

# EXECUTIVE COUNCIL

## CONFIDENTIAL

**Title of Report:** Earwig Biological Control

**Paper Number:** 119/13

**Date:** 3 June 2013

**Report of:** Head of Policy/Environmental Planning Officer

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### 1.0 Purpose

To outline a revised plan by Dr Maczey of the Centre for Agricultural Bioscience International (CABI) supporting the biological control of earwigs; noting the first year Phase 1 testing costs.

### 2.0 Recommendation

That Executive Council:

- (a) **Approve the principle of undertaking testing of biological control agents in Europe to support the potential control of earwigs in the Falkland Islands.**
- (b) **Approve the principle of further funds being made available next financial year from the Environmental Studies Budget to complete the Phase 1 work.**

### 3.0 Summary of Financial Implications

None

### 4.0 Background and Impact

- 4.1 Earwigs have increased in numbers (based on anecdotal evidence and surveys) since their accidental introduction to Stanley in the early 2000s.
- 4.2 The impact of earwigs is widely felt by the residents of Stanley and many mainland settlements which are also host the insect. Impacts include wide-ranging nuisance impacts, impacts on vegetable gardens and the market garden, chemical spraying and potential long-term impacts on the wider environment.

- 4.3 Nuisance impacts are felt due to the large number of earwigs which enter residences and gardens in the late summer and autumn. A survey conducted by the Dept of Agriculture in 2011 demonstrated that earwigs affect most residences in Stanley and a considerable number of camp settlements.
- 4.4 Several businesses offer chemical spraying to control earwigs. Figures show that the residents of Stanley collectively spend a considerable amount to have their properties sprayed; over £15,000 in 2011. The Dept of Agriculture has a budget of £5000 which is available to fund spraying for the elderly and those on social benefits. Stanley Growers Market Garden spend over £1000 annually to control earwigs in their facilities. The Market Garden sell over £1000 of product each year specifically for the control of earwigs.
- 4.5 The impacts of regular chemical spraying are not well understood – with the potential for contamination and impacts on health that may become present if long term spraying of chemicals continues.
- 4.6 Personal gardens in Stanley are undoubtedly affected by earwigs with anecdotal evidence of widespread losses of vegetables as a result of earwigs eating leaves of many vegetable types. Stanley Growers report the loss of over £8,000 worth of produce each year and have given up growing some crops such as Chinese cabbage and celery. The risk of increased vegetable losses has the potential to undermine the import substitution programme supported by FIDC.
- 4.7 The potential long-term impacts if earwigs spread throughout the Falkland Islands, particularly into the wider environment are even greater. It is currently understood that earwigs only affect areas with human population as they require buildings and associated human development for cover and food. If earwigs were to make the jump and inhabit natural habitats they could potentially impact existing ecosystems and disrupt native insects and plants having further impacts on wildlife and agriculture.

## **5.0 Biological Control**

- 5.1 Dr Norbert Maczey of the Centre for Agricultural Bioscience International (CABI) visited the Falkland Islands in 2012 to produce a feasibility study on the potential use of biological control agents. His assessment of priority invasive plant and insect species of concern in the Falklands rated earwigs as the invasive species with the largest impact.
- 5.2 Dr Maczey has prepared a revised concept note for the biological control of earwigs (see appendix 1). Dr Maczey describes Stanley earwig numbers as being ‘epidemic’ in number compared to their natural habitat in Europe and Asia. It is believed that the introduction of host specific tachinid flies will control the reproduction of earwigs at therefore reduce the population.

- 5.3 The concept note produced by Dr Maczey was considered by Environmental Committee in May where it was roundly endorsed as a worthwhile initiative. This report follows earlier reports to Environmental Committee and Executive Council (209/12) and comprises a detailed proposal for the initial feasibility and testing of biological agents in Europe to support the control of earwigs subject to further approvals and funding.

