Prospects for Biological Control of Privet

(*Ligustrum* spp.) (Oleaceae)

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Environment Bay of Plenty
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1. Summary

1.1 Project and Client

Manaaki Whenua-Landcare Research, Palmerston North, investigated the feasibility of biological control of privet (*Ligustrum* spp.) (Oleaceae) in New Zealand for Auckland Regional Council, Environment Bay of Plenty, and Environment Waikato, in April 2000.

1.2 Objectives

- Record the distribution and weed status of *Ligustrum* spp. in New Zealand.
- Summarise the literature and current information available from biological control of weeds researchers worldwide on the current status of biological control of *Ligustrum* spp.
- Assess the likelihood of success of a biological control programme for *Ligustrum* spp. in New Zealand and review the steps necessary to implement such a programme.
- Propose a realistically costed programme for implementation by the Auckland Regional Council, Environment Bay of Plenty, Environment Waikato and other affected councils.

1.3 Main Findings

- Four species of privet are adventive in New Zealand: *L. lucidum*, *L. sinense*, *L. ovalifolium*, and *L. vulgare*, with the first two species being most important as weeds.
- Other members of the Oleaceae in New Zealand include four endemic species of *Nestegis* (maire) and several cultivated exotic species like olive, lilac and ash.
- Privet is readily dispersed by birds, so it invades and degrades native shrub and forest communities. Recent evidence also supports the long-held belief that privet pollen causes asthma and other respiratory allergies.
- Current control methods are highly labour-intensive, with the most common method being to fell the tree and apply herbicide to the cut stump. Metsulfuron methyl is the most effective herbicide for privet control.
- None of the invertebrates listed in published literature as being associated with *Ligustrum* spp. appear promising as potential biological control agents for privet.
- Some fungal pathogens, particularly rusts, deserve further investigation.
- *Ligustrum* spp. have been poorly surveyed so far in their region of origin (south-eastern Asia), so the prospects of discovering natural enemies that may be suitable for biological control of privet are good.
- CABI Bioscience has begun an investigation of biological control of *L. robustum* subsp. *walkeri*. Preliminary surveys in south-east Asia have already disclosed a lepidopteran caterpillar and some fungi that may be useful for biological control of privet in New Zealand.
- The CABI Bioscience programme offers excellent opportunities for collaboration to implement biological control of the New Zealand adventive privets.

1.4 Conclusions

- A biological control programme for privet in New Zealand could be initiated at relatively low cost if several agencies cooperated to support the current CABI Bioscience research. Top priority for this collaboration would be the proposed survey of *Ligustrum* spp. in China, as there is no guarantee that any of the very few promising agents so far identified would a) be safe for release in New Zealand; and b) control privet. Initial host range screening would also be more cost effective if carried out by CABI Bioscience, with New Zealand funding for plant species not already included in that testing.

1.5 Recommendations

- Survey populations of privet in different seasons throughout the species' known ranges in New Zealand to determine which invertebrates and diseases are currently associated with these species in New Zealand (approx. $35,000 over two years);
- Collaborate with CABI Bioscience to survey *Ligustrum* spp. in south-east Asia, particularly China (approx. $20,000);
- Negotiate to include *Nestegis* spp. and, if necessary, other plant species relevant to New Zealand in the CABI Bioscience host range testing of prospective biological control agents (($30–50,000 over 3 years).

2. Introduction

Privets, particularly tree privet (*Ligustrum lucidum*) and Chinese privet (*L. sinense*), are invasive, poisonous plants that are implicated as causes of allergies such as asthma. Current control methods rely heavily on herbicides and require intensive, sustained effort. Consequently, the feasibility of biological control of *Ligustrum* spp. (Oleaceae), was investigated by Landcare Research for Auckland Regional Council, Environment Bay of Plenty and Environment Waikato, in April 2000.

3. Objectives

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- Propose a realistically costed programme for implementation by the Auckland Regional Council, Environment Bay of Plenty, Environment Waikato and other affected councils.

4. Sources of Information

Information for this report was obained by searching computer databases (CAB abstracts, Current Contents, UnCover, Agricola) and Internet sites for information on *Ligustrum* spp.; by cross-referencing known references; and from:

Michael Bent, Environment Waikato, Hamilton;
Chris Buddenhagen, Department of Conservation, Wellington;
Lynley Hayes, Landcare Research, Lincoln;
Steve Hix, Auckland Regional Council, Auckland;
Peter Ingram, Environment B.O.P., Whakatane;
R. (Dick) Shaw, CABI Bioscience, Silwood Park, UK;
W.R. (Bill) Sykes, Landcare Research, Lincoln;
G.W. (Gregor) Yeates, Landcare Research, Palmerston North.

