolvir, Campdevanol, and Isóvol), in Lérida (Escaló, Las Bordas, and Esterri d'Aneu), in Huesca (Jaca and Canfranc), in Burgos (Cornudilla), in Navarra (Cárcar) and in La Rioja (Ansejo) –almost in every place where I have investigated the host. There are also a few Portuguese reports (SOUSA DIAS & LUCAS, 1974 as "new to Portugal"; LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982).

On * *Chenopodium ambrosioides*.—It has been found once in Spain –Madrid 1978, leg. J. Merino (MA). The taxonomy of *Peronospora* on *Chenopodium* needs closer investigation, and I thus place this collection under *P. chenopodii* mainly owing to lack sufficient material to make a comparative study. As far as I know this plant species has not previously been reported as a host of *Peronospora*.

Peronospora chenopodii-opulifolii Săvul. & Rayss

On *Chenopodium opulifolium*.—It is reported by DURRIEU (1966) from Gerona (Manresa) and from Portugal (cf. SOUSA DA CAMARA & OLIVEIRA, 1944). As in some other cases Săvulescu and Rayss seem to have accepted Gäumann's method of describing new species after studies of single collections. In my opinion this is not sufficient for a description of a new species. The correct name of this species is thus perhaps *P. chenopodii* as above, but I follow the earlier used terminology as I have no results of my own.

***Peronospora boni-henrici** Gäum.

On *Chenopodium bonus-henricus*.—It is very easily seen owing to the large yellowish or brown spots on the upper side of the host leaves and the thick, greyish layer of conidiophores on their underside. In spite of this there are no earlier records from the Iberian peninsula. I have found the fungus in Huesca (Baños de Panticosa, two different localities, and Baños de Benasque) and in Asturias (Leitariegos).

Peronospora chenopodii-polyspermi Gäum.

On *Chenopodium urbicum*.—It has been found in Spain (Sevilla –two or three localities in two collections– "Sevilla, Camino de S. Juan", 1-V-1914, MA, and "Sevilla et S. Juan de Aznalfarache", 1-V-1914, MA –by GONZÁLEZ-FRAGOSO, 1924). There is also a Portuguese locality –"*Chenopodium* sp. cf. *urbicum*" (LUCAS & SOUSA DIAS, 1976).

Peronospora muralis Gäum.

On *Chenopodium murale* and *Ch. vulvaria*.—It was found by GONZÁLEZ-FRAGOSO in Sevilla (1924), on *Ch. vulvaria* in 1913 (MA). I have not seen the collection on *Ch. murale*. As I have made no investigations of this *Peronospora* species, I have had to take the taxonomy and nomenclature used by GÄUMANN (1923) and González-Fragoso for granted. There are, however, reasons to believe that the taxonomy of *Peronospora* on *Chenopodium* species calls for new investigations.

When LUCAS & SOUSA DIAS (1976) report *Peronospora* on *Chenopodium quinoa* from Portugal they use the name of *P. farinosa* and thus do not discuss the problems connected with *Peronospora* on *Chenopodium* and related plants.

Peronospora sp.

On *Chenopodium* sp.—This fungus is very briefly mentioned by LOSA ESPAÑA (1944) from a locality in Huesca (Santa Cruz de la Serós).

Peronospora effusa (Grev.) L. R. Tul.

On *Spinacia oleracea*.—I have not searched for this species, as my object was primarily *Peronospora* on wild plants, but LÁZARO E IBIZA reported it in 1920 –"región central". GONZÁLEZ-FRAGOSO (1924) quoted this statement and reported the locality Sevilla (Salteras, 1913, MA), and UNAMUNO (1930a) reported it from Albacete (Caudete, 1928, MA). In the herbarium at Bellaterra, Barcelona, there is also a collection of this species (Barcelona, 1982, C. Casas). LUCAS & SOUSA DIAS (1976) give a Portuguese locality, which seems to be the only report from this country.

Peronospora minor (Caspary) Gäum.

On **Atriplex hortensis*.—My new collection of this species is from Carcabada in Asturias, where a rather large population of host plants was very heavily infected.

On *Atriplex prostrata* [=*A. latifolia, A. hastata* (cf. GUSTAVSSON, 1959b: 34)].—It has been found by Unamuno in Asturias (Oviedo), which is reported by

GONZÁLEZ-FRAGOSO (1924) (MA). There are also three unpublished collections of this species in MA: Cantabria, Santander, 1924; León, San Román de los Caballos, 1927, and Burgos, La Vid, 1927, all made by P. Unamuno. J. Girbal collected it in Barcelona (Bellaterra) (BCB Mycotheca).

On **Atriplex patula*.—It was found in Andorra (El Serrat) during my field trips in 1990.

On *Atriplex halymus*.—It is reported from Portugal, first by LAGERHEIM (1890) and then by de SOUSA DA CAMARA & OLIVEIRA (1944).

Peronospora litoralis Gäum.

On *Atriplex portulacoides*.—It is perhaps not a species, possible to separate from *P. minor* but, as I have no investigations of my own, I follow the nomenclature used by SOUSA DA CAMARA & OLIVEIRA (1944), when they report this fungus as new to Portugal. The only known Spanish locality is in Zaragoza (Monegrillo), reported by DURRIEU (1966) using the host name of *Obione portulacoides* and calling the fungus *Peronospora obionis-verruciferae* Såvul. & Rayss. As several other investigations by these authors the studies of *Peronospora* on *Atriplex* are far too superficial to allow a reliable species determination of the fungus. This problem calls for new studies.

Species on *Caryophyllaceae*

Peronospora alsinearum Casp.

On *Stellaria media*.—It was first reported from Spain by LÁZARO E IBIZA in 1920: "*Stellaria*" without species name. This is possibly the same collection as mentioned by GONZÁLEZ-FRAGOSO in 1924 —Sevilla, La Trinidad, 1913, MA. I have not been able to find any *Peronospora* in this collection, however. This species does not seem to be known in the literature from Portugal. Together with J. Girbal I found two new localities in Gerona (Llanars and Tregurá).

Peronospora conferta (Unger) Unger

On (*?) *Cerastium fontanum*.—It was perhaps reported by GONZÁLEZ-FRAGOSO (1924) when, apparently referring to LÁZARO E IBIZA (1920), he wrote "En *Cerastium*, región central y septentrional" and by "*Cerastium*" he may refer also to the common *C. fontanum*. I have collected this species in Gerona (Ribes de Freser), Lérida (Puerto de Bonaigua), Huesca (two localities in Ordesa National Park), and Cantabria (Gamonal).

It should be observed that this host species can be infected by both *Peronospora conferta* and the recently described *P. fontana* A. Gust. (cf. GUSTAVSSON, 1988). Using my earlier results it is easy to separate these two fungi:

A) *Peronospora conferta*

Conidia: 18.6-37.7 × 14.5-24.8 µm, averages 26.6 × 18.4 µm, quotient between length and breadth 1.11-1.89, average 1.45.
Conidiophores: stem 30-270, crown 50-270, totally 130-450 µm.
Oospores: not found.

B) *Peronospora fontana*

Conidia: 12.4-20.7 × 10.4-16.6 µm, averages 15.8 × 13.3 µm, quotient between length and breadth 1.00-1.50, average 1.19.
Conidiophores: stem 50-470, crown 60-240, totally 130-630 µm.
Oospores: 29-47 × 27-44 µm with a reticulated wall.

From my investigations in Scandinavia it seems clear that the older species *P. conferta* is distributed more to the south of that area, and that *P. fontana* goes more to the north and perhaps also prefers higher altitudes. It seems important then to examine each collection of *Peronospora* in the Iberian peninsula also –especially those made in the mountains– to search for both these *Peronospora* species. However, all my collections above are from mountain localities –up to 1600 m– and the distribution of *Peronospora* on *Cerastium fontanum* may be quite different in southwest Europe and in Scandinavia.

Measurements of conidia and conidiophores made from my Spanish material compared with my earlier results:

Collection		Conidia			Conidiophores			
No.	*n*	Length	Breadth	*l*:*b*	n	Crown	Stem	*c*:*s*
7434	14	25.3	18.9	1.33	10	120	130	1.10
7503	100	26.4	18.7	1.41	29	150	140	.91
7635	8	23.8	18.1	1.31	29	190	160	.96
7726	77	24.7	18.0	1.37	17	130	160	1.22
7742	100	23.9	18.1	1.32	27	130	140	1.07
This should be compared with the fungus on *C. alpinum* – see below:								
7490	200	27.5	19.1	1.44	41	140	130	.91

It is clear that all the collections of fungi from *C. fontanum* are *P. conferta* and not *P. fontana*. This is shown especially by the large conidia and the short stems of the conidiophores.

On * *Cerastium alpinum*.—It has been found for the first time in the studied area on a mountain slope south of the highway tunnel west of Viella in Lérida, altitude about 1500 m. The infection was widely spread in a large population of host plants. On *Cerastium* species *Peronospora* conidiophores often cover one half of the underside of the leaf, often less than that. A distinct yellowish-green color on the infected leaf parts occurs, where the fungus is growing, and the snow white color of the conidiophore layer can hardly be overlooked upon close examination.

The few measurements above do not give any definite indication in that direction, but there may be some doubt that the *Peronospora* on *Cerastium alpinum* is the same species as the one on *C. fontanum*. The name *P. tornensis* Gäum. (cf. GÄUMANN, 1923) should perhaps be used for the fungus on *C. alpinum*. I have discussed this problem in an earlier paper (cf. GUSTAVSSON, 1987) dealing with these fungi in the Scandinavian mountains.

Peronospora tomentosa Fuckel

On *Cerastium glomeratum*.—It has not been found in Spain but is reported from Portugal (SOUSA DA CAMARA & *al.*, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & SOUSA DIAS, 1976).

Peronospora moenchiae Sousa da Camara & Oliveira

On *Moenchia erecta*.—It is reported and described as a new species from Portugal in 1944 (SOUSA DA CAMARA & OLIVEIRA, 1944). I have had no opportunity to study this fungus.

