This article was downloaded by: [A.C. Scorsetti]
On: 21 August 2012, At: 09:42
Publisher: Taylor & Francis
Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK

Biocontrol Science and Technology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/cbst20

New records of hypocrealean fungi infecting aphids and whiteflies: pathogenicity against Myzus persicae and interaction with its predator Eriopis connexa

A.C. Scorsetti [a], S.A. Pelizza [a b] & M.N. Cabello [a]

[a] Instituto Spegazzini, Facultad de Ciencias Naturales y Museo, UNLP, La Plata, Argentina

[b] Centro de Estudios Parasitológicos y de Vectores (CEPAVE), CCT-La Plata-CONICET-UNLP, La Plata, Argentina

Accepted author version posted online: 19 Jul 2012. Version of record first published: 15 Aug 2012

To cite this article: A.C. Scorsetti, S.A. Pelizza & M.N. Cabello (2012): New records of hypocrealean fungi infecting aphids and whiteflies: pathogenicity against Myzus persicae and interaction with its predator Eriopis connexa , Biocontrol Science and Technology, 22:9, 1099-1105

To link to this article: http://dx.doi.org/10.1080/09583157.2012.710320

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.tandfonline.com/page/terms-and-conditions

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Biocontrol Science and Technology,
Vol. 22, No. 9, September 2012, 1099–1105

Taylor & Francis
Taylor & Francis Group

Downloaded by [A.C. Scorsetti] at 09:42 21 August 2012

SHORT COMMUNICATION

New records of hypocrealean fungi infecting aphids and whiteflies: pathogenicity against *Myzus persicae* and interaction with its predator *Eriopis connexa*

A.C. Scorsetti[a]*, S.A. Pelizza[a,b] and M.N. Cabello[a]

[a]*Instituto Spegazzini, Facultad de Ciencias Naturales y Museo, UNLP, La Plata, Argentina;* [b]*Centro de Estudios Parasitológicos y de Vectores (CEPAVE), CCT-La Plata-CONICET-UNLP, La Plata, Argentina*

(*Received 3 August 2011; final version received 2 July 2012*)

Occurrence of hypocrealean entomopathogenic fungi in Argentina is reported. Bioassays were performed to evaluate their pathogenicity against *Myzus persicae* and *Eriopis connexa*. The findings underscore the importance of preserving these fungi and of investigating their potential for vector control.

Keywords: bioassays; entomopathogenic fungi; *Eriopis connexa*; Hypocreales; *Myzus persicae*

The green-peach aphid *Myzus persicae* Sulzer (Hemiptera: Aphididae) is one of the major horticultural pests worldwide. It transmits more than 100 plant viruses (Blackman and Eastop 2000). Fungi are among the most common and significant microbial pathogens of both insects and arachnids, such as mites and spiders. At least 16 species of fungi are known to infect aphids in nature, and several species frequently cause epizootics among aphid populations (Lacey, Frutos, Kaya, and Vail 2001; Pell, Eilenberg, Hajek, and Steinkraus 2001; Chen, Li, and Feng 2008). In Argentina, few entomopathogenic fungi for Aphididae have been documented, mainly the Entomophthorales fungi (López Lastra and Scorsetti 2006, 2007; Scorsetti, Humber, Garcia, and López Lastra 2007; Cedola and Greco 2010; Scorsetti, Macia, Steinkraus, and Lopez Lastra 2010).

Aphids are also attacked by other natural enemies including various arthropod predators and hymenopterous parasitoids. Coccinellids are a major group of natural enemies that could be considered generalist predators, but nevertheless show a certain preference for soft-body prey such as the whiteflies, aphids, mealybugs, and mites (Michaud and Grant 2003). The coccinellid, *Eriopis connexa* (Germar) (Coleoptera: Coccinellidae) is common in agroecosystems of the Neotropical Region in horticultural crops and is considered as a potential control agent (Sarmento et al. 2007).

Entomopathogenic fungi can have detrimental effects on intraguild predators. Sixteen genera of coccinellids have been recorded as having been infected by the entomopathogenic fungus *Beauveria bassiana* Vuill. (Ascomycota: Hypocreales) (Yeo 2000). Other species of entomopathogenic fungi have also been found to be pathogenic for coccinelids (James and Lighthart 1994). On the basis of these

*Corresponding author. Email: ascorsetti@conicet.gov.ar

ISSN 0958-3157 print/ISSN 1360-0478 online
© 2012 Taylor & Francis
http://dx.doi.org/10.1080/09583157.2012.710320
http://www.tandfonline.com

considerations, a greater understanding of the interactions among aphids, entomopathogenic fungi, and natural enemies of the aphids is clearly essential for a more effective aphid control.

