



Rediscovering the Bordered brown lacewing (*Megalomus hirtus*).

A survey in Holyrood Park.

November 2015

Mike Smith

people's
trust for
endangered
species



HISTORIC SCOTLAND
ALBA AOSMHOR

Saving the small things that run the planet

Summary

Holyrood Park was surveyed between 23rd June 2015 and 23rd September 2015, with a specific focus on the Bordered brown lacewing (*Megalomus hirtus*), a Scottish Biodiversity List species that was last recorded in the UK from Holyrood Park, Edinburgh in 1982.

Surveying revealed that the Bordered brown lacewing is still extant in the UK. Only one specimen was collected in June from Wood sage (*Teucrium scorodonia*). This either reflects low population levels or a short flight season early in the summer that was missed by the surveying period. Because of this nothing could be discerned about the ecological requirements of the Bordered brown lacewing. Given the need for further information, it is recommended that surveying work is continued in subsequent years with a focus on Arthur's Seat and Salisbury Crag within Holyrood Park.

A total of 123 species of invertebrate were recorded in this survey, and this includes 62 species of moths collected through light traps. Of the total, 100 species (includes 48 species of moth) are new to Holyrood Park and 12 new to the vice-county area. Efforts should be made to build up a picture of the invertebrate diversity of the park and this could be done by running workshops with either local natural history groups, or specialist conservation organisations. Further efforts should be made to improve on the records of moths by continuing regular moth trapping sessions across the park. This could be done in conjunction with Butterfly Conservation, with schemes such as national moth night to increase public involvement.

No specimens of Bordered brown lacewing were collected during visits to historic sites at Blackford Hill, Edinburgh and St Cyrus, Aberdeenshire. It is advised though that attention is paid to lacewings collected during future general invertebrate surveys at these sites.

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1. Introduction

Lacewings are holometabolous insects, which have two pairs of large membranous wings with complex venation that are held over the body 'roof-like' while at rest (Figure 1). They are mostly all predators as larvae and adults, although there are exceptions, with some species known to feed on decaying vegetation as larvae and others that feed on nectar and pollen as adults (New, 2007).

There are currently up to 18 families of lacewing recognised globally (New, 2007). Within the UK there are 6 lacewing families: Hemerobiidae, Chrysopidae, Coniptyrigidae, Myrmeleontidae, Osmylidae and Sisyridae, comprising 66 species (Plant, 1997). Of these 40 species are found in Scotland, with 3 being only found in Scotland within the UK (Plant, 1994).

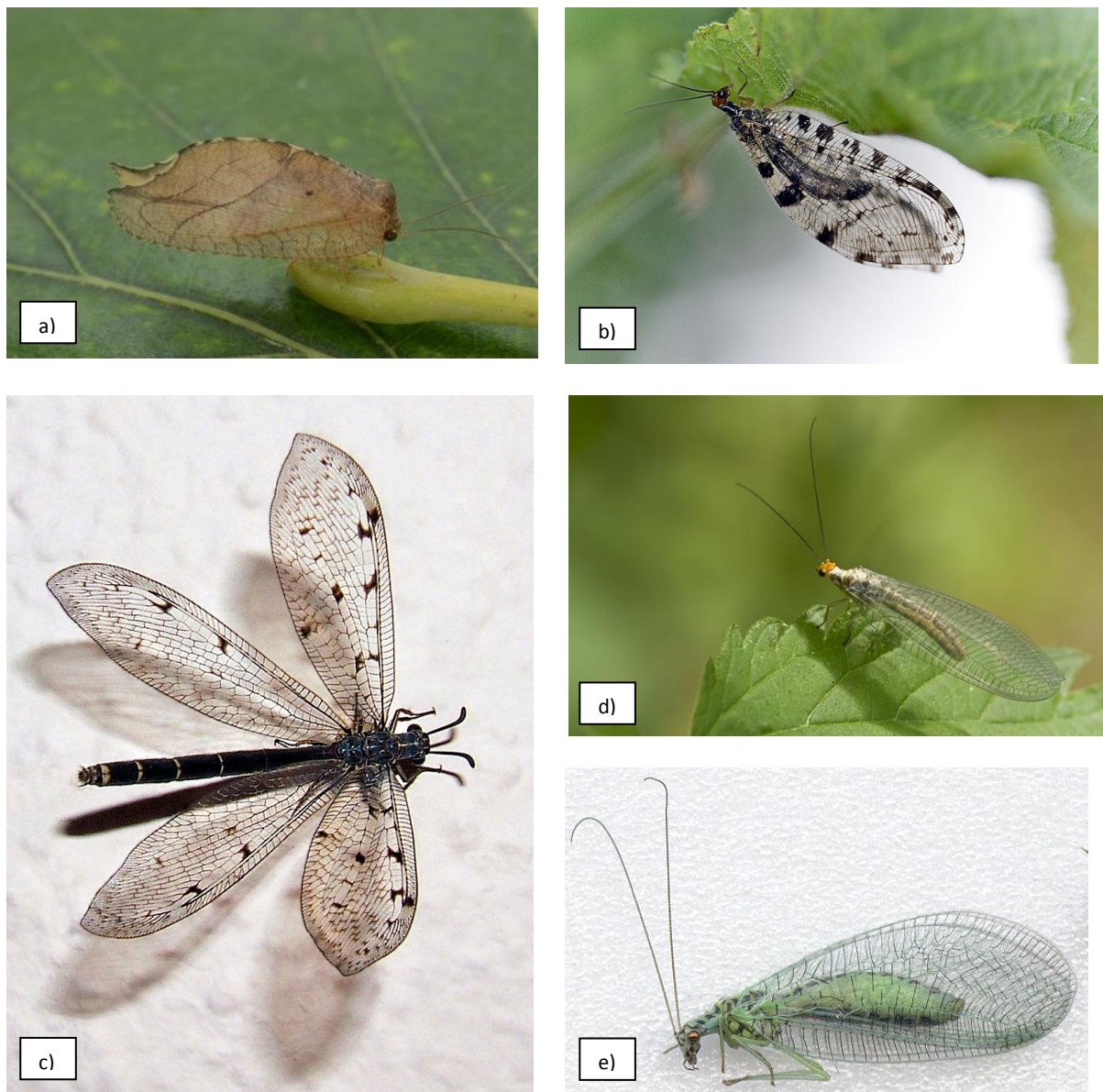


Figure 1. Showing examples of some of the lacewings that occur in the UK. a) *Drepanopteryx phalanoides* b) *Osmylus fulvicephalus* c) *Euroleon nostras* d) *Nothochrysa fulviceps* e) Common green lacewing (*Chrysopa perla*); see images for copyright information.

The brown lacewings (Family Hemerobiidae) are known to be predacious in both adult and larval stages (Kovanci *et al.* 2014). They feed on slow-moving and soft bodied arthropods, predominantly

within the Hemipteran (True bugs) sub-order Sternorrhyncha (aphids, whiteflies and scale insects) (Canard, 2007). They are known however to feed on other prey such as Acari (mites) and Lepidoptera (moth and butterfly) eggs, with some species, such as *Drepanepteryx phalaenoides*, adopting an omnivorous diet feeding partially on honeydew or pollen (Canard, 2007). Substrate specificity is common within the brown lacewings with many adopting a narrow prey range (Canard, 2007). In the UK there are 30 species of brown lacewing in 7 genera (Plant, 1997).

The Bordered brown lacewing (*Megalomus hirtus*) is widely distributed in northern and central Europe, becoming more locally restricted in the south of Europe (Figure 2). In the UK, this species of lacewing has a very restricted distribution thought only to still be extant within Holyrood Park in Edinburgh. The last record from Holyrood Park was from 1982 (Plant, 1994; Littlewood and Stockan, 2013). There are historical records from both St. Cyrus and Muchalls in Aberdeenshire, both dating to 1935 (Littlewood and Stockan, 2013).

As a result of its restricted distribution, the Bordered brown lacewing is classified as a UK Biodiversity Action Plan (UKBAP) priority species (JNCC 2010). In Scotland, this species is on the Scottish Biodiversity List and falls into the category of 'conservation action needed'; the Scottish biodiversity list contains species that are considered to be of importance to Scottish biodiversity (Scottish Government, 2015). Given the conservation status and the poor knowledge of its current distribution there is a pressing need to determine its status in the UK.

There is very little information on the ecology of the Bordered brown lacewing with regards to its flight season, habitat and prey. It is thought to have an association with Woodsage (*Teucrium scorodonia*) growing on rocky slopes (Plant, 1994). The Biological Records Centre (BRC, 2015) reports a number of other invertebrates associated with Wood sage (BRC, 2015). Of these none of the aphids, whiteflies and scale insects, that are the most likely prey food, have been recorded to occur in the Lothians region (National Biodiversity Network (NBN), 2015), though this more likely reflects a lack of recording effort. With regards to flight season in the UK it is known to have been taken between June and August (Littlewood and Stockan, 2013).

There are some historical accounts of the Bordered brown lacewing in the UK. McLachlan, writing in 1873, said that 'its rarity in Britain is unaccountable' (McLachlan, 1873). Writing in 1931 Morton echoed those views when he stated that it 'is reputed a very rare insect in Great Britain' (Morton, 1931). Morton himself found one specimen at the Samson's ribs area of Holyrood Park in 1931 and then failed to find anymore despite repeated searches (Morton, 1931).

