Diversity in the Herpetobiont Ground Beetle Assemblage (Coleoptera, Carabidae) in the Val Grande National Park, Italy

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Abstract: We evaluated the richness, diversity, and assemblage of Carabidae in the Val Grande National Park. Monitoring, by pitfall-trapping, was performed in 2021–2022 in two sites (S1 and S2), and considering six vegetation habitats ("Terraced ferns", "Terraced grassland", "Wood", "Chestnut grove", "Ecotone", and "Grassland"). A total of 2707 carabids consisting of 34 species were collected. The assemblage displayed the dominance of *Calathus fuscipes graecus* (27%), followed by *Carabus glabratus latior* (15%), and *Carabus problematicus problematicus* (15%). Besides the species already known for the Park, seven further species have been recorded. While in S1 the carabid assemblage was unexpectedly poor, a rich biodiversity with an excellent balance among the numerous brachypterous, macropterous, and pteropolymorphous species was recorded in S2. The species recorded in the habitat "Terraced ferns" and in "Ecotone" constituted the dominant groups and they accounted for 51% and 41%, in S1 and S2, respectively. The awareness of the species composition, richness, and ecology can be a useful tool for the Park to address the management of the surfaces in order to avoid disturbing the carabid fauna, especially for carabids of conservation concern, to mitigate their potential decline.

Keywords: Carabidae; distribution; biodiversity; bioindicator; forest insects

1. Introduction

Carabid beetles (Coleoptera, Carabidae) are one of the most common and numerous beetle families, with over 40,000 species worldwide [1–3]. Among the Italian fauna, they are represented by around 1300 species [4]. Adults are rather homogeneous in appearance, varying in size from less than 1 to 80 mm and they are characterised by long cursorial legs, jutting mandibles and palps, striated elytra, and groups of tactile bristles. Campodeiform larvae have well-developed legs, antennae, and mandibles and carry fixed urogomphi [5,6]. Most carabids are generalist predators with a high ability to adapt to differentiated habitats, even if some groups include specialist predators or phytophagous [7]. Carabid beetles are involved in copious ecosystem services and functions, playing direct or indirect roles in soil formation and structure, energy flow, and nutrient cycling [8,9]. They also contribute to pest regulation [10] and serve as food for a wide range of animals [11]. Carabids are well-known from a taxonomic point of view, and they have been particularly well investigated throughout Europe over the past century, with several studies describing changes in their abundance and range [12]. They can be efficiently collected, by an easily standardisable field method, pitfall-trapping. Moreover, they are used for the characterisation of different environments, both natural and anthropised [13,14]. Indeed, they are indicators of ecosystem quality, since carabidocoenoses respond, directly or indirectly, to changes in ecosystem management and human activities [15–17]. Niemelä [17] reported

a list of potential criteria for the selection of bioindicators, and carabids fulfilled several requirements for a bioindicator (biologically relevant, sensitive, large geographic coverage, cost-effective, historical databases).

The increase in disturbance is leading to a reduction in the quantity of species and individuals [18–20], affecting above all large-sized and specialist species with lower possibilities of dispersion [21]. However, not all carabids seem to be impacted by anthropogenic activities; smaller, generalist species with a good dispersal activity, or species that prefer arid conditions could be favoured [20,22].

The aim of this research, carried out over a two-year period, was to promote knowledge about the carabid beetle community inhabiting different vegetation habitats in the Val Grande National Park in NW Italy. Specifically, we aimed to answer the following questions: (i) do the carabid richness and abundance differ in the investigated area? (ii) do the carabid species found in different vegetation habitats exhibit distinct patterns of catch rates?

2. Materials and Methods

2.1. Study Area

The investigated area is located in the Val Grande National Park (Piedmont, NW Italy, 17,021 ha). In the lower Val Grande, mixed broadleaf forests predominate with a prevalence of chestnut trees. The beech is, on the other hand, the most widespread arboreal species of the upper Val Grande, mostly on the humid and less sunny slopes, but also on the southern ones, as a result of the high rainfall of this area. The coniferous forests, whose main species are spruce and white fir, are added to beechwoods, albeit that they are limited by extension.

The research was carried out in the municipalities of Premosello-Chiovenda (hamlet of Colloro, locality Ronchi, 46°00′35.91″ N, 08°20′13.60″ E), hereafter called S1, and Cossogno (hamlet of Cicogna, 45°59′57.57″ N, 08°29′09.94″ E), hereafter called S2 (see Supplementary Figure S1). The investigated area in S1 faces south and has an elevation ranging from 491 to 510 m a.s.l., covering an area of 9662 m^2. The studied area in S2 faces south-east and has an elevation ranging from 674 to 755 m a.s.l., covering an area of 42,390 m^2. The climate is sub-Atlantic, with very high average yearly rainfall (higher than 1500 mm/yr in nearby Verbania Weather Station, [23]), with a precipitation minimum during winter months and no dry summers (see Supplementary Figure S2). The lithological substrate is sialic glacial till and slope materials in S1, and granulite and gneiss in S2. The soils are acidic, thick, and very rich in organic matter, particularly in unglaciated S2. They are also characterised by a very low bulk density and high porosity, and high Al-oxides contents. According to the WRB classification [24] they are classified as Cambic Umbrisols (Loamic, Densic) in S1, and Cambic Umbrisol (Hyperhumic, Loamic) in S2. Three soil profiles in S1 were described and sampled in Colloro (Co0, Coa1, Cob), and in S2 in Cicogna (P1, P2, P3). Field data and classification were performed according to IUSS [24], and laboratory analysis following van Reuwjik [25] (see Supplementary Figure S3; Supplementary Tables S1–S4).

Due to the considerable ecological and vegetation heterogeneity of the sampled area, we identified six "macro-units" or "vegetation habitats", namely:

terraced polyphitic meadow (mainly *Lolium pratense* (Hudson) Darbysh.) dominated by ferns in S1 (hereafter reported as "Terraced ferns");
terraced polyphitic meadow (mainly *L. pratense*) with absence of ferns in S1 (hereafter reported as "Terraced grassland");
broadleaved wood (dominated by *Castanea sativa* Miller, 1768, *Fraxinus ornus* Linnaeus, 1753, *Acer pseudoplatanus* Linnaeus, 1753, *Betula pendula* Roth, 1788) in S1 (hereafter reported as "Wood");
Castanea sativa wood (Habitats Directive Annex I habitat type 9260) in S2 (hereafter reported as "Chestnut grove");
ecotone (transition environment between *C. sativa* wood and polyphitic meadow) in S2 (hereafter reported as "Ecotone");

polyphitic meadow (mainly *L. pratense*, *Plantago lanceolata* Linnaeus, 1753, *Taraxacum officinalis* (Weber) ex Wiggers, 1780, and *Vicia cracca* Linnaeus, 1753) in S2 (hereafter reported as "Grassland").

2.2. Trapping

Carabid beetles were monitored using pitfall traps in all sites and years. For an efficient sampling strategy, a careful plan was carried out considering the number of traps and their spatial arrangement. Specifically, traps were aligned forming a transect, with a fixed inter-trap distance (2–3 m) in accordance with Ahmed [26], deviating from this value only in the case of the presence of stone walls and different height gradients. A total of 12 and 45 traps were placed in S1 and S2, respectively, according to the vegetation habitat (4 traps per vegetation habitat in S1, and 15 traps per habitat in S2). Pitfall traps consisted of a plastic cup (diameter at the top: 7.0 cm, diameter at the base: 4.5 cm, height: 8.5 cm) placed in the ground and covered with a plastic lid to prevent flooding, reduce the evaporation of the vinegar, and decrease vertebrate bycatch. The plastic glasses were filled three quarters with red vinegar (Ponti® Ghemme (NO), Ghemme, Italy; acidity 6%) for attractivity and dish soap for breaking surface tension [10,27,28]. Surveys were conducted continuously from the beginning of April until October. During this time, traps were recovered every 15 days, and all carabid species were counted and then placed in 50 mL plastic tubes (Sarstedt Ag. & Co., Nümbrecht, Germany) filled with 60% ethanol to preserve the insects. After sorting, adults were identified at the Department of Agricultural, Forest and Food Sciences (DISAFA), using dichotomous keys [29–37]. Voucher specimens representing taxa collected in this study were deposited at the DISAFA.

