2010, *Entomologist's Gazette* **61**: 53–64

Hedgerow species richness influences the presence of Orthoptera and Dermaptera along green lanes in Essex, U.K.

TIM GARDINER

2 Beech Road, Rivenhall, Witham, Essex CM8 3PF, U.K.
tg@writtle.ac.uk

Synopsis

A small-scale beating survey of the Orthoptera (bush-crickets) and Dermaptera (earwigs) of green lane hedgerows was undertaken in Essex. Hedgerow dating (Hooper's Rule) was used to ascertain whether insects were related to woody plant species richness. Orthopteroid abundance and species richness was significantly correlated with the number of woody plants in the hedgerows. Byways had particularly species-rich, ancient hedgerows (often over 500 years in age) favourable for bush-crickets such as *Meconema thalassinum*. Sunlit patches of Blackthorn *Prunus spinosa* and Bramble *Rubus fruticosus* hedgerow were especially important for orthopteroids in this survey.

Keywords: earwig, bush-cricket, footpath, bridleway, byway, highways, Hooper's Rule, microclimate.

Introduction

Green lanes (double-hedged tracks) are important for insects, particularly butterflies, in areas of intensive agriculture (Dover & Sparks, 2001). Hedgerows can also be valuable corridors for the dispersal of sedentary insects such as *Lampyris noctiluca* (Linnaeus) (Gardiner, 2008*b*), particularly along green lanes in Epping Forest where the beetle has declined in the last 50 years (Gardiner, 2007c). Hedgerows provide sheltered conditions where reduced wind speed can create a warm microclimate suitable for insects (Dover, Sparks & Greatorex-Davies, 1997; Gardiner & Dover, 2008). Green lanes often have public rights of way (PROW) running down them, the most common are public footpaths (pedestrian use only), bridleways (use by pedestrians, cyclists and horse riders) and byways (open to all traffic: use by pedestrians, cyclists, horse riders, horse drawn and motorised vehicles). Some green lanes are very old (in existence for over 1000 years) and often have unimproved, species-rich grassland and hedgerows of some considerable age (Walker *et al.*, 2006). In Essex, wildflowers such as *Primula veris* L. and *Orchis mascula* (L.) L. can be found along byways (the former species can be frequent) despite their vehicular usage (Plumb, 2004) and the unimproved verges of green lanes in Epping Forest are inhabited by localised orthopterans such as *Omocestus viridulus* (Linnaeus) (Gardiner & Harvey, 2004; Gardiner, 2007*a*). It is estimated that there are 230 km of green lane habitat along byways in the county, on which there is approximately 65 ha of linear scrub and woodland (Gardiner, 2008*c*). It was highlighted from a survey of byway hedgerows in the county, that 64% are species-rich (≥ 5 woody plant species/30 m) and likely to be over 500 years old (Gardiner, 2008c).

Given the extent and quality of the green lane resource in Essex and other lowland counties, there is surprisingly little research on hedgerow insects in these habitats. Hedgerows are especially important in areas where removal has been particularly severe e.g. in Essex approximately 44,000 field boundaries have been removed since 1880 and the loss is scattered throughout the county (data from Essex County Council's Historic Environment Branch). It is the aim of this paper to discuss the results of a small-scale study of the orthopteroid assemblages (Orthoptera and Dermaptera) of hedgerows along green lanes in Essex. The results are discussed in relation to hedgerow species richness (of woody plants) and the type of green lane studied (e.g. footpath, bridleway or byway).