* **Peronospora polycarponis** Mayor & Viennot-Bourgin

On *Polycarpon tetraphyllum*.—It was found in Portugal as early as 1889 by Lagerheim (cf. LAGERHEIM, 1889; GONZÁLEZ-FRAGOSO, 1924). There is one collection from Spain known to me, Gerona: Riells, 1989, S. Santamaría (BCB Mycotheca).

Peronospora silenes G. W. Wilson
= *Peronospora melandrii* Gäum.

On *Silene alba (Melandrium album)*.—It is reported as new to Portugal by SOUSA DA CAMARA & *al.* in 1936 and is also published by LUCAS & SOUSA DIAS in 1976. I have investigated the same host in Spain without finding the parasite, and my experience from earlier investigations in northern Europe is that it does not seem to be very common there. In most cases distinct yellowish parches on the host leaves indicate the presence of an infection, and infections by this parasite should thus not be difficult to discover.

On *Silene gallica*.—It has been recorded from Portugal (LUCAS & SOUSA DIAS, 1976) but not from Spain.

I have earlier (GUSTAVSSON, 1959b) regarded *Peronospora silenes* and *P. melandrii* as different species although I could find no clear difference between the two *Peronospora* species described for *Melandrium*. Considering the problems with Gäumann's method of describing new species after studying just one or very few collections and my own, very brief investigations in this case, I now feel it safer, however, to use the name of *P. silenes* for all *Peronospora* on *Silene* species, including *Melandrium*.

Peronospora dianthi de Bary

On *Vaccaria hispanica* (Miller) Rauschert *(V. pyramidata* Med.).—It is reported from Portugal (LUCAS & SOUSA DIAS, 1976) and the authors use de Bary's name of the fungus as they do for the fungi on *Melandrium* and *Silene (Peronospora silenes* above). There is little reason, however, to believe that this is all the same fungus and I thus follow Wilson's work concerning the fungi on the latter host genera.

Species on *Ranunculaceae*

Peronospora ranunculi Gäum.

It has not been reported very often by earlier authors. To a certain extent this is surely caused by the fact that even if there is an infection in a *Ranunculus* population, it is very often on just a few specimens out of, perhaps, several hundreds of plants. The infection is thus very easily overlooked. One possible explanation for this type of infection is that it might have been caused by oospores in just a few hosts. In certain cases I did see what I believe to be conidial infections. They have been restricted to a number of small infections on the leaves.

On * *Ranunculus acris*.—It was found during my Spanish field trips in Lérida (Ribera de Cardós), Huesca (Linás de Broto and Baños de Panticosa) and Cantabria (Puerto del Escudo).

On *Ranunculus bulbosus*.—It was found by DURRIEU (1966) in Gerona (San Pedro Pescador) and was collected by me in Gerona (Tregurá and Linás de Broto), Lérida (Espot), and Huesca (Samper, Baños de Panticosa and Linás de Broto).

On * *Ranunculus repens*.—It was first found in Spain in 1987 by J. Girbal in Bescanó, Gerona (BCB Mycotheca) and later on by me also in Gerona (Santa Fe del Montseny, Tregurá, Setcases, Puigcerdá, and Vallfogona), in Lérida (Valencia d'Aneu) and in Cantabria (Puerto del Escudo).

On *Ranunculus sardous*.—It is not reported from Spain but as new to Portugal by SOUSA DA CAMARA & OLIVEIRA in 1944. In my Scandinavian investigations I have found this host infected in most localities, and this is probably also the case in the Iberian peninsula, where I have not studied it. I regard the fungus on *R. sardous* as *P. ranunculi,* as I do not find that the species *P. ranunculi-sardoi* Săvul. & Rayss (cf. SĂVULESCU & RAYSS, 1930) can be regarded as a species of its own, as it has been established from studies of just a single collection.

Peronospora alpicola Gäum.

On * *Ranunculus platanifolius*.—It was found new to Spain by J. Girbal during our field trips in Gerona: Ull de Ter, in June, 1989. I later made a special investigation on this species in the Swiss alps and found heavy infections in almost every host locality —this also could be the case in Spain and Portugal. As described for *Peronospora ranunculi* above the infection is often found in just a few plants in large populations. The flowers and seeds of heavily attacked plants appear to be little damaged by the fungus as to flowers and seeds, which is similar to infections by *P. ranunculi. P. alpicola* seems to be morphologically different from *P. ranunculi.* It has larger and somewhat more elongated conidia.

Peronospora pulveracea Fuckel

On *Helleborus foetidus*.—It has been reported for Portugal (LUCAS & *al.*, 1982).

Species on *Papaveraceae*

Peronospora arborecens (Berk.) de Bary

On * *Papaver dubium.*—It was found by me in 1990 in Cantabria: Puerto de San Glorio, and is apparently new to Spain on this host.

On *Papaver hybridum.*—It has been found in Portugal (LUCAS & *al.*, 1982).

On *Papaver rhoeas.*—It was reported by DURRIEU (1966) from Barcelona (Arenys de Mar). I found it in Gerona (Llanars), Lleida (Pont d'Arros), Cantabria (Naroba), and Burgos (Puerto de Canales and La Parte de Bureba). It has been found previously in Portugal (SOUSA DA CAMARA, 1936; SOUSA DA CAMARA & *al.*, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & SOUSA DIAS, 1976).

On *Papaver somniferum.*—It has been found in Portugal (LUCAS & SOUSA DIAS, 1976) and in Madeira (SOUSA DIAS & LUCAS, 1980).

On "*Papaver* sp."—It is reported by LÁZARO E IBIZA in 1920: "Sobre amapolas, región septentrional y central". GONZÁLEZ-FRAGOSO (1924) quotes this paper and also a report for Portugal: "Citada también en Portugal por Niessl".

The symptoms for *Peronospora* infections on *Papaver* are very typical and may be of two different types. Most easily seen are infections on young plants, which are often totally infected and which turn into a yellowish green color. Leaf infections on older plants seems to be more rare or are at least more difficult to discover –they are quite easy to see, however, on *Papaver somniferum. Papaver* specimens are sometimes infected in the flower-stalks in such a way that these are heavily deformed and twisted in a way similar to what is often seen in *Peronospora*-infected *Capsella.* The infected stems also turn black.

Peronospora affinis Rossman

On *Fumaria capreolata.*—It was first reported for Spain by DURRIEU (1966) from Barcelona and was found by me in Asturias (Llanes, Carreño, and Cornellana). It seems as if this species can be found in most localities for this host. It may be difficult to discover, however, as it often attacks only small parts of the leaves. The symptoms may be hard to see if the leaves turn a more yellowish color.

On * *Fumaria densiflora* (matrix nova).—It is here reported for the first time. I found it in Burgos, Cornudilla, in June, 1990.

On *Fumaria muralis.*—This host was reported by UNAMUNO in 1933 for Galicia (Santa María de Castrelo de Miño, 1931 – MA): "Es matriz nueva para la flora mundial." The plant is reported as "*F. media*" but was determined by M. Lidén as "*Fumaria* cf. *muralis* Sonder ex Koch". The fungus was found earlier on this host in Spain by Unamuno (GONZÁLEZ-FRAGOSO, 1924) in Asturias (Llanes, 1920, MA) and UNAMUNO (1927) in Vizcaya (Guernica, 1926, MA). I found it in Asturias (Berbes, Arriondas and Cornellana) and in Cantabria (Molledo). Reports from Portugal give several localities (GONZÁLEZ-FRAGOSO, *l.c.;* LUCAS & SOUSA DIAS, 1976).

On * *Fumaria officinalis.*—It was found in Burgos: Miranda de Ebro in 1939 by L. M. Losa (MA), by me in Lérida (Pont d'Arrós), and by J. Girbal in 1990 in Gerona (Sant Martí de Llémena, BCB Mycotheca). It is known also from Portu-

gal (SOUSA DA CAMARA & *al.*, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & SOUSA DIAS, 1976). According to my experience this species is found in almost every host locality, especially during the fall. Small plants are often entirely covered by conidiophores, which changes their color very clearly. They appear to be severely damaged, but other plants may show only very slight infections which are not easily seen.

The determination of the *Fumaria* species has been made or checked by Dr. Magnus Lidén, University of Gothenburg, Sweden. I thank him for his valuable help.

Peronospora roemeriae Zaprometov (spelling by author: "roemerii")

On *Roemeria hybrida.*—It was found by Durrieu in 1963 (cf. DURRIEU, 1964, 1966) in Zaragoza (La Almolda de Monegros) as new to the region, and he found it also in Navarra (Valtierra) (cf. DURRIEU, 1966). He writes (DURRIEU, 1964) "*Peronospora roemeriae* Zapor. ?" as he has not seen the description. Zaprometov described this species on a single collection from Tashkent in April, 1926 (cf. ZAPROMETOV, 1928). I believe that it should be studied more in detail. Like GAUMANN (1923) and some other authors Zaprometov made his description based on only one collection, which may easily result in questionable conclusions. He does not mention the oospores, but DURRIEU (1964) found them in his Spanish collection and shows this by a drawing – "elles ont de 26 à 36 µm de diamètre et sont ornées de fortes crétes irrégulières anastomosées en réseau". *Peronospora* species on *Papaver* have oospores with smooth walls without a net pattern (GUSTAVSSON, 1959a) (Group *Effusae* de Bary within *Peronospora).* As he writes, however, Durrieu has observed oospores with such a net pattern, which should place this species within the group *Reticulatae.* My material is not sufficient to allow further studies on this matter.

Species on *Brassicaceae*

Peronospora brassicae Gäum. f. sp. **brassicae**

On *Brassica napus.*—It was briefly reported by GONZÁLEZ-FRAGOSO in 1924: "Norte y Centro". He apparently quoted LÁZARO E IBIZA (1920), who only wrote "nabos – norte y centro", however. GONZÁLEZ-FRAGOSO *(l.c.)* also gives one locality from Portugal.

On * *Brassica oleracea.*—It was collected only once in Spain as far as I know –Gerona: Bescanó, 1987, J. Girbal, BCB Mycotheca– but has been found more often in Portugal (GONZÁLEZ-FRAGOSO, 1924; COSTA & CAMARA DA SOUSA, 1953; LUCAS, 1957; LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982) also on *Brassica* sp., which probably is an indication that it is not rare in Spain either. I have not searched for this species.

