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Short communication. Phenology and abundance of *Enoicyla pusilla* in conifer stands

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Abstract

Aim of study: We study the abundance of *Enoicyla pusilla* (Burmeister) in pine plantations and the effects of silvicultural thinning on insect population. This species is considered a rare member of the order Trichoptera, reported as absent or occasional in conifer forests. It has been suggested that the proliferation of conifer plantations may be a threat for this species by favoring population isolation.

Area of study: Plantations of native and non-native pines in Galicia (NW of Spain).

Material and methods: We used different traps systems, including 28 pitfall traps, to compared populations of insects in 14 thinned and unthinned plots of *Pinus pinaster* and *P. radiata* distributed across 3 forest stands. Traps were checked every 15 days during one year.

Main results: We caught 1.219 larvae of *E. pusilla.* It was the third most abundant species captured in pitfall traps. Larval activity extended from January to late July. They were more abundant in the stands of *P. radiata,* probably because the denser foliage produced limits sunlight and helped to maintain litter moisture. Additionally needles of *P. radiata* had lower toughness and higher nitrogen content, which probably makes it a higher quality resource for the detritivorous larvae. Thinning did not affect larvae population.

Research highlights: Although managed forests cannot match the biodiversity value of native mixed species stands, if managed appropriately, they may provide habitat for native fauna while also allowing for forest production

Key words: caddisfly; *Pinus pinaster, Pinus radiata;* plantations; thinning.

Introduction

The order Trichoptera is represented by 327 species in Spain (González and Martínez, 2011). The larvae of this group of insects are aquatic and most of them make tubular cases of various materials to protect their bodies. All adults are terrestrial. *Enoicyla pusilla* (Burmeister) is an aberrant member of the family Limnophilidae (Trichoptera) because it has terrestrial larvae and the adult females are nearly wingless. Both characters are very rare within the order Trichoptera. The species is present in Western Europe and occupies the northern half of the Iberian Peninsula (Mey, 1983; Vieira-Lanero, 2000). Adults are active in fall and live for only a few days (Harding, 1995). Females lay their eggs within a gelatinous structure amongst moss at the base of the trees. Recently hatched larvae stay within the egg mass, where they consume the gelatinous material (Kelner-Pillaut, 1975). Next, as other caddisflies, larvae of *E. pusilla* construct conical cases, made with litter and sand grains (Harding, 1995). Larvae are typically detritivores, feeding on undecomposed leaves, mosses and fungi (Packham *et al*., 1992; Harding, 1998).

This species is of ecological interest due to its role in litter decompositions. Soil arthropods such as *E. pusilla*, favor microbial activity through particulation, channelling, and alteration of nutrient availability (Wolters, 2000). *E. pusilla,* larvae can consume 5 to 19% of the litterfall in a stand of oak. Of the material ingested, 7% is assimilated and 93% egested. The fecal pellets have a higher surface area, better aeration and water-holding capacity, and higher pH than the original litter (Drift and Witkamp, 1959). The ecological interest of *E. pusilla* was also pointed out by Nahmani *et al.* (2006), who described it as an indicator of unpolluted woodlands in France. Despite its ecological interest, very few papers deal with the biology of this species; most of the literature references are geographical records. The species is reported to prefer mature deciduous woods with additional scattered findings in hedgerows with deciduous trees (Drift and Witkamp,

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1959; Harding, 1998; Vieira-Lanero, 2000). Its presence in conifers is more controversial, some authors indicated that it can be found occasionally in conifers stands (Harding, 1995, 1998) although preferring broadleaved woodlands (Harding, 1995, 1998; Vieira-Lanero, 2000). Other authors state that larvae cannot be found under conifers (Rathjen, 1939; Masselot and Dortel, 2004). Masselot and Dortel (2004) added that the proliferation of conifer plantations may contribute to isolation of populations and be a threat for this species.

During 2009 and 2010 we carried out a study to assess the influence of silvicultural thinning on insect communities in stands of two pines species in Galicia (NW of Spain): *Pinus pinaster* Ait. and *P. radiata* D. Don. *E. pusilla* was a common species among our captures and due to the ecological interest of the species and the controversy about conifer as suitable habitat for this species, we present here our records of abundance and phenology of *E. pusilla* in conifer plantations in Galicia and how forestry practices may influence its presence.

