Results of the "Stag Beetle 'larval incidents' in private gardens" survey

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Abstract

The results of an internet based survey into the interactions between people and the Stag Beetle larvae in their gardens are presented. 111 *Lucanus cervus* L. (Lucanidae, Coleoptera) records were obtained. In addition to new information on its larval ecology, the survey revealed several important aspects about the human-Stag Beetle interactions during their vulnerable larval stage. People disturbed their larvae throughout the year and nearly half of records had to be relocated. The relocation incidence was higher when larger clutches were disturbed and with the residents that had moved in recently who were also the least aware of living in a Stag Beetle area. Suggestions for the conservation of the Stag Beetle larvae in private gardens are given.

Introduction

Our biggest terrestrial beetle has a penchant for urban areas: over 70% records of *Lucanus cervus* come from urban and suburban areas (Percy *et al*. 2000, Smith 2003); hence private gardens are an extremely important breeding habitat for this saproxylic species currently classified as "Nationally Scarce Category B".

L. cervus has a mysterious life history, spent mostly under the ground away from the view of the urban dwellers that they share their habitat with. Soon after emergence in late May-early June, the beetles mate; afterwards the females lay their eggs, about 30, in the vicinity of the pabulum where the larvae are going to develop; at the same time, they leave by each egg a swab of symbiotic yeasts which will give the larvae a good start (Tanahashi *et al*. 2010). The beetles die soon after reproducing and the larvae will develop on their own. The duration of the larval stage is often quoted in the literature as a minimum period of three years which can extend up to seven years spent feeding on decaying wood (Rink & Sinsch 2008, Harvey *et al*. 2011); many websites have opted for three and up to seven years. However, there is now mounting evidence that it may last only two years in field conditions; for example: in a recently cut stump (Fremlin 2012) and freshly cut wood chips (Fremlin unpublished); and buried logs (Arno Thomaes pers. comm.).

In any case, when their larvae reach maturity, they bury themselves deep into the soil from mid-May onwards, about the same time that the adults become active above the ground; by early September the adults have eclosed and will overwinter in their cocoons, or nearby, in a dormant state till the following year (Harvey *et al*. 2011).

To complicate things, from the human point of view, it is rather difficult to spot the places where the beetles have chosen to breed for there are hardly any tell-tales above the ground. Hence the chances of being disturbed in people's gardens are rather high.

This certainly seemed to be the case in Colchester, a well known Stag Beetle hotspot, where over the years many stories about Stag Beetles 'larval incidents' were heard. First, it was not uncommon to be told: "when we moved in, we found their larvae when we were clearing up and, if then we had known what they were, we wouldn't have killed them". Later, as the profile of this beetle was raised after being included as a protected species in the Biodiversity Action Plan in the late 90's, people became more aware of their larval habitat. This was achieved mainly by surveys (Bowdrey 1997, Percy *et al*. 2000, Smith 2003) coupled with important publicity about their conservation needs mainly by the People's Trust for Endangered Species (PTES). At the same time, as the Stag Beetles for Everyone website, run by the author, got increased content about their larval stage, enquiring emails about 'larval incidents' became a regular feature from the mid 00's. Mostly people either wanted to know what they had found or/and what to do with it. This raised a lot of questions as regards to the fate of the larvae which are known not to relocate well (Bowdrey pers. comm.); some people were quite willing to provide more information about it, but in general information was rather difficult to collect. Hence in order to find out more about the interactions between people and the Stag Beetle larvae in their gardens an internet survey was launched by the author in 2009.

Methods

The survey consisted of ten questions, see Appendix 1. They were set up in http://www.surveymonkey.com/ and hosted there for a couple of years. The survey was advertised primarily in Stag Beetles for Everyone (maria.fremlin.de/stagbeetles) and also in other websites, for example, Essex Field Club and PTES. Posters were set up in various places, locally and elsewhere.