On *Brassica adpressa.*—It has been collected by F. Sennen in Barcelona, host called *Hirschfeldia adpressa,* in 1916 (MA) and is reported by GONZÁLEZ-FRAGOSO in 1924, he uses the name of *Erucastrum incanum:* "Esta crucífera es matriz nueva para la especie de Gäumann, a la cual la adscribo sin experimentación cultural, por la similitud de matriz y de caracteres morfológicos. Los ejemplares son

muy escasos en *Peronospora* y sumamente abundantes en *Cystopus candidus* (P.) Lév."

Investigating this collection I found a very heavy infection of *Albugo candida (Cystopus),* but I found no signs of *Peronospora.* This fungus is apparently so rare on the leaves in the collection –"muy escasos" as quoted above– that I did not find it in an investigation that could not be done thoroughly due to the age and fragility of the material.

DURRIEU (1966) has pointed out that the name of *Peronospora erucastri* Gäum. has been established because the host plant was not considered as a species of *Brassica* but as belonging in another genus: "– détermination spécifique douteuse, uniquement basée sur le fait que Fragoso place l'hôte dans le genre *Erucastrum*". Durrieu writes "*P. erucastri* Gäum.?", the question mark probably indicating that he finds the species dubious, and not that there should be any doubt that Gäumann really described this species.

I agree with Durrieu that the name would have been *P. brassicae* if the host had not been moved to another genus, and I cannot, as Durrieu did with a question mark, recognize *P. erucastri* as a species of its own without new investigations, no matter what the host is called.

González-Fragoso is wrongly taken into the discussion by Durrieu –Gäumann described *P. erucastri* in 1918 (cf. GÄUMANN, 1923), but the Spanish author published his paper six years later. It could not have been the basis for the dubious naming of the new species.

* **Peronospora brassicae** f. sp. **raphani** Gäum.

On *Raphanus raphanistrum.*—It is represented only by my new collection from Asturias, Llanes, but is, as is f. sp. *brassicae* above, probably more common than is known.

Peronospora brassicae f. sp. **sinapidis** Gäum.

On *Sinapis alba.*—It has been found in Portugal (LUCAS & SOUSA DIAS, 1976) but is not recorded from Spain.

On * *Sinapis arvensis.*—It has been found in its first Spanish locality during my field trips in Lérida (Escaló). After having studied *Peronospora* on *Sinapis* in other countries I suspect that it could be found in many other localities in Spain. The infection often occurs on quite small patches on the leaves and is easily overlooked in spite of the white color of the conidiophore layer and the yellowish spots on the upper side.

Peronospora diplotaxidis Gäum.

On *Diplotaxis catholica.*—It has its only reported Spanish locality in Barcelona (Montserrat), published by DURRIEU (1966).

On * *Diplotaxis erucoides.*—It was found for the first time in Spain by J. Girbal in 1991 in Barcelona (Prat de Llobregat) (BCB Mycotheca).

Peronospora lepidii (McAlpine) G. W. Wilson

On *Lepidium subulatum.*—It has been found and reported by DURRIEU (1964,

1966) in Huesca (Almudevar). He uses the name of *P. maublancii* Săvul. & Rayss. GÄUMANN (1923) described two species of *Peronospora* on *Lepidium*, which I have rejected (GUSTAVSSON, 1959b), and as Săvulescu and Rayss have described this species after investigating very little material, I cannot consider it reliable.

On *Lepidium graminifolium*.—It is known from one collection, made by Losa España (1945) in Gerona (Ripoll): "No se conocía citada sobre esta matriz."

Peronospora parasitica (Pers.: Fr.) Fr.

On *Capsella bursa-pastoris*.—It is one of the most easily discovered species within the genus owing to the bright white color and the often heavily infected and twisted stems and flower-stalks of the host. In many countries it is one of the most common *Peronospora* species, and this is presumably also the case in the Iberian Peninsula. LÁZARO E IBIZA made the first report in 1920 –"Norte y centro"–, which is quoted by GONZÁLEZ-FRAGOSO in 1924 (Sevilla, 1914 and 1916, MA). The first one contains mainly *Albugo candida* but there is also a very weak infection of *Peronospora*, and BENITO MARTÍNEZ (1930) found it in Madrid. J. Girbal has collected it in Gerona: Celrá, in 1982 (BCB Mycotheca). I have made several collections: Gerona (Setcases, El Boix, Bolvir, Isóvol, and Vallfogona), Huesca (Jaca, Canfranc, and Benasque), León (Confiñal) and Burgos (Cornudilla). I also found this species in Andorra (Bixesarri, July 1990). Collections have even been reported from Portugal (LUCAS & SOUSA DIAS, 1976).

Peronospora alyssi-calycini Gäum.

On *Alyssum alyssoides*.—It is represented by only one collection made by J. Cogolludo in Madrid: La Moncloa, in 1920 (MA) and reported in the literature by GONZÁLEZ-FRAGOSO (1924).

Peronospora nesliae Gäum.

On *Neslia paniculata*.—It has in Spain been found only by UNAMUNO (1930a) in Albacete: Caudete, 1928, MA, "La matriz y la forma son nuevas para nuestra flora". I have found *Neslia* in Spain in a few localities but not seen its *Peronospora* there. Like other *Peronospora* species on plants within this family this one is bright white and very easy to detect even if the infection is only in a small spot. The flower-stalks are sometimes twisted and covered by the white layer of conidiophores.

* **Peronospora dentariae** Rabenhorst

On *Cardamine amara*.—It has been found by J. Girbal in Gerona: Bescanó, in 1988 (BCB Mycotheca). I have examined this host in several localities in Spain but without results. My investigations in Scandinavia have given a far better result in this case –the fungus is not difficult to find and is not easily overlooked owing to its white color.

On *Cardamine hirsuta*.—It has been reported from Portugal (LUCAS & *al.*, 1982) and was found by S. Santamaría in Gerona: Riells i Viabrea, in 1990 (BCB Mycotheca). My investigations on this and other *Cardamine*-species like *C. flexuosa* have not given any new localities for *Peronospora*.

Peronospora arabidopsidis Gäum.

On *Arabidopsis thaliana*.—It has been recorded for Portugal (LUCAS & *al.*, 1982). I have not been able to study the spring flora in Spain and have thus not been able to investigate this species. A spring investigation would very likely reveal a number of new localities –this species is quite common in other countries.

Peronospora rorippae-islandicae Gäum.

On *Rorippa nasturtium-aquaricum (Nasturtium officinale)*.—It has been reported once from Portugal (LUCAS & SOUSA DIAS, 1976).

* **Peronospora coronopi** Gäum.

On *Coronopus didymus*.—It has been found in Portugal (cf. SOUSA DA CAMARA & *al.*, 1936 as "new to Portugal"; LUCAS & SOUSA DIAS, 1976), but my collections from Navarra (Ventas de Yanci) and Asturias (El Condado) seem to be the first ones from Spain.

On *Coronopus squamatus*.—It is reported from Portugal (SOUSA DIAS & SOUSA DA CAMARA, 1953; LUCAS & SOUSA DIAS, 1976). The first Spanish collections were made by J. Girbal in Barcelona (Prat de Llobregat) in 1990 and 1991 (BCB Mycotheca).

* **Peronospora matthiolae** Gäum.

On *Matthiola incana*.—It was collected by R. Sardiña in 1922 (MA) in Galicia (Coruña, Vilaboa) but has evidently not been reported in the literature before.

Peronospora cheiranthi Gäum.

On *Cheiranthus cheiri*.—It is known from three Spanish localities (MA), Asturias: Llanes (GONZÁLEZ-FRAGOSO, 1924), Vizcaya: Durango, Santa Susana, leg. Unamuno, not published before, and Barcelona: Bellaterra, 1991, J. Girbal (BCB Mycotheca).

Peronospora niessleana Berl.

On *Alliaria petiolata*.—It is first mentioned for Spain by LÁZARO E IBIZA (1920), who wrote: "Alliaria... Norte y Centro". GONZÁLEZ-FRAGOSO has quoted this in 1924. The species has later been collected by J. Girbal in Gerona: Bescanó, in 1987 (BCB Mycotheca). The fungus is easily recognized by the yellowish parts of the host leaves.

* **Peronospora sisymbrii-officinalis** Gäum.

On *Sisymbrium officinale*.—It has not been previously recorded for the countries studied here but has been found in several places during my studies: Gerona (Setcases, Abella, and Rocabruna), Lérida (Esterri d'Aneu), Navarra (Ventas de Yanci), Cantabria (La Hermida and Puerto de San Glorio), and León (Cofiñal). Also large populations of the host are often heavily attacked by this species, which

is easily seen by the yellow spots on the upper sides of the leaves and the snow white conidiophore layer ties.

On *Sisymbrium irio*.—This infection was found by J. Girbal in Barcelona (Prat de Llobregat) in 1991 (BCB Mycotheca).

*** Peronospora biscutellae** Gäum.

On *Biscutella laevigata*.—It has been reported from few countries (cf. GÄUMANN, 1923). The first locality –and thus far the only one– from the area studied here was found by me in Huesca (Baños de Benasque) in 1989. The infection was rather weak and difficult to find, as the host did not show any clear signs of an infection. The fungus may thus not be so rare as it appears –it may just be overlooked.

Peronospora camelinae Gäum.

On *Camelina* sp.—It has been reported very briefly by LÁZARO E IBIZA (1920). He writes "*Camelina*" without giving the species and only "Norte y Centro". GONZÁLEZ-FRAGOSO in 1924 quoted this without comments. I have found this fungus in other countries –in Scandinavia and in Canada– but when I have found *Camelina* in Spain, there has been no *Peronospora*. The fungus is as a rule very easily seen as it seriously disturbs the growth of the stems, the flowers and the flower-stalks, which get badly twisted and often to a large extent are covered by the white layer of conidiophores.