Material and methods

The study was carried out in long-term thinning trials established by the Forest Sustainable Unit of the University of Santiago (Lombardero *et al*., 2012). Two trials were located near Lugo, one in a stand of *Pinus radiata* and the other in a stand of *P. pinaster* (the Begonte and Corgo trials, respectively, both located in temperate-subhumid bioclimatic gradient (Martínez-Cortizas and Pérez-Alberti, 1999). There was a matching trial of *P. pinaster* near Ourense (Punxin trial, located in a temperate-dry bioclimatic gradient (Martínez-Cortizas and Pérez-Alberti, 1999). The Begonte and Punxin trials were 17 and 19 years old respectively at the time of our study. Each consisted of replicate 900-m^2 plots, three of which were thinned in 2004 and three left as controls. The Corgo trial was 24 years and consisted of one large plot (2500 m^2) that was thinned in 2008 and a matched control plot that was left unthinned. Our protocol for insect sampling included 28 pitfall traps located in the forest floor of the study plots. The traps were baited with 70% acetic acid, and were checked every 15 days from April of 2009 to April of 2010. Insect abundance was analyzed with a two-way ANOVA of locality (Begonte, Corgo, Punxin), treatment (thinned *vs.* control) and their interaction (all treated as fixed effects). Since this study is not a replicated experiment among species, we used orthogonal a priori contrasts to test for (a) differences between pine species (Begonte vs. Corgo and Punxin = *P. radiata vs. P. pinaster*) and (b) differences between bioclimatic zones (Corgo vs. Punxin = *P. pinaster* in subhumid *vs.* dry climate). We also analyzed the toughness and nitrogen content of needles within the study plots.

Results and discussion

We captured a total of 1.219 individual larvae of *E. pusilla* in 28 pitfall traps during one year of sampling; it was the third most abundant species in pitfall traps, representing about 7 % of the total captures. The number of individuals we detected, with consideration of the different sampling methodology, is comparable with that reported by Harding (1998) for a hardwood forest in Britain. Larvae were significantly more abundance in stands of *P. radiata* than in stands of *P. pinaster* ($F_{2,145} = 5.6$, $p = 0.004$; Fig. 1). Differences remain when comparing both localities with the two species (*P. pinaster* and *P. radiata*) located nearby Lugo in the temperate subhumide bioclimate ($F_{1,100} = 8.14$, $p = 0.005$). However there was not differences in *E. pusilla* abundance when we compared the two localities with the same species (*P. pinaster*) located in different bioclimates ($F_{1,62} = 2.46$, $p = 0.12$). Differences among pine species may be related with moisture content in the soil. Moisture is a critical factor for egg masses and

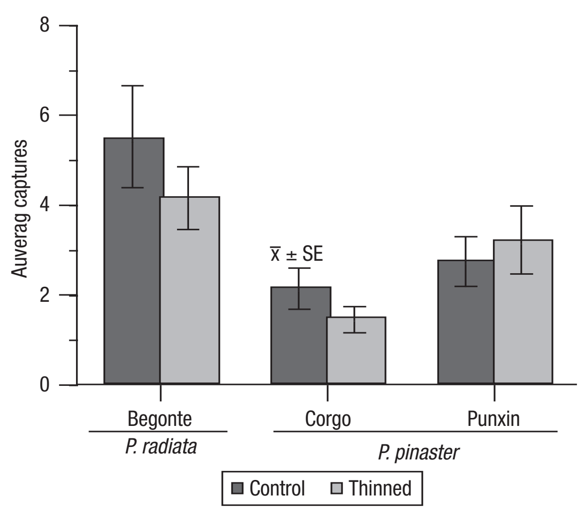

Figure 1. Average captures of *Enoicyla pusilla* by tree species and thinning treatment (Data back-transformed log).

for developing larvae (Kelner-Pillaut, 1960). The crowns of *P. radiata* plots have denser foliage than crowns of *P. pinaster* – at least partly because *P. radiata* grows faster and attains greater canopy closure than equal aged stands of *P. pinaster* which may influence the penetration of radiation (Kuuluvainen and Pukkala, 1987). Additionally N contents of the needles were 40 % higher in the stands of *P. radiata* (mean % of N ± SE = 1.5 ± 0.3 *vs.* 0.9 ± 0.3 for *P. radiata* and *P. pinaster,* respectively) and needle toughness was about half that in *P. pinaster* (mean ± SE = 374.5 ± 14 *vs.* 720.4 ± 14 g/mm^2 for *P. radiata* and *P. pinaster,* respectively), this probably make *P. radiata* litter a more suitable habitat than *P. pinaster* litter as was pointed out for other detritivores (Molles and Graça, 2000).

