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Identification of Potential Biological Control Agents for *Ligustrum robustum* ssp. *walkeri*

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ABSTRACT. *Ligustrum robustum (Roxb). Bl. ssp. walkeri (Decne.) P.S. Green, family Oleaceae, is an invasive weed, which is endangering the regeneration of indigenous plants in the Mascarene islands of the Indian ocean. The weed has been identified as native to Sri Lanka by DNA analysis. Comprehensive surveys for natural control agents on the plant across its geographical and climatic range within Sri Lanka were undertaken in order to identify potential biological control agents of this weed. Over 25 natural sites were visited in Kandy, Nuwara-Eliya, Badulla and Ratnapura districts during these surveys and host specificity on collected insects was investigated in Sri Lanka and in UK under Quarantine conditions, using different plant species of the Oleaceae family. Among the 16 species of insect pests investigated using host-range and no-choice tests, Antestiopsis picturata, Hyphasis spp. 1 and 2, Palpita celsalis, and Epiplema albida warranted high priority for further study as bio-control agents of L. robustum. The results of preliminary host range testing indicated that Problepis deliaria, Dermorhytis lewisi, Dermorhytis ornatissima, Pangrapta grisangula, Phycita eulepidella, and Xylosandrus arguatus look promising.*

INTRODUCTION

The genus *Ligustrum* (*Oleaceae*) has around 40 species and is found throughout most of the temperate and tropical old world except in coldest regions and Africa (Green, 1987). *Ligustrum robustum* (Roxb). Bl. ssp. *walkeri* (Decne.) P.S. Green, known as Ceylon privet (English), Bora (Sinhala), Troéne (French) is thought to have originated in peninsular India, western hill country of Sri Lanka, and Vietnam (Green, 1987). In Sri Lanka, *L. robustum* grows in colonies in valleys and near streams. It can be described as a semi-forest tree in its native habitat, and is prominent in the boundaries of natural forests and home gardens. This tree has been reported as an invasive weed and a serious pest to pastures, native forests and some crops in the Mascarine islands of Mauritius and La Réunion (Lavergne and Shaw, 1999).

The native ecosystems of Mascarine Archipelago islands are threatened with extinction due to the presence of several alien plants such as *Ligustrum robustum*. In 1989

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there were 1052 introduced flowering plants in the natural or semi natural environment of La Réunion island, compared to 675 indigenous species. Of the total number, 620 (36%) are non-naturalized introductions, 432 (25%) are naturalized and 675 indigenous ones (39%). *Ligustrum robustum* has been reported as the most significant threat to these already impoverished ecosystems (Lavergne and Shaw, 1999).

Classical biological control programmes for weeds involve the introduction of exotic co-evolved natural enemies of the weed. It is aimed not to eradicate the weed, but to reduce its fitness and competitive ability, and suppress and stabilize weed populations permanently at a non-damaging level (Waage and Greathead, 1988). Compared to their native habitats, plant species frequently show increased competitiveness and vigor in exotic environments. Therefore, the aim of biological control is to find out the most viable and co-evolved natural enemies, which can adapt to the alien environment where the plant is introduced. As a rule, desired climatic region, should offer a variety of ecological conditions. On the other hand, the greatest number of safe, effective and virulent biocontrol agents for a weed may occur at the center of diversification of the weed genus or sub genus.

It is likely that seeds of *Ligustrum robustum* were deliberately introduced to Mauritius between 1902–1905 during exchanges, which took place between the botanical gardens of Peradeniya, Sri Lanka and the Pamplemouse botanical gardens in Mauritius (Anon., 1902–1905). Molecular studies carried out in the University of St. Andrews, United Kingdom has confirmed that the Sri Lankan species is more closely related to those found in Mauritius and La Réunion, than the Indian or Vietnamese species (CABI, 1999; Tassin, 1999). Control by mechanical removal of *Ligustrum robustum* is reported to be labour intensive and costly, as is herbicide application, which is undesirable for use in the natural forests of La Réunion Island, where this plant has been invading. Investigation of natural enemies (insects and pathogens) for consideration as biological control agents against *Ligustrum robustum* was thus initiated in 1996 on the request of the Regional Council of La Réunion in collaboration with CABI-Bioscience, UK.

The main objective of the study was to identify potential biocontrol agents for La Réunion and elsewhere with the aim of long-term control of this noxious weed. This paper reports studies on identification of natural enemies of *Ligustrum robustum*, their biology, host specificity and establishment of the selected agents in quarantine facilities in the country for introduction.