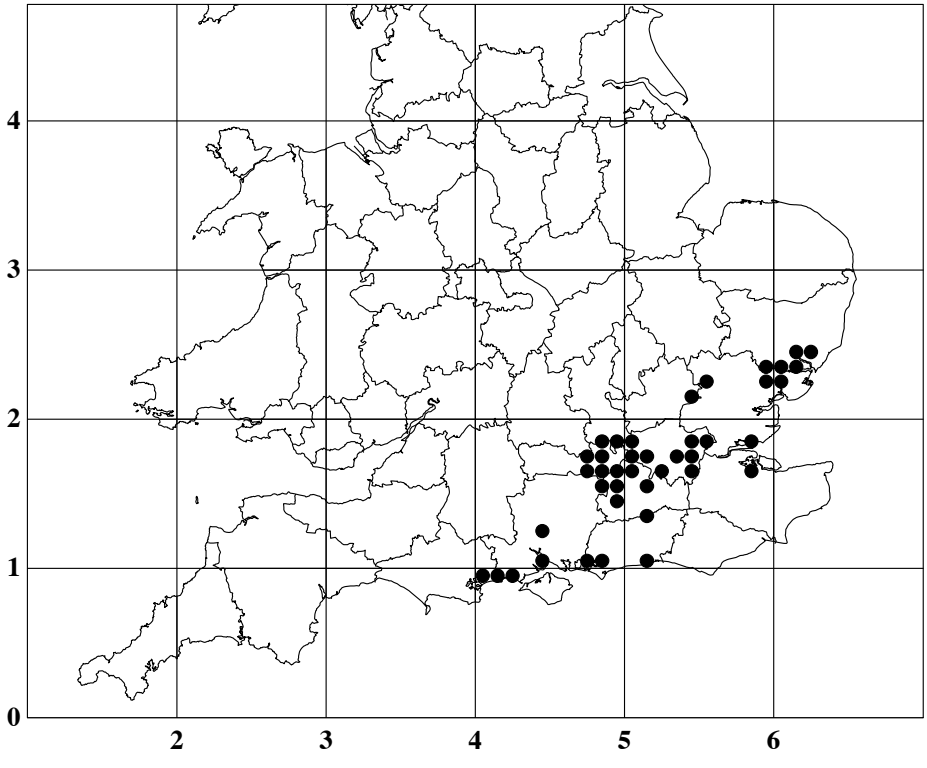
Results and discussion

A total of 175 responses were collected; 64 were deleted for various reasons (insufficient information, 34; the wrong species (*Dorcus parallelipipedus* L. (Lucanidae), 7; *Cetonia aurata* L. (Scarabaeidae, Cetoniinae), 11; root-chafers (Scarabaeidae, Melolonthinae), 8); Scarabaeoidea larvae from the wrong country (USA, 3; Hungary,1)). Some old records, 1999 to 2009, were also included when there was enough information, 23. Finally, a total of 111 *L. cervus* records were selected; the majority of them were accompanied by photo/s, 87%. It was possible to identify *L. cervus* with a good degree of certainly from most of the photos. Some records without photos were determined by specialists or the author; others were accepted based on sound information from the recorder.

Distribution

The overall distribution of the records is well within the boundaries of the current range of *L. cervus* in the UK (Smith 2011), Fig. 1 overleaf. For the number of records per county see Appendix 2.

Fig. 1. *Lucanus cervus* records, plotted by hectad (10km x 10km).
Map produced using DMAP, software produced by Dr Alan Morton.