In our study sites, larvae were active mainly from January to July (Fig. 2c), with a peak in February for the *P. pinaster* stands and a peak in May for *P. radiata* stands. There was little or no activity during summer and fall. In Britain, larval activity started earlier, in late October (Harding, 1998). Our sampling revealed that winter activity of *E. pusilla* occurs with very low air temperatures reaching values of below zero (down to –5.3 °C in Corgo); temperatures were somewhat moderated at the forest floor, but still reached –3°C at 10 cm (Fig. 2a). Larval activity was high in months where average relative moisture dropped to nearly 60 % (Fig. 2b). We did not follow the adults in this study but Gonzalez *et al*. (1989) and Ocharan *et al.* (2006) show records of adult captures during September and October, as was also recorded in other parts of Europe (Harding, 1998).

There were not effects of thinning on the abundance of *E. pusilla* ($F_{1,145} = 0.4$, $p = 0.51$; Fig. 1), therefore management seems do not have negative impacts on insect population. Our results show the existence of *E. pusilla* populations not only in conifer forests but in intensively managed plantations. Forest plantations represent today 7 percent of the forest area in the world, and are of global importance for the production of fiber, timber, and fuel. Usually plantations are regarded as negative for biodiversity, but our results add to studies that have shown plantation forests as habitat for a range of native forest plants, animals, and fungi (Barbaro *et al*., 2005), including threatened species (Brockerhoff *et al*., 2005). Although forest plantations can never have the same value for biodiversity as native mixed forests, the application of ecological principles of forest management may help to maintain and enhance biodiversity within the land that is required to support human needs for forest products. Managing forest plantations to promote biodiversity is a prominent goal of sustainable forest management and also a central value for forest certification systems.

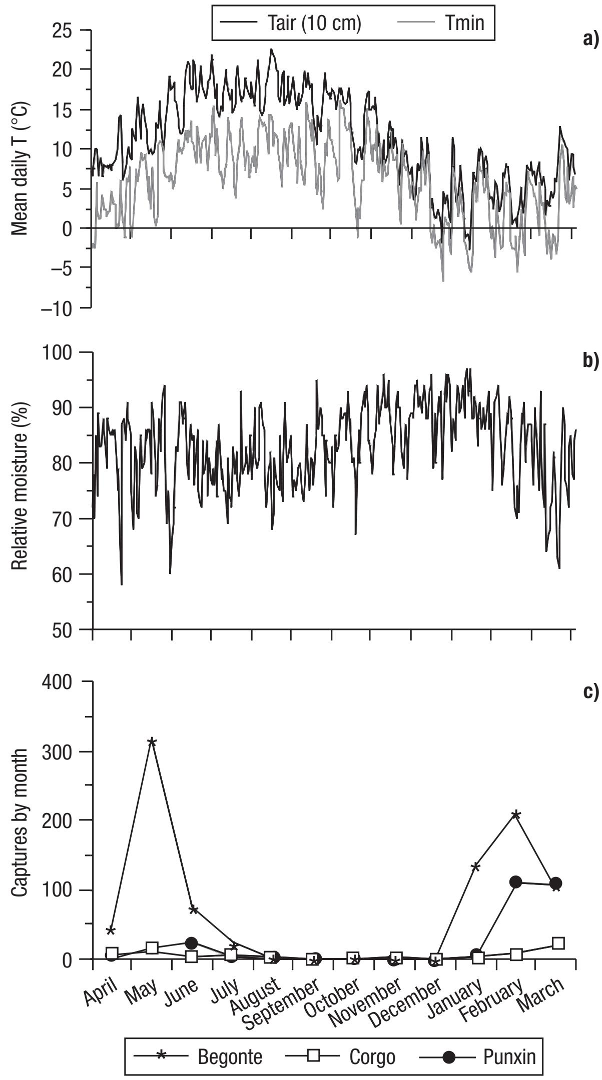

Figure 2. a) Daily minimum and average air temperatures at 10 cm above the forest soil (*Enoicyla pusilla* habitat). b) Daily mean relative moisture. c) *Enoicyla pusilla* captures by month in the study stands.

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