A FEMALE-BIASED SUMMER EMIGRATION PEAK FOR *CIS FAGI* WALTL (COLEOPTERA: CIIDAE) IN SOUTHERN ENGLAND

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ABSTRACT

The first description of a female-biased emigration peak for *Cis fagi* Waltl (Coleoptera: Ciidae) is provided. It comes from flight interception trap data obtained in summer 2022 from Kirtlington Park, Oxfordshire. These data and the questions arising from them highlight our inadequate understanding of ciid dispersal.

INTRODUCTION

Dispersal is a 'key life-history trait' which affects, and is affected by, many aspects of an organism's biology (Renault, 2020). Yet insect dispersal – particularly that of non-traditional model species without well-defined dispersal phenotypes – remains poorly understood (Asplen, 2018, 2020). Bonte & Dahirel (2017) state the broader need for more data on dispersal syndromes.

Dispersal, and specifically emigration, of the fungivorous Ciidae (Coleoptera: Tenebrionoidea) has received scant attention, notwithstanding the work of Paviour-Smith (1968) on the Australasian *Cis bilamellatus* Wood in southern England and the Scandinavian emergence data for several ciids presented by Thunes (1994). Here we report apparently novel emigration data for the European *Cis fagi* Waltl obtained from flight interception trap captures at a new locality for the species in southern England in 2022.

Cis fagi is a small brown beetle, 1.3–2mm long. It may be distinguished from all other British ciids by its combination of 10-segmented antennae, single elytral punctation with a conspicuous recumbent seta arising from each puncture, and the outer distal edges of the protibia dentate or angular.

Like most, if not all, other members of the cosmopolitan Ciidae, *C. fagi* is an obligate fungivore. Its larvae and adults exploit the sporophores and vegetative hyphae of wood-rotting basidiomycetes. In Britain the species is habitually (but not exclusively) found in both brown and white dry-rotten wood, where substantial populations can develop (K. N. A. Alexander, A. P. Fowles and the late P. M. Hammond, pers. comms.). Given that considerable amounts of potentially suitable rotten wood can occur in large old trees, it is not surprising that *C. fagi* has been noted as a 'reliable marker' of old primary woodland sites (Crowson, 1985), and as having an association with both ancient woodland and medieval pasture woodland (Lott, 2008). Alexander (2004) noted the possible utility of *C. fagi* as an indicator of ecological continuity, but has not included the species in his recent update of the Index of Ecological Continuity (Alexander, 2024).

METHODS

During 2022 BJP carried out a survey of saproxylic beetles associated with veteran and ancient parkland trees at Kirtlington Park, Oxfordshire, vc23, (SP505201), a privately-owned estate of approximately 305 acres situated 13 km north of Oxford. Laid out by Lancelot 'Capability' Brown in the 1750's, the parkland includes an area

of 34ha that was described as a 'park' over 700 years ago in 1279 (www.historicengland.org.uk).

As a part of the survey two roofed vane traps were positioned to target beetles associated with a large rot-hole at the base of the trunk of an ancient parkland oak, *Quercus robur* L., of approximately 7 m girth, (subsequently referred to here as the ancient Kirtlington oak) (Fig. 1). At the base of the trunk on the opposite side of this tree is a large sporophore of the heartwood-rotting fungus genus *Ganoderma* P. Karst. (Fig. 2). Trap construction followed the modified design reported by Piper and Allen (2020), with monopropylene glycol used as a preservative. Trap 1 was placed at ground level at the rot-hole's entrance, with fallen branches positioned to keep it upright. Trap 2 was suspended from a small branch, to the southwest of this hole, and approximately 1m away from the trunk (Fig. 3). Each trap was initially baited with synthesised pheromones of *Elater ferrugineus* L. (Coleoptera: Elateridae)

Fig. 1. The ancient Kirtlington oak with rot-hole at its base. © Benedict Pollard.

Fig. 2. *Ganoderma* sporophore at the base of the ancient Kirtlington oak. © Benedict Pollard.

in a 1.5 ml plastic Eppendorf vial supplied by Dr. Deborah Harvey. Following their release, via a pair of approximately 0.5mm holes pierced in each vial, these pheromones were not replenished. After being put in place on 12.5.2022 (trap 1) and 1.6.2022 (trap 2) each trap was inspected at intervals of between two and seventeen days up to, and including, 17.08.2022, and all captured specimens were removed. Ciids were separated, and some provisionally identified, before they were all passed to GMO for checking and determination. In addition, she obtained counts of males and females for three large *C. fagi* samples and examined them for sex bias using chi-squared tests.