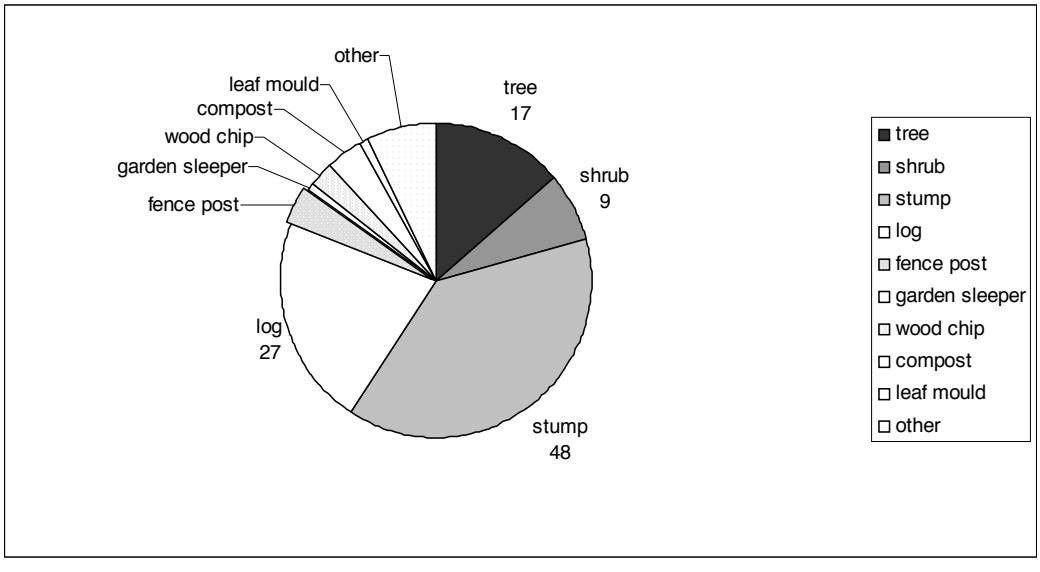


Larval ecology

The majority of the records were associated with dead trees, shrubs and their stumps, Fig. 2. Larvae were also found in a couple of still living trees and one shrub: when an old *Syringa vulgaris* and a diseased *Eucalyptus* sp. were felled; and above the ground inside an old branch of a *Buddleia davidii* which was being pruned, Plate 110. It was known that *Dorcus parallelipipedus* may breed in the dead parts of living trees (Jessop 1986, Fremlin & Hendriks 2013) but not so *L. cervus*. For all the tree and shrub species that were associated with the larvae see Appendix 3.

The records under logs were interesting; in quite a few cases they had been placed on purpose by the residents, two were being used as chopping blocks; in one instance they were supporting a garden seat, they were all unburied. One remarkable record was under logs placed in 2006 over a membrane covered with wood chips. Two years later larvae were found underneath one log; they had chewed holes on the membrane quite successfully, Plate 111. This shows a very interesting larval behaviour; perhaps it happened because they were getting ready to pupate at a deeper level. There were three more records associated with trees/shrubs/logs of larvae also found two years after the habitat was created. These records indicate prompt colonisation of a new habitat.

Fig. 2. Habitats where the larvae were found.



Fence posts broken by the action of the larvae were also reported (5). The garden sleeper, wood chip, compost and leaf mould records were relatively rare (1, 3, 5 and 1, respectively). In some cases the compost was enriched with woody material by residents which had shredders, and turned often.

The "other" category (8) included larvae found mostly in rich humus: a large oak planter, inside a growbag from the previous year, a potato trench, and cultivated soil in an allotment plot. One remarkable record was in humus rich soil in a place where there used to be the stump of a tree felled 22 years ago, the stump was removed four years ago, no signs of it any more, but a quick search yielded eight larvae.

Still in this category, there was one 'larval incident' in chipboards that were under concrete blocks, all placed on the soil 'no more than two years ago'. Several larvae (10-13), at different stages of development, were found right underneath the blocks. One photo showed the presence of a larva of a cardinal beetle (*Pyrochroa sp.*, Pyrochroidae, Tenebrionoidea). These larvae are carnivorous and may predate on Stag Beetle larvae.

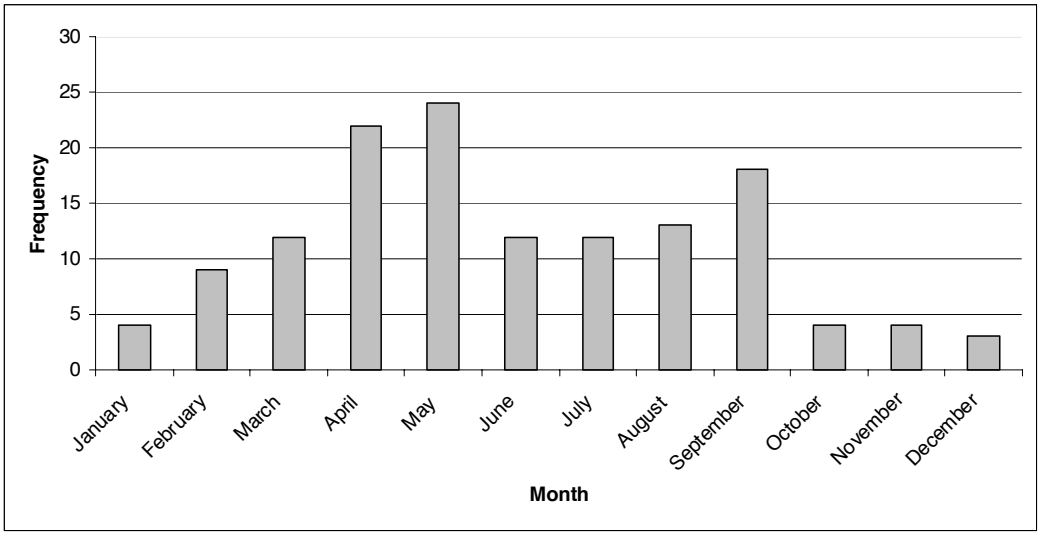
These records prove that *L. cervus* larvae has even more catholic tastes than reported by Hawes in Suffolk (2009); they included cat litter in wood shavings, compost heap, composted vegetable plot, horse manure, sawdust and wood chip heaps.