Looking at closely related species in the same genus may help to discern possible ecological habits of Bordered brown lacewing. Even within the wider genus though there is very little known about the ecology of different species (Klimaszewski and Kevan, 1992). A review of the associations of Neuroptera and scale insect prey by Miller *et al.* (2004) only mentioned *Megalomus balachowskyi* and suggested that it has an association with the mealy bug *Nipaecoccus nipae*. This does suggest that Sternorrhyncha predation does occur in the genus. In a study on the brown lacewings of north-western Turkey Kovanci *et al.* (2014) found that *Megalomus tortricoides* had a very short flight season of one month and a plant association with the Austrian pine (*Pinus nigra*), but made no mention of potential prey. Comparing distributions of European species it can be seen that the Bordered brown lacewing has a more northerly distribution compared to the other European species of *Megalomus* (Figure 2), and is more coastal at higher latitudes.

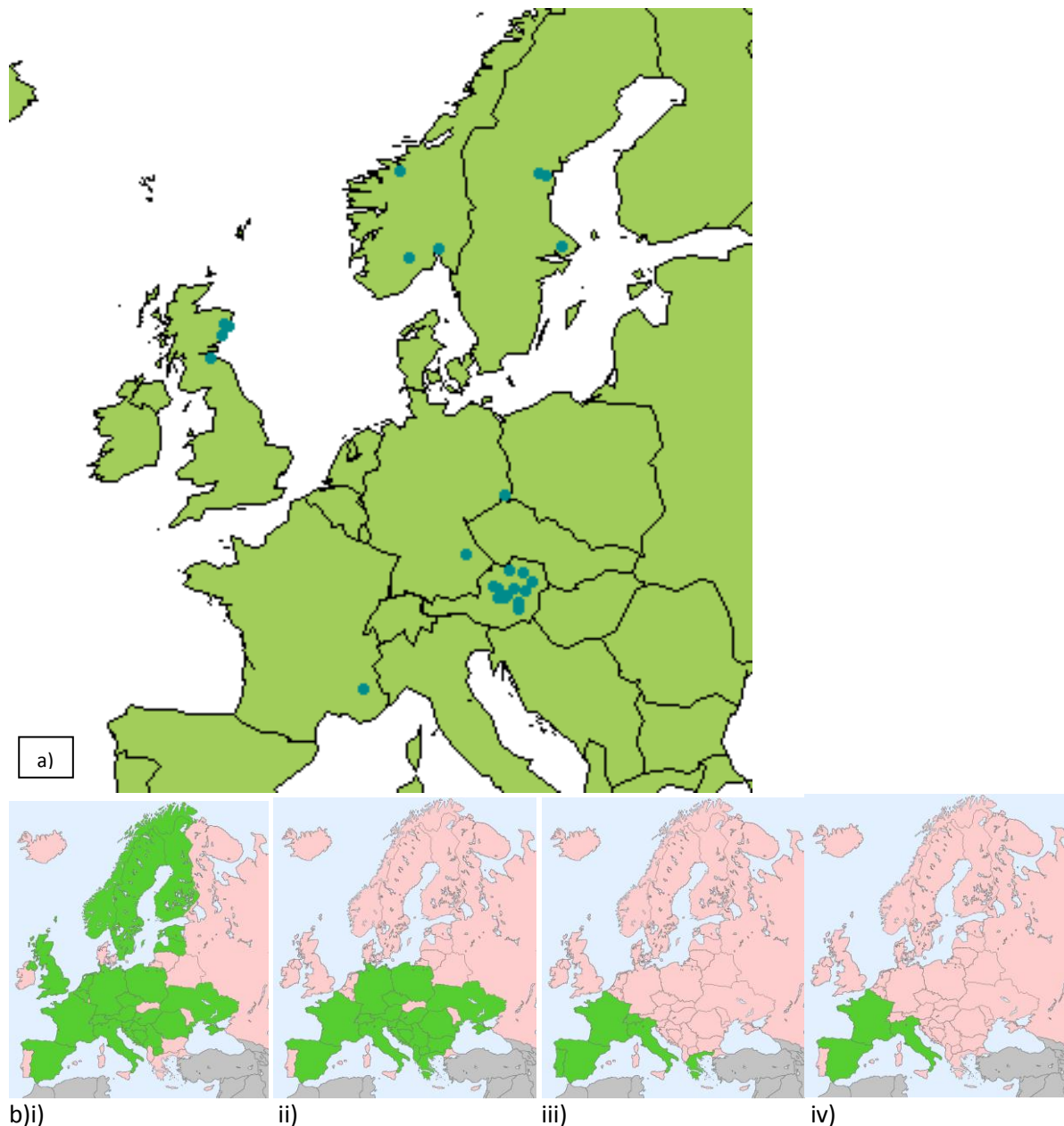


Figure 2. a) Showing European distribution of Bordered brown lacewing based on records from Global Biodiversity Information Facility (GBIF), created using R package 'Maps' (Becker and Wilks 2014). Note that this repository does not have all the known records, and appears to be skewed to records in Central Europe. b) Showing presence/absence of different *Megalomus* species in Europe i) *M. hirtus* ii) *M. tortricoides* iii) *M. tineoides* iv) *M. pyraloides* (Fauna Europea, 2015).

The aims of this project are to survey Holyrood Park in Edinburgh for the Bordered brown lacewing to:

- 1) Confirm its status in the UK, and whether it is extant.
- 2) Address ecological questions such as flight season, abundance, habitat requirements and prey.
- 3) Devise a habitat management plan.

2. Methods

2.1 Methods

Given the rarity of the Bordered brown lacewing a number of methods were used to try and address the project aims above. The methods of searching involved using a bug-vac, hand searches, light traps, sweep net and direct observations, while the searching patterns involved both quadrats and transects. Holyrood Park was the main focus of the study, but two other sites were also visited. Surveying was done between 23rd June 2015 and 26th of September 2015.

2.2 Holyrood Park site description

Holyrood Park is situated in the centre of the City of Edinburgh and is comprised of three main areas, Salisbury Crag, Arthurs Seat, and Whinny Hill. It is a Site of Special Scientific Interest (SSSI) on account of its diverse geology and flora and is managed by Historic Scotland for recreational, educational and conservation purposes (Historic Scotland, 2015) (Figure 3). Holyrood Park Ranger service conducts a number of wildlife surveys and practical conservation tasks within the park.



Figure 3. Map of Holyrood Park as bounded by Queen's Drive; image from Google Maps.

Holyrood Park is popular with both local residents and with tourists. Arthur's Seat is the highest point and a popular tourist attraction that frequently attracts large crowds in the summer. Salisbury's Crag also appears to be popular with walkers, particularly in the evenings where it gives a good view of the city. Whinny Hill by contrast appears to hold little interest for tourists and is predominantly visited by a few dog walkers and occasional joggers.

The Holyrood Park area has a complex topography and geology, with a diverse range of uses throughout history including religious, agriculture and recreation. This has given rise to a number of diverse habitats, ranging from grassland, bogs, lakes (both natural and artificial) and areas of both acidic and neutral soil. Given the diversity of habitats present it is a site that harbours a diverse range of wildlife. It's location within an urban area also means that it is not just an important environment for wildlife, but may also act as a stepping stone connecting habitat across Edinburgh.

2.3 Bug-vac

The bug-vac is a modified leaf blower used on the suction setting to collect invertebrates from vegetation, a pair of tights over the top is used to collect specimens (Figure 4). As the Bordered brown lacewing is thought to fall to the ground when disturbed the bug-vac was used to try collect it where a sweep net may fail. This was used in conjunction with the establishment of quadrats.

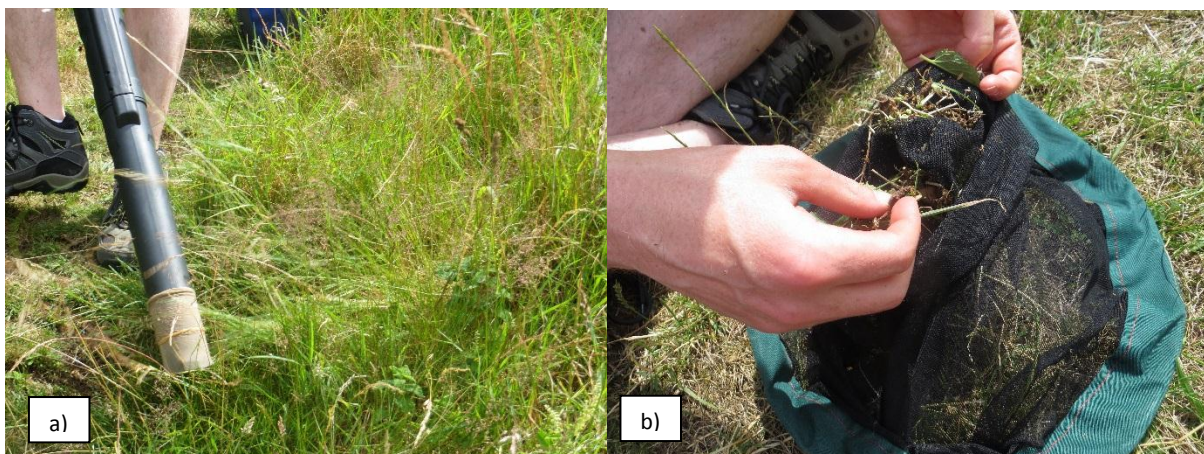


Figure 4. a) Bug-vac in operation b) sorting through contents after being emptied into sweep net.

Initial plans to use 10x10 metre quadrats were altered to take account of various limitations of the habitat. Some areas of the park were inaccessible (steep slopes, cliffs), could not be used to prevent disturbance (for example, areas with ground nesting birds), or had large amounts of Gorse (*Ulex europaeus*) which would have hindered surveying efforts. It was decided instead to use 2x2m quadrats but to increase the number of quadrats to 20. This also allowed for a greater range of the park to be covered. Quadrats were chosen across Holyrood Park to cover a range of habitats, Wood sage density, vegetation, disturbance, elevation, degree of exposure/shelter. Wood sage was noted as percentage ground cover, and included some quadrats with no Wood sage present.