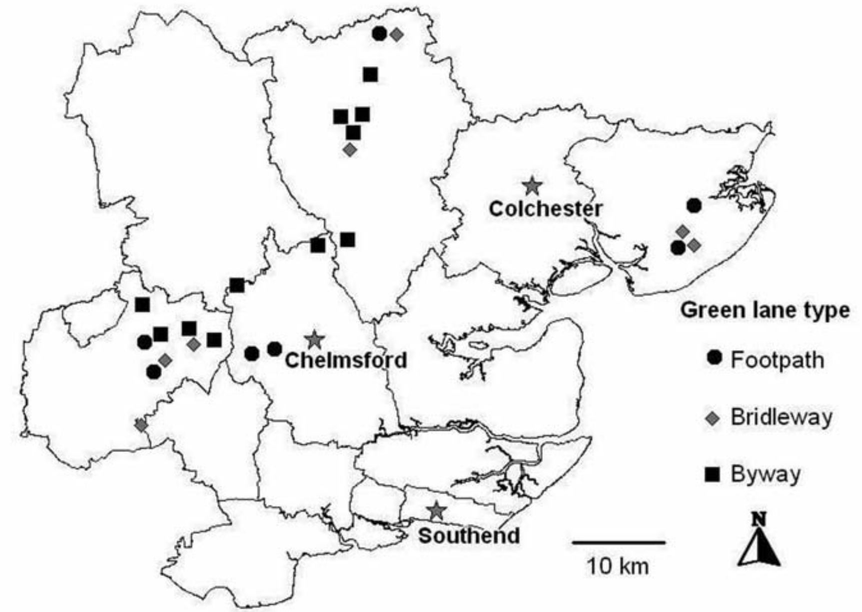

Fig. 1. Location of each green lane in Essex.

Methods

The orthopteroid assemblages of hedgerows along 25 green lanes were studied in 2008. All the lanes had PROW running down them, seven were public footpaths, seven were bridleways, and the remaining eleven were by-ways. The location of the 25 lanes is shown in Fig. 1. The lanes were distributed in clusters throughout Essex, as was necessary to provide a representative sample of hedgerows that were not too distant from other lanes. Lane length was taken from Ordnance Survey (OS) maps and a note was made of whether the lanes were open (< 50% of lane length with unenclosed canopy) or enclosed (shady, little light: > 50% of lane length with enclosed canopy). The orientation (e.g. running generally north-south or east-west) of beaten sections was noted from OS maps.

Orthopteroid sampling

Hedgerow beating was used to locate orthopteroid insects. Bush-crickets (Orthoptera: Tettigoniidae) and earwigs (Dermaptera: Forficulidae) were the target insects. To standardise sampling effort, a total of 30 min was spent beating hedgerows at each green lane. Beating was conducted randomly along each green lane (on both hedgerows), and approximately 40 locations were sampled (as the 30 min period allowed). At each beating location, hedgerow branches were struck five times at varying heights with a 1-metre pole. A plastic bowl (area 30 × 30 cm: sides 20 cm high) was used to collect orthopteroid insects dislodged from the branches.

Beating was conducted between 20 May and 4 July 2008 to ensure that orthopteroids of the same developmental stage were sampled along all of the green lanes. Bush-crickets such as *Leptophyes punctatissima* (Bosc) and *Meconema thalassinum* (De Geer) are easier to locate at this time because they are in their nymphal stages and are lower down in the foliage (Marshall & Haes, 1988). Earwigs were either nymphs or adults. It was possible to be certain of bush-cricket nymph identification, as both *L. punctatissima* and *M. thalassinum* are distinctive. *Meconema thalassinum* nymphs could be confused with those of *Meconema meridionale* (Costa), but as the latter species was only recorded in Essex for the first time in 2008, the chances are that it is not widespread yet (indeed there are only two records from the south of the county). Adult earwigs were found at each site to verify the identification of nymphs collected. Illustrations in Marshall & Haes (1988) were also used to identify *Forficula auricularia* Linnaeus.

A record was kept of which tree and shrub species (including *Rubus fruticosus* aggr.) were beaten along each lane, and which beaten individuals came from each woody species. All beating was conducted in similar weather conditions (> 17°C).

Hedgerow species richness surveys

Hedgerow dating methodology was used to sample the woody plant species richness of each green lane (Pollard, Hooper & Moore, 1974). Three 30-yard (27 m) sections of hedgerow were randomly selected along each green lane and all the woody plant species in each length were recorded (excluding species such as *R. fruticosus* and *Hedera helix* L.). The mean of the three lengths was taken as the hedgerow species richness of each green lane hedge. The species richness of each hedgerow can be related to its age using Hooper's Rule (1 woody species = 100 years; Pollard, Hooper & Moore, 1974).