The objectives of this study were to provide new records of natural infections of entomopathogenic fungi on insects (aphids and whiteflies) in Argentina, to select native entomopathogenic fungi that are virulent against *M. persicae*, and to evaluate the direct virulence of a selected isolate against *E. connexa*.

Entomopathogenic fungi were isolated from pests among the Hemiptera (Aphididae, Aleyrodida) as well as from forest soil samples (Table 1). Isolates were collected from the Argentine provinces of Buenos Aires, Corrientes and Tierra de Fuego. Collections of insects were made following the methodology described by Scorsetti et al. (2007). Fungal species were identified according to the taxonomic keys and monographs in Gams (1971), Samson (1974), and Zare and Gams (2001). Monosporic isolates were obtained from infected insects as described by Lecuona (1996). Isolates were deposited at the Culture Collection of the Instituto de Botánica Carlos Spegazzini (LPSC), La Plata, Argentina and at the USDA-ARS Collection of Entomopathogenic Fungal Cultures (ARSEF), Ithaca, New York.

The aphid *M. persicae* was cultured and assayed on cabbage (*Brassica oleracea* var. *capitata* L.) after Forbes, Frazer, and Chan (1985). Aphids were kept in ventilated cages at an insectary at $25 \pm 1°C$ and $70 \pm 5\%$ relative humidity with a 16:8-h light:dark regime. *E. connexa* was reared according to Matsuka and Niijima (1985)

Table 1. List of entomopathogenic fungi isolated from insect pests, host insect and locality.

Fungus species	Access No.	Host insect/substrate	Locality
Lecanicillium lecanii	LPSC 1089/ ARSEF 7207	*Trialeurodes vaporariorum*/ *Apium graveolens*	El Peligro, La Plata, Buenos Aires
	LPSC 1035/ ARSEF 7462	*M. persicae*/*Brassica oleraceae*	La Plata, Buenos Aires
Lecanicillium longisporum	LPSC 1090/ ARSEF 7461	*T. vaporariorum*/*A. graveolens*	El Peligro, La Plata, Buenos Aires
	LPSC 1092/ ARSEF 7459	*Capitophorus elaeagni*/*Cynara scolymus*	General Mansilla La Plata, Buenos Aires
	LPSC 1091	*M. persicae*/*Capsicum annuum*	Olmos, La Plata, Buenos Aires
**Lecanicillium muscarium*	LPSC 1034/ ARSEF 7782	*M. persicae*/*B. oleraceae*	La Plata, Buenos Aires
	LPSC 1093/ ARSEF 7460	*T. vaporariorum*/*A. graveolens*	El Peligro, La Plata, Buenos Aires
	LPSC 1094/ ARSEF 7785	*Aphis fabae*/*Solanum melongena*	General Mansilla, La Plata, Buenos Aires
Isaria fumosorosea	LPSC 1095/ ARSEF 7205	*T. vaporariorum*/*A. graveolens*	El Peligro, La Plata, Buenos Aires
	LPSC 1036	*Bemisia tabaci*/*Cucumis sativus*	Monte Caseros, Corrientes
Isaria javanica	LPSC 1096/ ARSEF 7477	*T. vaporariorum*/*Lycopersicon esculentum*	Colonia Urquiza, La Plata, Buenos Aires
Tolypocladium cylindrosporum	LPSC 1065	Soil/*Nothofagus pumilio*	Ushuaia, Tierra del Fuego

Downloaded by [A.C. Scorsetti] at 09:42 21 August 2012

and under the same conditions as for *M. persicae* and fed *ad libitum* with nymphs and adults of the bird cherry-oat aphid, *Rhopalosiphum padi*, raised on wheat seedlings.