## **6.0 Phase 1 Feasibility Study**

- 6.1 CABI regards the European earwig as a promising target species for biological control in the Falkland Islands. Off the shelf solutions using parasitoid tachinid flies are readily available and have been outlined on a number of occasions to Environmental Committee. As there are no other native Dermaptera invertebrate species present in the Falkland Islands, the risk of non-target effects is considered by CABI as very low. To narrow down the host range specificity of both control species, closely related Dermaptera and in addition further species belonging to other taxonomic orders need to be tested.
- 6.2 CABI stress there is no evidence that any side effects are likely to materialise from the potential release of tachinid flies. They propose to test for non-target impacts through the phase one study as detailed in the concept note attached at appendix 1 of this paper.
- 6.3 CABI plan to obtain specimens of two species of tachinid parasitoids from areas with a climate similar to that of the Falklands (Scotland and northern England) and bring these into cultivation at CABI's facilities in Europe. Host range testing should be very limited and will comprise of 2-3 earwig species and single test species from other orders closer related to Dermaptera. They will also test native camel crickets or a similar European species.
- 6.4 CABI can conduct the necessary research on earwigs and the two associated parasitoid fly species including cultivation, and host range testing by delivering the following:
- Carry out collection of the tachnid parasitoids *Triarthria setipennis* and *Ocytata pallipes* from sites in Northwest Europe climate-matched to the Falkland Islands
  - Transport cultures to their specialist facility for further assessment and cultivation in Egham, Surrey or alternatively establish cultivation at Delemont, Switzerland.
  - Conduct proposed host specificity studies on key non-target species using high-level containment infrastructure in Egham or Delemont.
  - Application to the appropriate bodies for the eventual release of *Triarthria setipennis* and/or *Ocytata pallipes* if appropriate.
- 6.5 If cultivation and testing is successful and approved by FIG, the second phase of the study would involve:

- Release of agents at suitable locations in Stanley and possibly MPA during two consecutive summers (release programme to be finalised).
- The production of an in-depth project report on *Triarthria setipennis* and/or *Ocytata pallipes* as a natural control agent for the European Earwig *Forficula auricularia*.

## **7.0 Funding**

- 7.1 Reported levels of earwig infestation in Stanley have been high in the past few months and it is clear that this problem is a continuing concern to many households and businesses.
- 7.2 CABI has indicated that it is willing and able to devote the necessary resources to undertake the Phase 1 work with immediate effect, but is unlikely to hold this offer open indefinitely.
- 7.3 Total funds required for Phase 1 laboratory cultivation and testing research are £25,346. This work would be undertaken from May to October 2013 in Europe. Collection of earwigs is already underway in the UK to progress the project prior to funding confirmation. If successful, consideration would be given to the release of control agents as early as November of this year. This would be subject to further consultation and approvals.
- 7.4 Through a combination of savings in salaries and reduced wardening requirements at Gypsy Cove the Department is projected to underspend its budget this financial year. Treasury have agreed that these funds can be made available to part-fund Phase 1 this financial year, with the remaining funding to come from next financial years Environmental Studies Budget.
- 7.5 If agreement is not forthcoming it is uncertain when Phase 1 might commence as it is unlikely that next years ESB could bear the full cost without impacting on other important projects.

## **8.0 Conclusion**

- 8.1 It is clear from the biological control feasibility study conducted by CABI that the biological control of European earwigs has an excellent chance of success in the Falkland Islands. It is also clear that the public are likely to support an initiative to reduce the impact of earwigs if it is deemed safe with no potential side effects.
- 8.2 The phase one testing phase is both a feasibility test and confidence building exercise to prove that the fly species considered for the control of earwigs will work effectively in the Falkland Island climate and conditions, and will not have any impact on native or commercial insect or plant species present in the Falkland Islands.

- 8.3 CABI is available to commence Phase 1 now and, subject to Treasury and Members approval, funding is also available.

