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The utilization of two-metre Countryside Stewardship Scheme grass margins by the gatekeeper *Pyronia tithonus* (L)

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Abstract

The utilization of 2-m Countryside Stewardship Scheme (CSS) grass margins by *Pyronia tithonus* was investigated during the period 1997–2000 at three farms in Essex, UK. The aims of the research were to investigate whether 2-m grass margins established using the CSS would provide suitable habitat for *P. tithonus*. Overall, there was no significant difference between *P. tithonus* abundance on the 2-m grass margins and the control sections without margins, but significantly more *P. tithonus* were observed on the 2-m grass margins in 2000 than in 1997. There was a strong relationship between *P. tithonus* abundance and the presence of hedgerows, and significantly more *P. tithonus* were recorded on 2-m grass margins next to hedgerows than on 2-m grass margins established in areas without adjacent hedgerows. It was suggested that *P. tithonus* would benefit most from habitats with 2-m grass margins sown with a seed mixture containing a range of fine-leaved grasses and wildflowers, next to a hedgerow, and managed in accordance with current practices.

Keywords: Countryside Stewardship Scheme, gatekeeper butterfly, *Pyronia tithonus*, two-metre grass margins

Introduction

Due to food surpluses in the European Union over the last decade and an increased awareness of environmental issues, options have been investigated for the use of underutilized farmland. One option is to remove the land from agricultural practices and start to restore semi-natural habitats on farmland. This conservation management can include either temporarily or permanently fallowed land, in the form of margins (MAFF 1997) or whole fields (MAFF 1998).

Grass margins can be created under the Countryside Stewardship Scheme (CSS) which started in 1991 as a 3-year trial and was seen as a success (Rebane and Tucker 1997). Other schemes, such as the Hedgerow Incentive Scheme, were merged into it. Farmers were encouraged to create 2-m grass margins around arable fields. These were to be sown with a

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dense tussocky sward seed mixture containing species such as *Phleum pratense* (Timothy), *Dactylis glomerata* (cocksfoot) and *Holcus lanatus* (Yorkshire fog). The margins were to be cut three times in the first year but then only one year in three after that to stop encroachment of scrub (MAFF 1997). Farmers were initially paid £15 per 100 m per year for these 2-m grass margins but that was reduced in 2000 to £8 per 100 m per year.

Grass margins can be valuable habitats for butterflies. Dover (1994) found 31 butterfly species using arable field margins and they were considered to be an important indicator of farmland biodiversity (Dover 1999). However, butterfly abundance was observed to be significantly higher on treatments sown with a grass and wildflower mixture (Buys 1995; Buys et al. 1996; Feber et al. 1996). Kirkham et al. (1999) suggested that butterfly species richness correlated with the number of plant species sown. Several authors (Watt et al. 1974; Murphy et al. 1983; Dover 1994; Feber et al. 1996) have found a lack of nectar sources to be critical to butterfly survival, which led Dover (1999) to suggest that it may be the limiting factor for butterflies in today's arable landscape. In a study of field margins, Smith et al. (1993) observed that the main nectar sources visited by *Pyronia tithonus* (L) were *Cirsium* spp. and *Carduus* spp. (thistles), with *Rubus* spp. (brambles), *Knautia arvensis* (field scabious), *Centaurea* spp. (knapweeds), *Leucanthemum vulgare* (ox-eye daisy) and *Pulicaria dysenterica* (common fleabane) also being used.

P. tithonus is often found in tall grassland near hedgerows, trees and scrub (Asher et al. 2001) and thus should benefit CSS 2-m grass margins next to hedgerows. A range of grasses such as *Agrostis* spp. (bents), *Festuca* spp. (fescues), *Poa* spp. (meadow grasses), and *Elytrigia repens* (common couch) are used as larval food plants (Asher et al. 2001).

This study investigates the utilization of 2-m grass margins by *Pyronia tithonus*, as set up and managed under CSS, at three farms in Essex during the period 1997–2000.

Method

This study was undertaken at three farms in Essex which joined the CSS in 1996. Monitoring work was undertaken at Writtle (NGR: TL 670070), Highwood (NGR: TL 630036) and Greenstead Green (NGR: TL810288) during the period 1997–2000. The main attributes of the established margins are summarized in Table I, while the composition of the mixtures sown is given in Table II. *P. tithonus* abundance was monitored between July and August each year using the transect method (Pollard 1977). Monitoring was undertaken once a week, when weather conditions were suitable (Pollard and Yates 1993), on 13 2-m grass margins and at least three control sections (field edges without grass margins). The total observations were summed and a figure was calculated for *P. tithonus* per km per visit.