Species on *Resedaceae*

*** Peronospora crispula** Fuckel

On *Reseda lutea*.—It is a rather difficult species to find owing to the often quite small infections, which do not seem to cause the host any visible problems. With this in mind since earlier studies I investigated this host species and *Reseda luteola* very carefully in many localities in northern Spain. The only locality where the parasite could be found was Linás de Broto in Huesca, but I still do not think that this is a rare species –I might have overlooked it in spite of many years of experience with it.

Species on *Rosaceae*

Peronospora sparsa Berk.

On *Rosa* sp.—It is reported for Portugal by LUCAS & SOUSA DIAS in 1976 as occurring in greenhouses. This has been the case also in many other places –*Peronospora sparsa* is perhaps not found anywhere in a certain area except on roses in greenhouses.

Species on *Leguminosae*

Peronospora cytisi E. Rostrup ("L. Rostrup" is a misprint in the description but quoted by some authors, also by Unamuno below)

On *Laburnum anagryoides (Cytisus laburnum).*—It has been reported by UNAMUNO (1935b) from one locality, Vizcaya: Abadiano, in 1934 (MA), also with oospores –"es especie nueva para nuestra flora". This fungus may be rare or difficult to discover –my experience is in this case quite small. Most *Peronospora* species on hosts within *Leguminosae* give very clear symtoms on the host, but they are often found on only a few leaves of a host. They may thus easily be overlooked.

Peronospora ononidis G. W. Wilson

On *Ononis breviflora, O. mitissima,* and *Ononis* sp.—It was reported by SOUSA DA CAMARA & *al.* (1936) on the former two hosts as new to Portugal and by SOUSA DA CAMARA & OLIVEIRA (1944) on *Ononis* sp. I have found no records in the Spanish literature concerning this fungus, and my numerous investigations of *Ononis* in the field have given no results.

Peronospora aestivalis H. Sydow

On *Medicago ciliaris.*—It has been reported from Portugal (SOUSA DA CAMARA & OLIVEIRA, 1944).

On *Medicago hispida* and *M. littoralis.*—It has been found on Mallorca (JØRSTAD, 1962).

On *Medicago truncata.*—It has also been reported from Portugal (LUCAS & *al.*, 1982) –called *P. trifoliorum* de Bary.

On *Medicago* sp.—It was also found in Portugal (LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982).

On *Medicago sativa.*—It was first reported from Spain by LÁZARO E IBIZA in 1920 –"alfalfas, región central y septentrional", which appears to be quoted by GONZÁLEZ-FRAGOSO in 1924. UNAMUNO has one record in 1927 –Vizcaya: Izurza, 1926, MA–, "Nueva para la flora española", which thus is not quite correct, as the fungus has been reported here twice before. I have studied this host, both cultivated and in the wild, in several places and found its *Peronospora* to be quite common. I have thus found it in Gerona (Puigcerdá and San Joan de les Abadesses), Lérida (Port de Perves), Huesca (Abella, Seira, Linás de Broto, Borrau and Bisaurri), Navarra (Lodosa), Burgos (Poza de la Sal and Santa María Rivarredonda), and La Rioja (Ansejo). It seems quite clear that this fungus makes heavier attacks when the host is grown in a dense population in a not very dry field than when it is found in a population on dry ground. Non-cultivated, often small host types in a dry environment do not show very heavy attacks either. Even if there are fields with vast infections, I do not believe that the damage is of great economic importance.

It should be noted that *Peronospora aestivalis* has been described for *Medicago sativa,* and that the other hosts mentioned above have been placed here because there are no detailed studies about their parasites; I then follow what is written by earlier authors. New investigations should be carried out here.

Peronospora medicaginis-minimae Gaponenko

On * *Medicago lupulina.*—It has evidently not been reported from the Iberian Peninsula before, probably due to the lack of investigations, as the fungus does

not seem to be rare. It is very easily found through the yellowish stripes on the leaves just as on a *Peronospora*-infected *Trifolium*. I have found this fungus in Gerona (Tregurá), Lérida (Llavorsí, Espot and Viella), Huesca (Aneto) and Asturias (San Antolín). I also found the parasite in Andorra (Bixesarri, July 1990).

On *Medicago minima*.—It is known from Portugal through literature records (SOUSA DA CAMARA & *al.*, 1936, as new for the country; LUCAS & SOUSA DIAS, 1976).

In an earlier work (GUSTAVSSON, 1959b) I counted the species on *Medicago lupulina* as *P. romanica* Săvul. & Rayss. There seems to be no doubt, however, that the disposition used here is the more correct one.

Peronospora meliloti H. Sydow

On *Melilotus* sp.—It was first reported for Spain by LÁZARO E IBIZA in 1920: "melilotos, región septentrional y central", which is quoted by GONZÁLEZ-FRAGOSO in 1924.

On *? *Melilotus albus*.—It has not certainly been reported from Spain (*Melilotus* sp. above?), where it, however, seems to be far from rare. I found it in Lérida (Escaló – two localities, Espot and El Pont de Suert), Huesca (Noales), Navarra (Burgui and Lecumberri) and Asturias (Lugones). Two of my collections are from Andorra (Bixesarri and El Serrat, July 1990).

On *? *Melilotus officinalis*.—It is reported as new to Spain with a question mark here (*Melilotus* sp. above?) through my collections in Huesca (Baños de Panticosa) and León (Embalse del Porna).

On *Melilotus segetalis* and *M. sulcata*.—It is found in literature reports from Portugal (LUCAS & SOUSA DIAS, 1976; SOUSA DA CAMARA & *al.*, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944, respectively).

Peronospora trifoliorum de Bary

On *Trifolium incarnatum*.—It is found in the Portugese literature as an unclear report (cf. LUCAS & SOUSA DIAS, 1976, "*Trifolium* cf. *incarnatum*").

Peronospora trifolii-pratensis A. Gust.

On *Trifolium pratense*.—It was probably reported for Spain in 1920 by LÁZARO E IBIZA: "sobre tréboles, región septentrional y central", but the exact host species is not given. This report is apparently quoted by GONZÁLEZ-FRAGOSO (1924), who gives the host as *Trifolium pratense* – he may thus have seen collected material or presumed that "tréboles" must be just this clover species. I have no investigations of my own to compare with this statement, and I have seen no herbarium material from Spain.

***Peronospora trifolii-arvensis** H. Sydow

On *Trifolium arvense*.—It does not seem to have been reported from Spain before, and my collections from León (Llánaves and Portilla de la Reina) are most likely the first ones. In both localities the infection was widespread in a large number of host plants, and many of these were heavily infected. In spite of this

they did not seem to suffer very much from the disease, and the flowers were developed just as on specimens without infection.

*** Peronospora trifolii-minoris** Gäum.

On *Trifolium campestre.*—It was found during my field trips in Huesca (Canfranc and Torla), in Cantabria (Fuente Dé), and in León (Vegacarneja).

On *Trifolium dubium.*—It was also found in León – Vegacarneja – in exactly the same place as on the previous host. The populations of the two *Trifolium* species grew close to each other, and there was also a certain overlapping. There seemed to be little doubt that the fungus could have been spread from one host species to the other, and this appeared to be a natural infection experiment showing that this *Peronospora* really can cross over between the two host species.

*** Peronospora trifolii-repentis** H. Sydow

On *Trifolium repens.*—It has not been reported earlier from the studied area, which may results from a certain difficulty in finding it. As most other *Peronospora* species on *Trifolium* it is easily discovered owing to the yellow colored parts between the veins on the leaves. The problem is that very few plants may be infected in a large population, just as pointed out for *Ranunculus* above. There is a considerable variation –I have scrutinized whole fields with *Trifolium repens, T. pratense,* or *T. hybridum* without finding any *Peronospora* at all or just a scanty infection on a single leaf, and in very rare cases I have found very heavy infections on many host specimens. In a case like this it is quite understandable if the fungus has been overlooked in many localities. I have found it in Gerona (Puigcerdá and Bolvir), Lérida (Llavorsí, Valencia d'Aneu, Garós, and Pont d'Arros), Huesca (Canfranc and Fiscal), and Cantabria (Vega de Pas).

Peronospora sp. *(Peronospora trifoliorum* de Bary, s.l.)

On *Trifolium resupinatum.*—It is reported from Portugal (LUCAS & *al.*, 1982).

On *Trifolium subterraneum.*—It is also reported from Portugal (LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982).

This is a very uncertain field taxonomically. GÄUMANN states (1923: 215), that the position of these *Peronospora* forms has not been elucidated. To put them under "*P. trifoliorum*" above would just place the parasite(s) where it/they probably not belong, unless this taxonomic unit is used in a very wide sense, which I do not think would be a correct way to go. As it is beyond the scope of this paper to make a closer investigation here, I prefer to use "*Peronospora* sp." in this case.

Peronospora coronillae Gäum.

On *Coronilla glauca.*—It has been described as a new species, *P. coronillicola,* by SOUSA DA CAMARA & OLIVEIRA (1944) from a Portugese collection. I find, however, that there are no certain differences between their species and the one described by Gäumann, and I regard them as synonyms. I have (cf. GUSTAVSSON, 1959b) criticized the method of describing new species after comparing just one collection with another.

On *Coronilla scorpioides*.—It is reported by the same authors (SOUSA DA CAMARA & OLIVEIRA, *l.c.*) as new to Portugal, but in this case they use the name given by Gäumann.

Peronospora sp.

On *Hippocrepis unisiliquosa*.—It has been listed by SOUSA DA CAMARA & *al.* (1936) as new to Portugal. They also give a description in latin of what they must have regarded as a new species, but they do not give it a name. It is thus of interest to search for more material of this fungus.

***Peronospora lotorum** H. Sydow

On *Lotus corniculatus*.—It is probably another overlooked species. The leaves of the host do not show much of the infection except that they often turn slightly yellowish, but there may still be a well developed layer of conidiophores on their undersides. I found this species in Lérida (Puerto de Bonaigua) and Asturias (Bezanes).

Peronospora ornithopi Gäum.

On *Ornithopus pinnatus* and *Ornithopus* sp.—They are found in the Portuguese literature (LUCAS & SOUSA DIAS, 1976; SOUSA DA CAMARA & OLIVEIRA, 1944, respectively).