## **9.0 Financial Implications**

Operating Budget      2012/13:  
None (£15,346 from existing dept budgets)

2013/14:  
£10,000 (from Environmental Studies Budget)

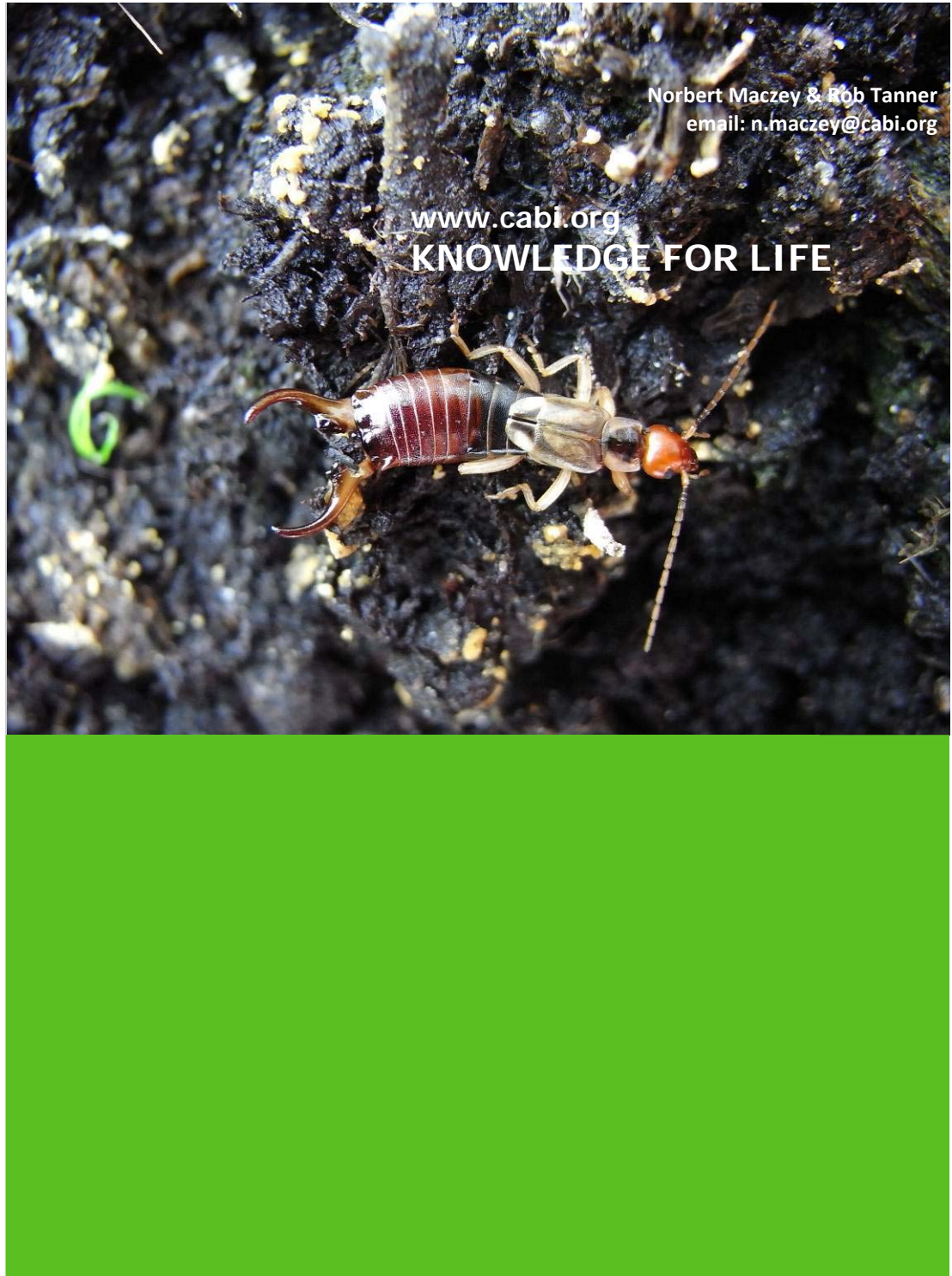
## **10.0 Legal Implications**

None

## **11.0 Human Resources Implications**

None

Update March 2013



## Biological control of the European earwig (*Forficula auricularia*) – a severe threat to horticulture and health & safety on the Falkland Islands

