Sugaring for stag beetles – different feeding strategies of *Lucanus cervus* and *Dorcus paralellipipedus*

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Introduction

The stag beetle *Lucanus cervus* (L.) (Coleoptera: Lucanidae) will feed on sugary liquids either from sap runs or ripe juicy fruits; an old Kent name for stag beetles, cherry-eaters, attests to their strong liking for this fruit by males in particular (Krenn *et al*., 2002; Fremlin, 2004). They imbibe liquid with their feathery tongues, the two central setaceous parts between their mandibles. In some cases in the Netherlands, on sap runs up to 20 beetles have been seen licking sap, mating and males fighting (Gerrit Rekers, pers. comm. and seen by PH). In general the females stay for a few days, whereas males stay much longer.

The large males often stand over the females, while smaller males try to get hold of the females and mate with them. The large males chase away the smaller ones, but sometimes a smaller male succeeds in mating with a female. Gerrit Rekers found several dead males in the vicinity of a sap run.

In the UK, however, there are no records of stag beetles *L. cervus* gathering at sap runs although there are some from continental Europe (Chop, 1893; Tippmann, 1954; Mamonov, 1991; Tochtermann, 1992; Jansson, this issue). MF has observed in her urban area courtship behaviour very similar to that at sap runs, but in the vicinity of breeding sites, or freshly cut trees. These gatherings occur in the evening at the beginning of the season and are of very short duration. Males may also gather and fight for females in crevices; they will come back as long as the females stay there even though they cannot mate with them (Fremlin, 2003; 2009; unpublished).

Natural gatherings of stag beetles such as may occur at sap runs enable direct information of their behaviour to be collated. We can determine their fidelity and comings and goings with some ease. In 2009 PH asked MF to set up an artificial sap run in her garden in order to observe them at close range throughout the flight season. We chose

maple syrup as an attractant because stag beetles are fond of it. In captivity the males feed on it frequently and the females do so when they appear in between egg laying sessions. Furthermore, maple syrup is the only tree sap that is readily available. After two seasons of intensive field work we have only partial answers to our primary interest, but unexpectedly gathered interesting information about the lesser stag beetle *Dorcus parallelipipedus* (L.)

Methods

Two patches, each approximately 11x13 cm^2, were cut from a terrycloth towel and were nailed to a couple of cherry stumps in Colchester, Essex at TL986244 in the garden of MF. The cherry trees were felled respectively in 2002 and 2005; the area has been an active breeding ground for some time for both *L. cervus* and *D. parallelipipedus*. One patch was placed on the top of the 2002 stump (height 70 cm, diameter 30 cm) and the other was placed half way up the trunk of the 2005 stump (height 76 cm, diameter 53 cm); they were left *in situ* until the following year. In 2010 a third patch was placed on