MATERIALS AND METHODS

Field survey to identify *Ligustrum robustum* sites

A series of field surveys were conducted over a period of two years (total - eight surveys) to identify sites where *Ligustrum robustum* is present, based on the information provided by Dassanayake and Fosberg (1987), as well as records from the Kew Botanical Gardens, Royal Botanical Gardens at Peradeniya, and the Botanical Gardens at Hakgala. Leaf samples from each identified site located in Kandy, Nuwara-Eliya, Badulla and Ratnapura districts (Table 1) were collected, immediately sealed in polythene bags with

indicator silica gel and dried. These samples were hand-carried to the University of St. Andrews, UK for studies on molecular taxonomy.

Table 1. ***Ligustrum robustum*** **sites selected for the study.**

Name of the sites	District	Lat. N.	Lon. E.	Alt. (m)
Deltota	Kandy	07 08 780	080 42 474	1125
Deltota	Kandy	07 08 509	080 42 913	1150
Loolecondera	Kandy	07 07 742	080 42 382	1175
Atulgama	Kandy	07 40 432	080 38 688	800
Loolecondera 2	Kandy	07 08 220	080 42 293	1175
Bandarawela-Ella	Badulla	06 50 987	081 00 752	1050
Bandarawela hotel	Badulla	06 49 905	080 59 342	1325
Haldummulla	Badulla	06 45 686	080 52 988	1100
Tewaligama	Badulla	06 55 297	080 51 534	1125
Gurutalawa	Badulla	06 50 635	080 53 926	1300
Pahala Kadurugama	Badulla	06 38 034	081 00 116	1200
Koslanda	Badulla	06 44 841	080 56 751	825
Koslanda 2	Badulla	06 44 841	081 01 736	725
Boralanda -Rahangala	Badulla	06 49 475	080 53 267	1325
Atampitiya	Badulla	06 56 270	081 00 116	1125
Boragasketiya	Nuwara-Eliya	06 54 445	080 49 962	1625
Balumgala	Nuwara-Eliya	06 54 367	080 51 182	1300
Gourawilla estate	Nuwara-Eliya	06 47 911	080 36 844	1400
Padinawela	Nuwara-Eliya	06 54 853	080 50 385	1375
Hakgala Garden	Nuwara-Eliya	06 55 746	080 44 365	1200
Hakgala	Nuwara-Eliya	06 55 746	080 44 365	1200
Galagama	Ratnapura	06 44 460	080 45 008	875
Galagama-Belihuloya	Ratnapura	06 44 468	080 45 003	875
Kalupahana	Ratnapura	06 45 828	080 45 003	950
Balangoda	Ratnapura	06 39 047	080 40 735	825

Lat. N. : latitude North Lon. E. : longitude East Alt : altitude

Studies were carried out in selected *Ligustrum* sites to identify potential insect-biocontrol agents, and study their ecology and host range, in order to select suitable agents for eventual release in La Réunion. These insects were identified at CABI-Bioscience, UK Centre.

Selection of sites for experiments

During the field survey, all the available ecological niches of *Ligustrum robustum* were observed. Since this Sri Lankan native is distributed throughout the hill country, it was necessary to prioritise those sites to which particular attention would be paid. The sites were thus selected to match the climatic and other abiotic conditions of the target area (*i.e.*, La Réunion) as closely as possible. The original surveys also took into account other members of the *Oleaceae* family so that natural enemy host range could be observed in the field. Herbarium samples were collected from each of the sites. Samples of phytophagous insects feeding on *L. robustum* were collected for experiments.

Host range test - Laboratory studies

Prior to conducting the host range tests, the list of non-target plant species to be screened was submitted to the regulatory authorities of La Réunion country for approval, as this is a pre-requisite for introducing biocontrol agents for any country (Julien and White, 1992). The test plants were selected according to the criteria suggested by Wapshere (1974). The host-plant selection procedure was rational and this was associated with the taxonomic position of *Ligustrum*, its morphology, biochemistry and geographic distribution. No other species of the same genus are recorded in Sri Lanka thus, other members of the *Oleaceae* family were selected, namely *Chionanthus zeylanica*, *Olea polygama* and *Jasminum spp.* (*J. angustifolium*, *J. flexile*) (Green, 1987).