On 12.5.2022, immediately before the first trap was put in place, BJP hand collected a sample of leaf litter and dry debris from inside the oak tree rot-hole and examined it for beetles.

A third roofed vane trap – the only other flight interception trap used in the survey – was placed about one metre above the ground on a large fallen oak, *Q. robur*, and approximately 340 metres from traps 1 and 2, on 15.6.2022. Thereafter it was serviced on the same dates as traps 1 and 2 and, like them, was initially baited with *E. ferrugineus* pheromones.

Ciid nomenclature follows Orledge & Booth (2012). This checklist follows Orledge & Booth (2006) and the subsequent changes of Jelínek (2007). The latter are summarised by Orledge (2009).

Results

Data for all Ciidae captured by traps 1 and 2 are given in Table 1; those for *C. fagi* obtained between 18th June and 20th July are described in more detail in Table 2.

Fig. 3. Rot-hole at the base of the ancient Kirtlington oak with vane traps 1 and 2 in position. © Benedict Pollard.

Together, these two vane traps captured 791 adult ciids belonging to four species, *viz* one *Ennearthron cornutum* Mellié, three *C. bilamellatus*, ten *Cis castaneus* Herbst and 777 *C. fagi*.

All but three of the *C. fagi* specimens were intercepted during the 36-day period between 15th June and 20th July, here recognised as an emergence peak. This peak comprises two clearly defined periods (subsequently referred to here as 'pulses') which were separated by at least 17 days when no specimens were captured (Table 1). During the initial 4-day period 15th–18th June (pulse 1) 549 adults were trapped, representing 71% of the beetles intercepted during the peak and a mean daily capture rate of 137.2. During the 15-day period 6th–20th July (pulse 2) 225 adults were trapped – 193 during the first five to six days (pulse 2a) representing a mean daily capture rate of 35.1, and 32 during the latter nine to ten days (pulse 2b) representing a mean daily capture rate of 3.4 (Table 2). The numerically dominant pulse 1 has a very highly significant female bias, and this is responsible for the similarly significant female bias of the emigration peak as a whole. In contrast, pulse 2 has no statistically significant sex bias, although the dwindling data suggest a weak male bias (Table 2).

Single adult specimens of two ciids, *C. fagi* and *C. castaneus*, were found in the hand-collected litter and debris sample. Trap 3 captured just one ciid – a female *Cis micans* (Fabricius) – that was intercepted between 18.6.2022 and 29.6.2022.

Discussion

Flight interception traps and Kirtlington Park ciids

Flight interception traps may not, on their own, generate a comprehensive site list for the Ciidae, but they can contribute useful ciid occurrence data to a more general survey. Indeed, the records detailed above are the first for the Ciidae from

Table 1. Numbers of adult Ciidae captured by vane traps 1 and 2, Kirtlington Park, SP503203 in 2022.

Trap inspection date	Species			
	Cis fagi	*Cis castaneus*	*Cis bilamellatus*	*Ennearthron cornutum*
15.05.2022[1]				
01.06.2022[1]	1[1]			
08.06.2022[1,2]				
13.06.2022[1,2]				
15.06.2022[1,2]				
18.06.2022[1,2]	545[1] 4[2]	2[1]	2[1] 1[2]	1[1]
29.06.2022[1,2]				
06.07.2022[1,2]				
11.07.2022[1,2]	185[1] 8[2]	1[1]		
20.07.2022[1,2]	32[1]	1[1]		
27.07.2022[1,2]				
04.08.2022[1,2]	1[1]	4[1] 1[2]		
17.08.2022[1,2]	1[1]	1[1]		
Species total	777	10	3	1

[1] Vane trap 1
[2] Vane trap 2

Kirtlington Park. The discovery of *C. fagi* is particularly pleasing and provides another instance of this species' association with sites of long ecological continuity.

The Kirtlington Park trap catches also demonstrate the potential for flight interception traps to yield unlooked for, and novel, ecological data. Specifically, the data obtained from traps 1 and 2 have enabled the first description of a *C. fagi* emigration pattern presented here.