People and their interactions with the larvae

People reported 'larval incidents' throughout the year. Some of them (35) had already found larvae in the past; a few (6) had larvae in more than one place. The frequency of the incidents with known dates (137), Fig. 3, indicates that the quietest period was from October to January. There was a

peak of activity during April and May which coincides with the time when the larvae get ready to pupate.

Fig. 3. Frequency of the larval incidents, by month



A couple of recorders proved this with their photos showing larvae during the pre-pupation stage and later a very late-stage pupa, Plates 112 and 113.

Photos of teneral (freshly eclosed) imagos were also received later in the year, Plates 114 and 115.

The larvae were disturbed for all sorts of reasons, mostly inadvertently. For example: while gardening or clearing-up (24); paving over the area (2), making room for a shed (4) or a greenhouse (1); when dead trees/stumps broke naturally (7) or by one intruder who jumped over the fence and fell on it, or by playing children (1); when repairing a fence (2) or a fence post broke (5). In some cases the people were removing the tree/stump, deliberately (6).

Predators, badgers (2) and foxes (1), also alerted people to the presence of the larvae by digging up the area.

The number of larvae disturbed varied a great deal. The majority of the records were of larvae from 1 to 6 (75), Table 1. At least six of the records of the "7 or more larvae" category were of rather large clutches, from more that two dozen, to up about 100 or even more larvae. Others were reported as just "loads".

Fate of the larvae

Once the larval habitat was disturbed, various things happened to the larvae. Only a couple of recorders killed them outright: one recorder in 1999 because then she did not know what they were and the other in 2011 because "I thought they were something dangerous for my kids". Other larvae

Table 1. Number of larvae disturbed during the most recent incident and their relocation.

Number of larvae in the most recent incident	1	2-3	4-6	7 or more	Total
number of records	22	34	19	36	111
%	19.8	30.6	17.1	32.4	
Relocation in the same garden	6	8	7	15	36
Relocation somewhere else	1	4	3	6	14
% relocation	31.8	35.3	52.6	58.3	

were killed (15) or injured inadvertently. This is because they have very soft bodies which are prone to fatal injuries under mechanical impact. The tell-tale for an injured larva is a darker body which turns black by the time that they are dead; several pictures attested to that, for example Plates 116 -118. Their haemolymph darkens due to an immune system response called melanisation (a chain of reactions triggered by the phenoloxidase enzyme) (Hoffmann 1995). This is an important defensive system in insects that live in 'dirty' environment like humus and soil. In spite of this defence, darkened larvae without any apparent external injuries also die. A recent dissection of a few of those revealed a consistent injury to the midgut; in extreme circumstances their hindgut may also prolapse (Fremlin & Natálio unpublished), see Plate 117. Their fragility needs to be studied further.

The other problem is that they do not seem to relocate well (Bowdrey pers. comm., pers. observ.) and nearly half of the 'larval incidents' (n=50) were relocated; the majority stayed in the same garden (n=36), the remainder had to go somewhere else; their chance of relocation was directly proportional to their number, Table 1. In one case around 100 larvae found in a log pile in a front garden had to go because the new house owner wanted to pave over the area. This recorder took a lot of trouble to find a new location for them: half went to a local wildlife trust and regarding the remainder he telephoned the author who arranged for them to be collected by Dr. D. Harvey, Royal Holloway University. In another larval incident the fate of the larvae discovered in garden sleepers fronting the wall of a terrace could not be fully traced because of a total lack of cooperation by the builder who reported "hundreds of larvae". All that could be traced, entirely by chance, were a few larvae that had been dumped in the adjacent allotment site by a walnut tree, Plate 118. An attempt to relocate the white-rotted oak sleepers, which possibly were harbouring some larvae, also failed.