Starvation trials (no-choice tests) were used to determine the physiological host range of all species of insects collected using the earliest immature stage, comparing the feeding response to selected plant species with that to *L. robustum*. In most cases, glass tubes were used in the tests, into which the plant materials (*i.e.*, leaves or stems depending on the feeding structures of insects) were placed. The tests were carried out under laboratory conditions at the temperatures of the collecting sites. Plant material was changed every 2nd day or when necessary, whilst all the other environmental conditions were kept uniform. The number of replicates varied from 4–10 depending on the availability of the insects. The feeding behaviour was assessed by rating the feeding damage on the plant materials (Table 2). Similar studies were carried out using the same insect species but with the full Réunion test plant list at the quarantine facilities of CABI-Bioscience, UK.

Host range tests : Field studies

Field experiments were carried out for all the insect species collected, in the mixed forests of Kandy, Badulla, Nuwara-Eliya and Ratnapura Districts. Damage levels by natural enemies and their specificity in the field were regularly recorded along the level of parasitism.

Table 2. Rating scale used for the feeding behavior of prospective biocontrol agents.

Feeding Damage	% Plant Materials Consumed
0	0
T	<1% trace
1	1–5%
2	5–10%
3	10–20%
4	20–50%
5	>50%

Biology of prospective biocontrol agents

Insect pests of *L. robustum* identified from the sites were kept in glass containers lined with filter paper, and supplied with excess plant material. These rearing boxes were kept inside moistened plastic bags or artificial insect rearing units to prevent desiccation. The development of the insects was monitored daily. The feeding behaviour of the insect species was studied in detail. Oviposition studies were carried out for selected species by placing the newly emerged females and males in plastic containers, as described above.

RESULTS AND DISCUSSION

DNA analysis indicated that Sri Lanka is the Center of origin of *Ligustrum robustum* (Roxb). Bl. ssp. *walkeri* (Decne.) presently found on the islands of Mauritius and La Réunion. Dassanayaka and Fosberg (1987) described *Ligustrum robustum* as evergreen shrubs or small trees up to 10 m tall. Distribution is mainly in the wet and intermediate regions of Sri Lanka. There were 22 *Ligustrum robustum* sites reported by Dassnayake and Fosberg (1987), and the sample collection in the National Herbarium at the Royal Botanical Gardens in Peradeniya confirmed this report. However, the present survey found 27 *Ligustrum* sites in Sri Lanka.

Potential biological control agents

The list of natural enemies found during the preliminary survey is given in Table 3. Sixteen species of insects were identified together with their distribution, feeding methods and occurrence. Other types of insects living in the tree such as saprophagous insects and predatory insects have also been taken into consideration. On the other hand, some polyphagous phytophagous insects such as grasshoppers were neglected during the study. Descriptions of the identified natural control agents is given below.

Table 3. Natural enemies of *Ligustrum robustum* found in Sri Lanka.

Species name	Distribution	Feeding method
Antestiopsis picturata Dist. (Heteroptera: Pentatomidae)	Every site	Sucks sap from flowers
Dermorhytis lewisi Jacoby. (Coleoptera: Chrysomelidae)	Every site	Adult eats leaf edges + larval root feeders
D. ornatissima Baly. (Coleoptera: Chrysomelidae)	Every site	Adult eats leaf edges + larval root feeders
Epiplema spp. (Lepidoptera: Epiplemidae)	Few sites in Upcountry	Leaf feeder
Euwallacea fornicatus (Eichoff) (Coleoptera: Scolytidae)	Every site	Stem borer
Hyphasis spp. 1 (Coleoptera: Chrysomelidae)	Every site	Leaf feeder (adult)
Hyphasis spp. 2 (Coleoptera: Chrysomelidae)	Every site	Leaf feeder (adult)
Lepropus immunis (Walker) (Coleoptera: Curculionidae)	Few sites	Leaf eating caterpillar
Palpita celsalis (Walker) (Lepidoptera: Pyralidae)	Every site	Leaf eating caterpillar
Pangrapta grisangula Hampson (Lepidoptera: Noctuidae)	Every site	Leaf eating caterpillar
Phycita eulepidella Hampson (Lepidoptera: Pyralidae)	Every site	Feeds on flower buds
Phyllocnistis citrella Stainton (Lepidoptera: Gracillariidae)	Every site	Leaf miner
Problepis deliaria Guenée (Lepidoptera: Geometridae)	Every site	Leaf eater
Rhopobota naevana (Lepidoptera: Tortricidae)	Every site	Leaf tier.
Xylosandrus arquatus (Sampson) (Coleoptera: Scolytidae)	Few sites	Stem borer
Zeuzera pyrina (Lepidoptera: Cossidae)	Few sites	Stem borer