Twelve strains of native entomopathogenic fungi were used in this study and fungal pathogenicity was tested on *M. persicae* adults. Fungal isolates were cultured on 2% (v/v) malt-extract agar in Petri dishes and incubated for 7 days at 25°C in the dark. Conidia were then harvested with a disposable cell scraper (Fisherbrand®) and placed into test tubes containing 0.01% (v/v) Tween 80® (Merck). The suspension was adjusted to 1×10^7 conidia ml^{-1} after counting in a Neubauer hemacytometer. The conidial viability of each isolate was assessed after 24 h through the use of the techniques described by Lane, Humphreys, Thompson, and Trinci (1988). Viability ranged between 93 and 100% on all occasions. The test insects were sprayed with 300 µl of a conidial suspension from a 35-ml glass atomizer, while the control insects were sprayed with 300 µl of 0.01% (v/v) Tween 80® alone. The experiment consisted of four replicate test groups and a control group, with all groups containing 20 insects each. Thereafter, the insects were arranged on a cabbage leaf and placed in a 35-mm Petri dish containing a sterilized moistened filter paper to maintain a 95% relative humidity. Both the treated and the control insects were incubated at 24 ± 1°C with a 16:8-h light:dark photoperiod. The cumulative mortality was recorded daily for 10 days. Dead insects were removed daily and their surfaces sterilized according to Lacey and Brooks (1997). The experiments were repeated three times under comparable laboratory conditions. The median lethal time (MLT) was estimated according to the methodology cited by Lecuona and Díaz (2001). The cumulative-mortality data were evaluated by the analysis of variance and their means by Fisher's least-significant-difference multiple-range test option ($P < 0.05$) through the use of a version of the InfoStat 2007 software (InfoStat 2001). Ten days post inoculation of the aphids in the pathogenicity test, we observed no significant differences between the treatments ($F = 4.05$, df $= 11$, $P = 0.4362$), and the mortality of the controls did not exceed 20%.

The 12 isolates were highly infective to adults of *M. persicae* and mortality ranged between 83 and 100% (Table 2). We observed significant differences between the average times of death (MLT) for each isolate ($F = 12.84$, df $= 11$, $P \leq 0.0001$; Table 2). Two strains of *Lecanicillium muscarium* (LPSC 1034 and 1093) were the most effective isolates (at 100% mortality); but since *L. muscarium* (LPSC 1034) had a shorter MLT (2.81 ± 0.25 days), it was selected for dose-response virulence tests and the *E. connexa* bioassays.

After evaluating the biological activity of the different fungal isolates, multiple-concentration assays were done with the most effective isolate as judged by its higher virulence and the lower MLT. Five serial concentrations of conidia, ranging from 1×10^2 to 1×10^6 conidia ml^{-1}, were assayed. The inocula were obtained by the same methodology as used for the virulence tests. Four replicates groups and a control group, all containing 20 insects, were treated at each dose. The cumulative mortality was recorded daily for 10 days. Dead insects were removed daily and their surfaces sterilized according to Lacey and Brooks (1997). The results of the dose-response test (LC 50) were analyzed by Probit analysis (Chi 1997). After 10 days a LC_{50} of 1.6×10^3 conidia ml^{-1} ($\alpha = 0.05$) ($x^2 = 0.74$, df $= 2$, LC $= 696.58/3255.61$) was obtained. This isolate showed higher virulence than Fournier and Brodeur

Downloaded by [A.C. Scorsetti] at 09:42 21 August 2012

Table 2. Results of conidial germination, median lethal time (MLT) and cumulative mortality of fungal isolates evaluated against *M. persicae*.

Fungus species	Conidial viability (SD)	% Mortality (SD)	MLT (SD)*
L. lecanii LPSC 1089/ARSEF 7207	100%	96.07 (6.79)	4.32 (0.75) e
L. lecanii LPSC 1035/ARSEF 7462	93.1% (±1.3)	92.15 (8.98)	4.19 (0.68) cd
L. longisporum LPSC 1090/ARSEF 7461	100%	90.66 (3.23)	4.78 (0.19) de
L. longisporum LPSC 1092/ARSEF 7459	100%	95.83 (7.21)	3.35 (0.26) ab
L. longisporum LPSC 1091	100%	95.83 (7.21)	4.95 (0.4) e
L. muscarium LPSC 1034/ARSEF 7782	98% (±3.5)	100	2.81 (0.25) a
L. muscarium LPSC 1093/ARSEF 7460	95.3% (±1.8)	100	3.9 (0.7) bc
L. muscarium LPSC 1094/ARSEF 7785	100%	88.23 (11.76)	4.32 (0.3) cde
I. fumosorosea LPSC 1095/ARSEF 7205	96.5% (±3.15)	95.83 (3.60)	3.25 (0.1) ab
I. fumosorosea LPSC 1036	100%	89.58 (13.01)	3.82 (0.54) bc
I. javanica LPSC 1096/ARSEF 7477	98.8% (±0.2)	92.56 (12.87)	3.1 (0.2) ab
T. cylindrosporum LPSC 1065	100%	83.75% (±8.53)	5.92 (0.25) f

*Data are given in mean ± SD; values followed by the same letters do not differ significantly according to least-significant-difference test ($P = 0.05$).