2.3. Statistics

The classical four-level classification for soil invertebrates [38], modified by Sharova [39] with the initiation of a 5th category "eudominant", was used for the determination of the dominance structure of the communities: eudominants (with a degree of dominance over 10%), dominants (5% to 10%), subdominants (2% to 5%), recedents (1% to 2%), subrecedents (<1%) [40].

Catches were expressed as "Activity Density" (AD), i.e., the number of individuals/traps over the standard 15-day period/the total number of days of exposure [41,42].

Shannon–Wiener (1) and Simpson (2) diversity indexes were calculated for each plot, aiming to determine the potential value of carabids as biodiversity indicators in the studied habitats and to investigate the biological diversity of the carabids' community.

$$H' = -\sum_{i=1}^{S} p_i * log(p_i) \tag{1}$$

$$D' = 1 - \sum_{i=1}^{S} (p_i)^2 \tag{2}$$

To gain a better overview of the population structure and to assess similarities in the composition of carabid assemblage in the monitored sites a non-metric multidimensional scaling (NMDS) based on the Euclidean distance of the abundance of the species was used [42,43]. To ensure solution stability, we used 20 runs for all NMDS analyses with random start points [44]. Furthermore, a principal component analysis (PCA) was used to determine the associations between habitats and species, providing insight into the influence of different habitats on the carabid community structure.

All statistical analyses were conducted using R software (4.4.1).

3. Results

A total of 2707 carabid beetles consisting of 34 species, from 17 genera and six subfamilies were collected (Table 1). The lowest number of specimens was recorded in S1

(163 individuals), while in S2 a total of 2544 individuals were collected in the two-year period. Several Geotrupidae, Nitidulidae, Silphidae, and Staphylinidae were also found in pitfall traps, but only Carabidae were identified.

The ground beetle assemblage displayed the dominance of *Calathus fuscipes graecus* Dejean, 1831 (730 individuals, 27.0% of the total catch), followed by *Carabus glabratus latior* Born, 1895 (412 individuals, 15.2% of the total catch), *Carabus problematicus problematicus* Herbst, 1786 (402 individuals, 14.9% of the total catch), and *Pseudoophonus rufipes* (De Geer, 1774) (382 individuals, 14.1% of the total catch), all together accounting for 71.2% of the total catches.

In the two-year period, the sex ratio analysis showed a predominance of female specimens: for S1, the sex ratio male/females was 0.32 (40 males and 123 females), while in S2 it was 0.50 (850 males and 1694 females) (Table 1). The investigated fauna of ground beetles included twelve zoogeographical elements: Holarctic, Palearctic, West-Palearctic, Asiatic-European, Sibero-European, Centralasiatic-European, Europeo-Mediterranean, European, Centraleuropean, South-European, South-Alpine endemic, and Alpino-Appenninic endemic species.

Open habitat species showed a dominant proportion (62.4%) in S1, with a much lower percentage of forest species (18.8%), and no species strictly associated with wet biocenosis. Only three species (namely *Carabus germari fiorii* Born, 1901, *Bembidion lampros* (Herbst, 1784), *P. rufipes*) were found belonging to intermediate ecological categories (18.8%).

In S2, both open habitat and forest species showed a dominant proportion (27.6% and 34.5%, respectively), with a much lower percentage of hygrophilous species (6.9%). In this site nine species (namely *C. germari fiorii*, *C. problematicus problematicus*, *Parophonus maculicornis* (Duftschmid, 1812), *P. rufipes*, *Cymindis cingulata* Dejean, 1825, *Laemostenus janthinus coeruleus* (Dejean, 1828), *Limodromus assimilis* (Paykull, 1790), *Abax baenningeri* Schauberger, 1927, and *B. lampros*) were found belonging to intermediate ecological categories (31%). Macropterous and brachypterous species represented 45.4% and 39.8% of all collected carabid species, respectively (in all sites and years).

The analysis of the dominance structure for S1 showed the presence of three eudominants: (*Abax contractus* (Heer, 1841), *Harpalus rufipalpis rufipalpis* (Sturm, 1818), and *Harpalus tardus* (Panzer, 1797)) in 2021 and two (*A. contractus* and *P. rufipes*) in 2022; three dominants (*Harpalus serripes serripes* (Quensel in Schönherr, 1806), *Harpaluus subcylindricus* Dejean, 1829, and *Pseudoophonus calceatus* (Duftschmid, 1812)) in 2021, and three (*H. tardus*, *P. calceatus*, *Pseudoophonus griseus* (Panzer, 1796)) in 2022; no subdominants in 2021 and two (*Carabus convexus convexus* Fabricius, 1775, *Pterostichus micans* Heer, 1841) in 2022; no recedents in 2021 and four (*Amara convexior* Stephens, 1828, *Amara fulvipes* (Audinet-Serville, 1821), *C. fuscipes graecus*, *H. subcylindricus*) in 2022; six subrecedents (*A. convexior*, *Calathus cinctus* Motschulsky, 1850, *C. germari fiorii*, *B. lampros*, *P. griseus*, *P. micans*) in 2021 and none in 2022. The study of the dominance structure for S2 showed the presence of four eudominants (*C. fuscipes graecus*, *C. glabratus latior*, *C. problematicus problematicus*, *P. rufipes*) in 2021 and four (*C. fuscipes graecus*, *C. problematicus problematicus*, *P. griseus*, *P. rufipes*) in 2022; no dominants in 2021 and one (*C. glabratus latior*) in 2022; five subdominants (*A. contractus*, *C. convexus convexus*, *H. rufipalpis rufipalpis*, *P. griseus*, *P. micans*) in 2021 and three (*A. contractus*, *H. rufipalpis rufipalpis*, *P. micans*) in 2022; two recedents (*Carabus intricatus* Linnaeus, 1761, *H. tardus*) in 2021 and three (*C. convexus convexus*, *C. intricatus*, *H. tardus*) in 2022; 13 subrecedents (*A. baenningeri*, *A. convexior*, *Calathus rubripes* (Dejean, 1831), *Calosoma sycophanta* (Linnaeus, 1758), *Carabus granulatus interstitialis* Duftschmid, 1812, *C. germari fiorii*, *Cychrus italicus* Bonelli, 1810, *C. cingulata*, *Harpalus atratus* Latreille, 1804, *Harpalus marginellus* Dejean, 1829, *B. lampros*, *P. maculicornis*, *Syntomus truncatellus* (Linnaeus, 1760)) in 2021 and 11 in 2022 (*A. baenningeri*, *Amara bifrons* (Gyllenhal, 1810), *A. convexior*, *Calathus melanocephalus* (Linnaeus, 1758), *C. granulatus interstitialis*, *C. italicus*, *C. cingulata*, *H. atratus*, *L. janthinus coeruleus*, *L. assimilis*, *Stomis roccae roccae* Schatzmayr, 1925). The frequency of the number of species by category is shown in Figure 1.