### What is the problem?

The European Earwig, *Forficula auricularia*, was recently introduced to the Falkland Islands, but has become locally common in the Port Stanley and Mount Pleasant Airport area. So far the main outbreaks are restricted to these two areas, but individual specimens seem to have been discovered on some of the isolated farmsteads. The earwigs seem to have become a real nuisance over the last four years, but the exact date of introduction is unknown. There seem to be no records or observations away from settlements. Currently, major negative impacts caused by this species are:

- Earwigs cause huge damage to garden crops (cabbages, broccolis, turnips, beetroot etc.) including commercially grown crops (damage caused by this species has led to the complete cessation of growing individual crops such as lettuce for commercial purposes); pesticide application in horticulture to control earwigs requires hefty treatment with undesired products
- Earwigs pose certain health hazards (hiding behind rubber sealing in oxygen masks of local hospital; found in asthma inhalers; children with earwigs in nose had to be treated in hospital, etc.)
- They become a particular nuisance in autumn when retreating into houses and have a tendency to show up in very unpleasant places (in food, toothbrushes, etc.)
- Households spend substantial amounts of money to control earwigs with a wide range of methods, with varying success and the need for repeated application (spraying with insecticides, use of furniture polish, painting houses from the outside with diluted diesel, sealing cracks with silicone etc.)

There was a great consensus during a workshop in Port Stanley in March 2012 about the feasibility of biological control of invasive non-native species on the South Atlantic UK OTs that the European earwig is by far the best target for this type of control on the Falklands. Both experts working on invasive species on the Islands and also members of the general public saw an urgent need for a sustainable control of this species. Equally, the Government of South Georgia is very supportive of any control efforts, which would reduce the risk of future introductions of earwigs to South Georgia. Chile also has got a huge problem with earwigs in southern parts of the country, particular at Punta Arenas and joint efforts between the Falklands Islands and Chile seem feasible. However, whereas there are currently no native Dermaptera known from the Falklands or South Georgia this is not true for Chile (and Argentina).

### An effective and sustainable solution

Classical biological control has the potential to offer effective, economic and sustainable control of this invasive species. It involves the deliberate release of specialist natural enemies - mainly insects and fungi - from the invasive's native range. The aim is to reduce the abundance of problem species in its introduced range below an ecological or economic threshold.

Currently we regard the European earwig *Forficula auricularia* a very promising target species for BC on the Falkland Islands. Particularly as chemical sprays are ineffective because of its widespread occurrence and great mobility (Santini & Caroli 1992). Off the shelf solutions using parasitoid tachinid flies are readily available. One of these species *Triarthria setipennis* has established successfully in Newfoundland and British Columbia (Morris 1984). Studies on the establishment of *T. setipennis* in

Newfoundland indicated a considerable reduction in earwig numbers, which was most probably due to high levels of parasitism in the mid-1970s (Morris 1984). However, since 1978, no further evaluation of parasitoid impact has been undertaken. A second species *Ocytata pallipes* has been introduced into Canada to control the European earwig during the 1990s (Kuhlman et al. 2001). Maggots were applied singly to about 115 earwigs, and the earwigs and 20 adult flies were later released at one site in Ottawa. Although this ad hoc release programme was useful as a pilot study, the release of such a low number of potentially infected *F. auricularia* makes success of this introduction unlikely and no follow up monitoring had been conducted. *Ocytata pallipes* and *Triarthria setipennis* have also been introduced into the USA and New Zealand. Introductions into the USA had been done as early as the 1920s (Oregon) (Kuhlman et al. 2001). Again, little is known about the success of these releases.

Risk assessments and host range testing programmes for the introduction of one or both of these tachinid species into the Falklands will be minimal as no closely related invertebrates occur on the Falklands or the nearest other islands. However, the host specificity of both parasitoids is fairly unknown and to date no laboratory host range studies were conducted. The ecological host range of *T. setipennis* includes two other earwig species, *Chelidura albipennis* Meg. (Thompson) and *Forficula decipiens* Gené, but the host range of *O. pallipes* is unknown. To narrow down the host range specificity of both species a number of closely related Dermaptera and in addition of further species belonging to other taxonomic orders need to be tested.