Statistical analysis

All data were square-root transformed to correct for non-normality before statistical analysis (Gardiner, Hill & Chesmore, 2005). To compare overall orthopteroid abundance and species richness for green lanes with enclosed and open canopies, and between lanes with differing orientation, a t-test was used (Heath, 1995). To determine if there was a significant difference between green lane length for footpaths, bridleways and byways, a one-way ANOVA was used. Hedgerow species richness (woody plant species richness/27 m) between lane types was tested using ANOVA, as were the abundances of individual orthopteroid species and overall abundance and species richness.

To ascertain whether there has been significant tree encroachment onto green lanes in Essex, the current passable width (without tree growth and accessible by public) and historical width (from boundary to boundary as determined by measuring from maps) were compared using a paired samples t-test for nine byways where data on both widths (in m) were known. To tease out the importance of lane length and hedgerow species richness in determining the abundance of orthopteroids, each species and overall abundance/species richness were correlated with these two factors using Spearman's Rank Correlation (Heath, 1995). A final Spearman's correlation was undertaken to ascertain whether lane length and hedgerow species richness formed an important relationship. All statistics were produced using SPSS Version 16.0 (SPSS, 2007).

Results

A total of 481 orthopteroid individuals were recorded during the survey (Table 1). *Forficula auricularia* was the most commonly beaten orthopteroid, comprising over 50% of the beaten individuals and being found from 22 of the 25 lanes. The bush-crickets *L. punctatissima* and *M. thalassinum* were much less frequent, although the former species was beaten from a higher number of lanes (17 vs 11 respectively; Table 1). Only five individuals of *Forficula lesnei* (Finot) were collected from two lanes.

Table 1. Total count and the number of lanes recorded for each orthopteroid species.

Orthopteroid species	Total count	No. lanes N = 25
Forficula auricularia	261	22
Leptophyes punctatissima	113	17
Meconema thalassinum	90	11
Pholidoptera griseoaptera	12	6
Forficula lesnei	5	2

Before assessing the effect of hedgerow species richness on orthopteroid occurrence, it was first necessary to test the influence of other factors such as lane length, canopy cover (open/enclosed) and orientation (e.g. lane runs north-south or east-west). There was no significant difference between the orthopteriod species richness (t = -1.18) and overall abundance (all species combined; t = -0.71) for lanes that had open (mean richness: 2.5 ± 0.3, mean abundance: 20.1 ± 3.9) or enclosed (mean richness: 2.1 ± 0.3, mean abundance: 18.1 ± 6.2) canopies. There was also no significant difference detected between the orthopteroid species richness (t = -1.02) and overall abundance (t = -0.77) for lanes that ran north-south (mean richness: 2.5 ± 0.2, mean abundance: 21.4 ± 5.0) or east-west (mean richness: 2.2 ± 0.2, mean abundance: 16.9 ± 5.2).

However, lane length differed significantly between lane type (F = 3.6, d.f. 2, P<0.05). Byways (mean lane length: 1028 ± 266 m) were much longer than bridleways (mean lane length: 469 ± 82 m) and footpaths (mean lane length: 440 ± 268 m). This indicates that the length of hedgerow available to orthopteroids differed significantly between lane types. However, hedgerow species richness (as defined by woody plant species richness from hedgerow dating) also differed significantly between lane type (Table 2). Byways and bridleways had much higher hedgerow species richness (≥ 5 woody plant species/27 m length) than footpaths (3.6 species/27 m). The species rich hedgerows of byways and bridleways had higher orthopteroid species richness and abundance (Table 2), indicating that lane type may have accounted for the variation in insect numbers and richness from the beating survey.

Table 2. Woody plant species richness in relation to orthopteroid species richness and overall abundance (all species combined) for green lanes with footpaths, bridleways and byways (all mean data/lane ± SE).

