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Species composition of carabid communities (Coleoptera Carabidae) in apple orchards and vineyards in Val d'Agri (Basilicata, Italy)

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ABSTRACT An entomological investigation was carried out in an agricultural area, mainly apple orchards, of the Agri river plain, located in some municipalities of Basilicata, Italy. Between 2012 and 2014, species richness and composition of carabid assemblages were investigated on the ground surface of differently managed (abandoned, organic, commercial and IPM) apple orchards and vineyards. Ground beetles (Coleoptera Carabidae) were sampled by means of pitfall traps. 1288 individuals belonging to 40 species were collected, representing two-thirds of the carabid fauna of this area found in our and earlier studies. The species richness varied between 4 and 20 in the different orchards. The common species, occurring with high relative abundance in the individual orchards in decreasing order were: *Pterostichus* (*Feronidius*) *melas* (Creutzer, 1799), *Pseudoophonus* (*Pseudoophonus*) *rufipes* (De Geer, 1774), *Brachinus crepitans* (Linnaeus, 1758), *Harpalus* (*Harpalus*) *dimidiatus* (P. Rossi, 1790) and *Poecilus* (*Poecilus*) *cupreus* (Linnaeus, 1758). Most of the collected ground beetles were species with a wide distribution in the Paleartic region, eurytopic and common in European agroecosystems. The assemblages were dominated by small-medium, macropterous species, with summer larvae. No endemic species were found.

KEY WORDS ground beetle; pitfall trapping; bioindicators; conservation; agro-ecosystem management.

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INTRODUCTION

In the frame of the ENEA project AGRIVAL (aree AGRIcole ad alto VALore naturalistico dell'alta val d'Agri = high nature value farmland in upper Val d'Agri) (Menegoni et al., 2012, 2014), an entomological investigation was carried out in an agricultural area, apple orchards and vineyards, of the Agri river plain, located in the municipalities of Marsico V., Tramutola, Grumento N. and Viggiano (Potenza, Basilicata, Italy).

The aim of this research was to investigate the Carabid assemblages. In Europe several studies gave faunal data on similar agro-ecosystems inhabiting carabids (Kutasi et al., 2004); these studies indicate that variations in cultivation management leads to variations in carabid beetle assemblages. Although the spatial distribution of carabid beetles may be primarily determined by microhabitat conditions and biotic interactions at the local scale, identifying general patterns of carabid responses to different agro-ecosystem managements may help to understand how species, functional groups and assemblages effectively distribute, and to predict how they will cope with current and future land-use and climatic changes (Brandmayr et al., 2011; Kotze et

al., 2011). In previous studies in Europe the following species were mentioned as common (Kutasi et al., 2004): *Pseudoophonus rufipes* (De Geer, 1774), *Harpalus distinguendus* (Duftschmid, 1812), *Harpalus tardus* (Panzer, 1796), *Nebria brevicollis* (Fabricius 1792), *Pterostichus melanarius* (Illiger, 1798), *Poecilus cupreus* (Linnaeus, 1758), *Harpalus affinis* (Schrank, 1781).

MATERIAL AND METHODS

Five traps were activated for a week every month in 12 sampling locations, from May until October. Sampling started on July, 2012 and ended on October, 2014. Locations have been selected according to the type of crop (10 apple orchards and 2 vineyards) and the managing practices (traditional, integrated and organic) (Fig. 1, Table 1). Due to logistic unpredictable problems, some of the locations selected at the beginning of the experiment (samples Aa, Ab and Ac) were not suitable anymore, and since 2013 were displaced with analogous locations, respectively samples G, H and L.

Ground beetles were sampled using plastic pitfall traps (500 ml and 100 mm the diameter of the top) buried in the soil and filled with 50 ml salt water. Pitfalls were covered with a 10 × 10 cm plastic roof to prevent flooding.