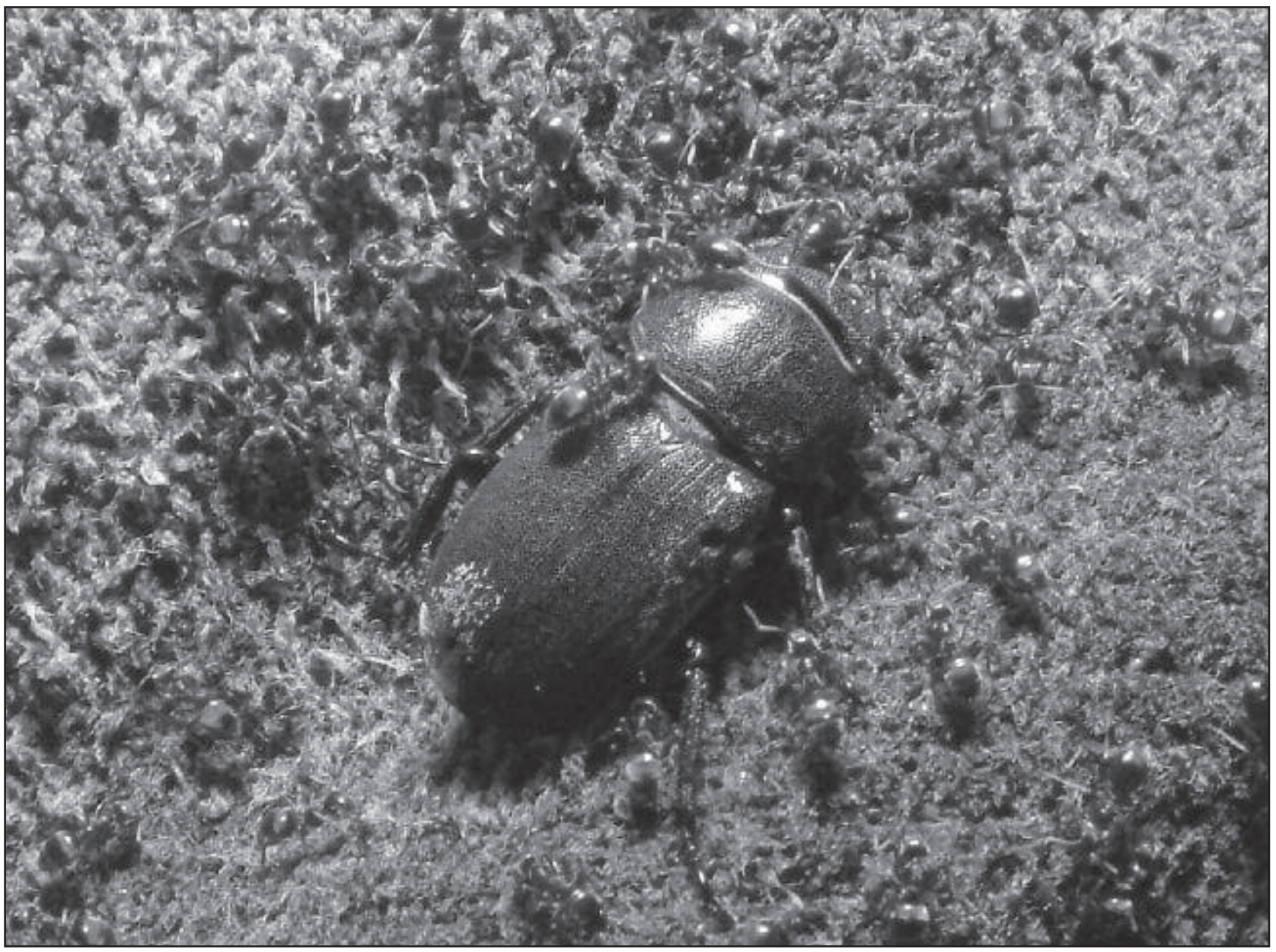

Figure 1. Female *D. parallelipipedus* surrounded by black garden ants (*L. niger*). 07/08/2009, 2203 hrs.