At each sampling site the percentage of Wood sage in flower was also noted. Appendix 1 contains a full list of the quadrats and associated habitat descriptions, while figure 5 shows the areas surveyed in the park.



Figure 5. Map showing the distribution of quadrats across Holyrood Park. Constructed in R with RGoogleMaps (2015).

The bug-vac was used over each quadrat for 2 minutes and was kept close to the ground whilst moving in a back to forth motion (Figure 4). Once the two minutes were finished the contents of the bug-vac were emptied into a sweep net and then worked through (Figure 4). Specimens that could be identified in the field were done so, as well as noting things that could not be identified (i.e. nymphs). Anything that could not be identified in the field was collected in 70% ethanol and taken back to identify microscopically.

All surveying was done on days where the weather was dry and not overcast. In total all quadrats were surveyed three times over the period of 23rd June to 9th September (Table 1). From run 2 onwards all quadrats were first visually inspected for lacewings, by examining Wood sage as well as the ground.

Table 1. Dates when quadrats were surveyed.

Run	Dates
1	23/06/2015 to 03/07/2015
2	14/07/2015 to 30/07/2015
3	10/08/2015 to 9/09/2015

2.4 Light traps

Lacewings are largely active at night, and are known to be attracted to light traps, so a number of these were set up across the park. In addition these were used to increase moth records for the park. It is known that the number of moth species have declined drastically over the last 40 years (Fox *et al.* 2013). Moths are also known to be nocturnal pollinators and so provide an important ecosystem service, albeit one that is often overlooked (McGregor, 2015). Holyrood Park Ranger service already conducts regular surveys of some pollinators, namely bumblebees and butterflies, but these are relatively species poor taxa when compared to the species richness of moths with over 2,500 species in the UK (Fox *et al.* 2013).

The current moth records for Holyrood Park are poor, with only 41 species recorded (Historic Scotland, personal communication). While this does not represent an area that is unrecorded by the standards of Butterfly Conservation's Moths Count (50 and fewer records and 25 or fewer species, in a 10 kilometre square) (Butterfly conservation, 2015) there is clear scope to improve on these records.

Light trapping was conducted using a rigid portable trap, with a battery powered 6W actinic bulb (Figure 6a). While the 6W actinic bulb gives off less light compared to a higher wattage mercury vapour bulb it was considered preferable to prevent any unwanted attention to the traps while left out overnight. Egg boxes were placed inside to provide shelter for captured moths (Figure 6b).

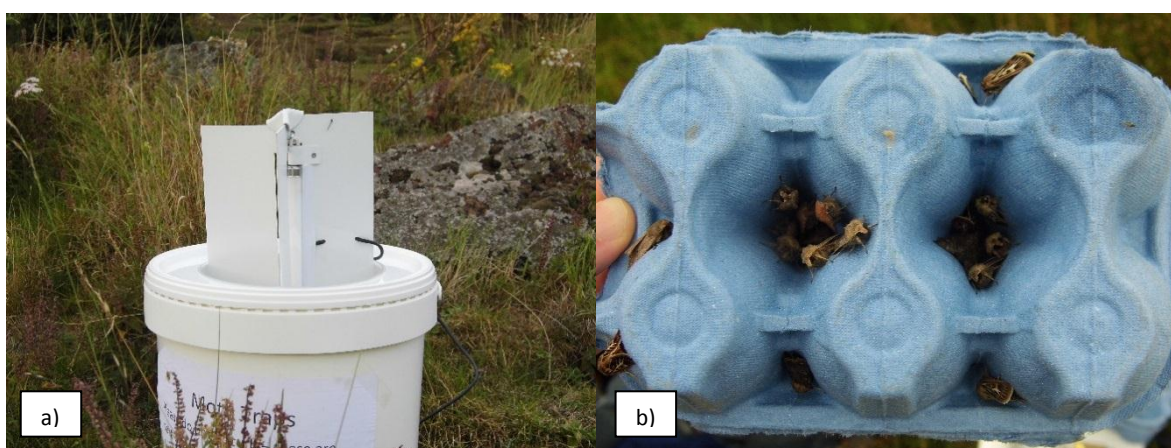


Figure 6. a) Showing a trap set up on site 9. b) Moths sheltering within egg box.

Traps were set up at 9 sites in the park, site descriptions can be found in appendix 2, while figure 7 shows a map of the sites. Moth traps were placed out between 9th July and 18th September in the evening when weather conditions were good (Table 2). In total sites 1-3 were visited 3 times, while sites 4-9 were visited twice each.

Table 2. Date when light traps were put out.

Sites	Dates
1-3	09/07/2015, 15/07/2015, 26/08/2015
4-6	22/07/2015, 09/09/2015
7-9	12/08/2015, 18/09/2015

Traps were collected at approximately 7.30 in the morning. A photo was taken of all specimens regardless of whether they could be identified in the field as this allowed for others to be confirmed later. It also meant that all species identification could then be confirmed by Alastair Somerville who is Butterfly Conservation's Midlothian Vice-County recorder.



Figure 7. Showing the sites of light traps. Constructed in R with RGoogleMaps (2015).

2.5 Sweep netting and casual records

When using a sweep net for sampling, a specific route was followed from Salisbury Crags along Radical Road past quadrats 11, 12, and 1. This route then continued up Arthur's Seat through the steps, past quadrats 13, 2, 18 and 17 and then onto Whinny Hill passing quadrats 6, 3 and 9 before ending at the wooded area on the North East side near quadrat 7. This route was walked on the 30/06/2015 and the 06/08/2015. An alternative transect was walked on the 03/08/2015 that ran from Haggisknowe (quadrat 15) along Volunteers Road past quadrat 10, 20 and 9 before following the same route along Arthur's Seat and Whinny Hill.

The net was swept every 5-10 metres and species collected were noted. Particular attention was paid to areas that contained large patches of Wood sage. This method did not collect some of the smaller invertebrates that the bug-vac collected or any ground dwelling invertebrates, but it allowed for a large area of the park to be covered. Attention was paid to any lacewings collected, and any other invertebrates that had not been encountered while using the bug-vac.

In addition targeted sweep netting was done around Arthur's Seat on 29/07/2015 focusing on the Wood sage present. This involved walking around the top of Arthur's Seat and sweep-netting a large amount of Wood sage as well as hand searching individual plants.

A number of direct observations of species were also made while walking around the park. As there are very few invertebrate records, it was felt that this would help to supplement the current park records. Butterfly and bumblebee species were not included in these observations as Historic Scotland already conducts weekly surveys of these taxa and have thorough records. The exception to this were species that are known to be of particular conservation concern and which Historic Scotland survey for, for example the Grayling (*Hipparchia semele*).

Like the current moth records, the list of invertebrates recorded in the park is mostly limited to those from casual observation and so misses a lot of species that may require specialist knowledge or equipment (such as microscopes or identification keys). Using a combination of the bug-vac, sweep-netting and ad-hoc observations it is hoped to expand on the current known invertebrate diversity of the park.

2.6 Historic site visits

The Hermitage of Braid and Blackford Hill Local Nature Reserve (LNR) is located on the south side of the City of Edinburgh and comprises two areas, 1) The Hermitage of Braid, which is a small woodland area through which the Braid Burn runs, and 2) Blackford Hill an area of scrub and grassland and the location of The Royal Observatory. The area is owned and managed by the City of Edinburgh Council. Two visits were made to the LNR, on the 28/08/2015 concentrating on Blackford Hill, and on the 31/08/2015 concentrating on the Hermitage of Braid. During these visits, Wood sage was targeted using a sweep net. All invertebrates that could be identified in the field were done so and released, while the rest were collected to be identified microscopically at a later date. City of Edinburgh Council were contacted beforehand to ensure that they were happy for such surveying to take place.

In addition St. Cyrus National Nature Reserve (NNR) was also visited on the 26/09/2015. St. Cyrus NNR was chosen as a historic site to visit as it had the most recent record of Bordered brown lacewing outside Edinburgh (in 1935), and also it had been recorded to a 1km square compared to the 10km for other records (NBN, 2015). It is a coastal site comprising dunes, wildflower meadows, as well as cliffs which provides shelter and a mild climate. St. Cyrus is managed by Scottish Natural Heritage, who were contacted beforehand to ensure that they were happy for such surveying to take place.

While this was later in the season than the Bordered brown lacewing had previously been known to occur it was felt that it would be worthwhile to survey the area for potentially suitable habitat. St. Cyrus NNR was contacted beforehand as well for information regarding levels of Wood sage. As the focus was not on invertebrate records no specimens were collected, though a number of invertebrates were identified in the field as casual observations.

3. Results

3.1 Bordered brown lacewing

A specimen of Bordered brown lacewing was collected on the 30th of June 2015 by sweep netting an area covered in Wood sage on a rock slope near the summit of Arthur's Seat, where quadrat 18 is situated (NT27527288) (Figure 8). This was the only specimen that was collected over the whole surveying period of 23/06/2015 to 09/09/2015.



Figure 8. a) Site on Arthurs Seat from which lacewing was found. b) Specimen of Bordered brown lacewing that was collected.

The bug-vac method of collecting in quadrat 18 revealed only one Hemipteran species present, the leafhopper *Eupteryx stachydearum* (Family Cicadellidae). Other species collected from using the bug-vac were the ants *Formica lemani* and Black garden ant (*Lasius niger*) and the Horned harvestman (*Phalangium opilio*). Examining the area by hand revealed a number of other species including grasshoppers, ladybirds and earwigs. The presence of predatory insects such as ladybirds and earwigs suggest the presence of prey food that lacewings could also be feeding upon.