In another case, some of the larvae had to go somewhere else because the recorder kept finding more than he could relocate in his own garden; this when he was thoroughly getting rid of a couple of sycamore stumps. The extra larvae were relocated nearby in Ian Rose's garden, who reported that they had "a big battering". On the plus side, one person postponed the installation of a new shed in order to leave the larvae where they were found.

Another way to look at the relocation data is to take into account the number of years that the residents had been living in the property and whether they were aware of living in a Stag Beetle area, Table 2. The shorter occupancy group, 0-5 years, relocated their larvae significantly more than the others (69.6%).

The great majority of people were aware that they were living in a Stag Beetle area, 80%; the longer that they had lived in the area the more aware they were; again there is a significant difference for the shorter stay residents who were much less aware of it, 52.2%.

Table 2. Data about residents: occupancy, relocation of larvae and Stag Beetle area awareness

Number of years the property has been occupied by present resident	**0-5**	**6-14**	**15-20**	**21 or more**	**Total**
number of records	23	28	17	43	111
Number of residents who relocated their larvae	**16**	**11**	**7**	**17**	**51**
relocation %	69.6	39.3	41.2	37.2	
stayed in the same garden	9	10	5	12	36
went somewhere else	7	1	2	4	14
Number of residents aware of living in a stag beetle area	**12**	**25**	**15**	**37**	**89**
%	52.2	89.3	88.2	86.0	

The survival rate of the relocated *L. cervus* larvae needs to be investigated. The author is only aware of one study in 2005, prior to an expansion of Frankfurt airport, 49 oak stumps were uprooted together with 7 m^3 of the surrounding soil (Ebert 2008). Their relocation was very successful judging by the number of emerged imagos in the following five years (Ebert 2011). There is no doubt that this species has rather specific habitat requirements and to replicate them somewhere else is a big challenge to the untrained urban dweller. Recorders did make an effort; that is, sought for information mostly in the internet. Consequently, one of them put them in "the 'bark bucket' & will look in 7 years time", from the accompanying photo the location seemed to be in the rain shadow though, surrounded by gravel. Other examples of unsuitable relocation places were: inside two stacked car tires on a lawn, no shade; buried under an upturned pine stump; a heap of small branches. There is a need to educate the public about the habitat needs of this species.

Peoples's feelings towards Stag Beetles

Peoples' feelings towards having Stag Beetles in their gardens were very positive, Table 3.

Table 3: How people felt about having Stag Beetles in their garden

Answer Options	**Delighted**	**Happy**	**Doesn't matter to me**	**I don't like them**	**Horrified**	**N/A**	**Response count**
the beetles	73	21	7	4	0	3	108
%	67.6	19.4	6.5	3.7	0	2.8	
the larvae	71	21	6	5	2	3	108
%	65.7	19.4	5.6	4.6	1.9	2.8	

The larvae were just marginally less popular than the adults and this was somewhat surprising because they have sometimes elicited very strong feelings. For example: hideous and spooky; grossed by them, twice; gave the creeps and frightened the bejusus out of girl friends; and the site of them made the recorder squirm or they were disgustingly big.

Of course, all the recorders were a special section of the population which lives in Stag Beetle areas; they really wanted to know what they found, most of them were very proud to have them and actively managed the garden to accommodate their needs. Indeed in one example the residents decided when they retired to come south from Scotland and choose a Stag Beetle area to live in. Spot on.

Conclusion

This survey brought a deeper insight into the urban ecology of *L. cervus*. For the first time important information on its life cycle has been directly sourced from their natural habitat by the recorders which have documented the onset of the pupation stage from early May all the way through to the teneral imagos in September.

This species was found breeding on an even wider range of habitats than previously recorded. New records of larvae found in the dead parts of living trees and shrubs were obtained.

At the other habitat extreme, larvae were also found in new humus rich places such as a growbag, a large planter and leaf mould pile. The records in humus together with others under unburied logs confirm the known prompt colonisation strategy used by this species in urban areas (Fremlin & Fremlin 2010, Fremlin 2010). It responds very well to active garden management. It would appear that, in England, *L. cervus* is synanthropic.

As regards the way people dealt with their ‘larval incidents’, this survey showed that the larvae were extremely vulnerable. First, they were easily injured when disturbed which is fatal to them, afterwards nearly half of the recorders opted for their relocation thus leaving them to an uncertain future.

