Selecting focal species to study ground beetles phenological responses to climate change

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Predicting the impacts of global change on species richness and species distribution has been the aim of several studies (e.g. McCarty, 2001; Parmesan & Yohe, 2003; Harte et al., 2004). Ecologists realise the importance of relating environmental change and community change with current climate warming, with particular reference to the temporal-scale approach (Gobbi et al., 2007).
Assemblage changes over time appear to be a good key to interpret global change (Bardgett et al. , 2005). These kinds of studies are important to try to identify keystone taxa or bioindicators. Ground-dwelling arthropods can indicate changes in the environment through their responses as individuals or communities (Gobbi et al., 2007). Ground beetles (Coleoptera: Carabidae), in particular, have been widely recommended as bioindicators (Rainio and Niemela, 2003)
The Alps are a true hot spot of ground-dwelling arthropod diversity. With regards to ground beetles, for example, more than 25% of the total number of species occurring in the southern Italian Alps (some 800 species) are endemic (Casale and Vigna Taglianti 2005). Some of these species may be qualified as endangered because they are found in few sites and/or are characterized by small population size. Recent surveys have shown that large-bodied, specialized, and brachypterous carabids are more subject to decline because of rapid changes in the environmental structure of their habitat (Kotze and O'Hara 2003).
The aim of this study was to pointed out focal taxa that could be useful bioindicators to study phenological responses to climate change.

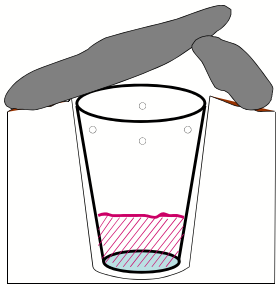

Fig. 2: Pitfall trap filled with vinegar and salts

STUDY AREA, MATERIAL AND METHODS

This research was carried out in St. Marcel (Aosta valley) in three transect (Fig. 1), located at different altitude: Laycher (1500 m a.s.l, A), Druges (1700 m, B) and Bren (1900 m, C). The site, north-east oriented, was dominated by coniferous forests (larch *Larix decidua* and Norway spruce *Picea abies*).
Twenty pitfall traps (aligned at 10 m intervals) were placed at each transect (Fig. 2). Pitfall traps were placed in three different years at April (2011)/June (2010)/July (2009) and emptied fortnightly until the end of September. They were 7.5 cm in mouth diameter and 9 cm deep. Four small holes (0.2 cm in diameter) were drilled 2.5 cm below the upper brim of the pitfall, so that excess rainwater could flow out. Each trap was filled with 150 ml of a mixed fluid (vinegar and salts) to preserve individuals. A flat stone was placed 3 cm above each trap to prevent rainwater from entering the traps.
The exact location of pitfall traps was established in the field by means of a Global Positioning System (GPS) Garmin eTrex navigator. Trapped arthropods were sorted and identified, whenever possible, to the species level using updated standard keys or specialists' works. Nomenclature follows Audisio and Vigna Taglianti (2004) .

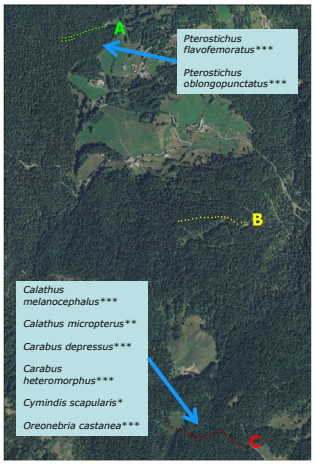

Fig. 1: A (1500), B (1700 m) and C (1900) transects. In the picture are shown indicator specie for each transect

Fig. 3: *Pterostichus flavofemoratus*

RESULTS

A total of 2,904 individuals, representing 12 different species, were collected altogether (Fig. 1): *Pterostichus flavofemoratus* (Dejean, 1828); *Calathus melanocephalus* (Linné, 1758); *Calathus micropterus* (Duftschmid, 1812); *Carabus depressus* Bonelli, 1810; *Carabus heteromorphus* K. Daniel, 1896; *Cymindis scapularis* Schaum, 1857; *Notiophilus biguttatus* (Fabricius, 1779), *Oreonebria castanea* (Bonelli, 1810), *Pterostichus oblongopunctatus* (Fabricius, 1787); *Synuchus vivalis* (Illiger, 1798); *Amara equestris* (Duftschmid, 1812); *Leistus nitidus* (Duftschmid, 1812). *P. flavofemoratus* was numerically predominant because it accounted for 68.8% of the total number of individuals collected, followed by *C. micropterus* (15.5%) and *C. depressus* (8.3%). The other species were infrequent with a percentage < 5 %.
The analysis of indicator species, using IndVal, showed that eight species had a clear preference for a particular altitude. Two species preferred lowest site (Laycher, 1500 m a.s.l) and six the highest one (Bren, 1900 m). No species positively selected intermediate elevation (Druges, 1700 m) (Fig. 1). Multivariate Regression Trees (MRT) confirm this pattern of selection. Only *P. flavofemoratus* (Fig. 4) was considered in order to evaluate changes in abundance, because it was the only species present in all transects with a sufficient number of individuals. In the three sampling sites we had two different trends (Fig. 5): while in Laycher the abundance increase from 2009 to 2010 in Druges and Bren it remain constant in the first two years and then decreses in 2011.

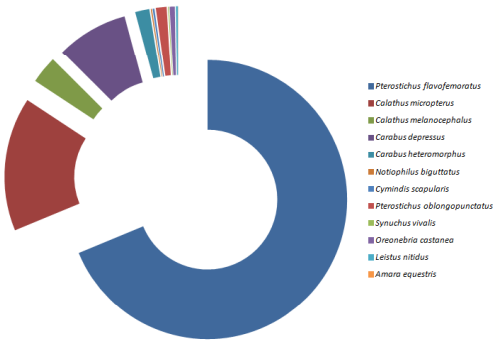

Fig. 4: Relative adundance of sampled species

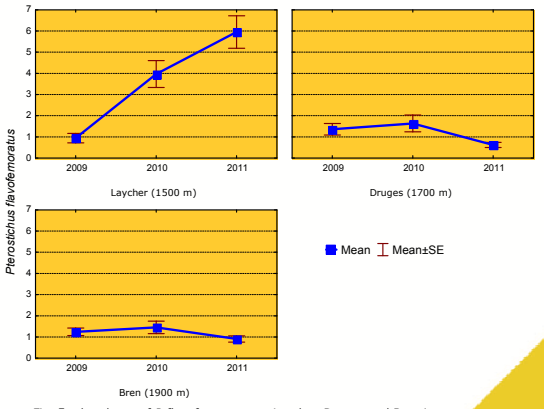

Fig. 5: abundance of *P.flavofemoratus* on Laycher, Druges and Bren in base of sampling year

DISCUSSION

Carabid beetles can be used for indicating changes in many kinds of alterations in the environment. Alteration in a certain environmental variable may have different consequences in abundance of different species (Pocock & Jennings 2008). In this study we pointed out a focal taxon (*P. flavofemoratus*) that could be a useful bioindicator to monitoring the effects of global warming. In particular we showed that the variation in abundances of this carabid beetle strongly varies among years at the lowest altitude (1500 m a.s.l.).

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