Peronospora viciae (Berk.) de Bary

On *Vicia* sp.—It has been reported for Spain by LÁZARO E IBIZA (1920): "región septentrional y central", which has been quoted by GONZÁLEZ-FRAGOSO (1924), using the name of *P. viciae-sativae* Gäum., which might indicate that he has seen a collection, unknown to me, on *Vicia sativa*. He reports this fungus even on *Vicia* sp., both from Spain and Portugal.

On *Vicia angustifolia*.—It was first reported from this region by DURRIEU (1966), who found it in Huesca (Monegrillo). I have found that infections on this host and the following one appear to be very frequent. There have been no difficulties in finding them in Gerona (Llanars, Tregurá, Pardines, and Planolas), Lérida (Llavorsí and Arties), Huesca (Aneto, Laspaúles, Neril, Canfranc, Bisaurri, and Col de Fadas), Vizcaya (Lanestosa), León (Vegacerneja), Asturias (Bezanes, San Esteban de los Buitres), and Burgos (Puerto de Canales).

On *Vicia sativa*.—It was first reported for Spain by GONZÁLEZ-FRAGOSO (1924) from Asturias (Llanes). JØRSTAD (1962) found it in Mallorca, and there are also reports from Portugal (LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982). I found it in Lérida (Arrós and Arties), Huesca (Linás de Broto), Asturias (Grado, Coaña, and Gobiende), and Cantabria (La Hermida and Roiz).

In some cases it may be difficult to separate *V. angustifolia* and *V. sativa*. There are, of course, the simple cases, where the determination is without problems, but there are also cases where the two species are very hard to keep apart. This is true especially in cases where the *Peronospora* infection has been so harmful to the host plant that it has not been able to grow to normal size and appearance. It

may also be difficult to find out whether or not a plant has really been demaged in cases where it is entirely covered by the parasite.

On * *Vicia dasycarpa.*—It was first found by me in Gerona (Bolvir) in 1989. I have found no other material or literature records from the Iberian Peninsula.

On * *Vicia pannonica.*—It was also found 1969 in Gerona (Isóvol).

On * *Vicia lutea.*—It is also new to this region, found by me in 1990 in León (Embalse del Porna).

On *Vicia pyrenaica.*—It was found by DURRIEU (1966) in Huesca (Turbon).

On *Vicia disperma.*—It is reported from Portugal (LUCAS & SOUSA DIAS, 1976).

***Peronospora ervi** A. Gust.

On *Vicia hirsuta.*—It was found by me in Gerona (Llanars) and Lérida (Arrós).

On *Vicia tetrasperma.*—It was found by me in Cantabria (Rioz), which seems to be the first Spanish locality.

On *Vicia pubescens.*—It is from a collection in Asturias (Gobiende). This is probably a new host for *Peronospora ervi.* As the infection is very similar to those on *V. hirsuta* and *V. tetrasperma,* I think there are good reasons to believe that it is the same fungus, but further studies should be carried out here.

This *Peronospora* makes a very "weak impression" –it is often restricted to small parts of a few leaves, and it is thus easily overlooked. Its appearance is not at all the same as the one of the, apparently very "strong" *Peronospora* on, e.g., *Vicia angustifolia, V. sativa, V. sepium,* or *V. cracca,* which may be completely covered, even the tendrils, by a compact layer of conidiophores.

Peronospora narbonensis Gäum. *(P. viciae*?)

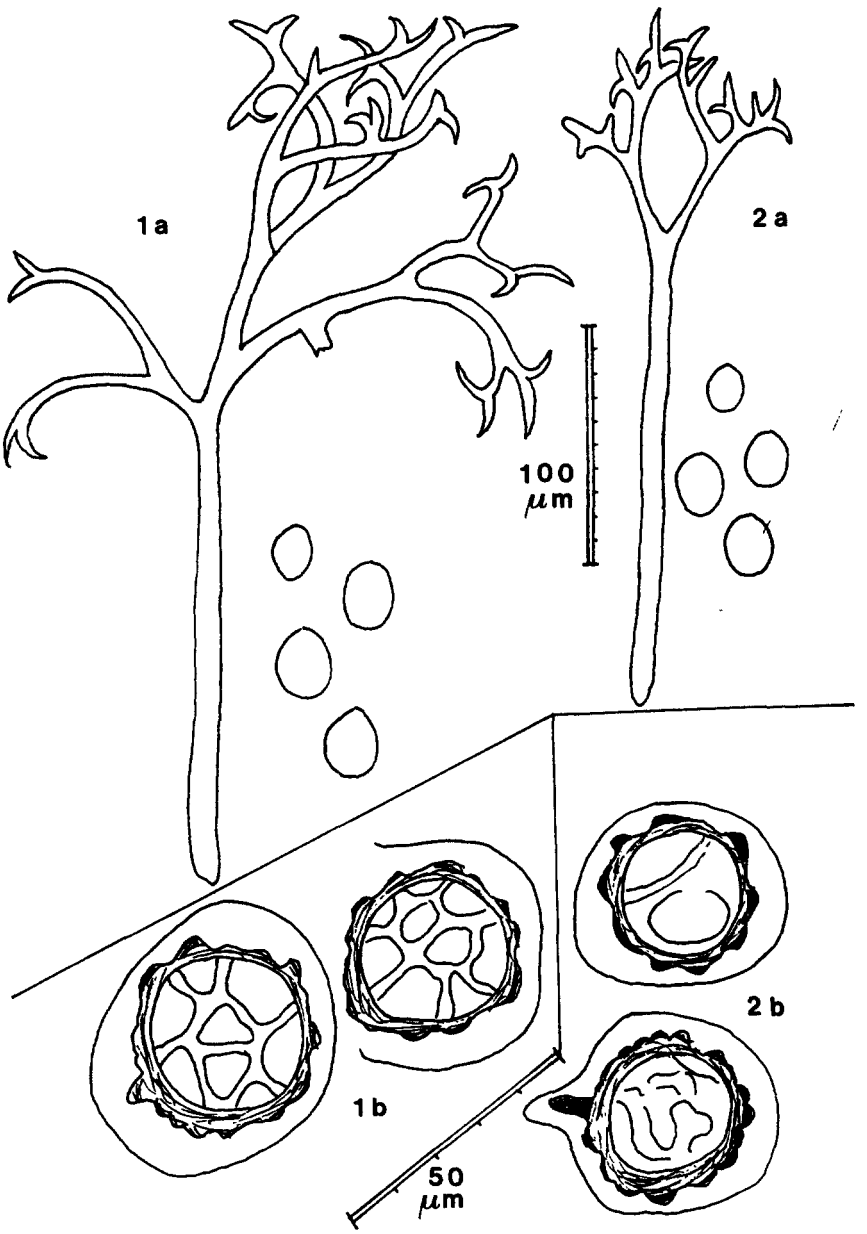
On *Vicia narbonensis.*—It was reported from Spain (Andalucía, Sevilla, Huévar, MA) by GONZÁLEZ-FRAGOSO in 1924 and has 1986 been found by E. Descals in Barcelona, Cerdanyola (BCB Mycotheca). Oospores are present in this collection. Gäumann's studies of this species are perhaps not extensive enough to allow a separation of this species from *P. viciae* –new investigations are needed.

***Peronospora sepium** Gäum.

On *Vicia sepium.*—It has evidently not been the subject of earlier investigations in this area, but I found it in Gerona (Setcases and Ribes de Freser), Huesca (Linás de Broto), Asturias (Buelna), and Burgos (Cilleruelo de Bezana). It is easily found, as it in most cases cover the entire undersides of the then somewhat yellowish leaves, which are also to a certain degree bent and rolled backwards. According to my earlier experiences from Sweden this species is very common early in spring on very young leaves.

Peronospora lathyri-palustris Gäum.

On * *Lathyrus latifolius.*—It was found for the first time in Spain by me in Lérida (Arrós) in 1990 (fig. 4) but had been previously reported from Portugal *("Lathyrus* cf. *latifolius")* by LUCAS & *al.* in 1982. The infection in Arrós was very heavy in a large population where it covered the plants almost entirely. An earlier



Figs. 1.—a, Conidiophore and conidia of *Peronospora orobi* on *Lathyrus montanus*. Spain, Lérida, 8 km south of Viella, mountain slope, alt. 1600 m, 20 June, 1989. Collection 7488. b, Oospores of same *Peronospora* species and host from Norway, Telemark, Skåtöy, 20 June, 1937, A. Hagen (Herbarium of the Botanical Institute, Oslo University). Figs. 2.—a, Conidiophore and conidia of *Peronospora fulva* on *Lathyrus pratensis*. Spain, Lérida, Ribera de Cardós, humid field, 18 June, 1989. Collection 7464. b, Oospores from same collection as in 2a.

statement by VIENNOT-BOURGIN (1950), that a sparse layer of conidiophores is typical for this species and that it is restricted to small parts of the leaves does not coincide with my observations. When describing the new species *P. lathyrina* Viennot-Bourgin had probably found a weak infection, and not taken into consideration the great variation one might find between different localities for the same *Peronospora* species. I regard *P. lathyrina* as a synonym of *P. lathyri-palustris*.

On *Lathyrus silvestris*.—It has been found by DURRIEU (1966) in Huesca (Sallent).

* **Peronospora fulva** H. Sydow

On *Lathyrus pratensis*.—It was found in Lérida (Ribera de Cardós) during my studies (figs. 2a-b) but has evidently not been reported from this area before.

* **Peronospora orobi** Gäum.

On *Lathyrus montanus*.—It seems to be new for the Iberian Peninsula. My only locality (figs. 1a-b) is from Lérida (Viella).

Peronospora senneniana González-Fragoso & Saccardo

On *Lathyrus niger*.—It is a species with long and rather narrow conidia, which clearly separates it from most other *Peronospora* species. It was collected by Sennen in 1916 in Gerona: Planes, alt. 1450 m (MA), and was reported by GONZÁLEZ-FRAGOSO (1917, 1924) twice from that place. I have no experience of this species from Spain but have studied it somewhat in Sweden, and it appears to me that the host species, like *Lathyrus vernus* (not discussed here) might be infected in most localities.