There is a need to investigate the relocation impact on their conservation. At the same time, more detailed advice should be given when relocation is unavoidable also on what to do when a tree or a stump breaks.

In Stag Beetle areas this publicity should be targeted at new residents as they were not only more likely to be unaware of living in a Stag Beetle area but of relocating them as well. It should include all other people involved with the housing market; for example, gardeners, tree surgeons, builders and garden centres should be made aware of their conservation needs during the larval stage. This publicity should be consistent when posted in various websites.

In spite of the fact that being disturbed by humans seems to be bad news for the Stag Beetle larvae, this species continues to thrive in urban gardens, mainly because it is very opportunistic, has catholic tastes, and most people are delighted to have them.

Acknowledgments

The author would like to thank all the recorders for their co-operation and above all for their concern regarding the welfare of the Stag Beetles in their gardens; all the people who helped with the survey publicity; and Peter Harvey for producing the map and helpful discussion. Also to David Fremlin and Paul Hendriks for their helpful remarks on the manuscript.

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Correction

I want to apologize for not mentioning an important survey in Suffolk, 1990-1997, by Colin Hawes:

> Hawes, C. J. (1998). The Stag beetle, *Lucanus cervus* L. (Coleoptera: Lucanidae) - a first report. *Trans. Suffolk Nat. Soc.* 34: 35-49.

Therefore the following sentence in the last paragraph of the Introduction, page 95,

> Later, as the profile of this beetle was raised after being included as a protected species in the Biodiversity Action Plan in the late 90's, people became more aware of their larval habitat. This was achieved mainly by surveys (Bowdrey 1997, Percy *et al.* 2000, Smith 2003) coupled with important publicity about their conservation needs mainly by the People's Trust for Endangered Species (PTES).

Should now read

> Later, as the profile of this beetle was raised after being included as a protected species in the Biodiversity Action Plan in the late 90's, people became more aware of their larval habitat. This was achieved mainly by surveys (Bowdrey 1997, Hawes 1998, Percy *et al.* 2000, Smith 2003) coupled with important publicity about their conservation needs mainly by the People's Trust for Endangered Species (PTES).

Maria Fremlin, 1 February 2014

Appendix 1 - Survey form

Stag beetle "larval incidents" in private gardens

Thank you for taking the time to participate in this survey; stag beetles are a protected species in the UK and your input will be very valuable towards their future conservation.
However their larvae can sometimes be confused with other beetle larvae, therefore it is very important to take photos, ideally with a ruler to show the scale, in order to counter-check the identification. Alternatively, get in touch with Maria Fremlin, mariafremlin@gmail.com, 01206 767746

***** indicates a question with required answer/s which in most cases have an * as well and are highlighted.

***1. Information regarding the location of the "larval incident" and yourself (optional).**

City/Town/Village:	
County:	
***Postcode:**	
Your name:	
Email Address:	

***2. How many years has this property been occupied by the**

	0-2	3-5	6-14	15-20	21 or more	don’t know
***present occupier**	○	○	○	○	○	○
***previous occupier**	○	○	○	○	○	○

Comments (optional) –

***3. When did you see your larvae**

	DD	MM	YYYY
***most recent incident**			
earliest past incident			

4. How many larvae have you found recently?

- ○ 1
- ○ 2-3
- ○ 4-6
- ○ 7 or more

Comments –

***5. Will you be sending any photo/s of your larvae to mariafremlin@gmail.com?**

○ **yes** ○ **no**

6. Indicate below the details of the habitat where you found your larvae

	healthy	diseased/rotting	dead	don't know
tree	☐	☐	☐	☐
shrub	☐	☐	☐	☐
stump	☐	☐	☐	☐
log/s	☐	☐	☐	☐
compost heap	☐	☐	☐	☐
leafmould pile	☐	☐	☐	☐
fence post	☐	☐	☐	☐
railway sleeper	☐	☐	☐	☐
woodchips	☐	☐	☐	☐
other	☐	☐	☐	☐

If found in a tree/shrub/stump identify it and, if you know, the date when it was cut

7. Relocation! If the larvae were relocated did they

○ stay in the same garden
○ go somewhere else

Please, give details of their new location

8. Were you aware that you were living in a stag beetle area?

○ yes
○ no

Comments (optional) –

9. How do you feel about having stag beetles in your garden

	Delighted	Happy	Doesn't matter to me	I don't like them	Horrified	N/A
the beetles	○	○	○	○	○	○
the larvae	○	○	○	○	○	○