Ciid emergence peaks

Although data resolution limits interpretation, it is reasonable to assume that most, if not all, of the trapped *C. fagi* were moving away from, rather than towards, the ancient Kirtlington oak, and that at least the greater majority of the moving ciids were intercepted. Therefore – and given the position of traps 1 and 2 with respect both to the rot-hole and to the *Ganoderma* sporophore on the opposite side of the trunk – these data may best be interpreted as a description of adult emigration from a population exploiting wood-rotting fungal hyphae (perhaps, but not necessarily, of *Ganoderma*) in this tree, and emergence via its basal rot-hole. The following comments on these data ignore the initial baiting of the traps with *E. ferrugineus* pheromones since any response of *C. fagi* to this lure is unknown.

The number of intercepted *C. fagi* adults is substantial, and their generation of such a well-defined summer emigration peak and its constitutive pulses is striking (Tables 1 and 2). The strong, brief first pulse contrasts with the weaker and gradually subsiding second pulse. In addition, the interception of single adults at the end of May and in August is consistent with a low level of emigration spreading away on either side of the peak (Tables 1 and 3). Indeed, supporting evidence for the movement of *C. fagi* between resource patches during spring in southern England

Table 2. *Cis fagi* emigration peak data from Kirtlington Park, SP503203, in 2022: combined data from vane traps 1 and 2.

Dispersal pulse[1]	Time period	Duration (days)[2]	*Cis fagi* adults					
			Number trapped				Sex ratio	Sex bias
			Total	Daily mean	Males	Females	♂ : ♀	
1	15.06.2022 – 18.06.2022	4	549	137.2	117	432	1:3.69	female[3]
2	06.07.2022 – 20.07.2022	15	225	15.0	124	101	1:0.81	ns[5]
2a	06.07.2022 – 11.07.2022	5-6	193	35.1	104	89	1:0.86	ns[5]
2b	11.07.2022 – 20.07.2022	9-10	32	3.4	20	12	1:0.60	ns[5]
Whole emigration peak		36	774	21.5	241	533	1:2.21	female[4]

[1] see text
[2] maximum possible duration
[3] significant female bias ($\chi^2 = 98.40$ $p = 0.000$)
[4] significant female bias ($\chi^2 = 57.11$ $p = 0.000$)
[5] no significant sex bias ($\chi^2 < 1.18$ $p > 0.05$)

comes from its first appearance in a newly dead sporophore of its known breeding host *Fomitopsis betulina* (Bull.) B. K. Cui, M. L. Han & Y. C. Dai (Orledge & Reynolds, 2005) in Oxfordshire sometime during the five-week period up to 22.5.1957 (Paviour-Smith, 1960).

Limited data consistent with a summer increase in the mobility of *C. fagi* in southern England come from the National Trust's Summer House Wood, North Somerset, vc6 (ST5174). In March 2020 two flight interception traps were deployed here – a straight horizontal vane trap placed adjacent to the recently-fallen decaying trunk of a mature ash, *Fraxinus excelsior* L., and a four-bottle vane trap attached close to the base of the red-rotting trunk of a mature oak, *Quercus* L. These traps were inspected every month for the rest of the year. All of the seven trapped *C. fagi* adults (three males and two females from the oak trap, two males from the ash trap) were intercepted between 1.7.2020 and 20.8.2020 (Fleetwood, 2022; Bob Fleetwood, pers. comm.).

Published emergence data comparable with those for *C. fagi* from Kirtlington Park relate to just four other ciids in Northern Europe: *Cis bidentatus* (Olivier), *C. castaneus*, *Cis jacquemartii* Mellié and *Cis lineatocribratus* Mellié (Thunes, 1994; Kula *et al*., 1999). Although sample sizes for each of these species are smaller than those reported here for *C. fagi*, they describe patterns of one or several dispersal peaks rising from a lower level of emergence that extends through spring, summer and autumn (Table 3). Whilst it is possible that the timing of such peaks may vary between years and with geographic location, it is noteworthy that all those documented occur between mid-spring and early autumn. Interestingly, the conclusions of Paviour-Smith (1968) concerning dispersal of *C. bilamellatus* in England also describe extended low-level activity that increases seasonally. Based on colonisation data for *F. betulina* from Oxfordshire, Staffordshire and the East Riding of Yorkshire, she deduced that this ciid disperses continuously (either by walking or

Table 3. Documented emigration activity for the Ciidae in Northern Europe [1].