Characteristic	**Footpath N = 7**	**Lane type Bridleway N = 7**	**Byway N = 11**	***F***
Woody plant species richness	3.6 ± 0.3	5.0 ± 0.5	5.8 ± 0.3	8.7**
Orthopteroid species richness	1.6 ± 0.4	2.6 ± 0.4	2.6 ± 0.2	3.9*
Orthopteroid abundance	7.4 ± 3.6	17.7 ± 4.4	27.7 ± 5.9	5.3**

ANOVA:
*significant at P<0.05, **significant at P<0.01

Of the five orthopteroid species recorded, only *M. thalassinum* abundance was significantly different between lane types (Table 3). The species-rich hedgerows (in terms of woody plants) along byways and bridleways had substantially higher numbers of this arboreal species. However, despite there being no significant lane effect, numbers of *F. auricularia* and *Pholidoptera griseoaptera* (De Geer) were higher along bridleways and byways than footpaths (Table 3). The current passable width (without tree growth and accessible by public) of nine of the surveyed byways is 40% of the historical width (width from boundary to boundary) and there was a significant difference between the two widths (t = 8.69, P<0.01, d.f. 8, mean current width = 2.3 ± 0.2 m, historical width = 5.8 ± 0.9 m).

Table 3. Abundance of each orthopteroid species along different lane types (all mean data/lane ± SE).

Orthopteroid species	Footpath N = 7	Lane type Bridleway N = 7	Byway N = 11	*F*
Forficula auricularia	3.4 ± 1.7	10.1 ± 5.0	15.1 ± 4.5	2.0 NS
Leptophyes punctatissima	3.3 ± 2.0	2.4 ± 0.8	6.6 ± 3.2	0.6 NS
Meconema thalassinum	0.0 ± 0.0	4.4 ± 1.9	5.4 ± 2.4	3.6*
Pholidoptera griseoaptera	0.1 ± 0.1	0.6 ± 0.6	0.6 ± 0.3	0.6 NS
Forficula lesnei	0.6 ± 0.6	0.1 ± 0.1	0.0 ± 0.0	0.9 NS

ANOVA:
NS = not significant, *significant at P<0.05

Table 4. Spearman's Rank Correlations (r_s values displayed) between lane length and hedgerow species richness (woody plant species/27 m length) for different orthopteroid species.

Orthopteroid species	Lane length	Hedgerow species richness
Forficula auricularia	0.10 NS	0.65**
Forficula lesnei	–0.07 NS	–0.33 NS
Leptophyes punctatissima	0.11 NS	0.42*
Meconema thalassinum	–0.02 NS	0.43*
Pholidoptera griseoaptera	0.39*	0.34 NS
Overall species richness	0.17 NS	0.65**
Overall abundance	0.11 NS	0.82**

Spearman's Rank Correlation:
*significant at P<0.05, **significant at P<0.01, NS = not significant

To try to confirm the importance of lane length and hedgerow species richness for orthopteroids in this study, Spearman's Rank Correlations were undertaken (Table 4). The analyses show significant positive correlations between *F. auricularia*, *L. punctatissima* and *M. thalassinum* abundance and hedgerow species richness. The lesser importance of lane length in determining orthopteroid occurrence is highlighted by the fact that only *P. griseoaptera* abundance was significantly correlated with it (Table 4). There was no significant relationship between hedgerow species richness and lane length (r_s = 0.23), indicating that longer green lanes did not have higher diversity of shrubs and trees.

There seemed to be clear preferences for certain woody species in this survey (Table 5). Of all the woody species beaten, the highest abundance of orthopteroids was from *Prunus spinosa* L. and *R. fruticosus*, from which all five orthopteroid species were collected. These woody species were also frequently beaten owing to their abundance along the green lanes (Table 5). All five orthopteroids were also beaten from *Rosa canina* L. (again a frequently beaten species owing to its abundance along the green lanes in this study).

Table 5. Mean number of orthopteroid insects for woody species beaten in more than five lanes (overall numbers).