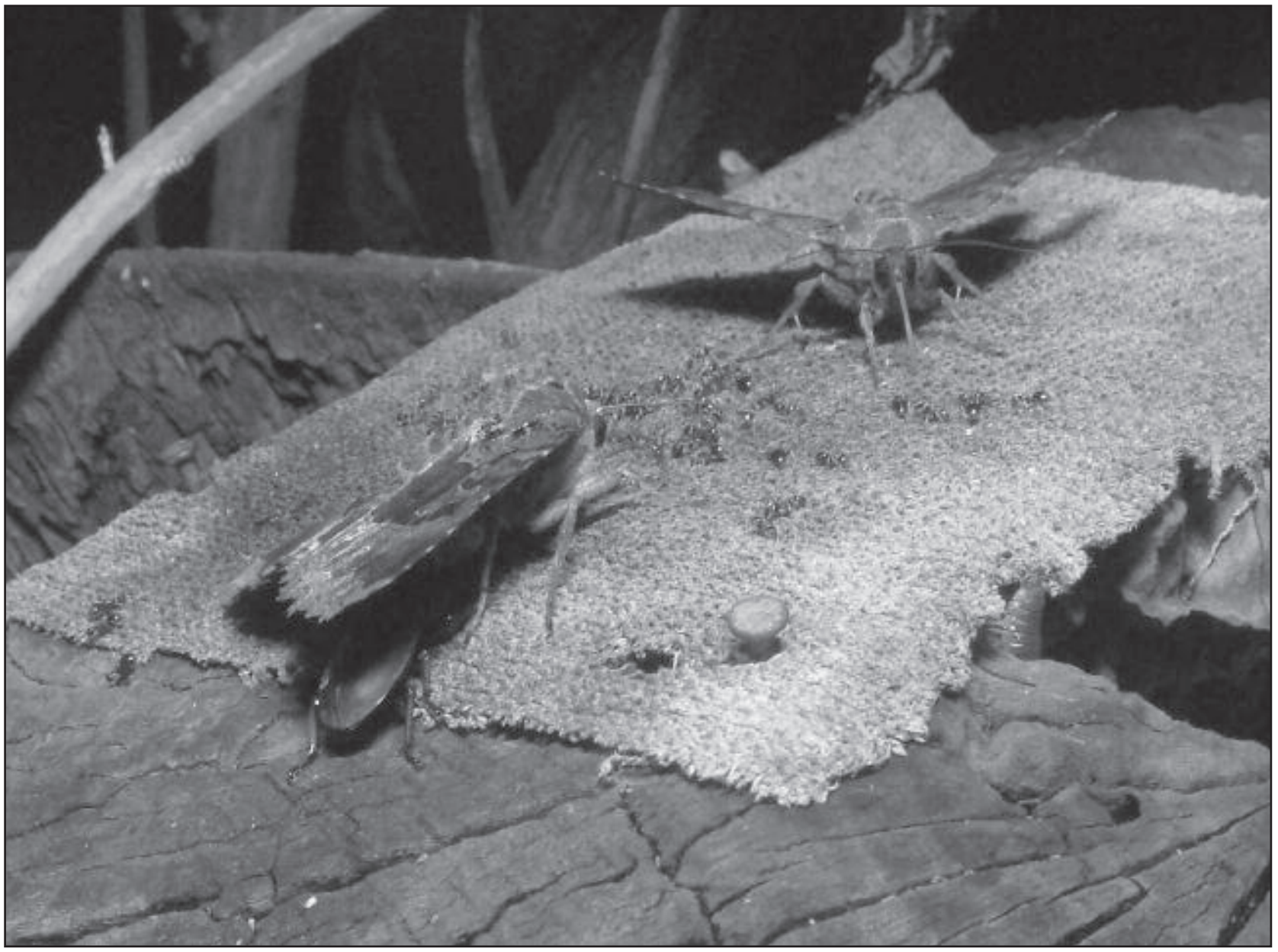

Figure 2. Male *D. parallelipipedus* under an old lady moth (*Mormo maura* L.) with black garden ants (*L. niger*) and another old lady moth in the background. This male appeared on four occasions. 05/08/2009 2203 hrs.

a walnut tree at a height of 145 cm. This tree is 90 cm from the stumps. The general area of the stumps faces south.

From mid May until early September the patches were refreshed daily at about 1900 hrs as follows. They were first sprayed with water with a spray gun and then maple syrup was applied with a drinking straw. The drinking straw was kept inside a small jar together with a small amount of syrup, covered with cling-film and refrigerated. A 330 g bottle of Sainsbury's Pure Canadian Maple Syrup was sufficient for one season.

The patches and surrounding street and alleyway were monitored daily from 2130 hrs; the overall area covered was roughly 40 m x 210 m. In 2010 this route was extended to include monitoring of a freshly cut stump in a nearby street, about 120 m away (Fremlin, 2010a).

All times are quoted in British Summer Time (BST).

Captured beetles were measured with a ruler, weighed with a Salter Pocket Electronic Diet Scale model 1250 with 0.1 g increments, marked and released. Their elytra were punctured with a needle following

Mendéz (2008). In the first year these punctures were painted over with a Tippex pen, but this was replaced in 2010 by an Edding 750 marker, coloured white for the males and pink for the females. This extra marking speeded up the identification of recaptures in the dark, particularly *D. parallelipipedus* which are not as strongly dimorphic as *L. cervus*.

Results

Stag beetles shared the maple syrup patches with quantities of black garden ants *Lasius niger* (L.) and woodlice, both of the latter appearing as soon as the patches were recharged. Slugs came later on in the evening and in 2009 moths visited (Figures 1-3).**2009 season**

Figure 3. Juvenile slug (*Arion ater* L.) crawling over a feeding male *L. cervus*, plus woodlouse (*Oniscus asellus* L.*)* and black garden ants (*L. niger*). 14/07/2010 2219 hrs.