Of all species associated with Wood sage, four were found during this survey, two at the same site as the Bordered brown lacewing (Table 3). A pollen beetle that could not be identified to species level (*Meligethes* species) also has two species associated with Wood sage. Only the Wood sage plume moth (*Capperia britanniodactyla*) has an association with only Wood sage and no other plant. All other species are associated with a number of other plants (BRC, 2015).

Table 3. Species found associated with Wood sage.

Species	Collected
<i>Eupteryx stachydearum</i> (Leafhopper)	Quadrats 11,13, 18 (run 1)
Northern rustic (<i>Standfussiana lucerneae</i>)	Light trap site 8 (12/08/2015)
Wood-sage plume moth (<i>Capperia britanniodactyla</i>)	Casual observation on 06/07/2015
Smoky wainscot (<i>Mythimna impure</i>)	Light trap sites 4, 6)22/07/2015) and 9 (12/08/2015)
<i>Meligethes</i> species	Quadrats 1 and 15 (run 1)

3.2 All invertebrate records

A total of 61 species of invertebrates (excluding Lepidoptera) were recorded during this survey, including the Bordered brown lacewing, by the combined methods of bug-vacating, sweep netting, casual observations and moth trapping. This includes 50 distinct species and a further 11 that could only be identified to genus or family. A full list of species gathered by these methods can be found in appendix 3, Table A3.1. Table 4 breaks them down by order, while figure 9 highlights some of the diversity observed in the park. The solitary bee *Colletes daviseanus* was the only species collected, other than the Bordered brown lacewing that is also on the Scottish Biodiversity List, under the watching brief category (Scottish Government, 2015).

Table 4. The number of species found within each order.

Order	Number of Species
Hymenoptera (bees, wasps and ants)	11
Diptera (true flies)	10
Hemiptera (true bugs)	11
Coleoptera (beetles)	14
Neuroptera (lacewing)	1
Collembola (springtails)	1
Trichoptera (caddisflies)	1
Orthoptera (grasshoppers)	2
Dermaptera (earwigs)	1
Aranaea (spiders)	7
Opiliones (harvestmen)	2

Of the total number of species collected in this survey, 54 were new records of the site based on current park records (Historic Scotland, personal communication). However some species that were not listed in the records for the park were, when checking them against NBN records, found to have been recorded previously. The datasets indicated that both the flea beetle *Derocrepis rufipes* and ground beetle *Philorhizus melanocephalus* were previously recorded in Holyrood Park. This reduced the number of new records from this survey to 52 species.

In addition some species were not new records for the vice-county, but were the first records for some time. For example, the springtail *Isotoma viridis* had records only dating to 1898, while the soldier beetle *Cantharis fusca*, only has one record dating to 1853 for the 10km square.

There were 11 species that were new records for the vice-county (Table 5). There was great variability in these records with some, such as the picture winged fly *Urophora jaceana* being found in the neighbouring vice-county of VC82 East Lothian. Others though had much more distant records such as the wasp *Gonatopus bicolor* recorded from Gretna in 1937.

Table 5. New vice-county records for the park, where in the park they were located and where closest records currently exist.

Species	Closest records	Location and Date
<i>Myrmica sulcinodis</i> (Ant)	Closest records are from North East England and Fife.	Found in quadrat 9 (29/07/2015)
<i>Gonatopus bicolor</i> (Wasp)	Only previous record in Scotland was from Gretna in 1937.	Found in quadrat 10 (29/07/2015)
<i>Kleidocerys ericae</i> (Ground bug)	Records from Highlands, and Cumbria.	Located in quadrats 17, (03/07/2015) and 19 (28/08/2015) that contained plants from Ericaceae family (heathers and bilberry).
<i>Dicranotropis hamata</i> (Planthopper)	Nearest records from Stirlingshire, but other than that no other records from central belt (other records from Highlands	Found in quadrat 10 (29/07/2015)

	and North East England).	
<i>Eupteryx stachydearum</i> (Leafhopper)	Only records in Scotland from Highlands. Most Northerly English records from Cumbria and Lancashire.	Found in quadrats 11 (29/06/2015), 13 (25/06/2015) and 18 (27/06/2015)
<i>Javasella discolour</i> (Planthopper)	Closest record from England-Scotland Border in the Borders	Found in quadrat 13 (25/06/2015)
<i>Urophora jaceana</i> (Picture winged fly)	Has been found in neighbouring vice-county East Lothian (VC82)	Found in quadrat 1 (23/06/2015) in vicinity of Common knapweed (<i>Centaurea nigra</i>) its larval host plant.
<i>Tachina fera</i> (Fly)	Has been found in neighbouring vice-county East Lothian (VC82)	Casual observation along vegetation between Radical road and Queens Drive on 02/09/2015
<i>Syntomus truncatellus</i> (Beetle)	Only one previous record in Scotland, on Isle of May from 1970.	Found in quadrat 14 (09/09/2015)
<i>Ctenicera cuprea</i>	Found in neighbouring vice-county of West Lothian (VC84).	Casual observation on Whinny Hill on 23/06/2015
<i>Hadroplontus litura</i>	Previous records in Scotland from Ardeer, also found in NE England.	Casual observation on Creeping thistle (<i>Cirsium arvense</i>) between Radical road and Queens Drive on 07/09/2015



Figure 9. Highlighting some of the diversity of the park a) solitary bee *Colletes daviesanus* b) Saddle back harvestman (*Mitopos morio*) c) Mirid bug *Grypocoris stysi* d) Common froghopper (*Philaenus spumarius*) e) Caddisfly (Family Limnephilidae) f) Red-legged shieldbug (*Pentatoma rufipes*) g) tachinid fly *Tachina fera* h) Wasp *Gonatopus bicolor*.

3.3 Moth records

Light traps and casual observations revealed 62 species of moth including 11 species of micro moths and 51 species of macro moths (Appendix 3, Table A3.1). Of the total, 48 were new records for the park, one of which was also a new record for the vice county, the Northern rustic (*Standfussiana lucerneae*). This represents a huge increase on current records, previously 41 species in total, giving a total of 89 moths recorded for Holyrood Park. Figure 10 highlights some of the diversity of the moths present in the park.

Eight species were recorded that have shown a marked decline of greater than 75% in the last 40 years in the UK (Fox *et al.* 2013). Nine species are also found on the Scottish Biodiversity List (Scottish Government, 2012) (Table 6).

Table 6. Species that have undergone a greater than 75% decline in the UK and those that are also on the Scottish Biodiversity List. Note not all species fall into both categories. All species on Scottish Biodiversity list are watching brief only.

Species	UK decline (%)	Scottish Biodiversity List Reason
Mouse moth (<i>Amphipyra tragopogonis</i>)	-85	UKBAP List and >25% Scottish Decline
Small square-spot (<i>Diarsia rubi</i>)	-87	UKBAP List
Small phoenix (<i>Ecliptopera silaceata</i>)		UKBAP
Autumnal rustic (<i>Eugnorisma glareosa</i>)	-94	UKBAP and >25% Scottish Decline
Garden dart (<i>Euxoa nigricans</i>)	-98	UKBAP
Rustic (<i>Hoplodrina blanda</i>)	-78	UKBAP
Broom Moth (<i>Melanchra pisi</i>)	-84	UKBAP, and >25% Scottish Decline
Rosy Minor (<i>Mesoligia literosa</i>)	-93	UKBAP, and >25% Scottish Decline
Lead/July Belle agg. (<i>Scotopteryx mucronata/luridata</i>)	-81	
Cinnabar (<i>Tyria jacobaeae</i>)		UKBAP

For the presence and absence of moth species present the number of moths that were unique to the site were calculated. This is the number of species that were present at that site only, and not recorded at any other sites. Site 6 (on Arthur's Seat) had the greatest diversity of moths with 19 different species found. Most sites though had very few unique species (1 or 2), with only sites 5, 6 and 8 having more than this (Table 7).

It should be noted that on the final session on the 18/09/2015 only three moths of three separate species were collected, with no moths collected at all in trap 8 that week (effectively meaning that moths were only collected on one date on 12/08/2015 for that site). The traps were instead populated with large numbers (>40 per trap) of Craneflies (Family Tipulidae, Order Diptera).

Table 7. Showing the number of species found in each site as well as the number of unique species (those not found on any other site).

Site	1	2	3	4	5	6	7	8	9
No Species found	9	14	11	16	14	19	7	10	11
No Unique Species	2	2	2	2	10	7	1	5	1



Figure 10. Moths of Holyrood park a) Scalloped oak (*Crocalis elinguria*) b) Canary shouldered thorn (*Ennomos alniaria*) c) Northern rustic (*Standfussiana lucerneae*) d) Square spot dart (*Euxoa obelisca*) e) Cocksfoot grass moth (*Glyphipterix simpliciella*) f) *Micropterix glypha* g) Small square-spot (*Diarsia rubi*) h) July belle (*Scotopteryx luridatatai*) i) Northern Spinach (*Eulithis populata*) j) Smoky Wainscot (*Mythimna impure*) k) Orange swift (*Hepialus sylvina*) l) Antler Moth (*Ceraapteryx graminis*) m) Square-spot rustic (*Xestia xanthographa*) n) Purple bar (*Cosmorhoe ocellata*)

3.4 Historic site visits

During the site visit to Blackford Hill on the 28/08/2015 and 31/08/2015 no specimens of the Bordered brown lacewing were collected. A list of species collected through sweep netting and ad-hoc observations can be found in appendix 3, Table A3.3, and some of the specimens observed can be seen in figure 11.