***Rhopobota naevana* (Lepidoptera: Tortricidae):** This is one of the most common natural enemies on *Ligustrum* in Sri Lanka and possibly the most devastating. The species also known as holly tortrix, is a pest introduced to Sri Lanka. This is a pest species widely spread in tropical and temperate regions of the world and is reported to be a severe pest on apple, holly and prune (Fitzpatrick *et al.*, 1995). The population significantly increases during the period when new flushes are growing so the damage is generally heavy in high humidity conditions. In cooler regions such as Hakgala, the damage is extensive that heavy

defoliation results in a low fruit set. However, it has been observed attacking flush growth of *Olea polygama* as well as other species and hence will not be considered further as a potential biological control agent for *Ligustrum robustum*.

***Euwallacea fornicatus* (Eichoff) (Coleoptera: Scolytidae)**: The pest was previously known as *Xyleborus fornicatus* or Tea shot hole borer, which a serious pests of tea in Sri Lanka. Thus, considerable attention has been paid to its control. It is also reported from the *Accacia pinnata* (Fabaceae) and *Annona squamosa* trees (Anon., 1999). However, this pest already exists in La Réunion (Shaw, 1998) and has not been recorded on *Ligustrum* thus, its attack of privet in Sri Lanka could be associated with proximity to tea estates.

***Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae)**: Commonly known as the Citrus Leaf miner, *P. citrella* is another polyphagous insect. This is one of the most troublesome insect pests in citrus growing areas of Sri Lanka. It has been recorded from *Rutaceae* such as *Citrus maxima*, *C. aurantium* and *Pleiospermium alatum* (Anon., 1999). It is interesting to note that this pest is reported from La Réunion as well (Shaw, 1998), although not attacking *Ligustrum*. This insect is thus not considered as a potential bio-control agent against *Ligustrum*.

***Xylosandrus arquatus* (Sampson) (Coleoptera: Scolytidae)**: This is an endemic insect, where the damage and its morphological characteristics are very similar to *Euwallacea fornicatus*, the shot hole borer of tea. However, this damages Cinnamon plantations in Sri Lanka, which is an important genus for agriculture with products such as *Cinnamomum camphora* (Camphor) and *C. verum* (Cinnamon) (Anon., 1999). Therefore, the species was rejected as a bio-control agent for *Ligustrum*.

***Zeuzera pyrina* (Lepidoptera: Cossidae)**: The pest known as the Leopard moth borer, which has a larval period of generally about 2 years, was found in some of the *Ligustrum* sites, namely Guruthalawa, Rahangala, Badulla and Galagama areas. This is a pest species causing damage to about 70 tree species (Shaw, 1998). This insect is one of the principal pests of olive groves in Italy (Longo *et al.*, 1995). In addition, this pest is very difficult to rear. Therefore, *Zeuzera pyrina* has also been rejected from further consideration as a potential biocontrol agent.

***Antestiopsis picturata* Dist. (Heteroptera: Pentatomidae)**: This is one of the most common natural enemies of *Ligustrum* during the fruiting and flowering seasons. This insect is likely to have impact upon flowers and fruits reducing seed production. According to literature available the insect is native to Sri Lanka although an unknown species of *Antestiopsis* has been recorded from Coffee plantations in Sri Lanka, which causes economic damage (Anon., 1999). Further investigation is required to clarify the species of the coffee insect. However, to-date, there are no records available to confirm that this insect feeds on any other tree species, and it is anticipated that further studies will be continued with host specificity tests on *Antestiopsis picturata*. Artificial rearing of this insect is difficult due to its sap feeding habits requiring live tree materials, thus the host-range test was not conducted.

***Dermorhytis lewisi* Jacoby. (Coleoptera: Chrysomelidae) and *Dermorhytis ornatissima* Baly (Coleoptera: Chrysomelidae):** These species are endemic beetles, which are common throughout Sri Lanka. However, they show seasonal behavior with higher numbers in the latter part of the year. They have only been recorded from *Ligustrum* (Shaw, 1998) and the adults are leaf feeders causing defoliation. The adult beetles are very shiny and the female is a little bigger than the male. Beetles were placed on plant material in Sri Lanka, where they laid eggs sandwiched between leaves and after hatching, the whitish grubs were introduced to potted *Ligustrum* plants with moist soils. The larvae are root feeders, which could help to provide an entry route for soil born pathogens as well. However, the rearing of these beetles in the laboratory is difficult and very few adults have been reared in the UK although larval studies are continuing.