5. Main Findings

5.1 Distribution and weed status of privet in New Zealand

L. lucidum (tree privet) and *L. sinense* (Chinese privet) are most common north of the Bay of Plenty but also occur elsewhere in the North Island. *L. sinense* has been recorded from Nelson, but *L. lucidum* is not known to be present in the South Island. *L. ovalifolium* (privet) and *L. vulgare* (common privet) occur in both Islands; the former being recorded from Auckland, Wellington, Westland, Invercargill and Bluff, and the latter from Tauranga, Wellington, Canterbury and central Otago (Webb *et al*. 1988). Hereafter in this report I use the common name privet to refer to any or all *Ligustrum* species in New Zealand; to avoid confusion (particularly with *L. ovalifolium*), individual species are referred to by their Latin binomials.

In New Zealand, *L. lucidum* and *L. sinense* are serious weeds that are a major threat to the environment. Both are National Surveillance Plant Pests (Vervoort & Hennessy 1997) and are of concern to the Department of Conservation (C. Buddenhagen pers. comm.). *L. vulgare* is generally of lesser importance, although it is the most abundant species in colder parts of the South Island (W. Sykes pers. comm.). *L. ovalifolium*, although the most commonly cultivated species, is less common as an adventive than other privets in New Zealand, presumably because it seldom fruits (W. Sykes pers. comm.; Webb *et al*. 1988).

Privet causes two main problems. First, it invades plant communities and degrades them, for example, by replacing other species such as shrubs and mid-canopy trees in native forest and shrublands (Haley 1998); and second, it is perceived by the public as a cause of allergies including "hay fever" and asthma (M. Bent pers. comm.; S. Hix pers. comm.; Webb *et al*. 1988).

Privet is highly invasive because its dark bluish or purplish black berries are eaten and dispersed by birds. Although the leaves of mature privet are poisonous to stock (Connor 1977) it is not a problem in pasture because stock eat seedlings and fresh growth. It severely infests land under lax management, including fence lines, drains and road verges. In these areas it can interfere with power and telephone lines, and clearing operations can be hampered by the weed's hard, resilient stems and trunks (James & Mortimer 1984).

Privet pollen is often blamed for allergies such as hay fever and asthma, but as the flower is pollinated by insects, it is sometimes argued that privet pollen cannot cause these allergies on any significant scale (e.g., Webb *et al*. 1988). One explanation is that privet flowering coincides with other factors that are the real cause of the allergies, another is that the allergen responsible for these allergies is produced elsewhere in the plant, e.g. it may be a volatile compound. However, privet pollen is indeed abundant in air: a recent Australian study showed that pollen of *L. sinense* and *L. lucidum* was among the most abundant of all airborne pollens in south-west Sydney (*L. lucidum* pollen peaked at 4 700 grains m^{-3} for a 24-h count) (Bass & Morgan 1997). Furthermore, the pollen of olive (*Olea europaea*), which is closely related to privet, is an important cause of hay fever and asthma in the Mediterranean area (e.g., Damato *et al*. 1998; Florido *et al*. 1999; Subiza *et al*. 1995), and cross-reactivity of various types between the allergen in olive pollen and privet pollen has been demonstrated in several studies (Baldo *et al*. 1992; Kernerman *et al*. 1992; Martin *et al*. 1994; Obispo *et al*. 1993).
Flowers of privet compete for bees, and extensive infestations may reduce the pollination of desirable crops like kiwifruit (Syrett 1987). Privet honey has a strong smell, is sickly sweet and is not valued by beekeepers – the plant is considered a weed (C. Buddenhagen, email to R. Shaw).

Privet may also harbour pests and diseases of other, economically important plants. For example, the mite *Brevipalpus oboratus* is a potential pest on kiwifruit (Ferguson 1976), while tomato spotted wilt virus

(Mertelik *et al*. 1996), *Pythium debaryanum*, *Rosellinia necatrix* (McKenzie 1999) and tobacco mosaic virus (Paulechova & Baumgartnerova 1989) have also been recorded from privet. It is uncertain whether infections of these diseases on privet can increase the risk of infection of these plants.