Nocturnal feeding *L. cervus* were generally unresponsive to sound or light, or even a slug (Figure 3). In contrast *D. parallelipipedus* were very sensitive to sound and in particular to light and thus had to be photographed and caught quickly. In both seasons in the monitored areas generally, there were far more sightings of *L. cervus* than of *D.parallelipipedus* but by the stumps or on the syrup patches the reverse was true (Table 1).

Season	16 May – 9 September 2009				16 May – 5 September 2010			
	No. of marked beetles	Sightings in the monitored area	Sightings by the stumps	Sightings on the syrup patches	No. of marked beetles	Sightings in the monitored area	Sightings by the stumps	Sightings on the syrup patches
L. cervus								
Male	51	99	16	5	58	146	28	4
Female	33	68	9	0	53	107	28	2
Unknown		32	3	0		42	1	0
Total	84	199	28	5	111	295	57	6
D. parallelipipedus								
Male	17	55	42	34	13	69	45	31
Female	17	33	13	11	19	32	11	3
Total	34	88	55	45	32	101	56	34

Table 1 – Stag beetle sightings during 2009 and 2010, Colchester, Essex.

Lucanus cervus

L. cervus emerged on 19 May and between 10 and 23 June there were five feeding sightings of three males. One was observed three times on the horizontal patch, twice in the same day; all males had been captured first nearby. There were no sightings of feeding females. The longest time between recaptures was 37 days for a rather worn female in the general area of the stumps which travelled a distance of at least 95 m. A male was recaptured dead (trodden) after nine days having travelled a distance of at least 59 m.

Dorcus parallelipipedus

D. parallelipipedus was first sighted on 19 May and they fed actively from 29 May until 31 August. The majority were males of which 42 were in the general area of the stumps and 34 at the feeding patches where nine males came regularly, some many times and the most assiduous recaptured seven times. Some feeding males were first captured elsewhere, one travelling at least 70 m over 20 days, another 107 m over four days.

There were significantly fewer sightings of feeding females, namely 11 representing four individuals. Two of these were also first captured

elsewhere, one having travelled at least 79 m in 60 days, another 32 m in nine days.

2010 season

Lucanus cervus

In spite of a late first emergence on 3 June 2010, this was a good year for *L. cervus* and there was a doubling of sightings in the general area of the stumps. However, numbers of feeding sightings stayed about the same as those of 2009 and were late. Between 12 and 23 July four males were sighted once and one was spotted feeding in the morning. Another male was seen twice, close to the syrup patches.

There were two sightings of feeding females, both rather worn; one on 25 July (Figure 4) and the other one at the end of the season on 16 August was found dead nearby four days later.

Figure 4. Female *L. cervus* with rather worn front tibiae teeth. 25/07/2010, 2159 hrs.

All individuals were first captured within 5 m of the general area of the stumps.

The longest time between recaptures was by the freshly cut stump for beetles that had been first captured there; a dead male (trodden)

after, 36 days and a very worn female after 19 days, she died the next day.

Dorcus parallelipipedus

D. parallelipipedus was first sighted in the area on 18 May and the feeding sightings were from 7 June until 30 August. The total was 34, slightly less than the previous year, due to a decrease in female sightings. Otherwise the total number of marked beetles and sightings was about the same as in 2009.

This year there were no long distance recaptures; the maximum was about 5 m after six days for a female, which settled into a bag of decomposing sawdust.

Very unexpectedly there were two recaptures from the previous season.

A female first captured in a stump elsewhere on 12 August 2009 was found dead (trodden) in the study area on 5 June 2010, 297 days later.

Secondly, a male from 2009 was sighted again on 27 July 2010 366 days later at the same spot, the 2005 stump. It was sighted feeding on the vertical syrup patch twice in 2009 and eight times during 2010.

There were only three other males seen frequently at the syrup patches, of which one appeared 14 times. Two females came at the beginning and end of the season, the latter was sighted twice underneath the vertical patch, a favourite place for the males as well.

Discussion and Conclusion

The proportion of *L. cervus* individuals that came to feed was extremely low, a disappointing result considering how healthy the local population is.

Thus with this experiment we were unable to replicate what reportedly happens at sap runs in continental Europe because the females only came at the end of the season, one probably between an egg laying session and the other at the end of it. The males fight for the females at the beginning of the season when in peak condition at a time when the females tend to make themselves scarce. As the season progresses females seek oviposition sites and males tend to lose interest in them (Fremlin, 2009; 2010a,b).