Figure 11. Showing some of the species of Blackford Hill a) *Heliophilus pendulus* b) Green veined white (*Pieris napi*) c) *Meta segmentata* d) *Sphaerophoria* sp.

The visit to St Cyrus NNR was undertaken very late in the season and so the main focus was to look for suitable habitat with Wood sage present. Very little Wood sage was found, though after consultation with the ranger service it was established that there are large areas of Wood sage present in parts of the reserve. A species list of casual observation can be found in Appendix 3, Table A3.4, and some of the specimens observed can be seen in figure 12.



Figure 12. Showing some of the diversity of St Cyrus NNR. a) Fox Moth (*Macrothylacia rubi*) caterpillar b) Hairy shield bug (*Dolycoris baccarum*) c) Field grasshopper (*Chorthippus brunneus*) d) Needlefly (Plecoptera: Leuctridae)

4. Discussion

4.1 Bordered brown lacewing

The discovery of the Bordered brown lacewing confirms that it is currently extant in the UK. Given this, it is important to continue conservation work to further determine its population strength and ecological requirements.

As only one specimen was found it is not possible to determine much about its ecological patterns. Having only found one specimen may suggest that either, 1) the population numbers are extremely low or, 2) that its flight season was limited to June this year and that surveying started too late to find it. This question could be partly resolved by starting surveying earlier in following years, for example in May. It should be noted though that flight seasons can vary between years and the Bordered brown lacewing has been found as late as August at Holyrood Park. This means that surveying work would have to continue up to that point.

Its discovery on a rocky slope with Wood sage supports previous associations (Littlewood, 2013; Plant, 1997). Again however, with only one specimen found during the study it is not possible to conclusively support this association. Of the other Wood sage associated species found it is unclear whether these could be prey items. The Smoky wainscot (*Mythimna impura*) and Northern rustic are associated with Wood sage as adults, feeding on pollen and nectar (BRC, 2015) and so it is unlikely that they are prey food. The Woodsage plume moth (*Capperia britanniodactyla*) has no

other plant association and only uses Wood sage during the larval stage. It is known that some lacewings feed on Lepidoptera eggs (Canard, 2007). It is also possible that the earlier, soft-bodied, nymphal stages of the leafhopper *Eupteryx stachydeorum* and the larval stages of pollen beetles *Meligethes* species are used as food. While these species are both associated with other plants, it is known that some lacewings will accept or reject the same food item depending on the plant on which it is located (Canard, 2007). It is of course entirely possible that the main prey food is a species that was not collected during this survey. At this stage nothing can be firmly concluded as to the dietary requirements of the Bordered brown lacewing.

The area where the Bordered brown lacewing was found is extremely popular with tourists, where one of the more popular activities appears to be taking stones and using them to write messages on the ground (Figure 13). As the Wood sage is growing up amongst the same rocks it is possible that this is causing disturbance to the habitat. In addition there is a large amount of Gorse (*Ulex europaeus*) growing around the area as well.



Figure 13. a) example of rocks being used to spell names/messages b) where the Bordered brown lacewing was found showing the rocky nature of the slope.

Given the further work needed to discern the status of the Bordered brown lacewing it is recommended that surveying continues in subsequent years at Holyrood Park. The following protocol is suggested.

- 1) Surveying following a transect from Salisbury Crag along Radical Road and Arthur's Seat through the steps, finishing at Arthur's Seat itself.
- 2) Wood sage, where it is found in abundance, should be first examined visually to determine lacewings present and then use a sweep net to collect any specimens.
- 3) The identity of whether it is a Bordered brown lacewing may be possible in the field with a hand lens, using the simplified guide in appendix (A4). A grid reference should be noted as well as weather conditions and status of plant (non-flowering/flowering/gone to seed).
- 4) Any specimens collected should be kept for confirmation by Colin Plant, lacewing recorder. In cases where a large number of specimens are found only one should be collected, and the number of specimens noted.

4.2 Other invertebrate records

A total of 122 species of invertebrate were recorded during this survey, including 62 species of moth. Of this, 99 are new records for Holyrood Park and 12 are new to the vice county. This large number of new records for the park and the vice county is a reflection of two things. The first is that most invertebrate records have focused on larger species that are easily identified by sight. For example, previous records indicated the presence of ants, but did not identify any beyond the family level of Formicinae. The second is that a number of species that were recorded were from taxa that are badly under recorded. In the case of Hemiptera there is also the added complication that there are few identification keys for identification to species level.

The vast majority of species present on the site remain under-recorded despite this renewed survey effort. For example, the numbers of spiders have been significantly underestimated. This was in part due to the large number of immature specimens that could not be identified to species, as well as a large number of money spiders (Family Linyphiidae) that could not be identified below family level.

There was only one species discovered, out with the Lepidoptera records and the Bordered brown lacewing, which is on the Scottish Biodiversity List. This may simply be a reflection of the fact that some orders are represented in greater numbers. For example there are 110 species of Lepidoptera, while only 4 Hemiptera on the list (Scottish Government, 2015). The number of species on the list may only be a reflection of the knowledge of species, rather than an accurate reflection of their conservation status.

Again given the large number of new records for the park, and particularly the number of new records for the vice-county, it would be worthwhile putting more effort into improving invertebrate records. While moths are easily identified by sight, a lot of the new records identified here required access to specialist equipment, such as microscopes, as well as a large number of reference keys for identification. In addition it requires a large amount of training and time to identify these invertebrates. Given that Historic Scotland staff do not currently have the equipment, training or time to conduct further invertebrate investigations in difficult taxa other avenues may need to be explored in improving these records. This could be done in conjunction with a number of local natural history societies, particularly those that may specialise in particular taxa such as the South Scotland Spider Group.

The hand searching that was undertaken, for example, around quadrat 18 showed that the bug-vac appeared to fail to collect larger species such as grasshoppers, ladybirds and earwigs, and these species may be better found by either hand searching or sweep netting. The bug-vac method of collection however was a particularly useful measure of collecting small and under recorded species with 8 out of the 11 new vice-county records being found by this method. If there are further targeted invertebrate surveys, particularly for smaller species, then consideration should be given to employing this method.

4.3 Moth records

A total of 62 species of moth were recorded during this survey, 48 of which are new to the Holyrood park and 1 of which is new to the vice county. The increase in the number of moths recorded most likely reflects a change in recording level. Previous moth records were either for species specific surveys (i.e. Wood sage plume moth), or ad-hoc casual observations. The discovery of the new vice-county record of Northern rustic, may reflect the sampling method of focusing on areas with high levels of Wood sage, which is its food plant (BRC, 2015). Given the importance of Holyrood Park for biodiversity in Edinburgh it is important to continue moth trapping on a regular basis. This will also benefit the moth atlas for 2018 that Butterfly Conservation are currently working towards. Given that the moth trapping has already resulted in new records for the vice-county there is clear potential for further trapping to be of great help. This could be done as part of a regular surveying effort by the Holyrood Park ranger service, and possibly with the assistance of volunteers or in conjunction with Butterfly Conservation.

Sites 5 and 6 had the highest number of unique species found. This was possibly a result of having very different vegetation and habitat from the other sites. Site 5 was a forested area and so would harbour a large number of species associated with trees and ferns that were not present elsewhere.

Site 6 was sheltered but also had large amounts of long grass, Rosebay willowherb (*Chamerion angustifolium*) and Brambles (*Rubus fruticosus* agg.) that were not present on other sites. It is possible that sites 5 and 6 had high levels of species uniqueness due to the weeks that they were studied coinciding with flight seasons of a large number of moth species. This does not explain the low levels of unique species found in site 4. In addition the number of species found at different times did not vary between site 1-3 and site 4-6, only the number of unique species.

It is of particular interest that trap 8 had 5 unique species found at it, the third highest of all the traps, particularly given it only collected moths in one week. Superficially it is no different from site 2, comprising Gorse and Wood sage on a rocky slope. It is also similar to sites 1, 5 and 7 being rockier areas with Wood sage present in high numbers, though these sites also had more diverse vegetation than site 8. The high number of species found therefore may be due to random variation, rather than habitat characteristics. The failure to catch any significant number of moths in the second trapping session at site 8 means that it is not possible to say either way.

Given the variation between sites it may be worthwhile for further moth trapping sessions to explore different areas from those identified so far. There are a number of sites that would be of interest for further moth trapping, due to having different vegetation composition to sites explored so far. Of particular interest may be:

- 1) Hunters Bog (Grid reference: NT273733) with large amounts of Horsetail (*Equisetum arvense*) and orchid species.
- 2) Between Whinny Hill and Arthur's seat (Grid reference NT276731), where a large amount of Cow parsley (*Anthriscus sylvestris*) grows.
- 3) On Salisbury's Crag along Volunteers Road (Grid reference: NT272735 and NT272734), where there are many sheltered areas, long grass with Yellow rattle (*Rhinanthus minor*) and other flowering vegetation.
- 4) Along Queen's Drive below Radical Road (Grid reference: NT267734 and NT267733). A large amount of dense vegetation grows here including Yarrow (*Achillea millefolium*), Hogweed (*Heracleum sphondylium*), Creeping thistle, Wood sage and long grasses (various species).

4.4 Historic site visits

Visits were made to Blackford hill and St. Cyrus that have historic records for the Bordered brown lacewing. In both cases the surveying was likely done too late in the season to have found the lacewing if it's main flight season is in June. Due to the historic records, it would be worthwhile to continue to survey for the Bordered brown lacewing at both of these sites. This may be better done as part of any general invertebrate survey being conducted at these sites with an awareness of the potential for the Bordered brown lacewing to be found.

