Intensive grazing by horses detrimentally affects orthopteran assemblages in floodplain grassland along the Mardyke River Valley, Essex, England

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SUMMARY

Grasshoppers and crickets (Orthoptera) were monitored in the Mardyke River Valley in south Essex in July and August 2007. A standardised transect method was used to count Orthoptera in horse-grazed and ungrazed pastures. Sward height measurements were taken from each pasture. In ungrazed pastures Orthoptera were much more abundant (17.3 individuals/100 m) with greater diversity (7 species) than in grazed pastures (0.8 individuals/100 m; 4 species). The low sward height of the grazed pastures (< 6 cm on average) is considered to have afforded Orthoptera little shelter from inclement weather or avian predators. Based on additional observations, a reduction in the grazing pressure from 3.5 horses/ha (current grazing density to the south of the Mardyke) to less than 2 horses/ha would lead to a more heterogeneous and overall taller sward, which would be favourable for orthopterans and a wider range of other grassland invertebrates.

BACKGROUND

Grazing and trampling are important influences on vegetation structure (Morris 2000). In the UK, heavy grazing by domestic cattle and sheep on fertile soils can produce a short, dense sward of neutral grassland species, such as perennial rye-grass *Lolium perenne*, which is unsuitable for grasshoppers (Gardiner *et al*. 2002). However, Clarke (1948) suggests that intense grazing by rabbits *Oryctolagus cuniculus* on chalk grassland and heaths promotes sparser vegetation, comprised of less vigorous species such as sheep's fescue *Festuca ovina*, which is consequently more favourable to grasshoppers. In another study on a heavily rabbit grazed calcareous grassland, the field grasshopper *Chorthippus brunneus* was more abundant within an ungrazed exclosure than on the surrounding grazed grassland with resulting shorter vegetation (Grayson & Hassall 1985). The authors suggested that the vegetation in the exclosure provided better cover from vertebrate predators and higher quality food resources for grasshopper nymphs than the shorter grazed vegetation.

Concerns have been raised about the negative effect of pony overgrazing upon the orthopteran assemblages of the New Forest, southern England (Tubbs 1986, Pinchen 2000, Denton 2006). Denton (2006) outlines the importance of exclosures, from which grazing ponies are largely excluded, for Orthoptera in the Forest. For example, both the nationally scarce woodland grasshopper *Omocestus rufipes*, and the wood cricket *Nemobius sylvestris* are found in exclosures; the varied and taller vegetation structure created in the absence of excessive grazing being particularly important. Similar concerns have been raised that over-intensive horse grazing is impacting upon insect biodiversity of floodplain grassland in the Mardyke River Valley, southeast England. Large areas of the floodplain are grazed by horses, leading to extensive patches of closely cropped turf. To determine whether horse grazing is having a damaging effect on the insect fauna of the site, populations of Orthoptera were monitored in grazed and ungrazed pasture in 2007. Orthoptera were chosen as indicator species of favourable habitat condition in this study because assemblages are particularly sensitive to disturbance of the grass layer in grasslands, especially during grazing (Jepson-Innes & Bock 1989). This paper presents and discusses the results of this small-scale study.

ACTION

Study site: The Mardyke River Valley in south Essex, southeast England, was created by glacial action and erosion from flooding. The floodplain grassland on the north and south sides of this slow flowing river is periodically flooded during wet weather in the winter. The grassland on both sides of the river is underlain by peat deposits and is fringed by ancient woodland, such as Brannett's Wood and Brickbarn Wood. The area has a temperate climate with an average air temperature of 10^{o}C and total annual rainfall of approximately 550 mm (Writtle College 2003).

Survey pastures: Orthoptera were surveyed in the River Valley in six grazed and six ungrazed pastures (located between Stifford Bridge and Ship Lane) in July and August 2007. Most of the ungrazed pastures were located on the north side of the Mardyke River and all grazed pastures were located to the south of the river (Fig. 1). However, pastures on the north and south sides of the river were of similar topography (more-or-less flat) and microclimate, being fairly open and exposed to the prevailing wind. The ungrazed pastures received no grassland management during 2007, although the creation of a bridleway necessitated a change of transect route for the August surveys to ensure that undisturbed grassland was surveyed.