Woody species	No. dating sections N = 75	No. lanes beaten N = 25	Mean no. insects/lane	Orthopteroid species
Prunus spinosa	61	25	5.8 (145)	Fa, Fl, Lp, Mt, Pg
Rubus fruticosus	–	25	4.7 (118)	Fa, Fl, Lp, Mt, Pg
Acer campestre	39	19	2.2 (42)	Fa, Mt, Lp
Euonymus europaeus	9	8	2.0 (16)	Fa, Lp, Pg
Rosa canina	34	18	1.9 (34)	Fa, Fl, Lp, Mt, Pg
Crataegus monogyna	60	25	1.8 (44)	Fa, Lp, Mt, Pg
Quercus robur	30	22	1.4 (30)	Fa, Lp, Mt
Sambucus nigra	32	15	1.2 (18)	Fa, Lp, Mt
Corylus avellana	16	6	0.8 (5)	Fa, Lp
Cornus sanguinea	8	8	0.5 (4)	Fa
Ulmus spp.	23	12	0.4 (5)	Fa, Lp
Fraxinus excelsior	26	12	0.4 (5)	Fa
Malus sylvestris	9	8	0.3 (2)	Fa
Carpinus betulus	12	6	0.0 (0)	None

Fa = *Forficula auricularia*; Fl = *Forficula lesnei*; Lp = *Leptophyes punctatissima*.
Mt = *Meconema thalassinum*; Pg = *Pholidoptera griseoaptera*

Orthopteroids were much less frequently beaten from woody plants such as *Corylus avellana* L., *Cornus sanguinea* L., *Malus sylvestris* Mill. and *Carpinus betulus* L., which were themselves less common along the green lanes in this study (Table 5). Overall, eight woody species had no orthopteroids beaten from them, including *Viburnum lantana* L., *Ilex aquifolium* L., *Tilia platyphyllos* Scop. and *Populus tremula* L. Of the woody species from which no orthopteroids were collected, only *C. betulus* was beaten on more than one occasion, indicating the rarity of these plants in the hedgerows sampled.

In total, *F. auricularia* was beaten from the most woody plant species (16), whilst *L. punctatissima* (11), *M. thalassinum* (7), *P. griseoaptera* (5) and *F. lesnei* (3) were more restricted in their choice of species.

Discussion

The results of this small-scale study seem to indicate the importance of hedgerows with a high diversity of woody plant species for orthopteroid insects. Nationally (Notable b) and locally (Essex Red Data List species; Gardiner & Harvey, 2004) scarce species such as *F. lesnei* can be beaten from green lane hedgerows, although much less commonly than *F. auricularia* in Essex (Table 1). Although lane length (and therefore quantity of hedgerow habitat) may be a factor for species such as *P. griseoaptera*, the most important indicator of orthopteroid occurrence in this study was the number of woody plant species per 27 m length. Dating revealed hedgerows along bridleways and byways to have ≥ 5 woody plant species/length, which generally indicates that these hedges are approximately 500 years old using Hooper's Rule

(Pollard, Hooper & Moore, 1974). The higher abundance and species richness of orthopteroids in these old hedgerows (e.g. Perryfield Lane in Fyfield had 10 woody species in a 27 m length) is probably related to the historical usage of the lanes. Many byways and bridleways are remnants of the highways system of the past (Rackham, 1986), being particularly important cart tracks that linked one village to another. These ancient highways would have been hedged on both sides and the continuity of their existence may have allowed bush-crickets and earwigs to build up large populations.

The older hedgerows of byways and bridleways are also likely to be important for orthopteroids owing to their diversity of tree and shrub species that provide a greater choice of food. Generally, a hedgerow with a large number of tree and shrub species will have a high number of insect species inhabiting it (Pollard, Hooper & Moore, 1974). Earwigs and *L. punctatissima* are omnivorous (Marshall & Haes, 1988) and would benefit from a greater choice of woody plants and insects to feed on in diverse hedgerows. *Meconema thalassinum* is mainly carnivorous (Brown, 1983) and would also benefit from the high numbers of insect prey, particularly aphids, in species-rich hedgerows.