Table 1. List of carabid species collected in the municipalities of Premosello-Chiovenda (S1) and Cossogno (S2) in the two-year period (2021–2022). For each species the sex, chorotype, ecology, and wings are reported.

No.	Species	Premosello-Chiovenda		♂	♀	Cossogno		♂	♀	Chorotype	Ecology	Wings
		2021	2022			2021	2022					
Family Carabidae												
Subfamily Carabinae												
1	*Calosoma* (*Calosoma*) *sycophanta* (Linnaeus, 1758)	0	0	-	-	10	0	5	5	PAL (OLA)	B	M
2	*Carabus* (*Carabus*) *granulatus interstitialis* Duftschmid, 1812	0	0	-	-	6	3	3	6	ASE (OLA)	I	P
3	*Carabus* (*Chaetocarabus*) *intricatus* Linnaeus, 1761	0	0	-	-	30	16	15	31	EUR	B	B
4	*Carabus* (*Megodontus*) *germari fiorii* Born, 1901	1	0	0	1	1	0	0	1	SEU	A (B)	B
5	*Carabus* (*Mesocarabus*) *problematicus problematicus* Herbst, 1786	0	0	-	-	292	110	183	219	EUR	A–B	B
6	*Carabus* (*Oreocarabus*) *glabratus latior* Born, 1895	0	0	-	-	342	70	133	279	EUR	B	B
7	*Carabus* (*Tomocarabus*) *convexus convexus* Fabricius, 1775	0	2	0	2	54	11	14	51	SIE	B	B
8	*Cychrus italicus* Bonelli, 1810	0	0	-	-	15	2	7	10	SEU (ALAP)	B	B
Subfamily Harpalinae												
9	*Harpalus* (*Harpalus*) *atratus* Latreille, 1804	0	0	-	-	3	1	1	3	EUR	B	B
10	*Harpalus* (*Harpalus*) *marginellus* Dejean, 1829	0	0	-	-	1	0	0	1	CEU	A	P
11	*Harpalus* (*Harpalus*) *rufipalpis rufipalpis* (Sturm, 1818)	32	0	3	29	38	25	14	49	SIE	A	M
12	*Harpalus* (*Harpalus*) *serripes serripes* (Quensel in Schönherr, 1806)	8	0	2	6	0	0	-	-	PAL	A	M
13	*Harpalus* (*Harpalus*) *subcylindricus* Dejean, 1829	6	1	1	6	0	0	-	-	SEU	A	M
14	*Harpalus* (*Harpalus*) *tardus* (Panzer, 1797)	17	3	7	13	24	13	17	20	ASE	A	M
15	*Parophonus* (*Parophonus*) *maculicornis* (Duftschmid, 1812)	0	0	-	-	1	0	0	1	SEU	A-B	M
16	*Pseudoophonus* (*Platus*) *calceatus* (Duftschmid, 1812)	6	4	0	10	0	0	-	-	ASE	A	M
17	*Pseudoophonus* (*Pseudoophonus*) *griseus* (Panzer, 1796)	1	5	1	5	74	103	86	91	PAL	A	M
18	*Pseudoophonus* (*Pseudoophonus*) *rufipes* (De Geer, 1774)	0	6	2	4	179	197	116	260	PAL (OLA)	A–B	M
Subfamily Lebiinae												
19	*Cymindis* (*Cymindis*) *cingulata* Dejean, 1825	0	0	-	-	1	2	2	1	CEU	A (B)	M
20	*Syntomus truncatellus* (Linnaeus, 1760)	0	0	-	-	3	0	1	2	SIE	B	P

Table 1. *Cont.*

No.	Species	Premosello-Chiovenda		♂	♀	Cossogno		♂	♀	Chorotype	Ecology	Wings
		2021	2022			2021	2022					
Subfamily Platyninae												
21	*Calathus* (*Calathus*) *fuscipes graecus* Dejean, 1831	0	1	1	0	406	323	203	526	EUM	A (B)	B
22	*Calathus* (*Calathus*) *rubripes* (Dejean, 1831)	0	0	-	-	3	0	0	3	SEU (ALAP)	B	B
23	*Calathus* (*Neocalathus*) *cinctus* Motschulsky, 1850	1	0	0	1	0	0	-	-	WPA	A	P
24	*Calathus* (*Neocalathus*) *melanocephalus* (Linnaeus, 1758)	0	0	-	-	0	2	0	2	PAL	A	P
25	*Laemostenus* (*Laemostenus*) *janthinus coeruleus* (Dejean, 1828)	0	0	-	-	0	1	0	1	SEU (ALPS)	A (B)	B
26	*Limodromus assimilis* (Paykull, 1790)	0	0	-	-	0	1	1	0	SIE	I–B	M
Subfamily Pterostichinae												
27	*Abax* (*Abax*) *baenningeri* Schauberger, 1927	0	0	-	-	1	1	0	2	SEU (ALPS)	A–B	B
28	*Abax* (*Abax*) *contractus* (Heer, 1841)	34	28	20	42	44	36	16	64	SEU (ALPS)	B	B
29	*Amara* (*Amara*) *convexior* Stephens, 1828	1	1	0	2	9	2	6	5	SIE	A	M
30	*Amara* (*Celia*) *bifrons* (Gyllenhal, 1810)	0	0	-	-	0	1	0	1	CAE	A	M
31	*Amara* (*Zezea*) *fulvipes* (Audinet-Serville, 1821)	0	1	1	0	0	0	-	-	EUR	A	M
32	*Pterostichus* (*Pterostichus*) *micans* Heer, 1841	1	2	2	1	63	19	26	56	SEU (ALAP)	B	B
33	*Stomis* (*Stomis*) *roccae roccae* Schatzmayr, 1925	0	0	-	-	0	1	0	1	SEU (ALAP)	I	B
Subfamily Trechinae												
34	*Bembidion* (*Metallina*) *lampros* (Herbst, 1784)	1	0	0	1	4	0	1	3	PAL (OLA)	A (I)	P
TOT		109	54	40	123	1604	940	850	1694			