Species	Spring			Summer			Autumn			Primary source of emigrating adults	Location	Source
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov			
Cis bidentatus		•			●	•	●	•	•	*Fomitopsis betulina* [2]	Western Norway	Thunes 1994
Cis castaneus		•	•	•	●	•	•	•	•	*Fomes fomentarius* [2]	Western Norway	Thunes 1994
Cis fagi			•	•	●	•				Wood-rotting mycelium	Southern England	This study
Cis jacquemartii		●	•	●	•	•	•	•	•	*Fomes fomentarius* [2]	Western Norway	Thunes 1994
Cis jacquemartii			•	•	●	●	●			*Fomitopsis pinicola* [2]	Czech Republic	Kula *et al.* 1999
Cis lineatocribratus		•	●	•	●			•		*Fomes fomentarius* [2]	Western Norway	Thunes 1994

[1] There is no documented activity for the winter months, December–February.
[2] Fruiting body.
● Emigration peak.
• Low level emigration.

flying between resource patches) in small numbers between February and December, with emigration most obvious in spring.

A prerequisite for the generation of an emigration peak with the focus and magnitude of that described above for *C. fagi* at Kirtlington Park must be a discrete source population of sufficient numerical size. Another report of a substantial *C. fagi* population being supported by fungal mycelium comes from a Worcestershire, vc37, record of approximately 700 adults and 1200 larvae feeding on an extensive mycelial sheet of *Armillaria* (Fr.) Staude under the bark of a dead ash, *F. excelsior*, in January 1994 (Whitehead, 1999). Wood-rotting mycelia in large trees can represent substantial and persistent resource patches. For instance, heart-rot fungi frequently form extensive mycelia which can be many years, if not decades, old and which continue to expand by exploiting the new layers of heartwood generated during growth of the host tree (Rayner and Boddy, 1988a, 1988b). Each of these mycelial resource patches may therefore have the potential to support not only the development of a large ciid population, but also its maintenance over a considerable period of time. It follows that emigration peaks may have been, and may continue to be, generated for some years by the Kirtlington *C. fagi* population being considered here.

The other four ciids included in Table 3 share with *C. fagi* not only emigration behaviour comprising low-level activity interrupted by emergence peaks, but also the exploitation of concentrated, substantial and persistent resource patches. The perennial sporophores of *Fomes fomentarius* (L.) Fr. can live for up to 25 years (Thunes, 1994) and those of *Fomitopsis pinicola* (Sw.) P.Karst. can persist for several years (Kula *et al.*, 1999); the annual fruiting bodies of *F. betulina* persist after sporulation and can support ciids for up to three years (Paviour-Smith, 1968).

The sex bias of emerging *Cis fagi*

The Kirtlington Park data for *C. fagi* appear to be the only documented emergence data for the Ciidae which include an examination of sex ratio. They describe a clear and indisputable female bias in the first, and largest, emergence pulse giving way to a lack of significant bias in the second, final, emergence pulse. Possible proximate explanations for this pattern include one or a combination of: *a*) a female-biased source population *b*) a greater propensity of females to emigrate *c*) differential responses of males and females to a factor, or factors, that might initiate or promote emigration (*eg* abiotic environmental variables, resource quality and availability, population density, beetle age size and physiological condition); (see, for example, Fadamiro *et al.*, 1996; Lobinger, 1996; Ranius & Hedin, 2001; Dubois *et al.*, 2010; Miller & Inouye, 2013; Asplen, 2018, 2020).

Given the possibility that female-biased emigration could translate into similarly biased colonisation of a new resource patch, it is noteworthy that Paviour-Smith (1968) found the colonisation of dying *F. betulina* sporophores in Oxfordshire during March-July 1957 by *C. bilamellatus* to be significantly female-biased.