On *Lathyrus laevigatus* (new as *Peronospora*-host)?—It is from Andorra: El Serrat, Pont de l'Estrell, humid grass slope, 27 June, 1990, leg. Ingrid Gustavsson. Figure 3 shows a conidiophore and conidia from this collection. The conidiophores of this species differ from those of other *Peronospora* species on *Lathyrus* in their a coarser, but not taller appearance. The branch ends are often thicker and more irregular than those of the other species. The conidia also differ greatly from the other species –see below.

Peronospora sp.

On *Lathyrus* sp.—It was reported from Portugal by SOUSA DA CAMARA & OLIVEIRA in 1944. I have not studied this collection.

Special study of the fungi on Lathyrus

As there are several *Peronospora* species described for *Lathyrus*, and as a closer investigation has been needed for the determination, I have made measurements of conidiophores, conidia, and –if possible– oospores in some cases. There are a few older studies published (GONZÁLEZ-FRAGOSO, 1917; GUSTAVSSON, 1959b), and I have included part of them as a comparison.

CONIDIOPHORES AND CONIDIA

Host	Average size of stem, crown, and whole conidiophores (µm)	Minimum, average, and maximum size of conidial Length and Breadth, Quotient average (µm)
L. latifolius E 1	170-150-320 ($n = 15$)	L: 22.8-27.3-31.1 B: 14.5-19.0-24.8 Q: average 1.43
L. pratensis S 1		averages L: 22.0 B: 17.5 Q: 1.26
S 2		L: 21.7 B: 17.7 Q: 1.23
S 3		L: 21.3 B: 18.2 Q: 1.17
E 4	180-120-300 ($n = 31$)	L: 18.6-22.3-26.9 B: 14.5-17.6-20.7 Q: average 1.27
L. montanus S 1		averages L: 20.7 B: 16.6 Q: 1.24
S 2		L: 21.7 B: 15.9 Q: 1.36
S 3		L: 24.2 B: 18.9 Q: 1.28
E 4	170-140-300 ($n = 34$)	L: 20.7-25.6-28.9 B: 14.5-18.9-22.8 Q: average 1.35
L. niger E 1 (in GONZÁLEZ-FRAGOSO, 1917)		species description: L: 35-38 B: 16-19
CH 2		averages L: 34.6 B: 18.6 Q: 1.86
S 3		L: 32.8 B: 16.8 Q: 1.95
L. laevigatus A 1	160-140-380 ($n = 21$)	L: 31.1-37.8-43.8 B: 16.6-21.0-26.9 Q: average 1.80

OOSPORES

Host	Minimum, average, and maximum size of Length and Breadth, quotient average (μm)
L. montanus N5	L: 24.8-30.7-37.3 B: 24.8-29.1-35.2 q: 1.00-1.05-1.13
N6	L: 26.9-36.4-43.5 B: 24.8-35.0-41.4 q: 1.00-1.06-1.23
L. pratensis E4	L: 24.8-30.9-35.2 B: 24.8-29.4-33.1 q: 1.00-1.05-1.15
N5	L: 26.9-31.4-35.2 B: 24.8-30.0-35.2 q: 1.00-1.05-1.14

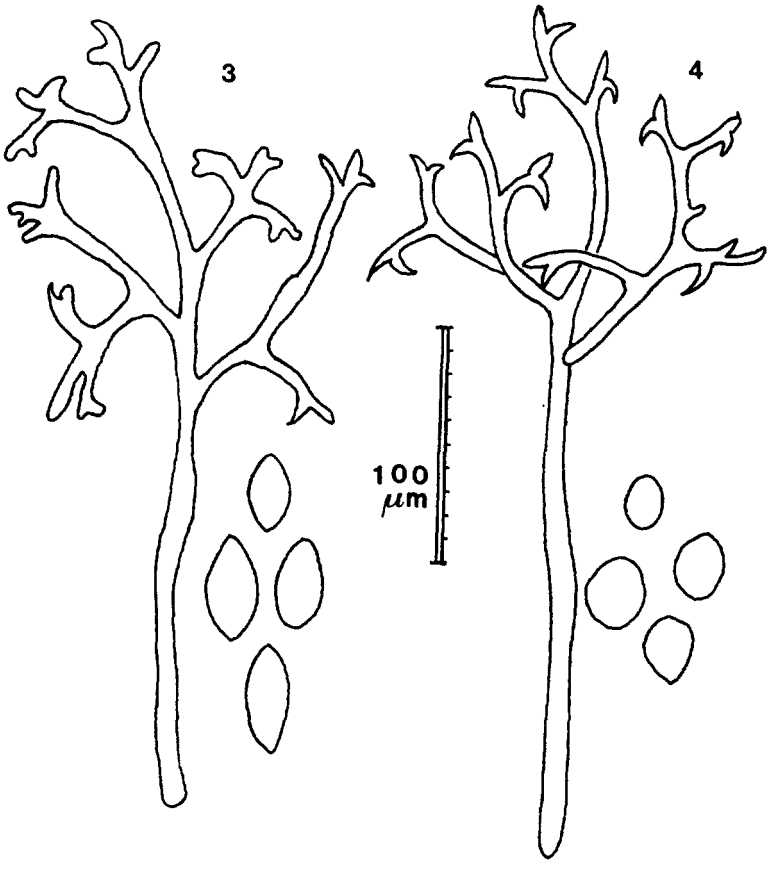


Fig. 3.—Conidiophore and conidia of *Peronospora senneniana* on *Lathyrus laevigatus*. Andorra, Pont de l'Estrell, humid mountain slope, 27 June, 1990. Collection 7750, leg. Ingrid Gustavsson. Fig. 4.—Conidiophore and conidia of *Peronospora lathyri-palustris* on *Lathyrus latifolius*. Spain, Lérida, Arrós, grassy mountain slope, 26 June, 1990. Collection 7731.

Localities marked E and A are from Spain or Andorra and mentioned above (also GONZÁLEZ-FRAGOSO, 1917), and localities marked N or S are from Norway or Sweden and published earlier (GUSTAVSSON, 1959b) or studied recently without publication. The collection marked CH is from Switzerland and published by GÄUMANN (1923).

Discussion of results given in the tables.—The fungi on *Lathyrus latifolius, L. pratensis* and *L. montanus* are placed under different *Peronospora* species as done above without difficulties –observe, e.g., that the conidiophores of *P. fulva* on *L. pratensis* has considerably smaller conidiophores than the other fungi (see also fig. 2a). The measurements agree well with earlier studies. However, there is the infection on *Lathyrus laevigatus,* which is a new host to *Peronospora.* A comparison with the fungi on other *Lathyrus* species is thus the only way to identify the parasite in the new collection.

The table and the figures show that there is little doubt that the fungus on *L. laevigatus* is not *P. lathyri-palustris, P. fulva,* nor *P. orobi.* The conidia are much longer, and the quotient between length and breadth is 1.80 compared to values up to 1.43 for the other species. The conidiophores do not differ very much in total size between different *Peronospora* species on *Lathyrus,* but the crown of *P. fulva* is clearly smaller than that of the other ones. The drawings clearly show these differences.

It is most interesting that the parasite on *Lathyrus laevigatus* seems to be *Peronospora senneniana,* which is known only from *Lathyrus niger* and which was described from a collection from this region, found in Planes in Gerona in 1916 –see above. The statements in the description and my earlier measurements agree well with what I have found now –the differences between different collections may well be caused by natural variations.

I found oospores in only one collection of those species of interest here, in *Lathyrus pratensis* from Ribera de Cardós (see drawing). I have compared this one with three Norwegian collections, one with material of *L. pratensis* and the other of *L. montanus.* The picture shows clearly that oospores of *Peronospora fulva* on the former host seem to show warts and irregular ridges on the oospore surface, and that oospores of *P. orobi* on the other host have more of a netlike wall structure (see figures 1b and 2b). It is interesting that two *Peronospora* species, most probably closely related to each other, show differences in oospore appearance.

Despite careful seaching I found no oospores in infected material of *Lathyrus latifolius, L. montanus* or *L. laevigatus* from Spain or Andorra. Studies of older, perhaps withered, material may give better results. There have been no difficulties in finding oospores in material of *L. montanus* from northern Europe, but I have then often used old and heavily damaged material, which I could not find this time.

Peronospora pisi H. Sydow

On *Pisum sativum.*—It was first recorded for Spain by LÁZARO E IBIZA in 1920: "región septentrional y centro", and this was quoted by GONZÁLEZ-FRAGOSO in 1924. In spite of this UNAMUNO writes in 1930: "matriz nueva para nuestra flora". His collections are from Huelva (Huelva and La Rábida). In 1935 (UNA-

MUNO, 1935a) he reports a locality also from Barcelona: "Segunda cita sobre esta matriz en la flora de Cataluña". *Peronospora pisi* on *Pisum sativum* has been reported also from Mallorca (JØRSTAD, 1962) and Portugal (GONZÁLEZ-FRAGOSO, 1924; SOUSA DA CAMARA, 1936; LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982). Being primarily intersted in *Peronospora* on wild plants I have paid little attention to this one. I have a definite impression from earlier studies in other countries, however, that it is quite common. It is easy to detect by the small leaf spots in red, brown or yellow. I have very seldom seen heavier infections on the leaves, but there have been occasions where the pods have been heavily damaged, also by oospores.

Species on *Geraniaceae*

Peronospora conglomerata Fuckel

On *Geranium dissectum.*—It has been found in Portugal (SOUSA DA CAMARA & *al.*, 1936; LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982) but apparently not in Spain.

On *Geranium pratense.*—It is reported by GONZÁLEZ-FRAGOSO (1924) for Spain from Lleida (Cerdaña: Estavar / MA / and Onzés). However, the fungus in this collection is, as could be expected, *Plasmopara pusilla* (de Bary) Schröter. DURRIEU (1966) has evidently not studied this collection but writes quite correctly "hôte douteux pour ce Mildiou".