Since there are no other native Dermaptera species reported from the Falkland Islands, the risk of non-target effects can be considered as very low. However, from the mainland of Argentina, 395 km west of the islands, 37 native species are known. Since it seems possible albeit unlikely that European parasitoids, when released on the Falkland Islands, could be accidentally introduced to the mainland, it is recommended to conduct host range studies for both parasitoids. The tests should be conducted with native, South American earwigs, closely related to the target, e.g. the five species within the family Forficulidae: *Doru gracilis* (Burmeister, 1838), *Doru lineare* (Eschscholtz, 1822), *Doru luteipes* (Scudder, 1876), *Doru platensis* Borelli, 1912, and *Doru taeniatum* (Dohrn, 1862). As European earwigs also pose a severe problem in southern Chile it seems feasible that a specific testing of the species listed above could be tested by the Chilean authorities themselves and we are therefore not further considering any testing of these taxa in this concept.

The parasitic flies are smaller than the earwigs itself (~ 5mm) and develop during summer in outside habitats. We do not expect them to be of any nuisance inside houses although the occasional occurrence inside buildings cannot be excluded. If not specifically surveyed they will rarely be observed even in suitable outdoor areas inhabited by earwigs. As the recorded rates of parasitism in earwigs in their native range is relatively low any agents released will most likely need to establish over at least 2-3 years only after this time period considerable positive effects can be expected to be observed. The currently limited distribution at two settlements should still facilitate a rather quick establishment and reduction of earwig populations to tolerable levels below a threshold where they cause considerable nuisance and crop damage. It is however, unrealistic to expect seeing an effect within the first two years after release. There remains the possibility, however, that in cases of local outbreaks on isolated farmsteads due to accidental introduction of earwigs free of parasitoids, repeated releases of parasitic flies or even of infected earwigs may become necessary in the future. Release should be conducted during the summer and we suggest releases in two consecutive years. Additional releases would only be necessary if a post release monitoring would show a failure of establishment.

### Non-target impacts

The Organisation for Economic Co-operation and Development (OECD) has developed guidelines to provide a regulatory framework for the introduction of invertebrates for classical and inundative biological control (OECD 2003). These guidelines were accompanied by a research paper proposing risk assessment methodology for the evaluation of agents used in inundative biological control (van Lenteren et al. 2003). Subsequently, this was followed by guidelines coordinated by the commission on 'Harmonised Regulation of Invertebrate Biological Control Agents' of the International Organization for Biological Control of Noxious Animals and Plants/Westpaleartic Regional Section



(IOBC/WPRS) (Bigler et al. 2005). CABI is prepared to follow this methodology, underpinned by number of follow-on papers providing more detailed frameworks and protocols (Kuhlmann et al. 2000, 2006; van Lenteren 2006a, 2006b; Toepfer et al. 2009). Host specificity is a key element if non-target effects of biological control agents are to be assessed (van Lenteren et al. 2003, 2005). At least until recently inundative BC was frequently using agents with relatively low degrees of host specificity and therefore carrying significant risks for impacts on non-target species. One principle in CBC is however, to eliminate such risks whenever possible by focusing on control agents, which are host specific enough not to be able to develop on native species. While host specificity testing became routine in weed biological control projects some decades ago, it was incorporated into arthropod biological control projects rather more recently (Babendreier et al. 2005). One reason for the late uptake of host range testing is the fact that very few non-target effects could ever been found in BC of insects (van Lenteren 2005). However, no consensus has emerged on how to compile a list of suitable non-target species and how many species should be tested (Babendreier et al. 2005). Creating a list of species that should be tested for attack by biological control agents is obviously a difficult task when faced with the prospect that potentially many closely related species are known to occur in the targeted control area, which cannot feasibly included in a comprehensive testing programme (as can easily be the case within such a diverse group as insects). As a general rule, test lists are based on knowledge from host records extracted from the literature. The first approach, which is similar to weed biocontrol projects, is to include those species that are most closely related to the target (Babendreier et al. 2005). However, the centrifugal phylogenetic approach (testing closest relatives first and other species of decreasing relationship during next steps), generally applied in weed biological control, may not always be feasible because of uncertainties in taxonomy and a much higher number of arthropod taxa compared to weeds (Kuhlmann et al. 2000). Additional non-target species such as economically important species, threatened or aesthetic (flagship) species or biological control agents of weeds may need to be tested as well (Babendreier et al. 2005). The ultimate aim of host specificity tests is to determine the agent's ecological host range, i.e. the number of hosts that will be attacked in the field where the biological control agent is to be introduced. Aside from direct field observations, in principle two major type of testing are used in any comprehensive testing programme, 'no choice' and 'choice' tests. No choice tests are generally conducted in the laboratory where the biological control agent is confined to a container (e.g. vial, petri dish) together with hosts for a certain amount of time. After this time, assessment is made as to whether the host has been successfully attacked by the agent. In choice tests, the aim is generally to evaluate relative host preferences for either non-target or target species when offered simultaneously. Host specificity is crucial in assessing potential environmental impact on non-target species in case agents are released. Even very host specific agents may still bear the risk for residual non target effects although these are generally negligible in comparison to the impact caused by the target species. However, sometimes it may be necessary to consider non target effects caused by very specific ecological traits of the agents. One extreme example would be if the agents would be toxic to predators and so impact on the local food chain.