Legend: Chorotype of the species, OLA: Holarctic, PAL: Palearctic, WPA: West-Palearctic, ASE: Asiatic-European, SIE: Sibero-European, CAE: Centralasiatic-European, EUM: Europeo-Mediterranean, EUR: European, CEU: Centraleuropean, SEU: South-European, ALPS: South-Alpine endemic, ALAP: Alpino-Appenninic endemic. *Ecology* A: Open habitat species, B: Forest species, I: Hygrophilous species. *Wings* B: Brachypterous, M: Macropterous, P: Pteropolymorphous.
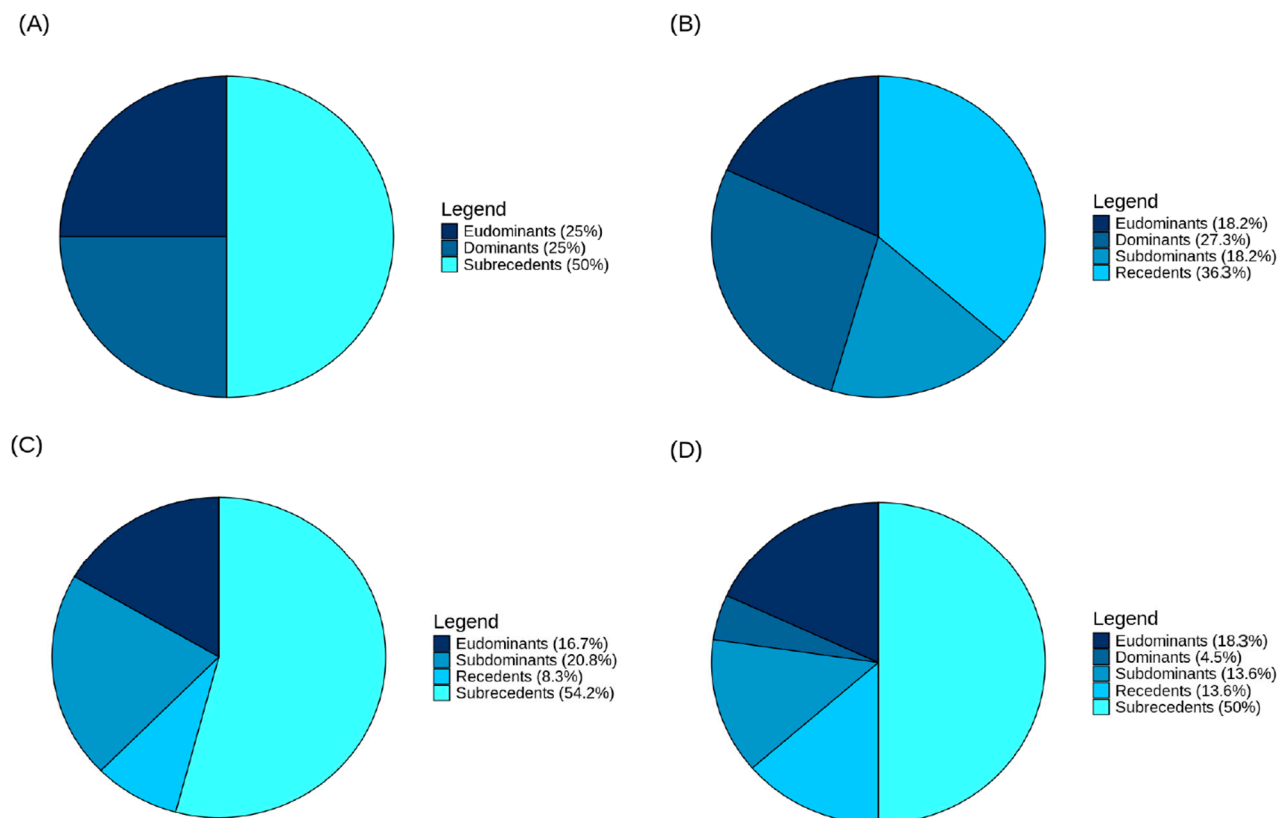
Figure 1. Dominance structure of the carabid assemblage in the municipality of Premosello-Chiovenda (S1) in 2021 (**A**) and in 2022 (**B**) and in the municipality of Cossogno (S2) in 2021 (**C**) and in 2022 (**D**).

The assessment of the Activity Density (AD) in S1 and S2 is represented in the histograms of Figure 2. In S1 high dissimilarities occurred in the habitat "Terraced ferns" with an AD of 1.89 ± 0.70 in 2021 and 0.37 ± 0.10 in 2022. "Terraced grassland" and "Wood" showed a similar AD (0.42 ± 0.15 in 2021 vs. 0.59 ± 0.14 in 2022 for "Terraced grassland"; 0.72 ± 0.52 in 2021 vs. 0.72 ± 0.45 in 2022 for "Wood") (Figure 2A). In S2, a higher AD was found in "Ecotone" (5.73 ± 1.02) and "Grassland" (3.89 ± 0.53) in 2021, in contrast to what we observed for "Chestnut grove" (2.85 ± 0.45). In 2022 similar AD values occurred in all the habitats (Figure 2B).

The average number of species per trap for each habitat showed that, overall, the higher number of species was caught in 2021, especially in S2. "Terraced ferns" and "Grassland" were the habitats with the higher number of species recorded, in S1 and S2, respectively (Figure 3).

The Shannon's and Simpson's indices were calculated in Premosello-Chiovenda (S1) and in Cossogno (S2) (Figure 4A–D).

The Shannon index, calculated for S1, showed that the habitats "Terraced ferns" (1.65 in 2021 and 1.81 in 2022) and "Grassland" (1.67 in 2021 and 1.87 in 2022) were the richest and showed a similar trend (Figure 4A), while the habitat "Wood" displayed a lower richness (0.77 in 2021 and 0.77 in 2022). As for the Simpson's index, we observed the same pattern, with the habitats "Terraced ferns" (0.74 in 2021 and 0.82 in 2022) and "Grassland" (0.77 in 2021 and 0.83 in 2022) having a higher diversity and the habitat "Wood" having a lower richness in both years (0.36 in 2021 and 0.39 in 2022) (Figure 4C).
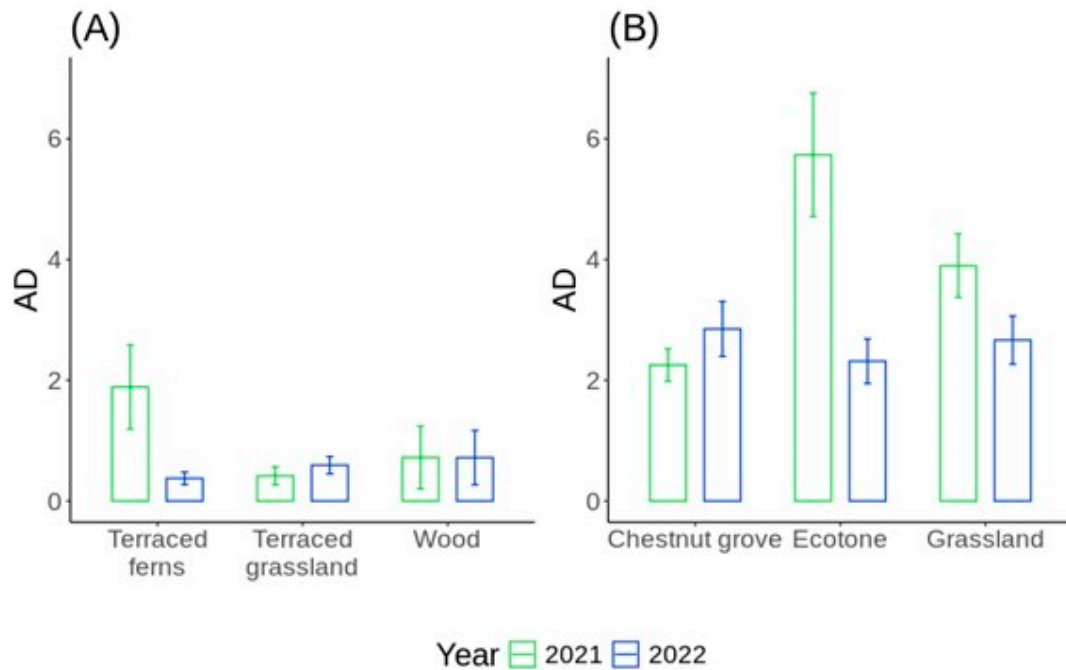
Figure 2. Activity Density (AD), to be referred to as the total number of individuals/traps in the standard 15-day period $\pm$ SE, in Premosello-Chiovenda (S1) (**A**) and Cossogno (S2) (**B**) in the two-year period 2021–2022.
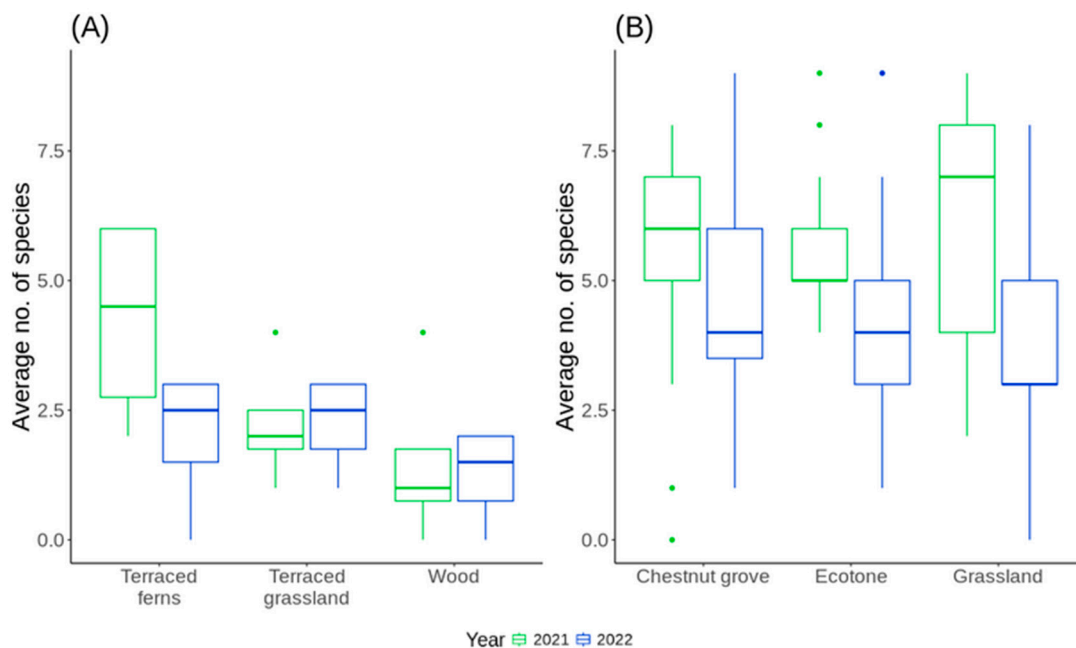