On * *Geranium molle.*—It has been found for the first time in Spain during my work in Gerona (Sant Hilary Sacalm) and in Asturias (Buelna). The infections have been rather weak and without the typical symptoms where *Geranium* leaves are entirely covered by the dense, dark conidiophore layer on the undersides, and where the leaves are smaller or much smaller than usual and entirely yellowish.

On *Geranium purpureum.*—It is known from a literature report from Portugal (LUCAS & *al.*, 1982).

On * *Geranium pusillum.*—It was found by me under similar circumstances and with similar symptoms as described under *Geranium molle* above in Gerona (Llanars and Ribes de Freser).

Peronospora erodii Fuckel

On *Erodium chium.*—It was reported by UNAMUNO (1930b) from Huelva (no exact locality given): "matrix nova y segunda cita de la especie en nuestra flora", 1929 (MA).

On *Erodium cicutarium* and *E. malachoides.*—It was reported by LÁZARO E IBIZA in 1920 for the first on these hosts in this area and by GONZÁLEZ-FRAGOSO (1924) —referring to the former author concerning the first host and to a collection made together with A. Caballero (Barcelona) (MA) as to the second one. I have examined this collection, also mentioned by DURRIEU (1966), but I did not find any *Peronospora* in it —the infection might have been so weak that it now cannot be found without a very thorough search, which would damage this old material too much.

This fungus on *E. cicutarium* is difficult to discover. It very seldom covers large parts of the leaves. As a rule the infection is restricted to small parts of the leaves,

especially at the tops of the leaf lobes. These turn yellow or red. The fungus is thus very easily overlooked, but I have found it many times in northern Europe, especially late in the fall. I made a few investigations of *Erodium cicutarium* in Spain but did not find any *Peronospora*. The result might be different if I looked for it during the fall.

Species on *Euphorbiaceae*

Peronospora cyparissiae de Bary

On *Euphorbia cyparissias*.—It was found by DURRIEU (1966) in Huesca (Puerto de Fadas and Plan de Gistain).

Peronospora euphorbiae Fuckel

On *Euphorbia peplus*.—It was reported for Sevilla (Dos Hermanas) by GONZÁLEZ-FRAGOSO in 1924 (MA). I have studied this collection but could find no *Peronospora* in it —I had to study the delicate material very carefully. The fungus has been found on this host also by JØRSTAD (1962) in Mallorca.

On *Euphorbia* sp.—It is found in a report from Portugal (SOUSA DIAS & LUCAS, 1962) as new to this country.

Peronospora embergeri Mayor & Viennot-Bourgin

On *Euphorbia characias*.—It is recorded from Portugal (LUCAS & SOUSA DIAS, 1976).

On *Euphorbia* sp.—It is also reported from Portugal (SOUSA DIAS & LUCAS, 1974; LUCAS & SOUSA DIAS, 1976).

The *Peronospora* species on *Euphorbia* does not seem to have been investigated to any greater extent —it is perhaps doubtful that there is more than one *Peronospora* species— and as the determination of the hosts also seems to be somewhat unclear in some cases, a new investigation is needed here.

Species on *Cistaceae*

Peronospora leptoclada Saccardo

On *Cistus psilosepalus*.—It is recorded from one locality in Portugal (SOUSA DIAS & LUCAS, 1974; LUCAS & SOUSA DIAS, 1976).

Species on *Violaceae*

* **Peronospora violae** de Bary

On *Viola arvensis*.—It was in Spain first found by M. Bausá in Salamanca: La Alberca, 1945, MA —not previously reported in the literature— and during my journeys in Gerona (San Joan de les Abadesses and Bolvir) and in León (Portilla de la Reina).

On *Viola tricolor*.—It was collected by me in Gerona (Setcases).

This species is very frequent, especially on *Viola arvensis*, in different parts of Europe, and is one of the most common *Peronospora* species of northern Europe,

especially in the fall. With this in mind it should surely be worthwhile to search tor it also in other localities in the Iberian Peninsula. The signs of the disease are quite easily observed: the leaves turn yellowish, often with brown or violet stripes and they are slightly bent backwards. The entire underside is often covered by the dense felt of conidiophores of a bright violet color.

Species on *Primulaceae*

Peronospora candida Fuckel

On *Anagallis arvensis*.—It has been found in Portugal (SOUSA DA CAMARA & *al.*, 1936) but is not reported for Spain.

On *Anagallis foemina*.—It was first reported by DURRIEU (1966) from Barcelona (Berga, Queralt). I discovered it in Navarra (Burgui) in a heavily infected host population. The locality was a very dry sand field, where *Peronospora* should have great difficulties establishing a conidial infection. There could, however, be no doubt that this almost extremely dry field was indeed suitable for the parasite —otherwise it would never have been able to build up an infection to this extent. I have discussed this problem concerning *Peronospora linariae* on *Chaenorrhinum minus* below.

Species on *Gentianaceae*

Peronospora chlorae de Bary

On *Blackstonia (Chlora) imperfoliata* and on *B. serotina*.—It was collected by Sennen in Barcelona: Castelldefels, 1915, and recorded by GONZÁLEZ-FRAGOSO in 1924 (MA), one collection of each host species from the same locality and on the same day.

On **Blackstonia perfoliata*.—It is known from Portugal through literature records (SOUSA DA CAMARA & *al.*, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & *al.*, 1982), and was found for the first time in Spain by S. Santamaría in Barcelona (La Batlloria) in 1990 (BCB Mycotheca).

Our information about this species is very incomplete. GÄUMANN (1923) reports it from France, Germany, Hungary, and Yugoslavia but mainly refers to older authors concerning the parasite itself. DURRIEU (1966) only refers to the older Spanish collections.

***Peronospora erythraeae** Gäum.

On *Centaurium erythraea*.—It has recently been collected for the first time in Spain, in Barcelona (Bellaterra), leg. J. Girbal 1990 (BCB Mycotheca).

Species on *Boraginaceae*

Peronospora omphalodis Gäum.

On *Omphalodes nitida*.—It has once been reported for Portugal (SOUSA DA CAMARA & OLIVEIRA, 1944).

*** Peronospora lithospermi** Gäum.

On *Lithospermum arvense*.—It is a parasite, which is somewhat difficult to discover. The fungus often occurs only on minor parts on the leaves, and these do not change their color very much. This may explain why this species has not been reported from the Iberian Peninsula before. I have investigated the host several times there but found the parasite only once, in Gerona (Puigcerdá).

Peronospora symphyti Gäum.

On *Symphytum tuberosum*.—It was earlier found in Gerona (Bolqueres) and in Vizcaya (Motrico) according to DURRIEU (1966), and was lately collected in Gerona (Llagostera, 1987 and Bescanó, 1989) by J. Girbal (BCB Mycotheca).

Peronospora echii (Krieger) A. A. Jaczewski & P. A. Jaczewski

On *Echium plantagineum*.—It was collected by I. Jörstad on the island of Menorca in 1960, but he just wrote "*Peronospora* sp." I think there are good reasons to believe, however, that this collection should be called *P. echii*, at least until further investigations have shown otherwise.

Species on *Labiatae*

*** Peronospora lamii** A. Braun

On *Lamium amplexicaule*.—It is here reported as new to Spain through my collection in Huesca (Canfranc) but has earlier been found in Portugal on this host (SOUSA DA CAMARA & *al.*, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & SOUSA DIAS, 1976). This parasite is most common in northern Europe during both spring and fall, an this may also be the case in other countries.

On *Lamium hybridum*.—It is represented in Spain by a single collection, made by J. Girbal in 1987 in Gerona: Bescanó (BCB Mycotheca), which has not been published before.

GONZÁLEZ-FRAGOSO (1924) writes concerning this species: "En *Lamium*, citada en Portugal por Sydow y el P. Torrend, y repartida en el Herbario portugués de Sampaio".

Species on *Solanaceae*

Peronospora tabacina Adam

On *Nicotiana tabacum*.—It is one of the most studied *Peronospora* species in the world. It has been reported from Portugal (LUCAS & SOUSA DIAS, 1976; LUCAS & *al.*, 1982), but I have found no records from Spain.

Species on *Scrophulariaceae*

Peronospora antirrhini Schroeter

On *Misopates (Antirrhinum) orontium*.—It was reported as new to Portugal

by SOUSA DA CAMARA & *al.* in 1936 and is also found in the paper by LUCAS & *al.* in 1982. I have found no records from Spain and have not found the host myself.

*** Peronospora linariae** Fuckel

On *Chaenorrhinum minus*.—It was found for the first time in this area during my field trips in 1989 in Lérida (Escaló). It is one of the *Peronospora* species which evidently develops well under very dry conditions. It seems there are no problems for the fungus to infect its host and to develop quite heavy infections, visible on the whole plant. One possible explanation for this is, of course, that the parasite may infect the host plants by oospores in the soil. Another is that the humidity in the air during the night and early morning or after rains is high enough to permit the conidia to germinate and to start the infection.

It is most certainly true, that most *Peronospora* species are found in localities where climatic conditions favor the development of conidia. Studying *Peronospora linariae* and a few other species in dry places, such as *P. candida* and *P. erodii* above, one feels, however, that we might have often overlooked them, as their localities seem to be unsuitable for *Peronospora*.

*** Peronospora sordida** Berk. & Broome

On *Scrophularia nodosa*.—It was found in Gerona (Ribes de Freser) in an environment, which must have been really suitable for a *Peronospora* infection: a vegetation with grasses and other plants growing tall on a rather humid slope in the shadow of a high railway bridge. This fungus is easily detected by the small, brown or yellowish infection areas between the veins of the leaf. It does not seem to follow its host in each locality – I have searched for it many times in vain both in Spain and in other countries.

*** Peronospora grisea** (Unger) Unger

On *Veronica beccabunga*.—It is a species which is easily detected at in a distance because of the symptoms of the host –many specimens in a population are as a rule completely infected by the fungus, their growth is often seriously disturbed, and they turn greyish yellow. The dense layer of the conidiophores covers their undersides entirely –the humid host locality in, e.g., a rivulet must be favorable for infection. I have quite often found this parasite in northern Europe, but in Spain I have only seen host populations without *Peronospora*. It has been found, however, by J. Girbal in Andorra: El Serrat, in August 1989 (BCB Mycotheca).