The analysis of the data was completed using Mann-Whitney for comparing two unmatched samples, Friedman's test for multiple comparisons and Spearman's rank correlation coefficient when investigating correlation between variables.

Results

Overall, a greater number of *P. tithonus* were observed on 2-m grass margins than on the control sections except for at Writtle in 1998 (Table III). At Highwood, there were significantly more *P. tithonus* seen on the 2-m grass margins ($U=2$, $P<0.05$) than on the control sections between 1998 and 2000 (Table III). At all sites there was a significant

Table I. Attributes of the margins at the three farms.

	Width of margin (m)	Section length (m)	Aspect	Hedgerow length (m)	Sown with mixture (see Table II)
Writtle					
W2.1	2	274	NE/SW	150	3
W2.2	2	274	NW/SE	274	3
W2.3	2	270	NW/SE	270	3
WN2.4	No margin	133	NE/SW	100	
Greenstead Green					
G2.1	2	450	E/W	390	1
G2.2	2	141	E/W	141	2
G2.3	2	250	E/W	150	1
G2.4	2	320	NE/SW	320	1
G2.5	2	285	NE/SW	0	2
GN2.6	No margin	180	E/W	160	
Highwood					
H2.1	2	200	N/S	200	2
H2.2	2	762	E/W-N/S	450	2
H2.3	2	467	N/S-E/W	467	2
H2.4	2	500	NE/SW	400	2
H2.5	2	285	ENE/WSW	0	2
HN2.6	No margin	343	ENE/WSW	300	

Table II. Seed mixtures used on the 2-m margins at the three farms.

	Writtle	Greenstead Green	Highwood	
Date established	October 1997	October 1996	October 1997	October 1997- October 2000
Length in research transect	818 m	1020 m	426 m	2214 m
Seed mixture	Mixture 3	Mixture 1	Mixture 2	Mixture 2
<i>Agrostis tenuis</i>		5%		
<i>Cynosurus cristatus</i>	15%	7.5%		
<i>Dactylis glomerata</i>	50%		50%	50%
<i>Festuca pratensis</i>	10%		25%	25%
<i>Festuca arundinacea</i>			10%	10%
<i>Festuca ovina</i>	20%	25%		
<i>Festuca rubra</i> subsp. <i>commutata</i>		30%		
<i>Festuca rubra</i>		25%		
<i>Poa pratensis</i>		7.5%	15%	15%
<i>Trisetum flavescens</i>	5%			

overall increase in abundance of *P. tithonus* seen on the 2-m grass margins ($U=8, P<0.05$) between 1997 and 2000 (Table IV). At Greenstead Green, there was a strong relationship between the abundance of *P. tithonus* and length of hedgerow ($r_s=0.819, P<0.01, n=20$), area of margin ($r_s=0.568, P<0.05, n=20$), and abundance of larval food plants ($r_s=0.577, P<0.05, n=13$).

There were significantly more ($U=2.5, P<0.01$) *P. tithonus* observed on 2-m grass margins with hedgerows (11.9 km per visit) than without hedgerows (0.2 km per visit) and significantly more *P. tithonus* recorded on the control sections than on the 2-m grass margins without hedgerows ($U=5, P<0.05$). *P. tithonus* abundance was not significantly ($M=1.55, P>0.05, k=3, n=3$) affected by different types of grass mixture originally sown,

Table III. Abundance of *Pyronia tithonus* (mean number per km per visit) on the 2-m margins at three farms.

	Number of 2-m margins	Margin mean	Range	Control
Writtle	3			
July 1998		4.9	2.2–10.2	36.1
July 1999		17.2	0–32.1	6.3
July 2000		13.7	11.9–17.3	9.4
Mean		11.9		17.3
Greenzstead Green	5			
July 1997		2.3	0–5.5	1.6
July 1998		3.1	0.8–7.5	0
July 1999		10.7	0–28.1	1.9
July 2000		11.1	0–22.2	4.2
Mean		6.8		1.9
Highwood	5			
July 1998		2.5	0.9–4.2	1.2
July 1999		9.6	4.7–14.2	1
July 2000		15.1	2.5–26.8	0
Mean		9.1 a		0.7 b

Means followed by different letters are significantly different at $P < 0.001$, Mann-Whitney U test.