Of all the orthopteroids beaten, *M. thalassinum* would seem to be the most restricted to older hedgerows (Tables 3, 4) – it was often hard to find this arboreal bush-cricket along more recent hedges (it was absent from footpath green lanes). That is not to say that it cannot colonise new hedgerows. A good example of this comes from Tomboy's Lane in Wethersfield, an old green lane (5 species/27 m length) with a byway running down it. Hedgerows along one section of the lane were removed in the 1950s to make a larger field and were replanted in the 1980s with a low diversity stand of *Crataegus monogyna* Jacq. and *T. platyphyllos* (*Sambucus nigra* L. has since colonised). Interestingly, the only *M. thalassinum* individuals beaten along this green lane were from the recently replanted, two-species hedgerow and not from the older, remnant hedges that were not grubbed out. This goes to show that even a species largely restricted to ancient hedgerows in intensively farmed countryside, such as *M. thalassinum*, can colonise new hedges as long as they are connected to older ones.

Marshall & Haes (1988) note that *M. thalassinum* is a good indicator of ancient woodland – the present research on green lanes suggests that it may also be a reliable determinant of old, species-rich hedgerows in Essex where it is beaten in any number. Fortunately many of these ancient hedgerows are given protection from the Hedgerow Regulations (1997), and are unlikely to be grubbed out. They are certainly an important feature of byways and are much less likely to be damaged by motorised vehicular usage than herb-rich grassland, which is particularly vulnerable to damage from four-track vehicles (Gardiner, 2008c). It was not difficult to find *M. thalassinum* along hedgerows that are the 'ghosts' of ancient woodland and contain *Sorbus torminalis* (L.) Crantz (Rackham, 1986), such as along Peppers Green Lane (Essex Way) at Abbess Roding. This lane, which forms a near continuous section of byway with hedgerows (with at least 1 km of 'ghost' hedge) for 3.5 km, must be one of the most biologically important green lane networks in Essex (Plumb, 2004).

Hedgerows provide shelter for Orthoptera in intensive arable farmland (Gardiner & Dover, 2008) and may be especially important in Essex, where field sizes can be large (owing to historic hedgerow removal) and nitrogen fertiliser usage is high (Gardiner, Hill & Marshall, 2008). However, the effect of canopy structure or lane orientation on orthopteroid occurrence in hedgerows is not confirmed by this study. The author would have expected those lanes with open canopies (> 50% of lane open and sunny) to be more favourable for orthopteroid insects than those with enclosed tree canopies that are very dark and shady, but this was not the case. Having said this, it was noticeable that bush-crickets, particularly *L. punctatissima* and *M. thalassinum*, were localised along many green lanes and were often beaten in high numbers from trees in 'sun traps' e.g. sections of hedgerow not in the shade of an enclosed canopy. Local microclimate in these 'sun traps' may lead to aggregations of orthopteroids in favourable sections and an absence from enclosed, shaded hedgerows. Lane orientation did not affect orthopteroids, with those hedgerows running north-south having similar species richness and abundance to those which ran east-west. Orientation of hedgerows has been found to be important for Orthoptera of field margins (Gardiner, 2007*b*; Gardiner & Dover, 2008).

A surprising feature of this study is the preference of orthopteroids for *P. spinosa* and *R. fruticosus* over other traditionally favourable tree species such as *Quercus robur* L. and *Acer campestre* L. (Table 5). Indeed, the percentage of the total number of insects beaten from *P. spinosa* and *R. fruticosus* combined, for *L. punctatissima*, *M. thalassinum* and *F. auricularia*, was 74%, 66%, and 42% respectively. The reason for the preference for these two species is partly due to their high abundance along the green lanes, which led to them being regularly sampled due to the random selection of beating location (Table 5). Less common woody species such as *C. avellana* and *C. sanguinea*, were sparsely populated by orthopteroids. However, the abundance of the woody species is not, in the author's opinion, the only reason for their favourability for orthopteroids. *Prunus spinosa* and *R. fruticosus* often formed dense sections of continuous hedgerow cover in full sunlight, which were particularly favourable for *M. thalassinum* and *L. punctatissima*. The former bush-cricket was not often found on *Q. robur* (eight out of 90 individuals beaten from this species), a tree it has often been beaten from in the county (Wake, 1997). *Leptophyes punctatissima* has been found to find young *R. fruticosus* favourable for feeding (Patricia Ash, pers. comm.), suggesting a reason for its abundance on this plant in this study.