Figure 3. Average number of species per trap collected in 2021 and 2022 in Premosello-Chiovenda (S1) (**A**) and Cossogno (S2) (**B**).

For S2, the Shannon index showed that the habitats with the higher richness were "Chestnut grove" (2.21 in 2021 and 1.86 in 2022) and "Grassland" (2.1 in 2021 and 1.85 in 2022), while the habitat with the lower diversity was "Ecotone" (1.64 in 2021 and 1.79 in 2022) (Figure 4B). Thus, the Simpson's index (Figure 4D) showed a higher value in 2022 in "Ecotone" (0.74 in 2021 and 0.8 in 2022), unlike in "Chestnut grove" (0.86 in 2021 and 0.77 in 2022) and "Grassland" (0.84 in 2021 and 0.78 in 2022), where the highest values were reported in 2021.
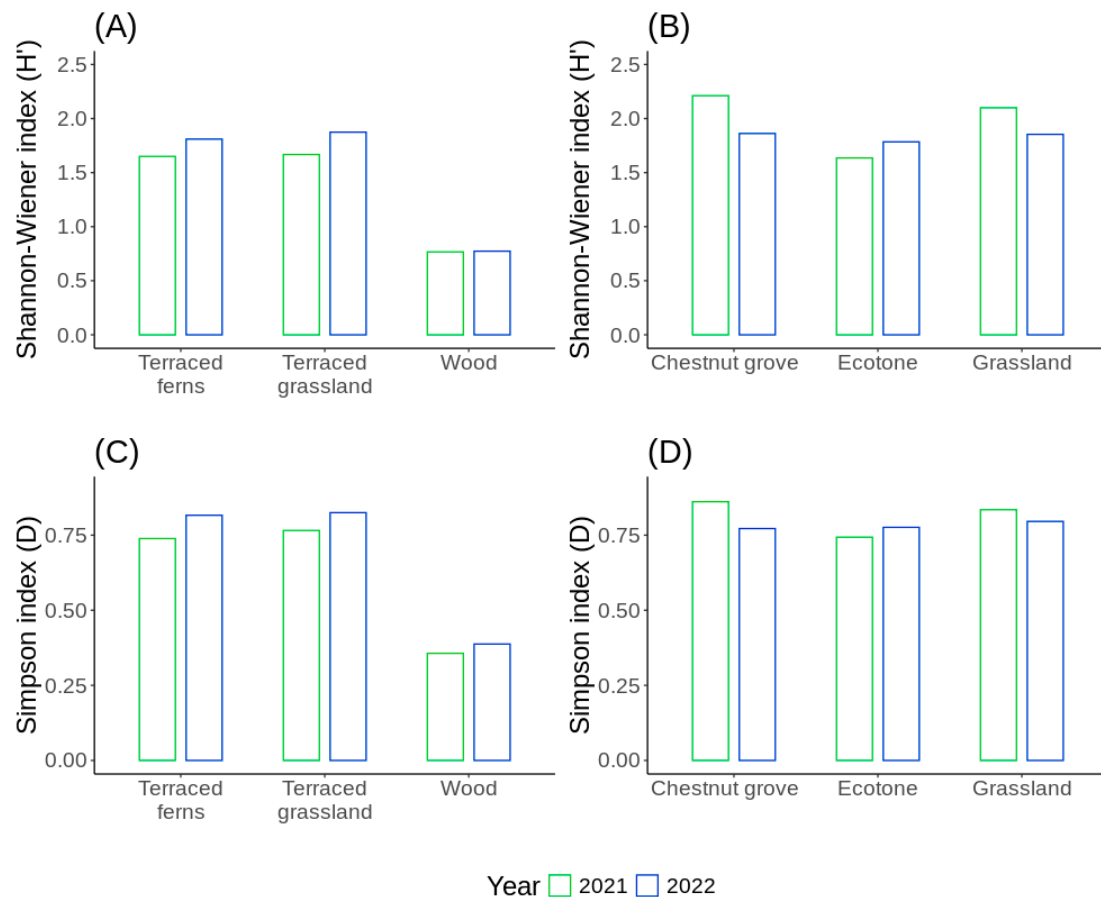
Figure 4. Shannon's and Simpson's indices calculated in Premosello-Chiovenda (S1) (**A**,**C**) and in Cossogno (S2) (**B**,**D**).

To investigate the similarities among habitats, a NMDS was carried out. For S1, the habitats "Terraced ferns" and "Terraced grassland" appeared distinct and separate, while the habitat "Wood" intersected with both "Terraced ferns" and "Terraced grassland" (Figure 5). For S2, "Ecotone" and "Grassland" as well as "Chestnut grove" and "Grassland" intersected only marginally, while "Ecotone" and "Chestnut grove" overlapped almost completely (Figure 6).