***Epiplema* spp. (Epiplemidae):** Sexual dimorphism confused the issue of identification of the species from family Epiplemidae, and it is likely to be *Epiplema albida*. Members of Epiplemidae family tend to be relatively specific (Shaw, 1998) thus, this insect should be considered further as a biocontrol agent. The feeding is relatively slow and tends to be eating the lower epidermis of the leaf and thereby skeletonizing the tissue, but it is multivoltine and could be quite damaging once released. Further studies will be conducted after precise identification of the species at CABI-Bioscience, UK.

***Hyphasis* spp. (Coleoptera: Chrysomelidae: Alticine):** There are two *Hyphasis* spp., (*Hyphasis* spp. 1 and spp. 2) which are recognized as endemic and newly identified from Sri Lanka. These are very small insects commonly referred to as flea beetles. They feed on immature leaves making small holes and are very easy to identify in the field. These species were collected from 7 *Ligustrum* sites as well as from one Jasmine site in Sri Lanka. Field observations and host range tests indicated that they are host specific to the family *Oleaceae*. Further surveys will continue giving priority to the species. The results of the host-range tests carried out on *Hyphasis* spp. 2 in the field (Table 4) indicated that the insect is relatively host specific to family *Oleaceae*.

***Palpita celsalis* (Walker) (Lepidoptera: Pyralidae):** This is one of the most common types of insects and are found in every *Ligustrum* site in Sri Lanka and India. The species *P. bivitralis* and *P. stolalis* are pests on the members of the *Moraceae* family such as *Ficus recemosa*, *F. religiosa* and *F. benghalensis* (Anon., 1999). *Palpita celsalis* lay eggs in very minute batches on the surface of leaves. The 1st to 3rd larval stages skeletonise the leaves and are relatively active compared to the final larvae instar. All larval stages tie the leaves together and form a shelter. The translucent green caterpillars grow to about 20 mm and the pupa is green-brown and about 13 mm in length. After about 7 days the adult stage emerges. *Palpita celsalis* has been recorded from *Chionanthus zeylanica* in the field and thus, great care should be taken with the Réunion test plants since this island boasts a congener. The results of the present study indicated that *Palpita celsalis* is relatively host specific on *Ligustrum* in laboratory conditions (Table 5). Further, no-choice tests carried out with plant materials from *Jasminum angustifolium*, *J. flexile* and *Chionanthus zeylanica* with 5 replicates resulted in larval starvation and death, and thus confirmed the host specificity.

Table 4. Host-range of *Hyphasis* spp. 2 under field condition.

Host	Day 2		Day 6	
Test Species	*Ligustrum*	Test spp.	*Ligustrum*	Test spp.
Jasminum anguistifolium	T*	1	2	1
Jasminum anguistifolium	T	T	1	1
Olea polygama	1	1	3	1
Olea polygama	1	T	1	T
Olea polygama	T	T	D	D
Olea polygama	3	1	3	0
Jasminum flexile	2	2	2	2
Jasminum flexile	4	2	4	2
Chionanthus zeylanica	4	0	NA	NA

* See Table 1 for rating scale used. NA - not available

Table 5. *Palpita celsalis* host range test results.

Host	Day 1		Day 4	
Test Species	*Ligustrum*	Test spp.	*Ligustrum*	Test spp.
Olea polygama	2*	0	5	0
J. flexile	4	T	5	1
J. flexile	3	T	4	T
J. flexile	4	T	5	1
J. flexile	4	T	T	5
J. flexile	4	T	5	T

* See Table 1 for the rating scale used.

***Lepropus immunis* (Walker) (Coleoptera: Curculionidae):** This is a weevil, which is endemic to Sri Lanka. It's feeding rate is relatively slow and appears to be seasonal. The same species has been recorded from *Rosa indica* (*Rosaceae*), *Erythina subumbrans* (*Fabaceae*), *Camellia sinensis*, *Artocarpus heterophyllum* and *Accasia* spp. (Anon., 1999). Therefore, there will be no effort to study this polyphagous insect.

***Pangrapta grisangula*:** This insect is most commonly collected as a pale green larva and is common on the eastern slopes of higher elevations areas, such as Boralanda and Haputale. So far, this insect has not been found on any other tree species except *Ligustrum*

(Table 6) indicating that the insect is a potential candidate as a bio-control agent. Therefore, further attempts will be made to clarify its host specificity.