To promote high orthopteroid abundance, the author would suggest retention of sections of *P. spinosa* hedgerow with a dense *R. fruticosus* base. Infrequent hedgerow cutting through a rotational system of mechanical trimming will encourage this kind of dense growth, and hedge management should aim for the classic 'A' shaped hedge (Rackham, 1986; Pollard, Hooper & Moore, 1974). Hedge-laying may also produce the bushy basal growth necessary for orthopteroids (Pollard, Hooper & Moore, 1974).

It is highly likely that many green lanes are favourable for the orthopteroids studied owing to the encroachment of scrub and woodland onto the grassy verges leading to a narrowing of the open, passable width for PROW users. For example, the current, passable width of byways in Essex is now only 40% of the historical width (from boundary to boundary) owing to scrub encroachment and succession to woodland, making them particularly favourable for bush-crickets such as *L. punctatissima* and *M. thalassinum*, which have a preference for woody habitats (Brown, 1983). It is acknowledged that the needs of earwigs and bush-crickets of scrubby habitats must be balanced with those of open unimproved grassland such as *O. viridulus* (a locally rare grasshopper found on green lanes in Essex; Gardiner & Harvey 2004; Gardiner, 2007*a*). Therefore some scrub removal will be necessary where there is botanical or insect richness on the grassland verges of byways. Management should aim for graduated vegetation of all stages of succession on a byway providing a valuable ecotone for Orthoptera; for example, the grass track (with patches of bare earth suitable for *Chorthippus brunneus* (Thunberg) and *Tetrix subulata* (Linnaeus) (Gardiner, 2007*b*)) should be bordered by scrub at the base of the hedgerows as at Epping Long Green in the west of the county (Gardiner, 2008*a*).

This study also adds to the list of woody species that the nationally scarce *F. lesnei* has been beaten from. This localised, but under-recorded earwig, was beaten from *P. spinosa*, *R. fruticosus* and *R. canina*. It has also been beaten from *A. campestre* and *Q. robur* in Essex (Harvey, 2005) and *C. monogyna* in Bedfordshire (Sutton, 2008), so is quite catholic in which woody species it can be found on.

It must be borne in mind that this was a small-scale study of only 12 hour's beating, but it does provide a standardised method for locating hedgerow orthopteroids that can reveal differences in habitat preference. It is important to note that the method is underpinned by the assumption that, if earwigs and orthopterans are not quickly revealed (e.g. in 30 min), then they must be in low density or absent from the hedgerow (Wake, 1997). Indeed, in areas where bush-crickets are scarce it is not uncommon to spend 30 min beating to find species such as *L. punctatissima* (Richmond, 2001). It is important that beating is conducted under similar, dry weather conditions (the author would suggest a threshold temperature of > 17°C similar to that for transect walks (Gardiner, Gardiner & Hill, 2005)). Beating is also best undertaken when species such as *L. punctatissima* and *M. thalassinum* are in their nymphal stages (May and June) on low shrubs; otherwise it may be difficult to detect them in any number. It is acknowledged that as these bush-crickets mature they will move higher up in the canopy and their habitat preferences may change. In a study by Patricia Ash and David Robinson at Wittenham Clumps in Oxfordshire, adult males of *L. punctatissima* have been recorded singing from 3.4–9.6 m above ground level, which makes them totally unsuitable for beating surveys (Patricia Ash, pers. comm.). The occurrence of the newly arrived *M. meridionale* (first Essex record in 2008) may also make it hard to differentiate between nymphs of this species and *M. thalassinum.*

Identification of earwig nymphs early in the year should also be done with caution and it is suggested that adults are found to verify the species. On most occasions, only *F. auricularia* will be present, but samplers should also be watchful for scarce earwigs such as *F. lesnei* and *Apterygida media* (Hagenbach). It is important to have adult individuals to identify these scarce species.

Acknowledgements

The author thanks Michelle Gardiner for assistance with the fieldwork and Writtle College for allowing the use of their computer resources for the write up. I am grateful for helpful discussions with Patricia Ash and David Robinson of the Open University on the habitat preferences of *L. punctatissima*.

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