The PCA biplot for S1 displays the distribution of species along the first two principal components, which together explain 98% of the total variance (58.6% by Dim1 and 39.4% by Dim2) (Figure 7). Species were differentiated by habitat: "Terraced ferns", "Terraced grassland" and "Wood". Figure 7 shows that species 1, 3, 8, 11 are associated with the habitat "Terraced ferns", species 2, 4, 5, 7, 15, 16 with "Terraced grassland", while species 6, 9, 10, 14 are related to the habitat "Wood".
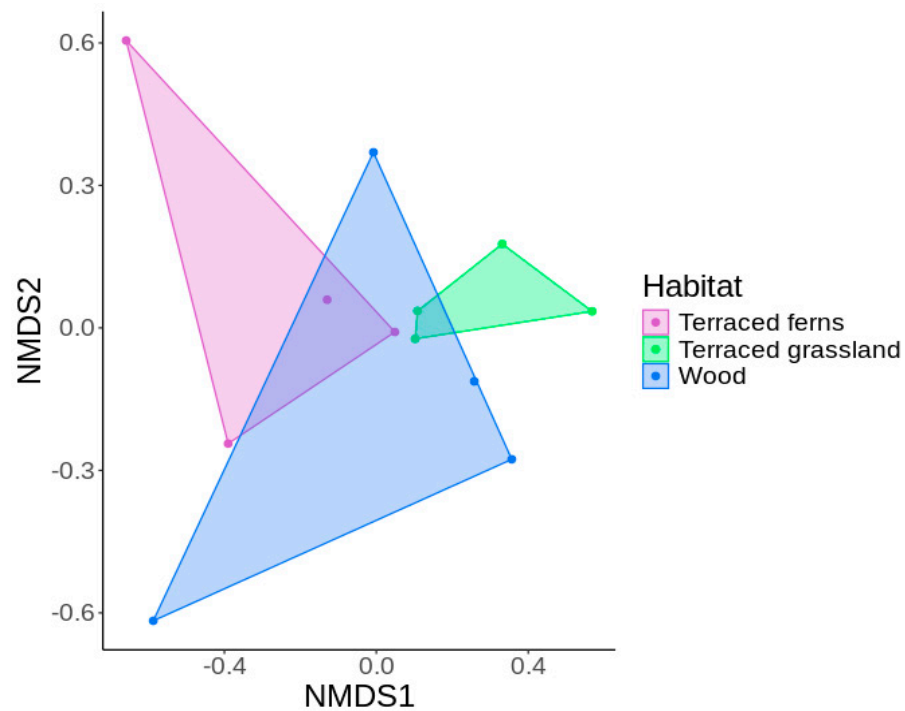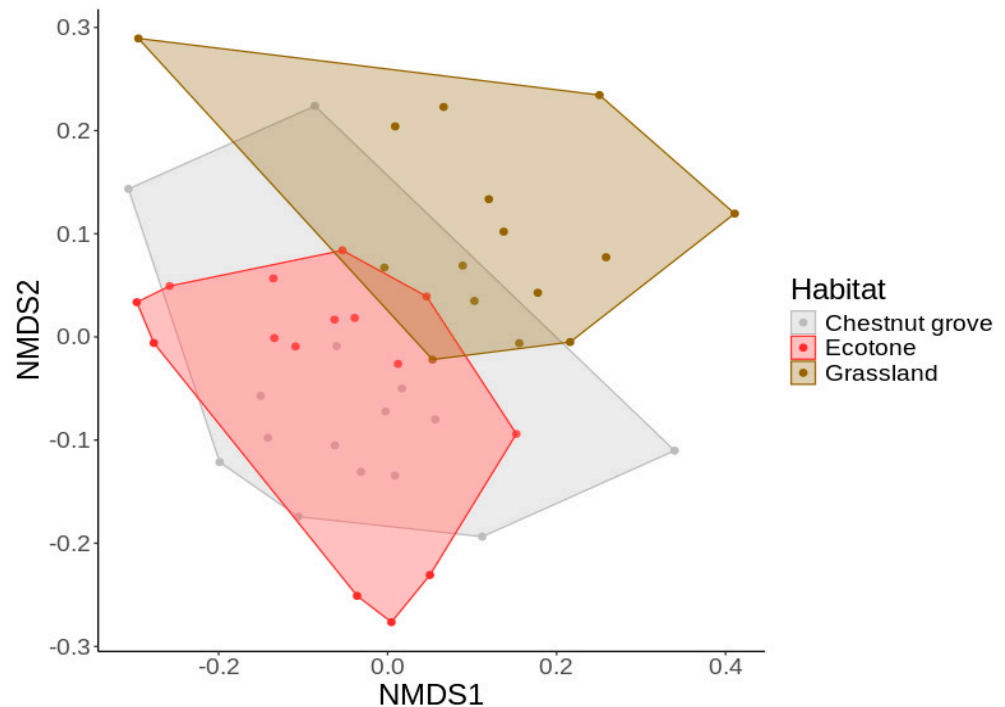
Figure 5. Non-metric multidimensional scaling (NMDS) ordination using Euclidean dissimilarity for carabid morphospecies assemblages (stress = 0.097, k = 2) in the municipality of Premosello-Chiovenda (S1). Each data point represents a trap, with purple circles representing the habitat "Terraced ferns", green circles representing "Terraced grassland", and blue circles representing "Wood".

Figure 6. Non-metric multidimensional scaling (NMDS) ordination using Euclidean dissimilarity for carabid morphospecies assemblages (stress = 0.212, k = 2) in the municipality of Cossogno (S2). Each data point represents a trap, with grey circles representing the habitat "Chestnut grove", red circles representing "Ecotone", and brown circles representing "Grassland".
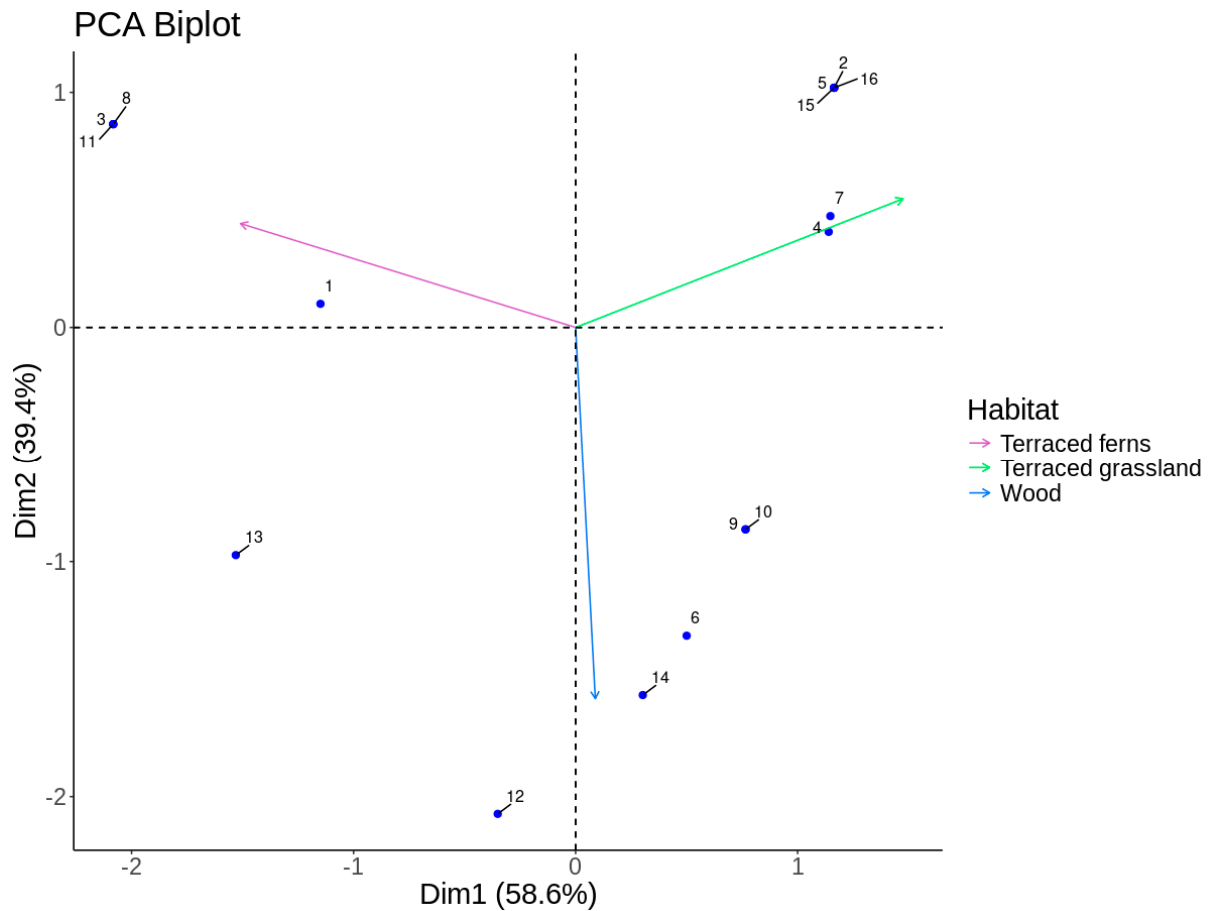
Figure 7. PCA for Premosello-Chiovenda (S1). Each point corresponds to a species (1: *Abax contractus*, 2: *Amara convexior*, 3: *Calathus cinctus*, 4: *Harpalus rufipalpis rufipalpis*, 5: *Harpalus serripes serripes*, 6: *Harpalus subcylindricus*, 7: *Harpalus tardus*, 8: *Bembidion lampros*, 9: *Pseudoophonus calceatus*, 10: *Pseudoophonus griseus*, 11: *Pterostichus micans*, 12: *Calathus fuscipes graecus*, 13: *Carabus convexus convexus*, 14: *Pseudoophonus rufipes*, 15: *Amara fulvipes*, 16: *Carabus germari fiorii*) and each arrow to a habitat (purple: "Terraced ferns", green: "Terraced grassland", blue: "Wood"). The axis Dim1 explains 58.6% of the total variance of the data, while the axis Dim2 explains 39.4% of the total variance. Hellinger transformation was applied before the analysis.