The qualitative and quantitative data of the carabid assemblages, recorded in the orchards of the selected areas of Val d'Agri, were analyzed in three different ways: 1) the weighted average of different species in the total catch of the 12 samples; 2) the sum of the scores was calculated (where the most abundant species collected in an orchard were placed in decreasing order, and the dominant species, with highest relative abundance scored 8, the second one 7 etc.; the scores from different orchards were summarised by species: the highest possible score, if a species was dominant in all orchards, was [12 × 8] 96); 3) the presence or absence of the species in the orchards was also investigated. The most widely distributed species (which were found in 12 of the 12 investigated orchards) got 100%; the species, which was collected in 9 orchards, got 75% etc.

Carabids were identified to the species level, if possible, following the nomenclature of Fauna

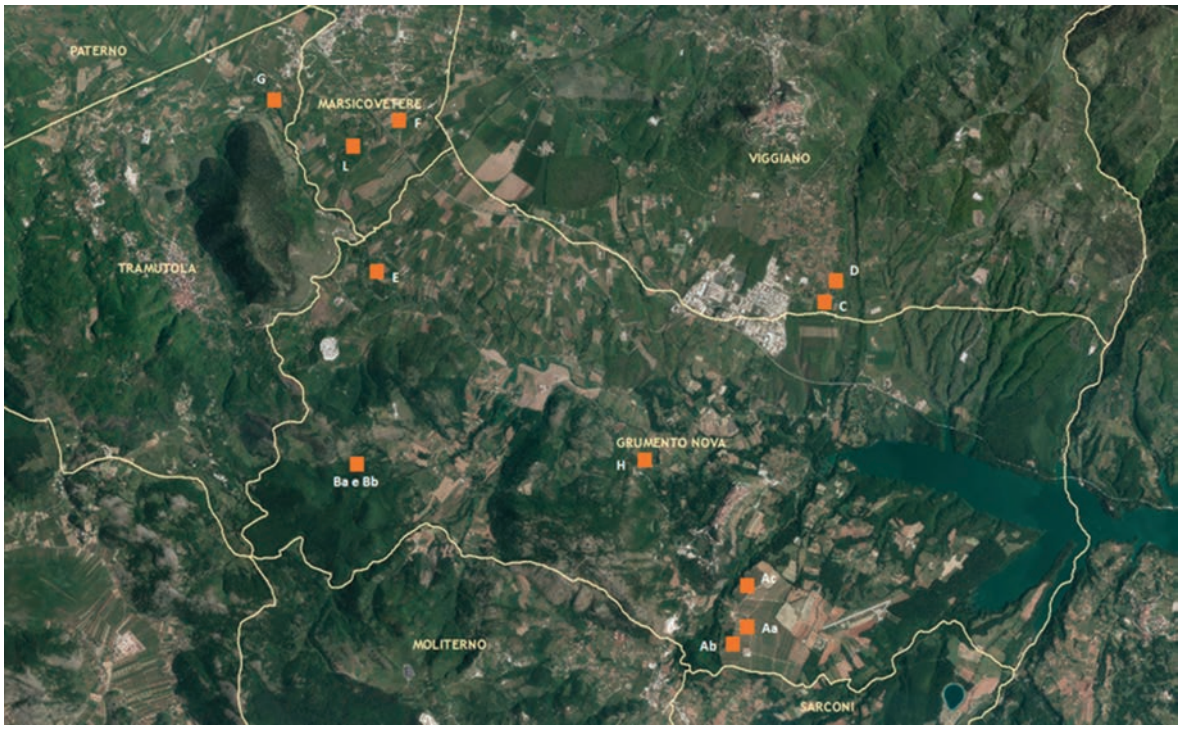

Figure 1. Locations of sampled farms: Val d'Agri (Basilicata, Italy). Modified from AGEA 2011.