10. More comments?

Many thanks for completing this survey. Please, post this form to Maria Fremlin, 25 Ireton Rd, Colchester CO3 3AT

Appendix 2 – Stag beetle records received from each county

County	Number of records		% of total
Berkshire	7		6.3
Buckinghamshire	1		0.9
Dorset	2		1.8
Essex*	55	49.5	
Greater London	12		10.8
Hampshire	5		4.5
Hertsfordshire	1		0.9
Kent	8		7.2
Suffolk	4		3.6
Surrey	13		11.7
West Sussex	3		2.7
	111		100

* This includes 42 records from Colchester

Appendix 3 – Tree and shrub species mentioned associated with the stag beetle larvae

Tree species	Common name	No. of records	%
Acer pseudoplatanus	Sycamore	4	6.2
Aesculus hippocastanum	Horse chestnut	2	3.1
Betula pendula	Silver birch	1	1.5
Betula sp.	Birch	1	1.5
*Buddleia davidi**	Butterfly-bush	4	6.2
Ceanothus sp.	Californian lilac	1	1.5
Crataegus monogyna	Hawthorn	3	4.6
Cupressus × leylandii	Leyland Cypress	1	1.5
Eucalyptus sp.*	Gum tree	2	3.1
Fagus sylvatica	Beech	2	3.1
Forsythea sp.	Forsythea	1	1.5
Fraxinus excelsior	Ash	3	4.6
Hebe sp.	Hebe	1	1.5
Ilex aquifolium	Holly	1	1.5
Juglans regia	Walnut	1	1.5
Laburnum sp.	Laburnum	1	1.5
Malus sp.	Apple	5	7.7
Malus sylvestris	Crab apple	1	1.5
Morus nigra	Black mulberry	1	1.5
Platanus x acerifolia	London plane	1	1.5
Populus nigra	Black poplar	1	1.5
Prunus sp.	Cherry	4	6.2
Pyrus sp.	Pear	1	1.5
Quercus sp.	Oak	8	12.3
Rhus coriaria	Sumac	1	1.5
Ribes sp.	Flowering currant	1	1.5
Sambucus nigra	Elder	1	1.5
Sorbus aucuparia	Rowan	1	1.5
*Syringa vulgaris**	Lilac	6	9.2
Tilia sp.	Lime	1	1.5
Viburnum sp.	Viburnum	1	1.5
	a conifer of some kind	1	1.5
	a laurel bush	1	1.5
		65	100

* This indicates that one record was in an old but still living species.

Plate 110 (top left). Larvae inside a *Buddleia davidii* branch, surrounded by frass, 26.ix.2008 © Maria Fremlin. **Plate 111 (bottom left). Membrane displaying holes dug by mature Stag Beetle larvae, 07.v.2008** © Polly Dolly. **Plate 112 (top right). Stag Beetle larvae next to a broken cocoon. Note that except the one in the middle they have empty guts, 08.vi.2010** © Philip Cunningham. **Plate 113 (bottom right). Fatally injured male Stag Beetle pupa, 24.viii.2010** © Phillip Vincent

Plate 114 (top left). Stag Beetle larvae and teneral male Stag Beetle,12.ix.2010 © David Rix. **Plate 115 (bottom left). Teneral male Stag Beetle inside its cocoon, 14.x.2010** © Philip Cunningham. **Plate 116 (top right). Fatally injured Stag Beetle larva, 22.v.2011** © Jim Cradbent. **Plate 117 (bottom right). Injured Stag Beetle larva with a prolapsed gut, 10.iii.2007** © Maria Fremlin See *Results of the "Stag beetle 'larval incidents' in private gardens" survey* pp. 94-106

Plate 118. Larvae discarded by a walnut tree. *Lucanus cervus*: 2 alive, 8 dead; *Dorcus parallelipipedus*: 1 alive; *Cetonia aurata*: 2 alive, 1 dead. 19.iv.2010 © Maria Fremlin See *Results of the "Stag beetle 'larval incidents' in private gardens" survey* pp. 94-106

Plate 119. *Lepista luscina* at Fryerning Churchyard © Graham Smith.
See *The Fungi of Fryerning Churchyard: 2012 update* pp. 115-117