The grazed pastures were grazed by 50 Shire horses (which included 15 foals), equating to an average stocking density of 3.5 animals per hectare (total grazed area = 14.3 ha). The horses could roam freely between pastures on the south side of the river as there were no boundary features (i.e. fences/hedges) to prevent their movement. Details of the 12 pastures surveyed are summarised in Table 1. The dominant grasses in the pastures were perennial ryegrass *L. perenne* and common couch *Elytrigia repens*.

Figure 1. The Mardyke River Valley, the heavily grazed pastures are on the south side of the river (right side of photo), the ungrazed pastures are on the north side; note the difference in vegetation height (photo: Peter Harvey).

Transect counts of Orthoptera: A transect was walked twice in each of the 12 pastures. The transect routes ran wherever possible in a straight line between the opposing boundaries of each pasture. Larger pastures required a longer transect route as there was generally further to walk between field boundaries. The first set of transect walks was conducted on 25 July 2007 and the second on 29 August 2007. These dates fall within the peak season for Orthoptera in Essex, when high numbers can be recorded throughout the summer months in favourable weather conditions. Each transect was walked at a slow pace (2 km/h) and the number of Orthoptera individuals 'flushed' in a 0.5 m wide strip in front of the observer were counted (Isern-Vallverdu *et al*. 1993). Only adults were recorded, as it is difficult to identify nymphs to species level during transect counts (Richards & Waloff 1954). Transect counting is considered fairly accurate in open swards of < 50 cm height where orthopteran densities are low (< 2 adults/m²) (Gardiner *et al*. 2005a), as was the situation in the Mardyke River Valley.

The total transect length walked on both surveys was calculated and the number of Orthoptera counted was standardised as number of individuals/100 m transect length between pastures with different transect lengths, to enable comparison between grazed and ungrazed pastures. The total distance walked (July and August surveys combined) in grazed pasture was 4,092 m, and in the ungrazed grassland 4,192 m.

Table 1. Location, area and transect length of the 12 pastures surveyed.

Pasture type/ replicate code	Ordnance Survey grid reference for each replicate	Area (ha)	Transect length (m)
Ungrazed			
A	TQ 592803	0.50	620
B	TQ 590802	0.40	380
C	TQ 585801	5.60	1228
D	TQ 582801	1.07	816
E	TQ 578799	2.90	764
F	TQ 592803	0.60	384
Grazed			
A	TQ 574795	1.46	388
B	TQ 575796	0.87	502
C	TQ 577797	1.66	424
D	TQ 580799	3.83	1260
E	TQ 586801	3.91	936
F	TQ 589801	2.53	582

An additional transect was walked through a pasture (just to the east of Ship Lane) that was lightly grazed by seven horses; equivalent to a stocking rate of approximately 1.1 horses per ha (pasture area: 6.4 ha). The data was not included in the main analysis, due to lack of replication, but implications of orthopteran observations in this less intensively grazed area are discussed.

Sward height: The height of the vegetation was recorded using a drop disc method (Smith *et al.* 1993, Stewart *et al.* 2001). The disc (200 g in weight; 30 cm in diameter) was dropped from the top of a metre-long ruler held vertically and the height of the vegetation where the disc settled was measured in cm. Stewart *et al.* (2001) conclude that this method is objective and simple to use. Ten drop disc measurements were taken at random locations in each pasture in July, and again in August

Data analysis: The number of individuals of each species recorded (abundance) was standardised between each pasture (as a different length of transect was walked in each one) by dividing the total number of individuals counted by the transect length (in metres) and then multiplying this figure by 100 to get the comparative figure per 100 m. Data presented therefore factors in transect length to give a representative figure of abundance for each pasture. Standardising abundance by section length has been used elsewhere (e.g. Gardiner *et al*. 2005b). However, species richness estimates produced from transect counts need to be viewed with caution as surveyors tend to miss bush-cricket species due to their ability to escape from the observer before identification has been confirmed or to avoid detection altogether (Gardiner & Hill 2006). Due to the problems in detecting bush-crickets during transect sampling, the number of species recorded was not corrected for transect length and data presented is the total number of species encountered.