Table IV. Abundance of *Pyronia tithonus* (mean number per km per visit) on the 2-m margins by year.

	Mean abundance	Range
July 1997	2.2 a	0–5.5
July 1998	3.5	0.8–10.2
July 1999	11.6	0–32.1
July 2000	12.9 b	0–26.8

Means followed by different letters are significantly different at $P < 0.05$, Mann-Whitney U test.

but abundance was lowest in each of the years 1998–2000 on mixture 2 (Table V), which was the least diverse mixture.

Discussion

The habitat requirements of *P. tithonus* (Asher et al. 2001) would suggest that 2-m grass margins alongside hedgerows should be ideal. The benefits of having hedgerows, area of the grass margins and an abundance of larval food plants are all suggested by this research, but only at Highwood were significantly more *P. tithonus* seen on the grass margins. At this site, the arable fields were cultivated almost to the hedge bottoms prior to the grass margins being established, so *P. tithonus* abundance was very low. At the other sites the 2-m grass margins were usually established next to hedgerows with a strip of habitat already suitable for *P. tithonus*, thus reducing its beneficial effects.

Table V. Abundance of *Pyronia tithonus* (mean number per km per visit) by seed mixture sown.

	Mixture 1	Mixture 2	Mixture 3
July 1998	3.9	2.1	4.9
July 1999	15.4	5.6	17.2
July 2000	16.8	6.8	13.7

There was a significant increase in *P. tithonus* abundance over the study period. This could have been due in part to the grass margins not being cut over the 3-year period (1998–2000) (MAFF 1997) thus providing the tall grassy strips favoured by *P. tithonus* (Asher et al. 2001). It is unclear what effect cutting grass margins would have on *P. tithonus* abundance.

The management and habitat type seems to favour *P. tithonus*, so why was it not more abundant? We suggest three possibilities. Firstly, there was a lack of nectar sources. Smith et al. (1993) recorded the species taking nectar from flowers such as *K. arvensis*, *Centaurea* spp., *L. vulgare*, and *Pulicaria dysenterica*. None of these was present on any of the grass margins in our study. Other nectar sources identified by Smith et al. (1993) include *Cirsium* spp., *Carduus* spp., and *Rubus* spp. These were occasionally available in most hedgerows on the study sites, so the control sections were nearly as abundant with *P. tithonus* as the sections with 2-m grass margins. On the section without a hedgerow the abundance of *P. tithonus* was found to be significantly higher on the control sections than on the grass margin, due to the presence of *Cirsium* spp., *Carduus* spp., and *Rubus* spp. in the hedgerows of the control sections.

Secondly, there was also a lack of larval food plants. All the grass margins at Writtle, Highwood and several at Greenstead Green were sown with a range of grass species which became dominated by *D. glomerata*. There were other suitable grass species present in the margins (*Festuca* spp. and *Poa* spp.) but they were agricultural cultivars. Whether they were suitable as larval food plants for *P. tithonus* is not known, as even though abundance increased significantly during the study period, there were still not significantly more *P. tithonus* seen on the 2-m grass margins than on the control sections.

Thirdly, the area of the 2-m grass margins may well be too small. *P. tithonus* is said to require 1–2 ha of suitable habitat to form a colony (Thomas 1984). None of the grass margins approached that size and, together with the lack of nectar sources and larval food plants, could explain the poor utilization of an apparently suitable habitat.

So in conclusion, the diversity of the original seed mixture, availability of larval and nectar sources, position, and the area of the margin are all important factors when establishing field margins which are likely to be beneficial for *P. tithonus*. For 2-m grass margins to promote *P. tithonus* they should be adjacent to a species-rich hedgerow and be sown with a mixture containing a range of fine-leaved grasses (from native seed) and wildflowers providing suitable nectar sources. Management can remain as specified under CSS rules, i.e. left uncut (MAFF 1997), but with the option of having a short, cut section which allows *P. tithonus* to bask in a sheltered area on cool, windy days (Smith et al. 1993). If the 2-m grass margins are located in areas away from hedges (Field 2002) and ditches (Feber et al. 1996), and the vegetation is not tall (Smith et al. 1993), it will result in few if any *P. tithonus* being observed.

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