Downloaded by [A.C. Scorsetti] at 09:42 21 August 2012

(2000) had reported using *Lecanicillium* sp. against *M. persicae* with a LC_{50} of 2.3×10^6 conidia ml^{-1}.

Virulence tests against *E. connexa* were carried out by a modified dip method according to Cottrell and Shapiro-Ilan (2003). The inocula were obtained by the same methodology as used for the tests against aphids. The bioassays were performed on eggs, larvae, pupae, and adults at the same time. Two doses were used, 1×10^7 conidia ml^{-1} and the dose producing a 50% killing level ($LC_{50} = 1.6 \times 10^3$ conidia ml^{-1}) obtained from previous assays. The assay consisted of four replicate test groups and a control group, with all groups containing 20 insects each. Each beetle was transferred to a sterile 9-cm Petri dish and was maintained in a plastic container ($30 \times 16 \times 9$ cm) placed at 25°C, 14:10 h light:dark photoperiod and 88% relative humidity. The experiments were repeated three times under comparable laboratory conditions. The insects were fed in the same way as during rearing. Dead insects were removed daily and their surfaces sterilized according to Lacey and Brooks (1997).

The results of the virulence test against *E. connexa*, showed low cumulative mortality, with the mortality of the controls of only a 2.2 ± 0.57%, and no infection by entomopathogenic fungi registered. At the higher dose (1×10^7 conidia ml^{-1}) first and second instar larvae proved the most susceptible with 45 ± 5% and 30 ± 5% mortalities, respectively. The LC_{50} (1.6×10^3 conidia ml^{-1}) doses only caused a cumulative mortality of 5 ± 0% on first istar larvae. No eggs, pupae, or adults were found infected at both doses. All dead insects were infected by *L. muscarium*. Consistent with Steenberg and Harding (2009), these preliminary data indicate that larvae are more susceptible to infection than other developmental stages.

We found a considerable diversity of Hypocreales fungi on pests of Argentine horticultural crop systems. Among the six species recorded here, the two species isolated from aphids, *Lecanicillium longisporum* and *L. muscarium* (Table 1), are new records for South America; while the fungus *Lecanicillium lecanii*, isolated from *M. persicae*, represents a new record for Argentina. Although in South America there are reports of entomopathogenic fungi that infect other agricultural insect pests (Aruta, Carrillo, and González 1974; Lange 1996; Méndez Sánchez, Freitas, and Roberts 2001; Edelstein and Lecuona 2003; Pelizza, Cabello, and Lange 2010), there is little few documentation of such fungi infecting aphids (López Lastra and Scorsetti 2006; Scorsetti et al. 2007, 2010). These new records thus represent an extension of the aphid-host range for the Hypocreales fungi in South America.

Because of their host specificities, most fungal entomopathogens pose little risk to nontarget hosts (Rashki, Kharazi-pakdel, Allahyari, and van Alphen 2009), but possible fungal activities against beneficial arthropods in the target environment must also be considered. A consideration must be made of adult aphid predators' susceptibilities to the fungus, mainly with respect to damage attributable to direct and/or indirect infection as sublethal effects. Thus, the survey of native fungal species within the same natural environments of the target species is of high priority.

The strain of *L. muscarium* (LPSC 1034) was isolated from *M. persicae* on *Brassica oleraceae* crops in La Plata, Buenos Aires province. This fungus seems to be a good candidate for further development as a potential biological-control agent against aphid pests. Furthermore, our results support the hypothesis that the more virulent fungal strains are isolated from the target organism itself (Shah and Pell 2003), thus increasing the chances of having success in the realization of effective formulations for biological control of insect pests.

Further studies of the interactions with natural enemies need to be carried out under field conditions in order to confirm whether the laboratory results with this isolate do, in fact, accurately predict its performance in the field.