Privet also has desirable characteristics. It is widely grown as an ornamental, being fragrant and easily trimmed for hedges and formal shrubberies, while its ability to withstand difficult and often polluted city environments makes it a useful small amenity tree (Benavides & Segura 1996; Chacalo *et al*. 1994; Pignata *et al*. 1997). There is some equivocal evidence that *Ligustrum* extracts may inhibit some cancers (Hashi 1991; Lau *et al*. 1994; Wong *et al*. 1992a,b; but see Khoo & Ang 1995). In some parts of China a herbal extract that often includes *Ligustrum robustum* or *Ligustrum pedunculare* is drunk as a tea (Ku-Ding-Cha or Kuding tea) for its reputed medicinal properties (Fukuda *et al*. 1996, Yu 1997). Another, complex preparation called NaO Li Su includes an extract from the fruits of *L. lucidum*; it is supposedly a remedy for failing memory, but a clinical trial of NaO Li Su failed to vindicate this (Iverson *et al*. 1997).

5.2 Taxonomic status of *Ligustrum* spp. and their relatives in New Zealand

The ability of natural enemies to attack new hosts is strongly influenced by the evolutionary history of those potential hosts (Briese 1996), so in any biological control programme it is essential to understand the relationships between the target plant and its relatives, particularly those that are economically or culturally significant. The approximately 40 species of *Ligustrum* L. that are native across Europe to eastern Asia and south to Queensland (Webb *et al*. 1988) belong to Oleaceae, a family that includes many economically and culturally significant trees. Naturalised species of Oleaceae in New Zealand, other than *Ligustrum* spp., include ash (*Fraxinus excelsior* L.), five species of jasmine (*Jasminum beesianum* Forrest et Diels; *J. humile* L.; *J. mesnyi* Hance; *J. officinale* L.; and *J. polyanthum* Franchet), African olive (*Olea europea* L.subsp. *africana*), lilac (*Syringa vulgaris* L.) and forsythia (*Forsythia suspensa* (Thunb.)) (Webb *et al*. 1988). Many cultivars of these species are grown as ornamentals, and the European olive (*Olea europea* L.subsp. *europea*) is an increasingly important crop; conversely, the jasmines can be weedy and *J. polyanthum* is a regional surveillance plant pest in the Auckland region. The only indigenous Oleaceae are the four species of *Nestegis*: *N. cunninghamii* (Hook. f.) (maire, black maire), *N. lanceolata* (Hook. f.) (white maire), *N. montana* (Hook. f.), and *N. apetala* (Vahl).

Of these exotic and indigenous species, lilac is most closely related to the privets (Green & Fliegner 1991; Qin 1996). It typically grows less vigorously in New Zealand than in many other countries; nevertheless, because it is a valued ornamental plant, any prospective biological control agents would have to be tested rigorously to ensure that they did not attack it.

5.3 Current control options

Privet control is difficult because many of the habitats it invades preclude blanket spraying and make individual plants hard to find. Seedlings can be pulled or dug out, while older plants can be cut down but the stumps must be treated with herbicide to prevent resprouting (Haley 1998). This "cut and swab" method of control is the most commonly recommended method of control (M. Bent pers. comm.; S. Hix pers. comm.). Standing trees can also be poisoned by making a series of downward-sloping holes or cuts around the trunk and filling these with herbicide ("stem injection") (Haley 1998; Madden & Swarbrick 1990; O'Connor 1998). This is a useful method for trees that would otherwise be difficult to fell. The method referred to as "wet stump" application involves completely spraying the basal 30 cm of stem until runoff, but the herbicides tested by Madden and Swarbrick (1990) using this method had killed only 9–71% of plants after 14 months, despite an apparent kill after 6 months of 92% by triclopyr ester.

Metsulfuron methyl (Escort®) appears to be the only herbicide that consistently gives effective, long-term control of privet when sprayed onto foliage (Haley 1998; Madden & Swarbrick 1990; O'Connor 1998). Glyphosate with an adjuvant can kill most plants when applied in spring but not in autumn (James & Mortimer 1984). Glyphosate without adjuvant is not effective when applied as a foliar spray nor by stem injection (Mowat 1981; Wye College 1972 (in James & Mortimer 1984)). Metsulfuron methyl (listed as DPX T6376 in James and Mortimer (1984) (T. James, *pers. comm.*)) applied to cut stumps or by stem injection also kills most privet plants, as do cut stump applications of triclopyr ester (Grazon®), picloram mixed with 2,4-D (Tordon® 50-D), and picloram mixed with triclopyr ester (Tordon® Brushkiller) (James & Mortimer 1984; Little 1982; Madden & Swarbrick 1990).