In Figure 8 we can observe the PCA biplot for S2, explaining 96.8% of the total variance (66.2% by Dim1 and 30.6% by Dim2). Species were differentiated by habitat: "Chestnut grove", "Ecotone", and "Grassland". Most of the species were grouped together in the upper quadrant in association with the habitat "Ecotone", while the remaining species were evenly distributed in the lower quadrants.
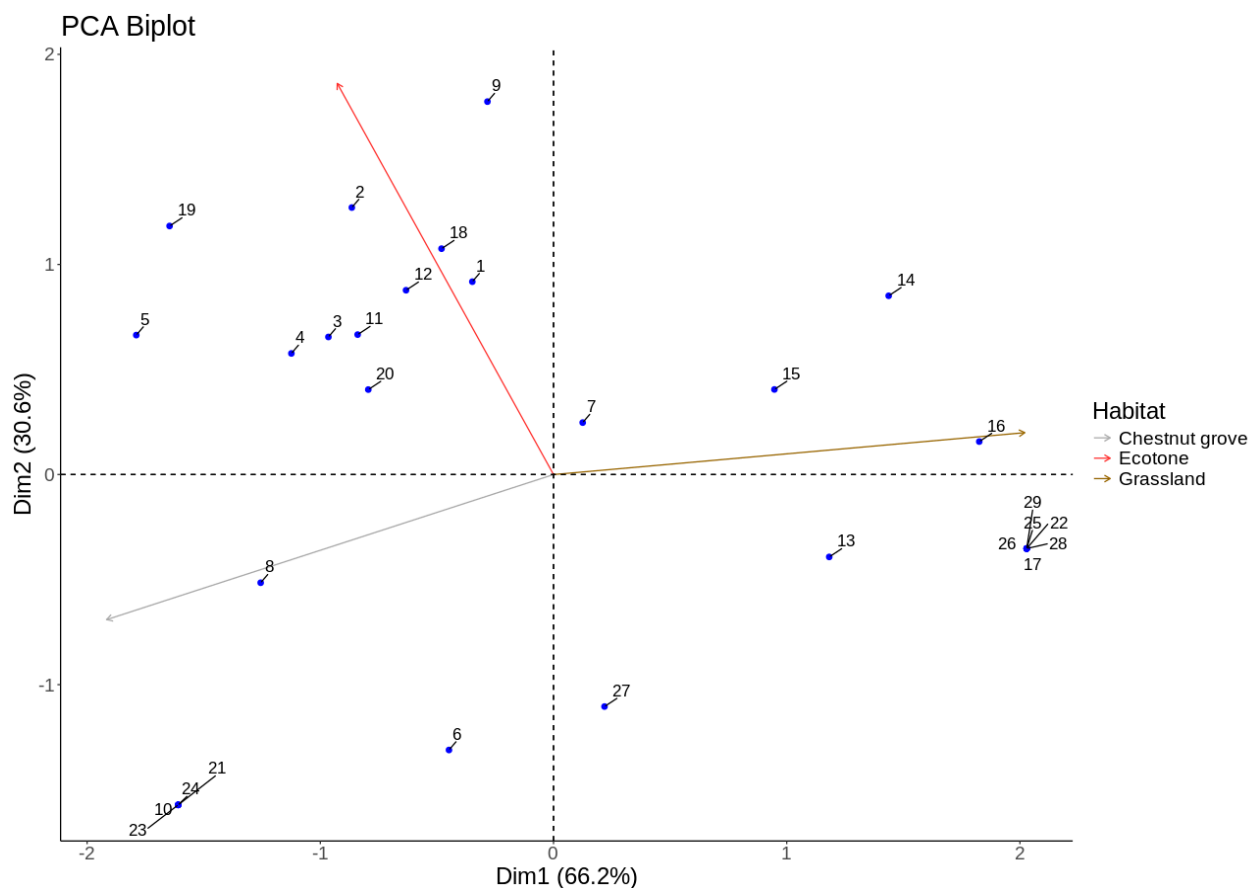
Figure 8. PCA for Cossogno (S2). Each point corresponds to a species (1: *Calathus fuscipes graecus*, 2: *Carabus problematicus problematicus*, 3: *Carabus convexus convexus*, 4: *Abax contractus*, 5: *Cychrus italicus*, 6: *Harpalus atratus*, 7: *Pseudoophonus rufipes*, 8: *Pterostichus micans*, 9: *Carabus glabratus latior*, 10: *Cymindis cingulata*, 11: *Carabus intricatus*, 12: *Carabus granulatus interstitialis*, 13: *Pseudoophonus griseus*, 14: *Amara convexior*, 15: *Harpalus tardus*, 16: *Harpalus rufipalpis rufipalpis*, 17: *Syntomus truncatellus*, 18: *Bembidion lampros*, 19: *Calathus rubripes*, 20: *Calosoma sycophanta*, 21: *Abax baenningeri*, 22: *Carabus germari fiorii*, 23: *Limodromus assimilis*, 24: *Stomis roccae roccae*, 25: *Amara bifrons*, 26: *Laemostenus janthinus coeruleus*, 27: *Calathus melanocephalus*, 28: *Parophonus maculicornis*, 29: *Harpalus marginellus*) and each arrow to a habitat (grey: "Chestnut grove", red: "Ecotone", brown: "Grassland"). The axis Dim1 explains 66.2% of the total variance, while the axis Dim2 explains 30.6% of the total variance, adding another dimension to the variation in the data. Hellinger transformation was applied before the analysis.

4. Discussion

The species collected were mostly conformed to those expected and already known for the Val Grande National Park in the scientific literature [45]. Moreover, in this research, seven further species have been recorded, namely *C. sycophanta*, *H. marginellus*, *H. rufipalpis rufipalpis*, *H. serripes serripes*, *H. subcylindricus*, *P. maculicornis*, and *C. cinctus*, representing, to the best of our knowledge, the first record for the investigated area.