The current known distribution in the UK raises the question of what is likely to be restricting the distribution. A species geographic distribution is usually controlled by three things- biotic factors, abiotic factors and movement. This is known as the BAM model (Soberón and Peterson, 2005). Climatic abiotic factors are unlikely to be a restricting factor given that the Bordered Brown lacewing appears to adapt to a wide range of climatic conditions from the south of France to the coast of Norway (Figure 2). Given the historical records in the UK of Bordered brown lacewing and the largely coastal distribution observed amongst European populations (Figure 2) though it is possible that the Bordered brown lacewing is restricted to coastal regions at this latitude. It is possible that there is a requirement for rocky slopes that this may be an abiotic restriction. Wood sage presence as a biotic factor is unlikely given its ubiquitous presence across the UK. It is possible that the prey species required though may be a limiting biotic factor. Movement may be a factor if the Bordered

brown lacewing has a short dispersal range. If further populations are found then this will help to not just determine the UK range, but also the habitat requirements as well.

Key recommendations

- 1) Further surveying for Bordered brown lacewing should be conducted. This should be conducted earlier in the season, ideally starting in May, but no later than June. Given the variability in accounts of the flight season this should continue to August. The protocol mentioned in the discussion section 4.1 should be followed.
- 2) While further work commences to discern ecological patterns of the Bordered brown lacewing it would be advisable to ensure that suitable habitat is allowed to remain, particularly at Arthur's Seat and that levels of Gorse are controlled to allow Wood sage to continue to grow.
- 3) Moth trapping sessions should be continued across Holyrood Park. This can be done by Historic Scotland staff, and would be best done all year round. As well as potentially attracting lacewings to the traps this would also improve on current moth records. Traps should be placed out once a month, with a view to altering sites between sessions focusing on sites where traps have not been placed before. While Historic Scotland staff may not be familiar with moth identification they are a relatively easy group to ID and can be done largely through digital photography and with assistance from the vice-county recorder. This can also be done in conjunction with volunteers.
- 4) Further invertebrate surveys should be continued in some form. A number of options are open to Historic Scotland as to how best to proceed with this.
 - 1- Organising a Bioblitz event for the summer, both as a means of promoting awareness of the invertebrate fauna of the park to the public as well as improving records.
 - 2- Inviting invertebrate organisations to run workshops, for example Edinburgh Natural History Society, South Scotland Spider Group or Buglife.
 - 3- Running workshops on invertebrate identification could contribute to invertebrate records, as well as allowing Historic Scotland to fulfil a public education service.

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Images

Figure 1a- Sloth, N. (n.d.) *Drepanepteryx phalaenoides* [image online] Available at: http://www.biopix.dk/drepanepteryx-phalaenoides_photo-102993.aspx Accessed on 7th November 2015.

Figure 1b- www.invertebradosdehuesca.com (2011) *Osmylus fulvicephalus* [image online] Available at: <http://www.invertebradosdehuesca.com/2011/08/osmylus-fulvicephalus.html> Accessed on 7th November 2015.

Figure 1c- Wildfleur (2008) *Euroleon nostras* [image online] Available at: https://en.wikipedia.org/wiki/Euroleon_nostras#/media/File:2008-07-30Euroleon_nostras01.jpg Accessed on 7th November 2015.

Figure 1d- Biopix (n.d.) *Nothochrysa fulviceps* [image online] Available at: http://www.biopix.nl/nothochrysa-fulviceps_photo-105461.aspx Accessed on 7th November 2015.

Figure 1e- Discover Life (n.d.) *Chrysopa perla* [image online] Available at: http://www.discoverlife.org/IM/I_MWS/0387/320/Chrysopa_perla,I_MWS38711.jpg Accessed on 7th November 2015.

Figure A4.2- BOLD Systems (2015) *Megalomus hirtus* [image online] Available at: http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=megalomus+hirtus&searchMenu=taxonomy&query=megalomus+hirtus Accessed on 12th November 2015.

Appendix

Appendix 1- Quadrat habitat descriptions

Site 1: Grid reference NT27117289

Elevation: 121m

Wood sage: 50%

Site description: Sheltered area with large amounts of Wood sage growing amongst rocks. Ribwort plantain (*Plantago lanceolata*), thistle (*Cirsium* species) and Common knapweed present.

Surveyed: 23/06/2015, 29/07/2015, 17/08/2015.



Site 2: Grid reference NT27527268

Elevation: 216m

Wood sage: 25%

Site description: Area of rock shingle with Wood sage growing amongst it. Large area of Gorse present.

Surveyed: 25/06/2015, 30/07/2015, 13/08/2015.



Site 3: Grid reference NT27767341

Elevation: 169m

Wood sage: 25%

Site description: Area of grassland with some Wood sage growing amongst rocks.

Surveyed: 23/06/2015, 20/07/2015, 28/08/2015.



Site 4: Grid reference NT26877357

Elevation: 44m

Wood sage: 35%

Site description: Area dominated by grasses, while sheltered by Gorse.

Surveyed: 03/07/2015, 23/07/2015, 17/08/2015.



Site 5: Grid reference NT27697281

Elevation: 242m

Wood sage: 0%

Site description: Area of rock, and short grasses at top of Crow hill.

Surveyed: 27/06/2015, 30/07/2015, 13/08/2015.



Site 6: Grid reference NT27817325

Elevation: 166m

Wood sage: 25%

Site description: Area is dominated by various grasses.

Surveyed: 03/07/2015, 20/07/2015, 02/09/2015.



Site 7: Grid reference NT28157375

Elevation: 90m

Wood sage: 0%

Site description: Area of deciduous and coniferous trees. Plants present include Broad buckler fern (*Dryopteris dilatata*), Bramble and grasses.

Surveyed: 29/06/2015, 14/07/2015, 27/08/2015.



Site 8: Grid reference NT27367332

Elevation: 68m

Wood sage: 30%

Site description: Near Hunter's Bog and is dominated by grasses and partly sheltered by Gorse.

Surveyed: 02/07/2015, 16/07/2015, 09/09/2015.



Site 9: Grid reference NT27207289

Elevation: 120m

Wood sage: 10%

Site description: Hedge bedstraw (*Galium mollugo*), Yarrow (*Achillea millefolium*), mosses and grasses all present.

Surveyed: 03/07/2015, 29/07/2015, 02/09/2015.



Site 10: Grid reference NT27047348

Elevation: 111m

Wood sage: 20%

Site description: Grasses dominant with some thistles (*Cirsium* sp.) also present.

Surveyed: 23/06/2015, 29/07/2015, 07/09/2015.



Site 11: Grid reference NT26997358

Elevation: 82m

Wood sage: 10%

Site description: Vegetation growing amongst rocks.

Hogweed and Bramble present.

Surveyed: 29/06/2015, 23/07/2015, 17/08/2015.



Site 12: Grid reference NT26827309

Elevation: 151m

Wood sage: 20%

Site description: Vegetation growing amongst rocks.

Cocksfoot grass (*Dactylis glomerata*) and Ribwort plantain present.

Surveyed: 29/06/2015, 29/07/2015, 17/08/2015.



Site 13: Grid reference NT27347275

Elevation: 129m

Wood sage: 20%

Site description: Wood sage growing around moss covered boulders, with some Cocksfoot grass present.

Surveyed: 25/06/2015, 30/07/2015, 02/09/2015.



Site 14: Grid reference NT27457339

Elevation: 93m

Wood sage: 10%

Site description: One of the small hills overlooking Hunters Bog with short grass vegetation.

Surveyed: 29/06/2015, 29/07/2015, 09/09/2015.



Site 15: Grid reference NT27387371

Elevation: 57m

Wood sage: 20%

Site description: Haggisknowe rock. Large rock with Wood sage growing around base and in cracks.

Other species include Common harebell (*Campanula rotundifolia*), Maiden pink (*Dianthus deltoides*) and Yarrow.

Surveyed: 02/07/2015, 16/07/2015, 13/08/2015.



Site 16: Grid reference NT27667314

Elevation: 142m

Wood sage: 0%

Site description: Dominated by Cow parsley earlier in the season, but replaced by Creeping thistle later.

Surveyed: 27/06/2015, 20/07/2015, 13/08/2015.



Site 17: Grid reference NT27847306

Elevation: 166m

Wood sage: 0%

Site description: Acidic soil, with Common heather (*Calluna vulgaris*), Bell heather (*Erica cinerea*) and Bilberry (*Vaccinium myrtillus*).

Surveyed: 03/07/2015, 30/07/2015, 02/09/2015.



Site 18: Grid reference NT27527288

Elevation: 225m

Wood sage: 50%

Site description: Large amount of Wood sage growing amongst shingle, with Gorse growing in vicinity. Near summit of Arthur's Seat.

Surveyed: 27/06/2015, 30/07/2015, 13/08/2015.



Site 19: Grid reference NT27787364

Elevation: 142m

Wood sage: 25%

Site description: Wood sage growing amongst grass. Some Bell heather also present suggesting acidic soil.

Surveyed: 02/07/2015, 14/07/2015, 28/08/2015.



Site 20: Grid reference NT27177310

Elevation: 79m

Wood sage: 25%

Site description: Midway along Volunteers Road, area of grassland, with a few deciduous trees in vicinity.

Surveyed: 03/07/2015, 20/07/2015, 07/09/2015.



Appendix 2- Moth trap sites and habitat descriptions

Site 1: Salisbury's Crag- Grid Reference NT27117289; habitat same as quadrat 1.

Site 2: Arthur's Seat- Grid Reference NT27527268, habitat same as quadrat 2.