Downloaded by [A.C. Scorsetti] at 09:42 21 August 2012

Acknowledgements

We wish to thank R.A. Humber (USDA-ARS, Ithaca, New York, USA) for fungal-identification confirmation and Dr. Donald F. Haggerty, a retired career investigator and native English speaker, for editing the final version of the manuscript. We also thank two anonymous reviewers for helpful comments on the manuscript. This study was partially supported by CONICET (PIP0049) and Universidad Nacional de La Plata (11/N-651). M. Cabello is a member of Carrera del Investigador CICPBA.

References

Aruta, C., Carrillo, R., and González, S. (1974), 'Determinación para Chile de hongos entomopatógenos del género *Entomophthora*', *Agro Sur*, 2, 62–70.

Blackman, R.L., and Eastop, V.F. (2000), *Aphids on the World's Crops: An Identification and Information Guide*, London: The Natural History Museum.

Cedola, C., and Greco, N. (2010), 'Presence of the Aphid, *Chaetosiphon fragaefolii*, on Strawberry in Argentina', *Journal of Insect Science*, 10, 1–9.

Chen, B., Li, Z.Y., and Feng, M.G. (2008), 'Occurrence of Entomopathogenic Fungi in Migratory Alate Aphids in Yunnan Province of China', *BioControl*, 53, 317–326.

Chi, H. (1997), *Computer Program for the Probit Analysis*, Taichung: National Chung Hsing University.

Cottrell, T.E., and Shapiro-Ilan, D.I. (2003), 'Susceptibility of a Native and an Exotic Lady Beetle (Coleoptera: Coccinelidae) to *Beauveria bassiana*', *Journal of Invertebrate Pathology*, 84, 137–144.

Edelstein, J.D., and Lecuona, R.E. (2003), 'Presencia del hongo entomopatógeno *Pandora gammae* (Weiser) Humber (Zygomycetes: Entomophthorales), en el complejo de "orugas medidoras de la soja" (Lepidoptera: Plusiinae) en Argentina', *Revista de Investigaciones Agropecuarias*, 32, 31–38.

Forbes, A.R., Frazer, B.D., and Chan, C.K. (1985), 'Aphids', in *Handbook of Insect Rearing*, eds. P. Singh and R.F. Moore, New York: Elsevier, pp. 353–359.

Fournier, V., and Brodeur, J. (2000), 'Dose-Response Susceptibility of Pest Aphids (Homoptera: Aphididae) and their Control on Hydroponically Grown Lettuce with the Entomopathogenic Fungus *Verticillium lecanii*, azadirachtin, and Insecticidal Soap', *Environmental Entomology*, 29, 568–578.

Gams, W. (1971), '*Tolypocladium*, eine Hyphomycetengattungmit geschwollenen phialiden', *Persoonia*, 6, 185–191.

InfoStat (2001), *Manual del usuario, Version 1*, Córdoba: Universidad Nacional de Córdoba.

James, R.R., and Lighthart, B. (1994), 'Susceptibility of the Convergent Lady Beetle (Coleoptera: Coccinelidae) to Four Entomogenous Fungi', *Environmental Entomology*, 23, 190–192.

Lacey, L., and Brooks, W.M. (1997), 'Initial Handling and Diagnosis of Diseased Insects', in *Manual of Techniques in Insect Pathology*, ed. L. Lacey, San Diego, CA: Academic Press.

Lacey, L., Frutos, R., Kaya, H.K., and Vail, P. (2001), 'Insect Pathogens as Biological Control Agents: Do They Have a Future?', *Biological Control*, 21, 230–248.

Lane, B.S., Humphreys, A.M., Thompson, K., and Trinci, A.P.J. (1988), 'ATP Content of Stored Spores of *Paecilomyces farinosus* and the Use of ATP as Criterion of Spore Viability', *Transactions of the British Mycological Society*, 90, 109–111.

Lange, C.A. (1996), '*Melonoplus* (Orthoptera: Acrididae) afectadas por micosis en la provincia de Buenos Aires, Argentina', *Revista de la Sociedad Entomológica Argentina*, 55, 107–109.

Lecuona, R.E. (1996), *Microorganismos patógenos empleados en el control microbiano de insectos plaga*, Buenos Aires: Talleres gráficos Mariano Mas.

Lecuona, R.E., and Díaz, B.M. (2001), 'Susceptibilidad de *Spodoptera frugiperda* (J.E. Smith) a los hongos entomopatógenos *Nomuraea rileyi, Metarhizium anisopliae* y *Beauveria bassiana*', *Revista de Investigaciones Científicas*, 30, 25–29.