To obtain an overall impression of the abundance of grazed and ungrazed pasture, the counts per 100 m were averaged between all pastures. The mean length for ungrazed transects (698.7 m) and grazed transects (682.0 m) are very similar so that differences between pasture types are unlikely to be due to differences in transect lengths.

To facilitate statistical analysis, all species' abundances and sward height data were square root transformed to correct for non-normality (Gardiner *et al.* 2005a). Student's t tests (unpaired samples) were then calculated for each of the seven Orthoptera species recorded to ascertain whether they were in higher abundance in grazed or ungrazed pasture. A Student's t test was also calculated for sward height data in both pasture types. Species richness data were not transformed and were subjected to a Mann Whitney U test to determine if the number of species varied between grazed and ungrazed pasture. Spearman's rank correlation (rs) was used to confirm whether there was an important relationship between species richness and sward height.

CONSEQUENCES

Orthopteran abundance and diversity: Orthopterans were much more commonly encountered in the ungrazed pastures, the most frequently recorded species were long-winged conehead *Conocephalus discolor* and meadow grasshopper *Chorthippus parallelus*. Roesel's bush-cricket *Metrioptera roeselii* and lesser marsh grasshopper *Chorthippus albomarginatus* were also regularly counted in ungrazed pasture; seven long-winged forms of *M. roeselii* (f. *diluta*) were sighted in the July survey. Less abundant species included field grasshopper *Chorthippus brunneus* and common groundhopper *Tetrix undulata,* neither of which were recorded from the grazed pastures. A total of seven Orthoptera species were recorded in the ungrazed pastures compared to four in the grazed pastures (Table 2).

The abundance of all seven species was also higher in ungrazed grassland (Table 2) and overall abundance (all species combined) was over 20 times higher in ungrazed pasture (17.3 individuals/100 m) than in grazed pasture (0.8 individuals/100 m). The species richness of Orthoptera was much higher in ungrazed pastures than in the grazed pastures (6 vs. 1 species/pasture respectively, Z value: -2.92, P<0.01).

Sward height: Sward height was significantly lower on the grazed swards (t-test value: 11.39, P<0.01). The short sward height in the grazed pastures (mean sward height = 5.7 cm) compared to the ungrazed pastures (mean sward height = 30.7 cm), tends to suggest that the grazing intensity, in terms of maintaining orthopteran diversity and abundance, is currently too high on the grazed pastures.

There was a very evident relationship (r_s = 0.76, P<0.01) between sward height and orthopteran species richness (Fig. 2); species richness was much higher in the taller vegetation of the ungrazed pastures, which had average vegetation heights > 25 cm, than that of grazed pastures, with an average vegetation height of around 5 cm.

Mean sward height does not give an idea of the variability (or heterogeneity) of the vegetation cover. If the range of sward height is examined for all pastures (Fig. 3), it can be clearly seen that the ungrazed pastures had high sward heterogeneity, whereas the grazed swards had low sward heterogeneity and very few patches of tall vegetation (maximum sward height in all grazed pastures was 19.8 cm compared to 63.8 cm for ungrazed).

Table 2. The abundance (mean number of individuals/100 m ± SE) of each Orthoptera species in grazed and ungrazed grassland, t-test values and significance are shown for each species.

Species	Grazed	Ungrazed	T-test value and significance
Chorthippus parallelus	0.58 ± 0.33	7.06 ± 3.71	2.83, P<0.05
Conocephalus discolor	0.14 ± 0.07	5.66 ± 1.80	4.78, P<0.01
Metrioptera roeselii	0.06 ± 0.04	2.27 ± 0.86	3.04, P<0.05
Chorthippus albomarginatus	0.03 ± 0.03	1.77 ± 0.44	6.77, P<0.01
Pholidoptera griseoaptera	0.00 ± 0.00	0.35 ± 0.11	3.96, P<0.01
Chorthippus brunneus	0.00 ± 0.00	0.17 ± 0.07	2.82, P<0.05
Tetrix undulata	0.00 ± 0.00	0.05 ± 0.05	1.00, not significant

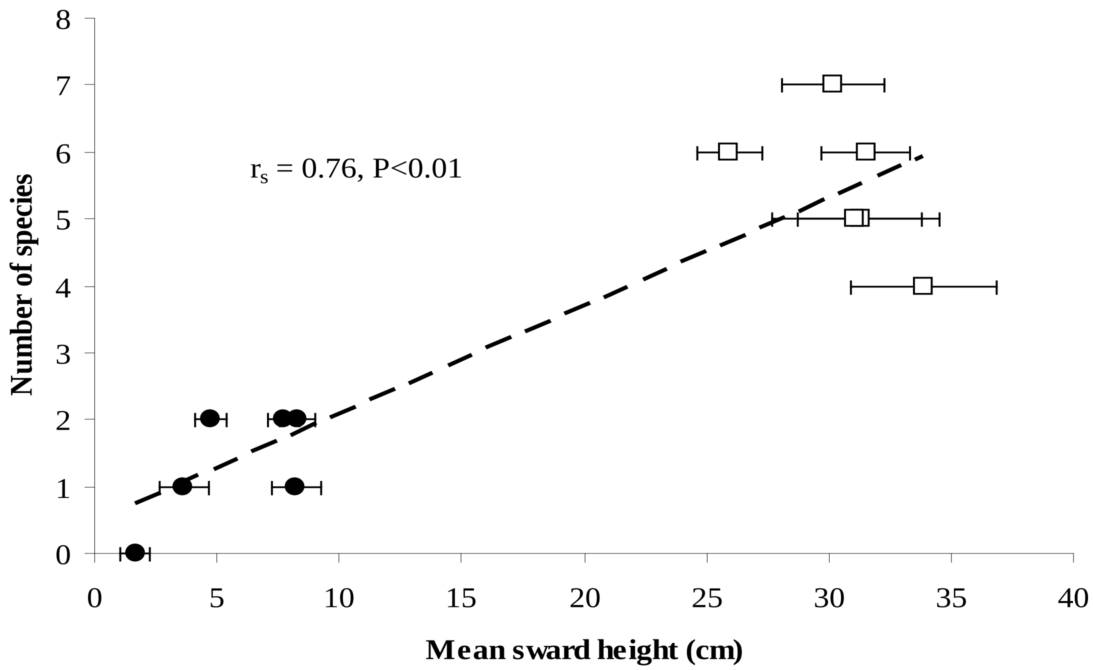

Figure 2. The relationship between sward height and species richness (each point is a pasture, solid circles are grazed pastures and open squares are ungrazed plots, SE bars shown for sward height).

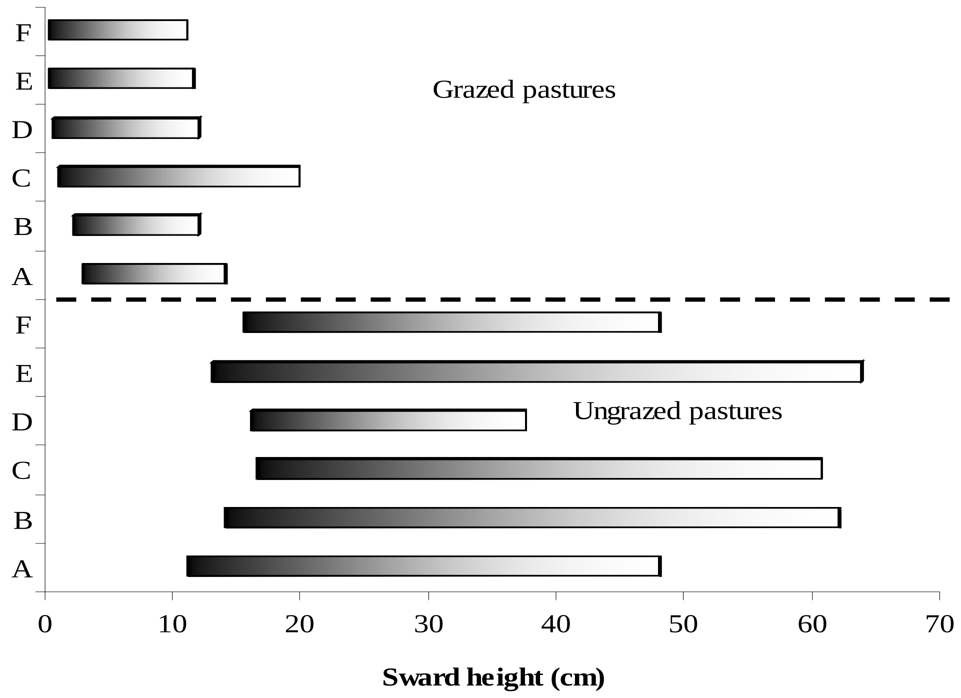

Figure 3. The sward height range of each grazed and ungrazed pasture, bars indicate the range of heights recorded for each pasture, the extremities of each bar show the minimum and maximum sward height.

Conservation implications: The survey showed that Orthoptera were extremely scarce in the intensively grazed pastures and that species richness was lower. The abundance of six of the seven species recorded in this survey was significantly lower in the grazed pastures (Table 2). The horses grazed continuously throughout the year on the south side of the Mardyke and this led to an extremely short sward (< 10 cm in height; Fig. 3) that is considered to provide insufficient cover from inclement weather and predators (particularly birds) for Orthoptera (Gardiner *et al*. 2002), which will search for taller grassland/scrub that meets their habitat requirements (Gardiner & Hill 2004). The preferred sward height of *C. albomarginatus* and *C. parallelus* is 10-20 cm (Gardiner *et al*. 2002); the horses had grazed most vegetation to much lower than 10 cm, which perhaps explains the rarity of both species in the grazed pastures. The only tall herbaceous vegetation (> 10 cm in height) that provided shelter for orthopterans was around isolated patches of hawthorn *Crataegus monogyna* scrub, and in horse latrine areas that were avoided by grazing horses. The latrine areas (with grass growth enhanced by nutrients from the dung) were identified as important habitat patches for Orthoptera in grazed pastures.

There was an important relationship between sward height and species richness in the Mardyke pastures (Fig. 2), species richness being much higher in the taller vegetation of the ungrazed pastures (average vegetation heights > 25 cm). Such swards are critical for bush-crickets such as *C. discolor* and *M. roeselii* that need tall, ungrazed grassland habitat (Marshall & Haes 1988); reducing the numbers of horses is the only realistic way of providing the patches of tall vegetation needed by bush-crickets.

The ungrazed pastures also had high heterogeneity of sward structure (Fig. 3). Grassland with heterogeneity of sward height is highly desirable for the conservation of many other insect groups, such as Homoptera, Heteroptera and Lepidoptera (Morris 2000) and this might be achieved over a relatively short time period through a reduction in grazing pressure. However, due regard should be made of any specialist (in particular thermophilous insects) species present at a site, that in fact may need a very short sward in order to persist.

Along the additional transect through the lightly grazed pasture (stocking rate 1.1 horses/ha), five orthopteran species were recorded and these were in much higher abundance compared with any of the grazed pastures with a higher stocking rate (3.5 horses/ha). For example, *C. albomarginatus* (3.5 individuals/100 m) and *C. parallelus* (10.7 individuals/100 m) were especially numerous. The sward was variable in height (min/max height recorded: 7-14 cm) and had very few closely cropped ‘lawn’ areas compared to the six, more intensively grazed pastures. We would therefore suggest that the number of grazing animals is reduced on the south side of the Mardyke so that a higher number of Orthoptera species can persist in the grassland.

It would seem that the lack of livestock-proof boundaries separating the pastures to the south of the river meant that the 50 horses present at the time of study had unrestricted access and ‘mob grazed’ each pasture in turn, seriously reducing vegetation height before moving onto the next field. Reinstating stock-proof hedgerows along existing ditch boundaries and installing gates would give control over which areas are grazed.

Conclusions: It would seem that overgrazing by horses in the Mardyke River Valley is extremely detrimental to orthopteran communities, both in terms of abundance and species richness. The stocking density of 3.5 horses/ha (the current stocking rate in most of the grazed pastures) is too high to allow suitable habitat to persist with eradication of patches of tall grass that may have otherwise formed a refuge for Orthoptera. The study results concur with findings of research undertaken in the New Forest (Tubbs 1986) that also indicate that overgrazing by horses is extremely detrimental to Orthoptera populations. A reduction in the intensity of horse grazing is therefore recommended.

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