Site 3: Whinny Hill- Grid Reference NT27767341, habitat same as quadrat 3.

Site 4: Haggisknowe- Grid Reference NT27387371, habitat same as quadrat 15.

Site 5: Whinny Hill- Grid Reference NT28157375, habitat same as quadrat 7.

Site 6: Arthur's Seat- Grid Reference NT27867283, Elevation 181m. On grassier area of the south side of Arthur's Seat. Wood sage is present, as well as long grasses and Rosebay willowherb (*Chamerion angustifolium*) and brambles (*Rubus* species).

Site 7: Whinny Hill- Grid Reference NT27697322, Elevation 169m. This area is rockier than most other areas surveyed and Wood sage is in the area as well as Gorse.

Site 8: Arthur's Seat- Grid Reference NT27527288, Elevation 225m, habitat same as quadrat 18.

Site 9: Arthur's seat- NT27537264, Elevation 192m. This area is hidden between Gorse and receives very little recreational traffic and is therefore quite undisturbed. Wood sage is present as well as Ragwort (*Senecio jacobea*), Gorse and Thistles.

Appendix 3- Species records.

Table A3.1. Moth records for Holyrood Park. Species marked with * are new records for the park. Those marked with + are those seen by casual observation, otherwise caught by light traps.

<u>Common name</u>	<u>Scientific Name</u>
*Grass moth	<i>Agriphila tristella</i>
*Micro moth	<i>Agonopterix nervosa</i>
*Heart and club	<i>Agrotis clavis</i>
*Mottled beauty	<i>Alcis repandata</i>
*Copper underwing	<i>Amphipyra pyramidea</i>
*Mouse moth	<i>Amphipyra tragopoginis</i>
+Nettle tap	<i>Anthophila fabriciana</i>
*Light arches	<i>Apamea lithoxylaea</i>
*Dark arches	<i>Apamea monoglypha</i>
Silver Y	<i>Autographa gamma</i>
*Plain golden Y	<i>Autographa jota</i>
*Light emerald	<i>Campaea margaritata</i>
Yellow shell	<i>Camptogramma bilineata</i>
+Wood sage plume moth	<i>Capperia britanniodactyla</i>
Antler moth	<i>Cerapteryx graminis</i>
*Dark marbled carpet	<i>Chloroclysta citrata</i>
*Red-green carpet	<i>Chloroclysta siterata</i>
Grass moth	<i>Chryosteuchis culmella</i>
*Chestnut	<i>Conistra vaccinii</i>
*Purple bar	<i>Cosmorhoe ocellata</i>
*Scalloped oak	<i>Crocallis elinguaris</i>
*Marbled beauty	<i>Cryphia domestica</i>
*Ingrailed clay	<i>Diarsia mendica ssp. mendica</i>
*Small square-spot	<i>Diarsia rubi</i>
*Small phoenix	<i>Ecliptopera silaceata</i>
*Micro moth	<i>Elachasta atricomella</i>
*Canary shouldered thorn	<i>Ennomos alniaria</i>
*Common carpet	<i>Epirrhoe alternata</i>
*Micro moth	<i>Eudonia angustea</i>
*Autumnal rustic	<i>Eugnorisma glareosa</i>
*Northern spinach	<i>Eulithis populata</i>
*Garden dart	<i>Euxoa nigricans</i>
*Square-spot dart	<i>Euxoa obeliscia ssp. Grisea</i>
*Yarrow plume moth	<i>Gilmeria pallidactyla</i>
*+Cocksfoot moth	<i>Glyphipterix simpliciella</i>
*Orange swift	<i>Hepialus sylvina</i>
*Uncertain	<i>Hoplodrina alsines</i>
Rustic	<i>Hoplodrina blanda</i>

July Highflyer	<i>Hydriomena furcate</i>
*Barred red	<i>Hylaea fasciana</i>
*Riband wave	<i>Idaea aversata</i>
Flounced Rustic	<i>Luperina testacea</i>
*True lover's knot	<i>Lycophotia porphyrea</i>
*Cabbage Moth	<i>Mamestra brassicae</i>
*Broom moth	<i>Melanchra pisi</i>
Common/Lesser common rustic	<i>Mesapamea secalis/didyma</i>
*Rosy Minor	<i>Mesoligia literosa</i>
*+Micro moth	<i>Micropterix calthella</i>
*Clay	<i>Mythimna farrago</i>
*Smoky wainscot	<i>Mythimna impure</i>
*Brown-Line bright eye	<i>Mythinma consigner</i>
Lesser yellow underwing	<i>Noctua comes</i>
Large yellow underwing	<i>Noctua pronuba</i>
*Common lutestring	<i>Ochropaca duplaris</i>
*Flame shoulder	<i>Ochropleura plecta</i>
*July belle	<i>Scotopteryx luridata</i>
*Northern rustic	<i>Standfussiana lucernea</i>
+Cinnabar	<i>Tyria jacobaeae</i>
Micro moth	<i>Udea litalis</i>
*Six stripe rustic	<i>Xestia sexstrigata</i>
Square-spot rustic	<i>Xestia xanthographa</i>
*Fan foot	<i>Zanclognatha tarsipennalis</i>

Table A3.2. Showing other invertebrate species collected or observed. Species marked * are new records for the park. Those marked + collected by bug-vac, ~ are direct observations, ^ by sweep netting, and # by moth traps.

Order	Common Name	Latin Name	Methods
Hymenoptera	Ant	* <i>Formica lemani</i>	+
	Ant	* <i>Lasius niger</i>	+
	Ant	* <i>Myrmica rubra</i>	+
	Ant	* <i>Myrmica ruginodis</i>	+
	Ant	* <i>Myrmica sabuleti</i>	+
	Ant	* <i>Myrmica sulcinodis</i>	+
	Wasp	* <i>Crabro cribrarius</i>	~
	Wasp	Ichneumonid wasp	+~^
	Wasp	* <i>Gonatopus bicolor</i>	+
	Solitary bee	* <i>Colletes daviesanus</i>	~
	Mason Wasp	* <i>Ancistrocerus</i> species	~
Diptera	Hoverfly	* <i>Sphaerophoria</i> species	^
	Hoverfly	* <i>Platycheirus albimanus</i>	^
	Hoverfly	* <i>Volucella pellucens</i>	^
	Hoverfly	* <i>Syrphus ribesii</i>	^
	Marmalade hoverfly	* <i>Episyrphus balteatus</i>	~

	Hoverfly	* <i>Eristalis</i> species	~
	Picture Wing Fly	* <i>Urophora jaceana</i>	+
	Fly	* (<i>Tachina fera</i>)	~
	Flesh fly	*Sarcophagidae	~
	Crane fly	*Tipulidae	~#
Hemiptera	Gorse shield bug	* <i>Piezodorus lituratus</i>	~
	Plant bug	* <i>Leptoterna dolabrata</i>	+
	Plant bug	* <i>Calocoris stsyi</i>	~^
	Common froghopper	* <i>Philaenus spumarius</i>	+~
	Ground Bug	* <i>Kleidocerys ericae</i>	+
	Plant hopper	* <i>Dicranotropis hamata</i>	+
	Leafhopper	* <i>Eupteryx stachydearum</i>	+
	Planthopper	* <i>Javasella discolor</i>	+
	Bracken Bug	* <i>Monolacris filicis</i>	+
	Lacehopper	* <i>Cixius nervosus</i>	~
	Red legged shield bug	<i>Pentatoma rufipes</i>	~
Coleoptera	Soldier beetle	* <i>Rhagonycha limbata</i>	+
	Leaf beetle	<i>Derocrepis rufipes</i>	+
	Soldier beetle	* <i>Cantharis nigricans</i>	+
	Soldier beetle	<i>Cantharis fusca</i>	+
	Pollen Beetle	* <i>Meligethes</i> species	+~
	2 spot ladybird	<i>Adalia bipunctata</i>	~
	7 Spot Ladybird	<i>Coccinella septempunctata</i>	+~
	Violet ground beetle	* <i>Carabus violaceus</i>	~
	Devils coach horse	<i>Staphylinus olens</i>	~
	Broad nosed weevil	*Curculionidae	+
	Ground beetle	* <i>Syntomus truncatellus</i>	+
	Ground beetle	<i>Philorhizus melanocephalus</i>	+
	Click beetle	* <i>Ctenicera cuprea</i>	~
	Weevil	* <i>Hadroplontus litura</i>	~
Neuroptera	Bordered brown lacewing	<i>Megalomus hirtus</i>	^
Trichoptera	Caddisfly	*Limnephilidae	#
Orthoptera	Field Grasshopper	* <i>Chorthippus brunneus</i>	+
	Mottled Grasshopper	* <i>Myrmeleotettix maculatus</i>	+
Collembola	Springtail	* <i>Isotoma viridis</i>	+
Dermaptera	Common earwig	* <i>Forficula auricularia</i>	+#
Aranaea	Zebra spider	* <i>Salticus scenicus</i>	~
	Candy stripe spider	* <i>Enoplognatha ovata</i>	+
	Wolf spider	* <i>Pardosa</i> species	+
	Crab spider	* <i>Xysticus</i> species	+
	Long jawed spider	* <i>Meta segmentata</i>	+
	Garden spider	* <i>Araneus diadematus</i>	~
	Money spider	*Linyphiidae	+
Opiliones	Horned Harvestman	* <i>Phalangium opilio</i>	+

	Saddle-back Harvestman	<i>*Mitopus morio</i>	+ #
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Table A3.3. Invertebrate records for Blackford Hill

<u>Order</u>	<u>Common Name</u>	<u>Latin Name</u>
Diptera	Hoverfly	<i>Sphaerophoria</i> species
	Marmalade hoverfly	<i>Episyrphus balteatus</i>
	Hoverfly	<i>Heliophilus pendulus</i>
Hemiptera	Common froghopper	<i>Philaenus spumarius</i>
Lepidoptera	Meadow brown	<i>Maniola jurtina</i>
	Comma	<i>Polygonia c-album</i>
	Green veined white	<i>Pieris napi</i>
Dermaptera	Common earwig	<i>Forficula auricularia</i>
Coleoptera	10 spot ladybird	<i>Adalia 10-punctata</i>
Hemiptera	Potato capsid bug	<i>Closterotomus norwegicus</i>
	Plant bug	<i>Lygus</i> species
Aranae	Spider	<i>Tetragnatha extensa</i>
	Spider	<i>Meta segmentata</i>
	Spider	<i>Pachygnatha</i> species
	Spider	<i>Xysticus</i> species

Table A3.4. Invertebrate records for St Cyrus NNR.