FARM	code	Lat. N	Long. E	destination	management	environment
New Ager	Aa	40° 16'	15° 53'	apple orchard	conventional	agro-ecosystem
New Ager	Ab	40° 15'	15° 53'	apple orchard	IPM	agro-ecosystem
New Ager	Ac	40° 16'	15° 53'	apple orchard	IPM	ecosystem
Caputi	Ba	40° 17'	15° 49'	apple orchard	conventional	agro-ecosystem
Caputi	Bb	40° 17'	15° 49'	apple orchard	conventional	near a ditch
Fiorenti	C	40° 18'	15° 54'	apple orchard	abandoned	industrial zone
Fiorenti	D	40° 18'	15° 54'	vineyard	conventional	agro-ecosystem
Donza	E	40° 19'	15° 49'	apple and pear orchard	abandoned	agro-ecosystem
Pisani	F	40° 20'	15° 50'	vineyard	organic	agro-ecosystem
Tropiano	G	40° 21'	15° 49'	apple orchard	conventional	agro-ecosystem
Padula	H	40° 17'	15° 52'	apple orchard	abandoned	agro-ecosystem
Bosco Galdo	L	40° 20'	15° 50'	apple orchard	IPM	agro-ecosystem

Table 1. Localization of farms samples and some their characteristics (Val d'Agri, Basilicata, Italy).

Europaea (Vigna-Taglianti, 2013). Specimens, preserved in alcohol, are stored in the collection of the ENEA Casaccia research centre.

RESULTS

Overall, 1,288 individuals have been collected belonging to 40 carabid species which represent, according to our elaboration of the available data (Casale et al., 2006; Letardi et al., 2014a,b), two thirds of the total carabid fauna reported for this geographic area. The species richness of the investigated carabid assemblages ranged between 4 and 20 in the different orchards: the weighted averages of different species in each samples were not statistically significantly different, nevertheless they show an evident tendency to increase in terms of biodiversity moving from conventional management farms towards organic and semi-abandoned, re-naturalized ones (Table 2). The relatively high biodiversity value in the conventional managed farm New Ager (Aa) could be an exception due to the very few number of samples (just 4, all during 2012) collected: in 2013 and 2014 it was not possible to sample inside the New Ager farm, due to technical logistic impediments.

Qualitative and quantitative data analyses have been performed among the collected carabid species following 3 methods: their proportion in the total catch of the investigated orchards; the scoring of the seven commonest species in the different orchards (total scores) and their presence in the orchards (distribution).

The most abundant species was *Pterostichus melas* (33%) followed by *Pseudoophonus rufipes* (20%), *Brachinus crepitans* (14%), *Harpalus dimidiatus* (8%) and *Poecilus cupreus* (6%). The species which dominated the carabid assemblages (with the total scores) were *Pterostichus melas* (80), *Pseudoophonus rufipes* (79), *Harpalus dimidiatus* (45), *Poecilus cupreus* (18), *Brachinus crepitans* (14), *Carabus rossii* Dejean, 1826 (11) and *Calathus fuscipes* (Goeze, 1777) (10) (Table 3). *Pterostichus melas* and *Pseudoophonus rufipes* were found in all investigated samples (100%), *Harpalus dimidiatus* was found in the 75% of the different habitats, *Poecilus cupreus* was found in the 67%, *Anchomenus dorsalis* (Pontoppidan, 1763) and *Calathus* sp. pr. *montivagus* Dejean, 1831 were found in the 58%, while *Amara* sp. pr. *aenea* (De Geer, 1774) and *Nebria brevicollis* (Fabricius, 1792) were also quite common (50%).

FARM	code	samples	average	standard dev.	species number
New Ager	Aa	4	3.00	±1.83	6
New Ager	Ab	4	1.50	±1.29	4
New Ager	Ac	4	2.25	±1.26	5
Caputi	Ba	17	1.65	±1.27	13
Caputi	Bb	16	1.75	±1.39	13
Fiorenti	C	14	2.93	±1.69	16
Fiorenti	D	17	2.00	±1.84	18
Donza	E	15	4.60	±2.32	18
Pisani	F	17	3.18	±1.70	20
Tropiano	G	12	1.00	±1.28	10
Padula	H	13	2.92	±1.98	17
Bosco Galdo	L	13	1.38	±1.12	10

Table 2. Weighted average of species biodiversity.