Conclusions

An appreciation of ciid dispersal syndromes requires knowledge of emigration characteristics. The Kirtlington Park flight interception trap data for *C. fagi* make a useful contribution to this requirement but, not surprisingly given our poor understanding of ciid dispersal, raise many more questions than they answer. Of immediate interest must be description and comparison of the patterns of emigration activity of other ciids, including those with more diffuse individual populations than the species discussed here, and investigation of factors initiating emigration. Also,

the female bias of the Kirtlington *C. fagi* emigration peak is intriguing. Whether this phenomenon is typical for *C. fagi*, what is its prevalence among other Ciidae, and how this bias might be explained, are questions that warrant further study.

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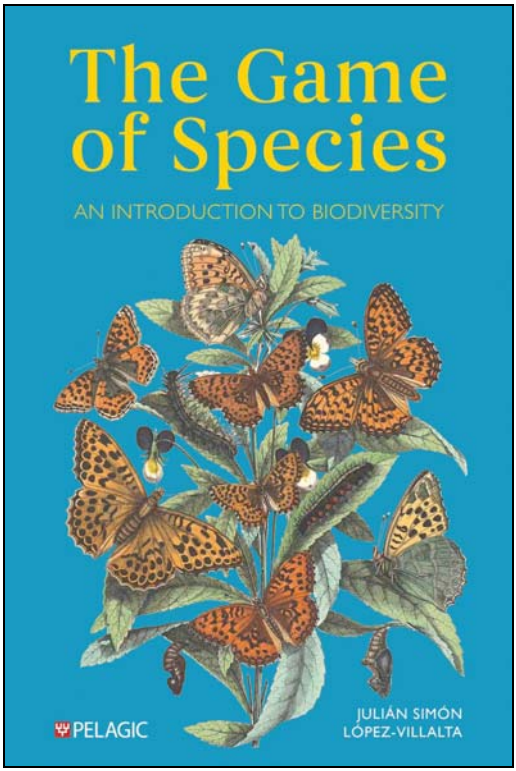
BOOK REVIEW

The Game of Species. An Introduction to Biodiversity. By Julián Simón López-Villalta. 2025. Pelagic Publishing. 102pp. ISBN 978-78427-558-7 Pbk £22.



This is a small book but an excellent one, well worth reading, about the 'game' of species – about the struggle for existence, about evolutionary mechanisms, about diversity within species, between species and within ecosystems. It has an extensive remit, with examples from around the world and from ancient history to the present day. It is written in an easy style available to all, with lovely illustrations and interesting figures. Sometimes a book reviewer might dip into a book, selecting bits here and there, but this is a book you can read in a single sitting. It is well referenced (I would have preferred to see references in the text rather than listed at the end of the book) and has an excellent glossary.

The game idea is based on the idea of competition. After an introductory chapter about the functioning of biodiversity, the author summarises our

knowledge about the origin of species, the constituents of his game – the biological species concept, the morphological species concept, the phylogenetic species concept. The classic stories are here, such as the Peppered Moth and industrial melanism, but there are more obscure stories, including an interesting experiment with colour forms of stick-insects on differently coloured bushes.

We then move onto the role of the pieces of the game including the idea of periodic tables of niches – an idea that I had not come across before – and concepts such as niche specialization and keystone predators. Chapter 4 discusses habitats and Chapter 5 discusses islands, focussing on the balance between immigration and extinction. Chapter 6 is entitled *The Red Queen's Board*, based on the idea that species are forced to evolve constantly (the Red Queen in *Through the Looking Glass* says to Alice 'it takes all the running you can do, to keep in the same place'). There are lots of ideas in this chapter, including biological oddities found on some islands such as carnivorous caterpillars in Hawaii, and the idea of speciation rebound after mass extinctions (perhaps giving hope to Mankind after what we are now doing to the wildlife of the planet). Chapter 7 is entitled *Redux* and summarises what López-Villalta calls the rules of the game in 18 bullet points. (I am not sure that bullet point 11 works, viz. the more species there are the harder it is to add another similar species, either by immigration or by speciation, because competition is stronger).

Chapter 8 *The Future of Life* is different, in that it sets out a stark warning about the loss of biodiversity in the modern world. We are in the midst of a mass extinction. He writes that 'it is fashionable in many governments to endorse sustainability and conservation and we appease our consciences by celebrating Earth Days, Biodiversity Days . . . but meanwhile we as a society continue to destroy nature' and he invites us to do something about the mass extinction we are witnessing, so that the game of species can continue to be played. But he doesn't say what we should do – and that of course is the question.

ADRIAN SPALDING