In case of the proposed agents for earwig control we will need to take into consideration the following possible impacts:

- A direct decline of earwigs could impact on any native species or other predatory species having adjusted to feeding on earwigs over recent years (basically forcing back populations to the situation before the introduction of earwigs).
- Adult tachinid flies will be subject to predation by other invertebrates or birds. Theoretically, this could release predatory pressure on other invertebrate species.
- Adult tachinid flies could impact on seed setting of flowering plants, both native and invasive, by pollination. Adult tachinid flies are known to feed on flowers and nectar from aphids and scale insects. As many species typically feed on pollen, they can be important pollinators of some plants.

There is currently no evidence that any of these theoretically possible side effects will materialise. The population of introduced tachinid flies will remain small (limited by a controlled earwig population) and a high number of native fly species are already providing a similar input into the existing ecosystem through services such as pollination. We therefore believe that any impacts caused by the

introduced agents would remain very small and negligible, certainly compared with any recorded unrecorded impacts earwigs currently have on the native ecosystem.



### What can CABI do?

With a long history of implementing biological control programmes globally (including the release of control agents against the European earwig into Canada), CABI is well placed to carry out the required work on *Forficula auricularia* and to undertake both laboratory and greenhouse evaluation, as well as field trials, to determine the host specificity and efficacy of control agents.

The most straightforward approach would be to obtain specimens of both previous used tachinid parasitoids from areas with a climate matching that of the Falklands (the North Sea coast of Germany or in Scotland) and bring these into cultivation at CABI's facilities in Delemont, Switzerland or alternatively if sampled on the British Isles at our facilities in Egham, Surrey. Host range testing should be very limited for the reasons described above and will comprise of 2-3 earwig species and single test species from other orders closer related to Dermaptera.

Dermaptera (earwigs) are a monophyletic order of insects belonging to the wider group called Polyneoptera, which includes a wider range of insect orders such as Blattodea (cockroaches) and Orthoptera (grasshoppers and crickets). Molecular studies suggest that the Dermaptera are most closely related to Plecoptera (stoneflies) and Ephemeroptera (mayflies) (Wan et al. 2012). Currently neither Plecoptera nor Ephemeroptera have been recorded from the Falkland Islands and due to their aquatic life-cycle are unlikely hosts of tachinid flies attacking Dermaptera. We suggest therefore the testing of a small range of British earwig species in order to determine the host specificity of the agents within this order: on genus level (*Forficula lesnei*), on family level *Apterygida media* (Forficulidae) and on order level *Labia minor* (Labiidae). We also suggest to include cockroaches (such as *Blaptica dubia* and/or *Ectobius pallidus*) and the House cricket (*Acheta domesticus*) into the testing programmes as closest relatives outside the order Dermaptera with a relatively comparable ecology. In addition, we also recommend including the only representative of the Orthoptera on the Falkland Islands, the Camel cricket (*Parudenus falklandicus*) into the test list.