It can be concluded that four species *Pterostichus melas*, *Pseudoophonus rufipes*, *Harpalus dimidiatus* and *Poecilus cupreus* were among the commonest species in the investigated samples in respect of all three approaches.

DISCUSSION

Altogether, as a result of our investigations, 40 carabid species, representing about two-thirds of the whole carabid fauna reported in this area in our and previous studies (Casale et al., 2006), were found in apple orchards and vineyards of the medium area of the Agri river plain.

Most of the collected carabids, both in the whole area and in each sample, were species with a wide distribution in the Paleartic region, eurytopic and common in European agroecosystems.

The assemblages were dominated by small-medium, macropterous species, with summer l arvae; we didn't find any endemism (Table 4).

species	Aa	Ab	Ac	Ba	Bb	C	D	E	F	G	H	L	Total score
P. melas	+	14.3	7.3	41	6.2	21.2	62.6	41.2	18.8	52.3	15.9	57.8	80
P. rufipes	46.2	28.6	87.8	6.4	87.7	50	10.1	7.4	12.5	8.1	5.7	15.6	79
H. dimidiatus		37.1		5.1	+	14.4	13.1	23.5	+		8.1	6.3	45
P. cupreus	43.1	+			+	+		10.3		+	7.2	+	18
B. crepitans	+			6.4					+	+	50.5		14
C. rossii				9		+	+		28.1		+		11
C. fuscipes		+	+						5.2	10.5		+	10
A. aenea		+		+			+			5.8	+	+	5
C. convexus									10.4				5
D. clypeatus				5.1							+		4
O. cribricollis		+		5.1						+			4
C. preslii				+		+			5.2		+		3
specimen n°	65	35	41	78	65	52	99	68	96	86	333	270	
species n°	6	10	4	17	5	10	13	13	16	18	18	20	

Table 3. Relative abundance (%) and the total scores of the most abundant carabid species.
Relative abundance lower than 5% were marked with +.