Madden and Swarbrick (1990) calculated the costs of effective herbicide treatment of *L. lucidum* in Australia and concluded that stem injection of metsulfuron methyl was the least costly treatment. Analysis of their results shows that it was about 40% cheaper than the next cheapest treatment, and that this advantage would not disappear unless labour costs fell from Australian $12 per hour to $A4.80.

Ward *et al.* (1999) suggested that gel pruning might also be an effective method for killing privet. The method is an extension of that developed by HortResearch for controlling summer growth in kiwifruit. A gel containing herbicide is applied to the cut surface as stems are pruned, conferring several advantages over other techniques: the method is safe for the operator as no mixing of herbicide is needed; high concentrations of herbicide can be applied, ensuring an effective kill with a single application; the gel formulation adheres well to cut surfaces, so run-off problems are avoided; and the equipment is compact, so that it can be easily carried to and used in difficult areas. The method deserves further investigation.

5.4 Potential agents for biological control of privet

Many organisms attack *Ligustrum* spp. Shaw (1999) listed 62 species of phytophagous invertebrates, and my literature search disclosed a further 20 arthropods and 17 nematodes (Table 1). However, none of those 99 are likely to be prospective biological control agents because they appear to be polyphagous or attack other plants that are valued for economic or ornamental reasons. Recently, the weevil *Ochyromera ligustri* (Coleoptera: Curculionidae) has been recorded as causing "considerable damage to *L. japonicum*" in the USA (R. Shaw 1999, in email to *Ligustrum* discussion group). It has also been recorded from seeds of *L. sinense* (Cuda & Zeller 1998) and may have potential as a control agent for other regions; however, adults of *O. ligustri* have been associated with feeding damage on lilac so this would have to be checked carefully (R. Shaw pers. comm.)

Of the nematodes listed in Table 1, *Axonchium vaginatum* belongs to a group that is presumed to feed on fungi; while the two species of *Paravulvus* are likely to be predacious, feeding on Enchytraeidae. Thus these are associations rather than host-parasite relationships with *Ligustrum*. Of the remaining nematodes in Table 1, *Aphelenchoides fragariae* is a foliar feeder and the others infest roots; however, all are known or are likely to have wide host ranges. The genera *Longidorus*, *Trichodorus* and *Xiphinema* are potential vectors of plant viruses, but unless a nematode-vectored, *Ligustrum*-specific virus were to be identified, this is of academic interest only (G.W. Yeates pers. comm.).

Table 1 Invertebrates recorded from *Ligustrum* spp. (records additional to those listed in Shaw 1999)

Classification	Species	*Ligustrum* host	Reference
Insects			
Coleoptera: Cerambycidae	*Pidonia tsuyukii*	*L. tschonoskii*	Kuboki 1994
Coleoptera: Chrysomelidae	*Pyrrhalta humeralis*	*L. calleryanum*	Shen & Mi 1992
Coleoptera: Curculionidae	*Callirhopalus bifasciatus*	*Ligustrum* sp.	Zepp 1978
Coleoptera: Curculionidae	*Ochyromera ligustri*	*L. sinense*	Cuda & Zeller 1998