López Lastra, C.C., and Scorsetti, A.C. (2006), 'Hongos Entomophthorales patógenos de insectos de la República Argentina', *Revista de Biología Tropical*, 54, 311–315.

López Lastra, C.C., and Scorsetti, A.C. (2007), 'Revisión de los hongos Entomophthorales (Zygomycota: Zygomycetes) patógenos de insectos de la República Argentina', *Boletín de la Sociedad Argentina de Botánica*, 42, 33–37.

Matsuka, M., and Niijima, K. (1985), 'Coleoptera: Coccinellidae', in *Handbook of Insect Rearing*, eds. P. Singh and R.F. Moore, New York: Elsevier, pp. 353–359.

Méndez Sánchez, S.E., Freitas, A.L., and Roberts, D.W. (2001), 'Detección de hongos Entomophthorales patógenos a insectos fitófagos, al sur de Bahía, Brasil', *Entomotrópica*, 16, 203–206.

Michaud, J.P., and Grant, A.K. (2003), 'IPM-compatibility of Foliar Insecticides for Citrus: Indices Derived From Toxicity to Beneficial Insects from Four Orders', *Journal of Insect Science*, 3, 1–10.

Pelizza, S., Cabello, M.N., and Lange, C. (2010), 'Nuevos registros de hongos entomopatógenos en acridios (Orthoptera: Acridoidea) de la República Argentina', *Revista de la Sociedad Entomológica Argentina*, 69, 287–291.

Pell, J.K., Eilenberg, J., Hajek, A.E., and Steinkraus, D.C., (2001), 'Biology, Ecology, and Pest Management Potential of Entomophthorales', in *Fungal Biological Control Agents: Progress, Problems and Potential*, eds. T.M. Butt, C. Jackson and N. Magan, Wallingford: CAB International, pp. 71–153.

Rashki, M., Kharazi-pakdel, A., Allahyari, H., and van Alphen, J.J.M. (2009), 'Interactions Among the Entomopathogenic Fungus, *Beauveria bassiana* (Ascomycota: Hypocreales), the Parasitoid, *Aphidius matricariae* (Hymenoptera: Braconidae), and its Host, *Myzus persicae* (Homoptera: Aphididae)', *Biological Control*, 50, 324–328.

Downloaded by [A.C. Scorsetti] at 09:42 21 August 2012

Samson, R.A. (1974), '*Paecilomyces* and Some Allied Hyphomycetes', *Studies in Mycology* (The Netherlands: Baarn), 6, 1–119.

Sarmento, R.A., Pallini, A., Venzon, M., Fonseca de Souza, F., Molina-Rugama, A.J., and Lima de Olivera, C. (2007), 'Functional Response of the Predator *Eriopis connexa* (Coloeptera Coccionelidae) to Different Prey Types', *Brazilian Archives of Biology and Technology*, 50, 121–126.

Scorsetti, A.C., Humber, R.A., Garcia, J.J., and López Lastra, C.C. (2007), 'Natural Occurrence of Entomopathogenic Fungi (Zygomycetes: Entomophthorales) of Aphid (Hemiptera: Aphididae) Pests of Horticultural Crops in Argentina', *BioControl*, 52, 641–655.

Scorsetti, A.C., Macia, A., Steinkraus, D.C., and Lopez Lastra, C.C. (2010), 'Prevalence of *Pandora neoaphidis* (Zygomycetes: Entomophthorales) infecting *Nasonovia ribisnigri* (Hemiptera: Aphididae) on Lettuce Crops in Argentina', *Biological Control*, 52, 46–50.

Shah, P.A., and Pell, J.K. (2003), 'Entomopathogenic Fungi as Biological Control Agents', *Applied Microbiology and Biotechnology*, 61, 413–423.

Steenberg, T., and Harding, S. (2009), 'Entomopathogenic Fungi Recorded from the Harlequin Ladybird *Harmonia axyridis*', *Journal of Invertebrate Pathology*, 102, 88–89.

Yeo, H. (2000), 'Mycoinsecticides for Aphid Management: A Biorational Approach', Ph.D. dissertation, University of Nottingham.

Zare, R., and Gams, W. (2001), 'A Revision of *Verticillium* sect. Prostata IV. The Genera *Lecanicillium* and *Simplicillium* gen. nov', *Nova Hedwigia*, 73, 1–50.

Downloaded by [A.C. Scorsetti] at 09:42 21 August 2012