Table 6. Host-range of *Pangrapta grisangula* in the field.

Host	Day 2		Day 7	
Test Species	*Ligustrum*	Test spp.	*Ligustrum*	Test spp.
Jasminum spp.	0*	T	5	T
Jasminum spp.	0	0	4	T
Jasminum spp.	1	0	5	0
	Day 2		Day 5	
J. Anguistifolium	1	0	5	T
Olea polygama	5	1	5	3

* See Table 1 for the rating scale used.

***Phycita eulepidella* Hampson (Lepidoptera: Pyralidae)**: This pyralid moth has been recorded from *Jasminum* spp. in Sri Lanka (Anon., 1999). They were found to damage fruits and flower buds commonly during May and June. However, the insect eats only on members of the *Oleaceae* family. Further host range tests are required before this insect is dismissed as a potential bio-control agent.

***Problepis deliaria* Guenée (Lepidoptera: Geometridae)**: This insect is native to Sri Lanka, and is found in India as well. Young larvae are very active and produce threads, which enable them to be carried on currents of air to reach new plants. As the larvae develop they come to resemble lignified shoots of *Ligustrum* spp., and are very hard to detect with the naked eye. The larvae eat leaves and ring-bark stems, thus killing the shoots, and these dead stems provide a background against which the larvae are camouflaged. This apparent adaptation suggests that this species could show a high level of specificity. After 18-24 days the larvae starts pupates after reaching a length of 52 mm. The adult is white in colour and has distinctive reflective silver-coloured eye spots on its fore wings.

The host range tests carried out in the present study, which proceeded with *Jasminum angustifolium*, showed that they feed equally on both *Ligustrum* and *Jasminum*. Quarantine studies conducted in UK using no choice test procedure indicated that the larval length attained on day 20 by *P. deliaria* fed on *L. robustum* is greater than when they are fed on other species of *Oleaceae* (Table 7). This natural enemy is also specific to the family Oleaceae as shown in Table 7. To-date there were no records available to confirm whether *P. deliaria* is specific to *Ligustrum* or not. Thus, the present study is the first to report the host-specificity of *P. deliaria*.

Table 7. No-choice test carried out on L1 Larvae of *Problepis deliaria* in Sri Lanka and under quarantine facilities of CABI-Bioscience, UK.

Plant Species	Day 1	Day 4	Day 12	Day 20	Larval length at Day 20 (mm)
L. robustum	3*	3	2	2	42
L. robustum	3	3	3	3	46
L. robustum	3	3	2	0	--
L. robustum	3	3	3	3	42
L. robustum	3	3	3	3	51
L. robustum	3	3	3	3	43
L. robustum	2	2	2	2	45
L. robustum	0	3	3	3	46
L. ovalifolium[a]	3	2	2	2	--
L. ovalifolium[a]	3	3	2	3	36
L. ovalifolium[a]	3	3	3	2	47
Olea lancea[a]	2	2	2	2	40
Olea lancea[a]	3	3	3	3	39
Olea lancea[a]	3	3	2	2	42
O. europaea europaea[a]	3	3	3	3	36
O. europaea europaea[a]	3	3	3	3	35
O. europaea europaea[a]	3	3	3	3	36
O. europaea africana[a]	3	3	2	2	44
O. europaea africana[a]	3	3	3	3	32
O. europaea africana[a]	3	3	0	0	--
J. polyanthus	3	3	3	3	39
J. polyanthus	3	3	2	2	41
J. polyanthus	3	3	3	3	41

* See Table 1 for rating scale used.
[a] Studies carried out in the quarantine facility of CABI, UK.

CONCLUSIONS

Antestiopsis picturata, *Hyphasis* sp. 1 and 2, *Palpita celsalis*, and *Epiplema albida* were the insects, which warrant high priority for further study. Their life cycles and detailed host specificity with quarantine testing are now being continued. The results of preliminary host range testing indicated that *Problepis deliaria*, *Dermorhytis lewisi*, *Dermorhytis ornatissima*, *Pangrapta grisangula*, *Phycita eulepidella*, and *Xylosandrus arquatus* look promising but needs further screening tests in quarantine. These insects will be considered as medium priority. *Euwallacea fornicatus*, *Lepropus immunis*, *Phyllocnistis*

citrella, *Rhopobota naevana* and *Zeuzera pyrina* are recognized as polyphagous insects with wide host ranges, and hence are dismissed as biological control agents.

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