Coleoptera: Curculionidae	*Otiorhynchus crataegi*	*L. vulgare*	Palm 1998
Coleoptera: Scarabaeidae	*Anomala antiqua*	*Ligustrum spp.*	Tong & Fang 1989
Diptera: Cecidomyiidae	*Placochela ligustri*	*L. vulgare*	Robbins 1999
Formicidae: Attini	*Atta texana*	*L. japonicum*	Waller 1989
Hemiptera: Miridae	*Lygocoris furvus*	*L. obtusifolium*	Yasunaga 1992
Hemiptera: Pentatomidae	*Loxa deducta*	*L. lucidum*	Panizzi *et al*. 1998
Hemiptera: Ricaniidae	*Scolypopa australis*	*Ligustrum* sp.	Dale & Maddison 1982
Homoptera: Aleyrodidae	*Dialeurodes citri*	*Ligustrum sp.*	Gargani 1990
Homoptera: Cicadellidae	*Fieberiella florii*	*Ligustrum sp.*	Fos 1976
Homoptera: Diaspididae	*Quadraspidiotus perniciosus*	*L. vulgare*	Dale & Maddison 1982
Lepidoptera: Lymantriidae	*Lymantria dispar*	*Ligustrum sp.*	Heskova 1973
Lepidoptera: Sphingidae	*Psilogramma increta*	*L. quihoui*	Chen & Pang 1985
Lepidoptera: Tortricidae	*Ctenopseustis obilquana*	*L. vulgare*	Dale & Maddison 1982
Lepidoptera: Tortricidae	*Planotortrix excessana*	*L. vulgare*	Dale & Maddison 1982
Lepidoptera: Yponomeutidae	*Prays citri*	*L. lucidum*	Sinacori & Mineo 1997
Mites			
Tenuipalpidae	*Brevipalpus phoenicis*	*L. lucidum*	Rodrigues & Nogueira 1996
Nematodes			
Aphelenchida	*Aphelenchoides fragariae*	*L. vulgare*	Goodey *et al*. 1965
Dorylaimida	*Axonchium vaginatum*	*L. obtusifolium*	Choi & Jairajpuri 1998
Dorylaimida	*Longidorus maximus*	*L. vulgare*	Goodey *et al*. 1965
Dorylaimida	*Paravulvus kyeryongensis*	*L. obtusifolium*	Choi & Jairajpuri 1998
Dorylaimida	*Paravulvus papillatus*	*L. obtusifolium*	Choi & Jairajpuri 1998
Dorylaimida	*Xiphinema americanum*	*Ligustrum* spp.	Siddiqui *et al*. 1973
Dorylaimida	*Xiphinema brevicolle*	*Ligustrum* spp.	Siddiqui *et al*. 1973
Triplonchida	*Trichodorus* sp.	*Ligustrum* spp.	Siddiqui *et al*. 1973
Tylenchida	*Meloidogyne hapla*	*Ligustrum* sp.	Goodey *et al*. 1965
Tylenchida	*Meloidogyne incognita*	*Ligustrum* sp.	Goodey *et al*. 1965
Tylenchida	*Meloidogyne javanica*	*L. lucidum*	Goodey *et al*. 1965
Tylenchida	*Pratylenchus penetrans*	*Ligustrum spp.; L. ovalifolium; L. vulgare*	Siddiqui *et al*. 1973; Goodey *et al*. 1965
Tylenchida	*Pratylenchus thornei*	*Ligustrum spp.*	Siddiqui *et al*. 1973
Tylenchida	*Pratylenchus vulnus*	*L. japonicum*	Talavera *et al*. 1999
Tylenchida	*Rotylenchus buxophilus*	*Ligustrum* spp.; *L. vulgare*	Siddiqui *et al*. 1973; Goodey *et al*. 1965
Tylenchida	*Rotylenchus robustus*	*Ligustrum* spp.	Siddiqui *et al*. 1973
Tylenchida	*Tylenchorhynchus* sp.	*Ligustrum* spp.	Siddiqui *et al*. 1973

Fungi are perhaps more promising than invertebrates as potential control agents for privet. Shaw (1999) listed 124 species of fungi recorded from *Ligustrum* spp, and noted that there was good potential for discovering new species from *Ligustrum* spp. The wood rot fungus *Trametes versicolor* has been recorded from dead wood of *L. sinense*; while this is not likely to be a classical biological control agent, it may be useful if bulked up and applied either as a gel formulation to wounds (see section 5.3) or as an aqueous suspension for pressure injection into trunks (Ward *et al*. 1999).

In addition to the fungi listed by Shaw (1999), *Cercospora adusta*, *Thedgonia ligustrina* and *Colletotrichum gloeosporioides* have been recorded from *L. ovalifolium*, *L. japonicum* and *L. vulgare*, respectively (Orlikowski & Wojdyla 1991; Shin 1998; Yoshikawa & Yokoyama 1992). Lima *et al*. (1994) described the symptoms of a ringspot virus from *L. lucidum*, and a mycoplasma-like organism (MLO) has been found attacking *L. ovalifolium*, *L. obtusifolium* and *L. japonicum* (Chai & Kim 1989); however, given our current poor state of knowledge of MLOs, this is not a prospect for biological control of privet.

The current literature records may paint an unduly pessimistic picture. Shaw (1999) pointed out that most records are from countries where privet has been introduced, and there are few records from its native range. He noted that privet has potentially good chemical defences against herbivores, so that outside its native range it is likely to be attacked primarily by suitably polyphagous herbivores (Shaw 1999). This has the corollary that within its native range it is likely to be attacked by natural enemies that have adapted to overcome these defences; therefore, the likelihood of finding agents that attack only privet may be much higher if surveys were to be carried out within the native range of *Ligustrum*. To this end, CABI Bioscience, funded by La Région Réunion, is engaged in surveys of *Ligustrum* spp. in Sri Lanka, Vietnam, the Western Ghats in south-west India, and Assam and Maghalaya in Northern India, and is keen to carry out further surveys in China. A geometrid caterpillar from Sri Lanka and a flea beetle from Vietnam have already been screened, but rejected. However, an epiplemine caterpillar (Lepidoptera: Uraniidae) from Sri Lanka appears promising, and a variety of hemibiotrophic plant pathogens are still being investigated, including a species in Dothideales that causes premature leaf fall (R. Shaw pers. comm.). Other potentially useful fungi recorded from *Ligustrum* spp. include several rusts, three species of *Phyllosticta*, and *Colletotrichum ligustri* (Shaw 1999).