Cultivation of the tachinid agents in laboratory facilities is required to conduct the host specificity tests but also to obtain sufficient numbers for release. Cultivation over several generations also eliminates the risk of accidentally introducing any hyper-parasitoids associated with the tachinid flies.

CABI can conduct the necessary research on *Forficula* and the two associated parasitoid fly species including cultivation, host range testing and release by delivering the following work packages:

- Carry out collection of the tachnid parasitoids *Triarthria setipennis* and *Ocytata pallipes* from sites in Northwest Europe climate-matched to the Falkland Islands
- Transport cultures under license to our specialist facility for further assessment and cultivation in Delemont, Switzerland or alternatively establish cultivation at Egham, Surrey.
- Conduct proposed host specificity studies on key non-target species using our high-level containment infrastructure in Delemont or Egham.
- Application to the appropriate bodies for the eventual release of *Triarthria setipennis* and/or *Ocytata pallipes* if appropriate.
- Release of agents at suitable locations at Port Stanley and MPA during two consecutive summers.
- The production of an in-depth project report on *Triarthria setipennis* and/or *Ocytata pallipes* as a natural control agent for *Forficula auricularia*.

### The budget

Based on previous projects we have calculated the following budget to cover the objectives for a biological control programme on *Forficula auricularia* using *Triarthria setipennis* and/or *Ocytata pallipes* as outlined above. We would also recommend jointly seeking additional funding to

accompany the suggested biological control programme by a mid-term scientific monitoring of impact of BC agents on population levels of *Forficula auricularia*. Due to its limited size and isolation the Falkland Islands are a well suited place to allow the effects of biological control to be measured in a quantitative way, which would provide valuable data for future programmes elsewhere. The current budget does not include monitoring activities after the release (this could possibly also be provided by local researchers) or the testing of species from South America aiming for a release of the agents in other areas than the Falkland Islands.

### **Budget:**

#### **Staff cost, detailed (inflation factor for year 2 and 3 = 4%)**

		Year 1		Year 2		Year 3		TOTAL
	Daily charge out rate at project outset (£)	Days	Salary costs	Days	Salary costs	Days	Salary costs	Salary costs
Entomologist (based in Delemont)	260	25	6,500	20	5,408	18	5,061.89	16,969.89
Entomologist (based in Egham)	260	10	2,600	15	4,056	15	4,218.24	10,874.24
Technician	150	16	2,400	8	1,248	8	1,297.92	4,945.92
<b>Total</b>			<b>11,500</b>		<b>10,712</b>		<b>10,578.05</b>	<b>32,790.05</b>

#### **COSTS BILLED TO PROJECT DONOR (£)**

		Year 1	Year 2	Year 3	TOTAL
<b>Staff costs</b>		<b>11,500.00</b>	<b>10,712.00</b>	<b>10,578.05</b>	<b>32,790.05</b>
Direct costs	Travel & subsistence	2,000.00	6,000.00	6,000.00	14,000.00
	Technical facilities (incl. glasshouse/quarantine)	1,000.00	500.00	500.00	2,000.00
	Misc. consumables, such as field, lab. & office supplies, shipments	1,000.00	1,000.00	1,000.00	3,000.00
<b>Total direct costs</b>		<b>4,000.00</b>	<b>7,500.00</b>	<b>7,500.00</b>	<b>19,000.00</b>
<b>Overheads</b>	<b>O/H on Staff Costs (33%)</b>	<b>3,795.00</b>	<b>3,534.96</b>	<b>3,490.76</b>	<b>10,820.72</b>
	<b>O/H on Direct Costs (33%)</b>	<b>1,320.00</b>	<b>2,475.00</b>	<b>2,475.00</b>	<b>6,270.00</b>
<b>Total costs (exclusive of VAT)</b>		<b>20,615.00</b>	<b>24,221.96</b>	<b>24,043.80</b>	<b>68,880.76</b>

CABI has a long history of classical biological control of invasive species on the UK overseas territories. If you are interested in the enhanced control of earwigs on the Falkland Islands or would like to know more, please contact:

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For other weed biological control projects CABI works on, please visit our webpage at [www.cabi.org](http://www.cabi.org)

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