Aa	**Bb**	**D**	**G**
Brachinus crepitans	*Nebria brevicollis*	*Trechus quadristriatus*	*Amara* sp. pr. *aenea*
Calathus circumseptus	*Poecilus cupreus*		*Calathus fuscipes*
Nebria brevicollis	*Pseudoophonus rufipes*	**E**	*Egadroma* cfr. *marginatum*
Poecilus cupreus	*Pterostichus melas*	*Amara* sp.pr. *aenea*	*Harpalus dimidiatus*
Pseudoophonus rufipes	*Pterostichus* cfr. *nigrita*	*Anchomenus dorsalis*	*Harpalus distinguendus*
Pterostichus melas	*Trechus quadristriatus*	*Brachinus crepitans*	*Ophonus cribricollis*
		Calathus circumseptus	*Poecilus cupreus*
Ab	**C**	*Calathus* sp. pr. *montivagus*	*Pseudoophonus rufipes*
Calathus fuscipes	*Acinopus megacephalus*	*Carabus preslii*	*Pterostichus melas*
Harpalus serripes	*Anchomenus dorsalis*	*Carabus rossii*	*Pterostichus* cfr. *nigrita*
Pseudoophonus rufipes	*Brachinus crepitans*	*Carterus* cfr. *fulvipes*	
Pterostichus melas	*Calathus cinctus*	*Chlaenius chrysocephalus*	**H**
	Calathus circumseptus	*Ditomus clypeatus*	*Amara* sp.pr. *aenea*
Ac	*Calathus fuscipes*	*Drypta dentata*	*Brachinus crepitans*
Acinopus megacephalus	*Calathus* sp. pr. *montivagus*	*Harpalus dimidiatus*	*Calathus cinctus*
Harpalus dimidiatus	*Carabus convexus*	*Harpalus distinguendus*	*Calathus circumseptus*
Poecilus cupreus	*Carabus preslii*	*Nebria brevicollis*	*Calathus* sp. pr. *montivagus*
Pseudoophonus rufipes	*Carabus rossii*	*Ophonus* sp.	*Carabus preslii*
Pterostichus melas	*Cychrus italicus*	*Poecilus cupreus*	*Carabus rossii*
	Harpalus dimidiatus	*Pseudoophonus rufipes*	*Cryptophonus tenebrosus*
Ba	*Pseudoophonus rufipes*	*Pterostichus melas*	*Ditomus clypeatus*
Agonum sordidum	*Pterostichus melas*		*Harpalus dimidiatus*
Amara sp.pr. aenea	*Pterostichus* cfr. *nigrita*	**F**	*Harpalus distinguendus*
Anchomenus dorsalis	Carabidae sp. 1	*Agonum sordidum*	*Harpalus serripes*
Calathus sp.pr. montivagus		*Amara* sp.pr. *aenea*	*Harpalus* sp.
Carabus rossii	**D**	*Anchomenus dorsalis*	*Ophonus cribricollis*
Cryptophonus tenebrosus	*Amara* sp. pr. *aenea*	*Brachinus sclopeta*	*Ophonus* (*Metophonus*) sp.
Cymindis miliaris	*Anchomenus dorsalis*	*Calathus cinctus*	*Pseudoophonus rufipes*
Harpalus dimidiatus	*Brachinus crepitans*	*Calathus fuscipes*	*Pterostichus melas*
Harpalus sp.	*Bradycellus* cfr. *verbasci*	*Calathus* sp. pr. *montivagus*	
Nebria brevicollis	*Calathus cinctus*	*Carterus* cfr. *fulvipes*	**L**
Pseudoophonus rufipes	*Calathus fuscipes*	*Harpalus dimidiatus*	*Anchomenus dorsalis*
Pterostichus melas	*Calathus* sp. pr. *montivagus*	*Harpalus distinguendus*	*Calathus circumseptus*
Pterostichus cfr. nigrita	*Carterus* cfr. *fulvipes*	*Harpalus* sp.	*Calathus* sp. pr. *montivagus*
	Cryptophonus tenebrosus	*Harpalus* sp.pr. *affinis*	*Carabus preslii*
Bb	*Cymindis miliaris*	*Lebia sp.*	*Carabus rossii*
Agonum sordidum	*Harpalus serripes*	*Nebria brevicollis*	*Harpalus dimidiatus*
Anchomenus dorsalis	*Nebria brevicollis*	*Olisthopus* cfr. *fuscatus*	*Poecilus cupreus*
Brachinus sclopeta	*Olisthopus* cfr. *fuscatus*	*Poecilus cupreus*	*Pseudoophonus rufipes*
Cychrus italicus	*Ophonus cribricollis*	*Pseudoophonus rufipes*	*Pterostichus melas*
Harpalus dimidiatus	*Poecilus cupreus*	*Pterostichus melas*	Carabidae sp. 2
Harpalus serripes	*Pseudoophonus rufipes*	*Trechus quadristriatus*	
Harpalus sp.	*Pterostichus melas*	Carabidae sp. 2	

Table 3. Species collected in each locality (Val d'Agri, Basilicata, Italy).

The common species in agro-environments investigated were the same as those usually found in field crops and which can be considered as "disturbance-tolerant" species.

The number of captures, qualitative and quantitative data here reported have shown a clear tendency to be more abundant moving from conventional towards to organic managements, not supported by a solid statistical analysis; therefore sampling more distributed in terms of time and replicates would be necessary to provide more suitable data.

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