5.5 Prospects for achieving successful control of privet through biological control

Because privet's invasiveness results largely from its dispersal by birds, a focus on agents that reduce the production of fruits and viable seed would be the most direct way to attack the problem. Unfortunately, of the invertebrates currently known from *Ligustrum* spp, only the epiplemine caterpillar and perhaps *O. ligustri* appear to be worth further investigation, and only the latter attacks seeds. Nevertheless, other agents, including those that defoliate without directly attacking fruits, may reduce seed production, so the proposed surveys in China offer good prospects for disclosing potentially useful biological control agents.

Fungi may offer better prospects than invertebrates. Rusts can be highly specific to their hosts, with the potential to cause significant damage to foliage and perhaps stems. Again, the proposed surveys in China are likely to disclose new fungal pathogens, some of which may have the characteristics of good biological control agents.

A public education programme, aimed at drawing attention to the severity of the privet problem, may be necessary (and would at least be desirable) before introducing any biological control agents. While many people do not doubt that privet is undesirable, others still view the plant as an attractive ornamental. This is clearly illustrated by an anecdote from the Waikato region: residents on one side of a street complained about a privet hedge, but residents on the opposite side of the street vigorously opposed plans to remove it (M. Bent pers. comm.). However, complaints to regional councils about privet are common where the plant is abundant, and most of those complaints are based on the perception that it is a health risk. The accumulating evidence that, contrary to earlier beliefs, privet does cause allergies like asthma (see section 5.1) strengthens the argument that it is a weed and therefore supports the call for a biological control programme. Furthermore, privet's desirable characteristics are not unique. For example, a *L. sinense* hedge has no obvious advantages over a hedge of the native *Pittosporum tenuifolium*, which is easily clipped to shape, attractive and superbly scented; similarly, individual trees of *L. lucidum* might be replaced with one of many equally (or more) attractive trees that give a similar landscape effect (e.g., the native titoki, *Alectryon excelsus*). Indeed, Environment B.O.P. has negotiated a system with a local plant nursery so that landowners who remove privet may redeem approved vouchers for replacement plants from the nursery (P. Ingram pers. comm.).

Other, desirable Oleaceae that must not be attacked by prospective agents include ash, lilac, olive, and the four native species of *Nestegis*. Because *Nestegis* is an endemic genus, the likelihood that it would be opportunistically attacked by specialist *Ligustrum* herbivores is lower than for, say, lilac. Jasmine may be contentious; although it has weedy characteristics, with *J. polyanthum* being a regional surveillance plant pest in the Auckland region, it is nevertheless valued and grown by many gardeners. Some of these species may be included in host range testing of potential privet agents by CABI Bioscience, as part of their search for agents to control *L. robustum* subsp. *walkeri,* but New Zealand would certainly have to meet the costs of testing *Nestegis* spp., and possibly some other species if CABI did not consider these appropriate for their programme.

6. Conclusions

A biological control programme for privet in New Zealand could be initiated at relatively low cost if several agencies cooperated to support the current CABI Bioscience research. Top priority for this collaboration would be the proposed survey of *Ligustrum* spp. in China, as there is no guarantee that any of the very few promising agents so far identified would a) be safe for release in New Zealand; and b) control privet. Initial host range screening would also be more cost effective if carried out by CABI Bioscience, with New Zealand funding for plant species not already included in that testing.

7. Recommendations

- Survey populations of privet in different seasons throughout the species' known ranges in New Zealand to determine which invertebrates and diseases are currently associated with these species in New Zealand (approx. $35,000 over 2 years);
- Collaborate with CABI Bioscience to survey *Ligustrum* spp. in south-east Asia, particularly China (approx. $20,000);
- Negotiate to include *Nestegis* spp. and, if necessary, other plant species relevant to New Zealand in the CABI Bioscience host range testing of prospective biological control agents (($30–50,000 over 3 years).

8. Acknowledgements

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