<u>Order</u>	<u>Common Name</u>	<u>Latin Name</u>
Hymenoptera	Carder Bumblebee	<i>Bombus pascuorum</i>
Lepidoptera	Fox Moth	<i>Macrothylacia rubi</i>
	Nettle tap	<i>Anthophila fabriciana</i>
Diptera	Hoverfly	<i>Syrphus</i> species
	Hoverfly	<i>Heliophilus pendulus</i>
	Marmalade hoverfly	<i>Episyrphus balteatus</i>
	Hoverfly	<i>Eristalis pertinax</i>
	Hoverfly	<i>Meliscaeva auricollis</i>
Hemiptera	Hairy shield bug	<i>Dolycoris baccarum</i>
	Gorse shield bug	<i>Piezodorus lituratus</i>
Orthoptera	Field grasshopper	<i>Chorthippus brunneus</i>
Plecoptera	Needle fly	Leuctridae
Aranae	4 spotted orb weaver	<i>Araneus quadratus</i>

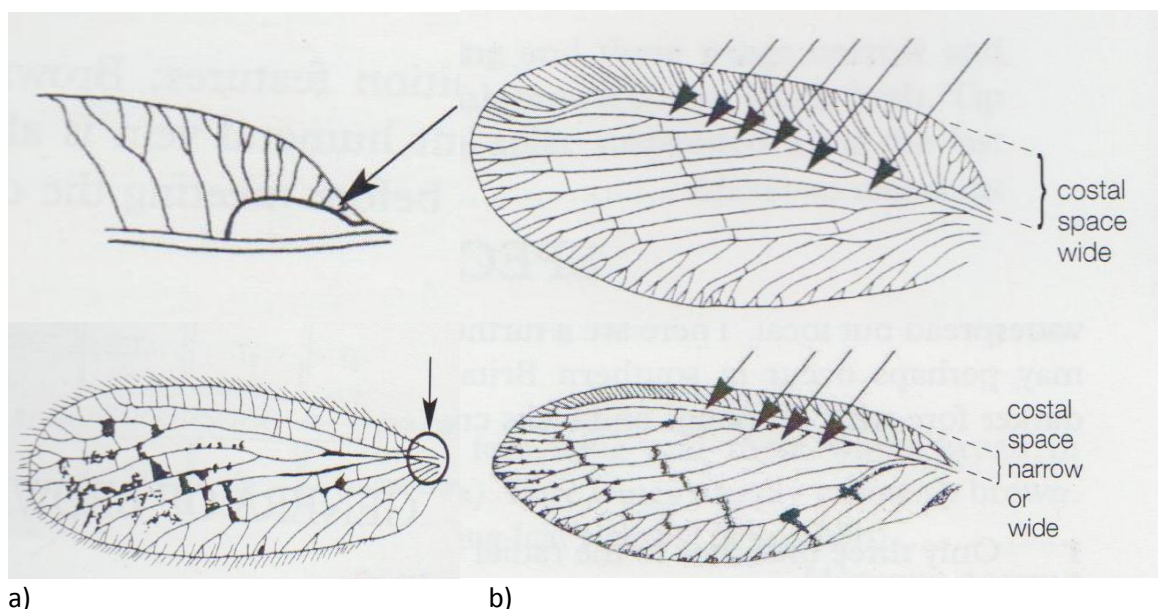
Appendix 4- Key to Identifying the Bordered brown lacewing

There are a number of diagnostic features of the Bordered brown lacewing that distinguish it from other brown lacewing species.

- 1) It has a rounded wing
- 2) It has a humeral vein (Figure A4.1a, and A4.2, feature B)
- 3) It has at least a cross vein in the outer third of the hind wing (the second pair of wings), and at least five altogether (Figure A4.2, feature C).
- 4) It has at least five branches to the radial vein (Figure A4.1b, A4.2 feature D), and a broad coastal vein (Figure A4.1b, A4.2 feature A)

Many of these features will not be seen clearly without the use of a microscope. The key feature though is the presence of the broad coastal space in the forewing shown. This can be seen with the use of a hand lens.

In all cases a specimen should be kept and sent to Colin Plant, lacewing recorder, for verification. Further information to determine other species can be found in 'A key to the adults of British Lacewings and their allies', by Colin Plant published by the Field Studies Council.

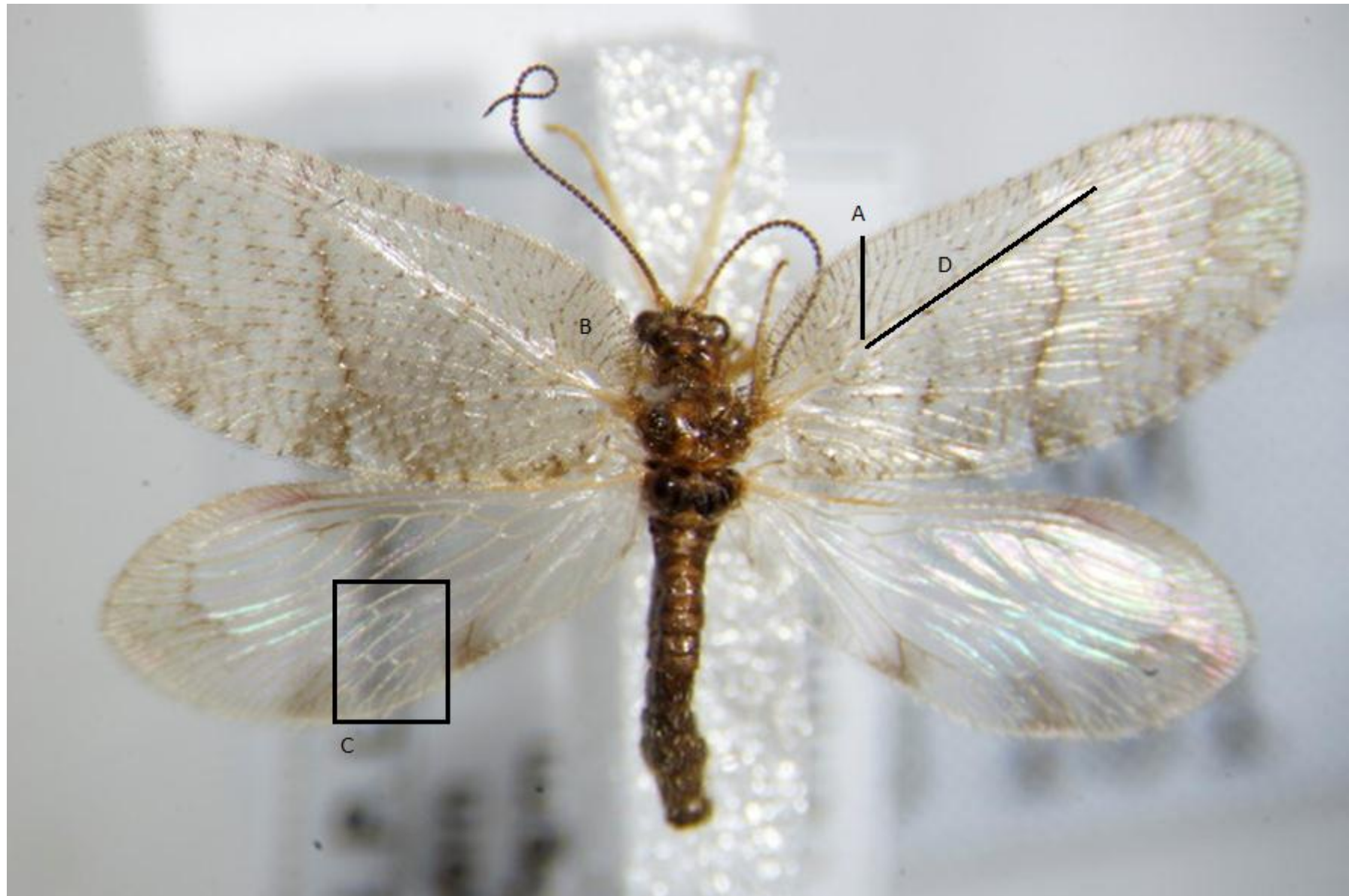


a)

b)

Figure A4.1 a) Above, the Humeral vein. Note that that humeral vein has additional cross-veins arising from it. Below, humeral vein absent b) Above, wide coastal space and branching of radial vein more than five. Below, narrow coastal space and fewer than 5 branches to radial vein (Adapted from Plant, 1997).

Figure A4.2 (overleaf). Showing the key diagnostic features of the Bordered brown lacewing. A- Broad coastal space B- The humeral vein C- Showing a number of cross veins in the hindwing. D- Radial branch in forewing with at least 5 branches to it. (Figure from BOLD Systems, 2015)



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