*** Peronospora agrestis** Gäum.

On *Veronica arvensis*.—It was found twice during my work in Gerona (Tregurá and Setcases). It was probably a little to late in the season to be able to investigate this species more in detail. During earlier investigations have found it primarily during the spring, when it often heavily attacks seedlings and young plants of the host.

On *Veronica persica*.—It was found by me in Gerona (El Boix, Campdevanol, and Vallfogona), in Cantabria (Vega de Pas), and in Asturias (Cornellana). The parasite is easy to find on this host especially during the spring, and I think there

are reasons to believe that the fungus could be found in most host localities. It is important, however to search for it early in the season and to pay special attention to the seedlings – many specimens of these *Veronica* species do not reach beyond that stage, if they are attacked by *Peronospora*.

Species on *Plantaginaceae*

*** Peronospora alta** Fuckel

On *Plantago lanceolata*.—It seems to be present in many host localities – perhaps more regularly than what I have found in northern Europe. The infections may be weak and very difficult to find – the yellowish patterns are seldom so clear as on *Plantago major* (below), and I may have overlooked it in some places. I found the parasite on this host in several localities in Lérida (Rubió, Llavorsí, Garós, Les Bordes, and Pont d'Arrós), Huesca (Abella and Asín de Broto), and Cantabria (Ramales de la Victoria), but I am quite sure that I have overlooked it many times.

On *Plantago major*.—It is common almost everywhere. *Plantago major* may well be the most *Peronospora*-infected plant species in Spain. The symptoms are very easy to see, even without a close look – sharp yellowish patches on the infected leaves and a dark conidiophore layer on the underside of these cannot easily be overlooked. Whole leaves are sometimes infected and carry conidiophores all over their undersides. It therefore seems rather peculiar that there does not seem to be a single literature record of *Peronospora alta* from the whole Iberian Peninsula – there may, of course, be collections I am unawere of.

The first collection I know of was made by J. Girbal in Barcelona: Bellaterra, in 1987 (BCB Mycotheca), and my collection are as follows: Gerona (Santa Fe del Montseny, Setcases, El Boix, Queralbs, Ger, and Vallfogona), Lérida (Ribera de Cardós, Espot – two localities, Valencia d'Aneu, Garós, Les Bordes, Viella, Bossost and Puerto de Bonaigua), Huesca (Seira, Torla, Canfranc, Fiscal, Bisaurri and Linás de Broto), Navarra (Vera de Bidasoa), Cantabria (Gibaja, Ramales de la Victoria, La Hermida, and Puerto de San Glorio), Asturias (Llanes, San Antolín, Asiego, Trescares, Lugones, El Condado, Cornellana, Belmonte de Miranda, Trelles, and Gobiende), León (Cofiñal), and Andorra (El Serrat, Pont de l'Estrell, July 1990, leg. Ingrid Gustavsson).

On *Plantago media*.—It seems to be rarer than on the two other host species. I have studied this host in several localities in different countries but have not very often found it infected by *Peronospora*. I have no satisfactory explanation for this – just to assume that a more hairy leaf is more difficult to infect by a fungus like *Peronospora* does not seem to be enough– there may also be genetical differences between the various host species of importance here. My only Spanish locality is from Huesca (Ordesa National Park).

Species on *Rubiaceae*

Peronospora sherardiae Fuckel

On *Sherardia arvensis*.—It was found in Navarra (Valtierra) by DURRIEU (1966)

and has been reported from some localities in Portugal (SOUSA DA CAMARA & *al.*, 1936; SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & SOUSA DIAS, 1976).

* **Peronospora rubiae** Gäum.

On *Rubia peregrina.*—It had been found in Portugal by LAGERHEIM (1890) about one hundred years ago –new host plant– and also by later authors (SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & SOUSA DIAS, 1976) but was not recorded from Spain. I found it as heavy infections twice in Asturias (La Isla and Gobiende). The infections were easily discovered, as nearly all the leaves on infected plants turned yellow –the picture was almost the same as is often the case when *Peronospora* attacks *Galium aparine* and *G. odoratum.*

Peronospora calotheca de Bary

On *Asperula arvensis.*—It has been reported for Portugal (SOUSA DA CAMARA & OLIVEIRA, 1944; LUCAS & SOUSA DIAS, 1976).

* **Peronospora aparines** Gäum.

On *Galium aparina.*—It is known from Portugal in the literature (LUCAS & SOUSA DIAS, 1976), but I have found no records for Spain. However, this is one of the most common *Peronospora* species at least in the northern parts of the country. It may appear strange that it has not been found before, but this must be due to few investigations. The parasite may be overlooked as it often infects only a few plants in a population, but these hosts may be completely covered by conidiophores on every leaf. They turn yellow and are easily separated from healthy ones at a distance. I have very seldom searched a host locality without finding the parasite. I found it in Gerona (Santa Fe del Montseny, Sant Hilari Secalm, Setcases, El Boix, Puigcerdá, and Vallfogona), Huesca (Linás de Broto), Cantabria (Vega de Pas, Molledo, La Hermida, and Luzmela), Asturias (Arriondas, El Condado, Belmonte de Miranda, Pesoz, Ambás, and Gobiende), León (Cofiñal and Orallo), and Vizcaya (Lanestosa).

Peronospora crucianellae Maire

On *Crucianella angustifolia.*—It has its only known Spanish locality in Huesca (Bujaraloz), found by DURRIEU (1966).

Species on *Valerianaceae*

Peronospora valerianellae Fuckel

On *Valerianella discoidea.*—It has been reported as new to Portugal (SOUSA DA CAMARA & OLIVEIRA, 1944), but there are no reports from Spain. I have studied *Valerianella* a few times there but have not found its *Peronospora,* which may be difficult to see, as the host plant, especially the ageing plant, in itself has such a yellowish color, that it is not changed much by a *Peronospora*-infection. My earlier studies of this species have shown that it is very easily overlooked even upon close examination.

On *Valerianella* sp.—It was found by DURRIEU (1966) in Navarra (Valtierra).

Peronospora sp.

On *Fedia cornucopiae*.—It has been reported under the name of *P. valerianellae* by GONZÁLEZ-FRAGOSO in 1924 for Andalucía (Sevilla). GÄUMANN (1923: 317) suspects that the fungus on *Fedia* is not this fungus but a separate species. As there are no investigations carried out far, I can make no decision here. I agree, however, with GÄUMANN *(l.c.)* that this species most likely is not *P. valerianellae*.

Species on *Dipsacaceae*

Peronospora violacea Berkeley

On *Knautia sylvatica* var. *dipsacifolia* (flowers).—It was found by Sennen in Lérida (Cerdaña: Val de Galba) and reported by GONZÁLEZ-FRAGOSO (1924) and DURRIEU (1966), but has evidently been found by no one else in Spain. The symptoms of this fungus are rather odd and restricted to the flower head, which turns brown and seems contracted into a globe shape. During investigations in northern Europe I have found that this species does not seem to be very common, and this may be the case in Spain also.

On *Knautia* sp.—It was found by DURRIEU (1966) in Huesca (Sallent).

There is a report by LÁZARO E IBIZA (1920) about a *Peronospora violacea* Casp. on *Urtica* –"sobre ortiga común". I have seen no herbarium material of such a collection and believe that there is some sort of mistake or misprint behind the statement.

Species on *Compositae*

Peronospora radii de Bary

On *Chrysanthemum segetum* (flowers).—It is known from Portugal through a collection reported by LUCAS & *al.* (1982).

On * *Matricaria perforata* (flowers).—It is in most cases easily observed as the white flower heads are discolored by the dark masses of conidia, and diskflorets never develop to normal size. The ray-florets are drawn together and look as if they have begun to wither. Only in one of numerous studied host localities did I find this fungus, in Gerona (Bolvir). The occurrence of this species seems to be quite uneven –in some districts in northern Europe I have found it regularly but in other areas I could not find it at all. I think that this lack of uniformity is to be expected among many parasitic fungi except the most common ones.

On *Chrysanthemum myconium* and *Ch. segetum* (leaves).—It has been published by SOUSA DA CAMARA & OLIVEIRA (1944) as new to Portugal for both hosts. The authors use the name of *P. danica* Gäum., as the fungus attacks the leaves of the host instead of the petals. I have not investigated these collections, but I have previously (GUSTAVSSON, 1959b) regarded *P. danica* as synonymous to *P. radii,* and it has been treated in the same way by CONSTANTINESCU (1989).

RELATED GENUS – *PSEUDOPERONOSPORA*

As the species within this genus in earlier publications were often counted in *Peronospora* I mention those of interest here.

Pseudoperonospora cannabina (Otth) Cursi

On *Cannabis sativa*.—It is recorded for Portugal (SOUSA DA CAMARA & OLIVEIRA, 1944) but I have found no statements about Spain.

Pseudoperonospora humuli (Miyabe & Takah.) Wilson

On *Humulus lupulus*.—It is listed for Portugal (LUCAS & *al.*, 1982).

PERONOSPORA SPECIES FOUND IN ANDORRA – SUMMARY

The following fungi are reported from Andorra in this paper:

P. minor on *Atriplex patula*.—El Serrat, July 1990, AG.

P. parasitica on *Capsella bursa-pastoris*.—Bixesarri, July 1990, AG.

P. medicaginis-minimae on *Medicago lupulina*.—Bixesarri, July 1990, AG.

P. meliloti on *Melilotus albus*.—Bixesarri and El Serrat, July 1990, AG.

P. senneniana on *Lathyrus laevigatus*.—Pont de l'Estrell, July 1990, leg. Ingrid Gustavsson.

P. grisea on *Veronica beccabunga*.—Rivulet Serrat, August 1989, J. Girbal – the first *Peronospora* collection from Andorra, known to me.

P. alta on *Plantago major*.—Pont de l'Estrell, July 1990, leg. Ingrid Gustavsson.

The investigations in Andorra have been very few so far, and as the region has a climate suitable for *Peronospora*, further investigations will certainly be very profitable.

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