During the two years of sampling, we found the presence of a Carabidae assemblage in all investigated habitats, namely "Terraced ferns", "Terraced grassland", "Wood", "Chestnut grove", "Ecotone", and "Grassland". In S1, NMDS ordination exhibited a clear separation in the carabid assemblage between "Terraced ferns" and "Terraced grassland" with no overlap in their respective multivariate polygons. Conversely, the habitat "Wood" partially overlapped with both "Terraced ferns" and "Grassland". In S2, "Chestnut grove" and "Ecotone" polygons almost overlapped, and only partially with "Grassland". However, as clearly shown in the PCA biplot, the dominant species (*C. fuscipes graecus*, *C. glabratus latior*, *C. problematicus problematicus*) were mostly related to the habitat "Ecotone" and they

were characterised by a mainly Palearctic (Holarctic) (*C. fuscipes graecus*) and European (*C. glabratus latior*, *C. problematicus problematicus*) distribution.

Shannon–Wiener and Simpson diversity indices have been used extensively in environmental studies to estimate the species richness and abundance of ecosystems [10,40,46–48]. The use of the indices works very well under comparative situations. In our research both indices denoted higher values for both "Terraced ferns" and "Terraced grassland" habitats, and a poorly diversified *coenosis* in "Wood" for S1. No clear difference emerged for S2 when comparing the different environments.

The form of wing development is a very significant evaluation parameter because it is closely related to the species' ability to disperse and colonise new environments. Specifically, in S1, most of the species were found to be macropterous (winged) or pteropolymorphous (with variable wing development) (12 species), typical of populations found in unstable environments or subjected to strong climatic variability (riparian environments, grasslands). The brachypterous component (with undeveloped wings unsuitable for flight), represented by four species is of little importance from a qualitative point of view and it is almost entirely represented by the species *A. contractus* (with 62 specimens recorded in 2 years). The sum of the specimens of the remaining brachypterous species is represented by only four specimens in 2 years of sampling. In S1, a total of 16 species of Carabidae, belonging to five subfamilies, were found in the two-year period. Harpalinae appears to be the predominant subfamily (seven species), followed by Pterostichinae (four species), while the remaining subfamilies are represented by no more than two species with few individuals collected. However, the small number of individuals found makes it difficult to justify a correlation between the environments. The species recorded in "Terraced ferns" constituted the dominant group and they accounted for 51% of the entire assemblage, followed by "Wood" (27%) and "Terraced grassland" (22%). Terracing slopes can in fact increase the heterogeneity of the landscape, diversifying the original forest environment, thus providing habitat, facilitating symbiosis of organisms and maintaining biodiversity, and playing a vital role in the reconstruction and improvement of ecosystems [49,50]. Furthermore, the biomass of non-terraced fields has been shown to be significantly lower than that of terraced land under similar environmental conditions [51,52]. The key reasons why terracing increases biodiversity can presumably be found in the major availability of water and nutrients that allows a better plant growth [53], consequently also contributing to an increase in the biodiversity of plant species. Better plant growth and increased species richness of plants are directly linked to the prosperity of the animal species associated with them, primarily for trophic reasons. Moreover, predatory species are favourably affected by the quantitative and qualitative increase in the phytophagous species that constitute their prey, increasing their populations and species richness. However, in our study, the carabid assemblage found in S1 and specifically in "Terraced ferns" and "Terraced grassland" was unexpectedly poor. The reduced biodiversity denoted by the scarcity of species (16) and the limited numerical size of the populations (also of the xerophilous elements, 163 individuals) may be related to the exposure (south-facing area). However, the southern exposure may determine the presence of thermophilic elements, with grasslands presenting South European–Mediterranean floristic elements, as already highlighted by Casale and Brambilla [54]; this condition can also negatively affect the presence of species commonly found in cool and damp environments [55]. However, the exposure does not fully justify the reduced specific richness, especially when considering the lack of typical sedentary species (e.g., Carabinae), raising some doubts about the quality and stability of the environment.

In S2, most of the carabid species recorded were typical of steppe or open habitats and showed mainly a macropterous state of wings. The species surveyed were characterised by broad geonemy, with distribution mainly Sibero–European, S-European (Alpino-Apenninic endemic), European, S-European (S-Alpine endemic), Palearctic (Olarctic) and secondly Palearctic, Centraleuropean and S-European. The collection, during the two years of sampling, revealed a rich biodiversity with an excellent balance between numerous brachypter-

ous species and macropterous and pteropolymorphous species. In S2, a total of 29 species of Carabidae belonging to six subfamilies were found in the two-year period. Carabinae appears to be the predominant subfamily (eight species), followed by Harpalinae (seven species), and Pterostichinae (six species). The species recorded in "Ecotone" constituted the dominant group and they accounted for 41.3% of the entire assemblage, followed by "Grassland" (33.3%) and "Chestnut grove" (25.4%).

The carabid beetle richness among sites may be correlated with different habitats and with resources availability. The dominance, both quantitative and qualitative, of predatory species is important from an ecological point of view because it may provide environmental resistance since zoophagous carabids significantly reduce the number of phytophagous species that threaten agricultural cultivation plantations [56]. Our study highlights that the diversity of carabid species may be deeply influenced by biocoenosis. For example, in 2021 the presence of *C. sycophanta* was presumably related to an outbreak of the European gypsy moth (*Lymantria dispar* (Linnaeus, 1758)) on chestnut trees. Moreover, the presence of *C. intricatus* and *C. italicus* species, both having a helicophagous diet at the larval and adult stages, was attributable to the great abundance of snails and slugs.

5. Conclusions

The carabid assemblage was demonstrated to have a patchy distribution, as already shown with the analysis of the dominance structure of the carabid populations. Specifically, in S1 we found a more salient evenness between the dominant and recedent categories (especially in 2021), unlike the other investigated site.

The average abundance of many species appears poor, and it becomes necessary to increase the collection effort to obtain a more representative sample of the fauna. This two-year monitoring period could be the start of a study able to assess the geographical variation potential in the trends of multiple species and their interactions with habitats. The number of beetles captured is dependent not only on environmental factors (temperature, humidity, climate) and the adopted research methodology (number of traps, study period), but in the case of agricultural ecosystems, also on the agroecosystem diversification [56]. Ground cover influences soil moisture, temperature, light penetration through the canopy, and other microhabitat conditions to which carabids respond. Furthermore, control interventions of arboreal-arbustive vegetation (clearing) and mowing to preserve hay meadows can be reflective of the preferences of different carabid species but can also affect their distribution as in the case of less mobile species (e.g., brachypterous species). In particular, the decline of grazing activities in the investigated area, with the resulting changes in the floristic composition and thus in the vegetation may affect the habitat in which the Carabidae live. Awareness of species composition, richness, and ecology could be a useful tool for the Park to address the management of surfaces (mowing, maintenance of the wooden necromass, irrigation, creating non-crop refuge habitats) in order to avoid disturbing the carabid fauna. Moreover, knowledge about the presence of carabids of conservation concern, endangered and/or endemic species (e.g., *S. roccae roccae*), is of crucial importance also with a view to mitigating their potential decline. Our findings, therefore, represent an important contribution to the knowledge already known in the scientific literature for the Park [45,57,58]. An improvement of monitoring, increasing the number of investigated sites and the typology of collections (also evaluating the beetle diversity in different ecosystem levels as canopy and stem) is thus needed. Moreover, long-term quantitative data may allow an accurate modelling of population trends, also helping to determinine a quantitative assessment of temporal changes in the carabid community.

observed in the municipality of Premosello-Chiovenda (S1) and in the municipality of Cossogno (S2) [24,59]; