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Impact of dairy farming on butterfly diversity in Alpine summer pastures

Jana Sabrina Jerrentrup[a,*], Sebastian Klimek[a], Elisa Marchiori[b], Giovanni Bittante[b], Maurizio Ramanzin[b], Enrico Sturaro[b], Lorenzo Marini[b]

[a] Thünen Institute of Biodiversity, Bundesallee 50, 38116 Braunschweig, Germany
[b] University of Padova, DAFNAE, viale dell'Università 16, 35020 Legnaro, Padova, Italy

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ABSTRACT

The practice of transhumance of livestock herds to Alpine summer pasture has experienced pronounced changes over recent decades due to the general process of agricultural intensification in productive areas and abandonment of farming in marginal areas. Instead of moving lactating cows to summer pastures raising replacement heifers recently gained much importance. Here, we analysed the impact of these changes in dairy farming on butterfly diversity inhabiting Alpine summer pastures in the eastern Italian Alps. We sampled butterflies (Lepidoptera) in 16 Alpine summer pastures that were either grazed by lactating cows (n = 11) or replacement heifers (n = 5) at two distances from the farm building. Butterflies were classified according to their mobility. Our results showed a distance effect on total butterfly species richness only in pastures grazed by lactating cows indicating a stronger impact on vegetation structure and composition nearby the farm building. Abundance of butterflies was higher with increasing distance from the farm building. In contrast to mobile butterflies, sedentary species reacted more strongly to disturbance induced by grazing livestock. Moreover, butterfly composition differed slightly between pastures grazed by lactating cows and heifers. Our results indicate that the widespread adoption of heifer grazing induces a shift in butterfly diversity and composition likely caused by the different behaviour of grazing livestock. In order to benefit butterfly diversity in Alpine summer pastures, we suggest that future agri-environment schemes should provide extra support for summer farming of lactating cows.

1. Introduction

Temperate semi-natural grasslands are key habitats for the conservation of biodiversity (Bignal and McCracken, 1996; Kuussaari et al., 2007; Veen, 2009). Across Europe, a continuous loss and degradation of these agriculturally unimproved species-rich habitats has been observed since the second half of the 20th century that is mainly attributable to agricultural intensification and land abandonment (Krebs et al., 1999; MacDonald et al., 2000; Stoate et al., 2009; Warren and Bourn, 2011; Wesche et al., 2012). These processes have been accompanied by a rapid decline in butterfly species richness (van Swaay, 2002; van Swaay et al., 2006) that are highly dependent on the continuation of low-intensity farming practices (Dover et al., 2011).

Mountain areas such as the European Alps are butterfly diversity hotspots (Girardello et al., 2009) and have experienced pronounced changes in land-use and farming practices (MacDonald et al., 2000; Falcucci et al., 2007; Tasser et al., 2007). However, the magnitude and direction of change vary, i.e. more fertile areas in the lowlands are predominantly characterised by a shift towards high-intensity, large scale and specialised farming, whereas low productive mountain areas are more prone to abandonment (MacDonald et al., 2000; Cocca et al., 2012). Particularly dairy farming has experienced a change towards concentration on fewer and larger farms, accompanied by higher cattle stocking rates (Marini et al., 2011). These trends have a strong impact on the livelihoods of Alpine pastoralists and transhumance systems that have come under pressure and face an uncertain future (Gellrich et al., 2007; Pardini and Nori, 2011; Mack et al., 2013).

Summer pasture farming has evolved over centuries through the adaptation of human activities to harsh climatic and topographic conditions and has been, and still is, an integrated element of Alpine agriculture (Pardini and Nori, 2011; Mack et al., 2013). In the European Alps, these transhumance systems involve the seasonal movement of dairy cattle from the permanent farms in the valleys to the mountain pastures during summer (from June

* Corresponding author.
E-mail address: sabrina.jerrentrup@thuenen.de (J.S. Jerrentrup).

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to September). This practice of transhumance preserves the landscape from reforestation (MacDonald et al., 2000; Mack et al., 2013; Sturaro et al., 2013a), increases the attractiveness for tourism (Scarpa et al., 2011) and helps ensuring the socio-economic viability of rural areas. Traditionally, summer pastures have mainly been used by dairy farms characterized by small to medium herd size, low productivity in terms of milk yields, use of local or regional breeds and tie stalls (Sturaro et al., 2013a). Recently, in order to maximise profitability of milk production, supplementary feeding with high energy concentrates and use of more specialized dairy cattle breeds have been widely introduced (Sturaro et al., 2013a). Moreover, instead of moving lactating cows to summer pastures raising replacement heifers has gained much importance (Zendri et al., 2013). Replacement heifers in dairy farming are young female cattle from weaning to first calving that are raised with the purpose to replace other cows or to improve the herd. Lactating dairy cows, in particular intensive breeds, are high demanding in terms of forage requirements and milking practices, while summer pasturing of replacement cattle such as heifers is less labor-intensive and time-consuming (Bovolenta et al., 2009). However, to date, only very few studies have analysed the impact of these changes in livestock transhumance on insect diversity inhabiting Alpine summer pastures (but see Marini et al., 2009).

Insects, and especially butterflies, are affected by changes in local grassland habitat quality induced by livestock grazing (e.g. Morris, 2000; Vickery et al., 2001). Grazing livestock alters vegetation composition and structure through defoliation, treading and leaving excreta. In particular grazing intensity affects vegetation characteristics directly, therewith impacting on associated herbivores and pollinators (Rook et al., 2004). Indeed, many recent studies have found that several insect groups, such as bees and wasps (Carvell, 2002), grasshoppers (Öckinger et al., 2006; Wallis De Vries et al., 2007; Dumont et al., 2009; Jerrentrup et al., 2014) and butterflies (Söderström et al., 2001; Kruess and Tscharntke, 2002; Pöyry et al., 2006; Wallis De Vries et al., 2007; Dumont et al., 2009; Jerrentrup et al., 2014) are in general negatively affected by a high stocking rate, mainly due to a deterioration of habitat quality and the disruption of trophic interactions between plants and herbivorous insects. Insect diversity is, however, not only influenced by stocking rate, but also by the spatial distribution of grazing livestock pressure across the pasture. Particularly in large-scale pastures livestock tend to concentrate grazing activities close to sheds and feeding stations (Bailey et al., 1998; Putfarken et al., 2008), whereas grazing intensity decreases as the distance from the farm building increases (Spatz, 1980; Parolo et al., 2011). In addition, grazing activities might also be influenced by cattle category (lactating cows vs. heifers; Bailey, 2004) and the level of supplement feeding (Krysl and Hess, 1993; Bovolenta et al., 2009). Hence, supplementary fed lactating cows can be assumed to show differences in grazing behavior and forage intake compared with heifers that receive no concentrates.

Here, we analysed the effect of grazing by replacement heifers ("heifers") versus lactating cows ("cows") at two distances from the farm building on butterflies inhabiting Alpine summer pastures. In contrast to lactating cows, replacement heifers do not need to keep coming back to the sheds for milking and concentrate feeding and can therefore be considered as free-ranging animals. We hypothesized that (i) butterfly abundance and species richness are lower nearby the farm building on pastures grazed by cows, while on heifer-grazed pastures, grazing activity and accordingly butterfly diversity is less affected by the distance to the farm building; (ii) sedentary butterfly species are more strongly affected compared to mobile species, because these species are more restricted and have higher habitat requirements than mobile butterflies; (iii) butterfly community composition differs between pastures grazed by heifers and cows. Finally, we highlight the key implications of our findings for the conservation of butterfly diversity, and make recommendations on how to optimize future agri-environment schemes.

2. Materials and methods

2.1. Study area

The study was carried out in the north-eastern part of the autonomous province of Trento in the Italian Alps. The province covers an area ca. 6200 km^2, with altitude above sea level ranging from 66 to 3769 m (Fig. 1). Utilized agricultural area (UAA) covers ca. 1372 km^2 and is dominated by meadows and pastures (81%). While meadows that are cut for hay are mainly located in the valleys, summer pastures with livestock grazing are mostly situated at elevations above 1500 m a.s.l. at or below the upper treeline. The practice of summer pasture farming has evolved over centuries and still plays an important role for dairy farms in the study region, as indicated by a total of 395 summer farms that were still active in 2010 (Zendri et al., 2013). Almost all the replacement cattle and more than one third of the dairy cows reared in the

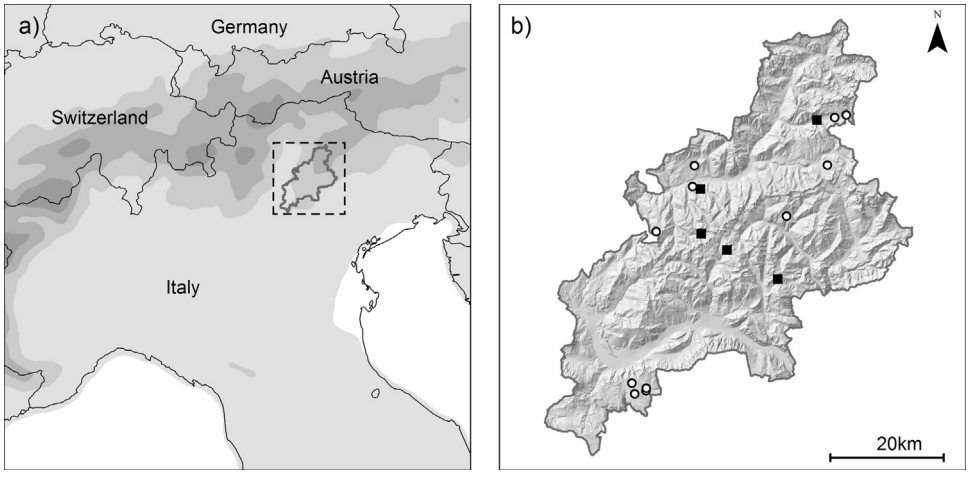

Fig. 1. Study region (A) and geographical location of studied Alpine summer pastures (B). Alpine summer pastures grazed by lactating cows are indicated by open circles (n = 11) and heifer-grazed pastures by filled squares (n = 5).