It could well be that the success in attracting several beetles to a sap run is more dependent on the presence of females at it than the presence of sap *per se*. The appearance of a freshly emerged female at

a sap run may be the crucial factor in instigating an assemblage. Female *L. cervus* pheromones are very powerful; males can detect receptive females from a distance of about 50 m (Deborah Harvey, per. comm.).

Moreover, the maple syrup patches employed by us were a very poor imitation of natural sap runs because they soon dried up. Natural sap runs attract a variety of microorganisms which ferment the sugars in the sap and may even stimulate the sap flow; this type of micro-habitat attracts a spectacular array of invertebrates including lucanids (Tippmann, 1954; Ratcliffe, 1970).

In laboratory controlled experiments with *L. cervus* only half of the males and less than a third of the females were attracted to maple syrup (Harvey *et al*., 2011). And in a terrarium PH observed that both males and females *L. cervus* had to get 'used' to the presented syrup; the attraction was not immediate. However, the attraction between males and females was very strong; males were observed actively looking for females and even locate them when they were just under the surface. Once they got used to the syrup it was readily taken.

Our results fit well with the extreme scarcity of feeding records in all major *L. cervus* surveys in the UK (Bowdrey, 1997; Percy, 2000; Smith, 2003). The limited need to feed during the adult stage is not uncommon for short lived saproxylic species within the superfamily Scarabaeoidea (Arrow, 2005; Henschel, 1962) and it has been suggested that *L. cervus* can survive perfectly well on its fat reserves during its short flight season. They then die at the end of it (Harvey & Gange, 2003). Klausnitzer (1995) mentions that their reproductive behavior is initiated by females who seek out sap runs especially at oak or beech, or create one themselves. Bark gnawing behaviour is a very rare occurrence with *L. cervus* for which we have found two citations, namely in the Netherlands (Smit & Krekels, 2008) and in Italy (Simon Newell, pers. comm.). A Japanese stag beetle deliberately pinches the bark of trees in an attempt to create sap runs (Hongo, 2005).

Altogether there are several aspects of the reproductive behaviour of *L. cervus* at natural sap runs that deserve to be studied further.

The present study shows clearly that *D.parallelipipedus* feeds at sap much more than *L. cervus*, particularly the males at a time when the females were probably ovipositing (Table1).

Unlike *L. cervus*, adult *D.parallelipipedus* spend a great deal of their life in, or very near, the host tree. Placing a cloth on a host stump

guarantees their appearance and explains why the baited cloths were more frequently visited by them. The mark-recapture results indicate that, like *L. cervus*, the adults will move around during the breeding season and they live much longer. PH kept individuals that had been captured in August 2005 for three years and when he released them they were still in good condition. Thus a species that can live as an adult for at least two breeding seasons is likely to have a different feeding strategy from one that lives for only for two to three months.

In rearing *D. parallelipipedus* PH revealed further interesting information about its feeding preferences. Males and females fed on the maple syrup all the time, but there was very intensive feeding immediately after overwintering which could last for days. Later in the season during July and August this decreased.

When adults are present in host trees the number of larvae in them seem considerably reduced compared to when adults are absent (PH, pers. obs.) Up to now there are only direct observations of females feeding on their own larvae. Cannibalism also occurs amongst larvae when they are in bad condition and have little decayed wood to feed on and this seems to be the case for other *Dorcus* species (Tanahashi & Togashi, 2009). We found that adults ignored frequently presented yellow mealworm (*Tenebrio molitor*) larvae and dead *Bombus* larvae. They did feed readily on the remains of a dead *L. cervus* female. One female started to feed directly on the remains at dusk and was still thus engaged the following morning (Figure 5).

Figure 5. Female *D. parallelipipedus* feeding on the carcass of a female *L. cervus*. 25/8/2010.

This intensive feeding continued for several days at intervals. The fact that adults fed only on other lucanids, including their own kind, is interesting. As adults and larvae can live together in large numbers in decayed wood, cannibalism would be an easy way to sustain protein need during relatively long adult stage. This needs to be investigated further.

Sugaring for stag beetles is a useful activity which, in conjunction with marking, may throw more light on *D. parallelipipedus* adult longevity. Survival in the wild for three seasons seems to us not impossible

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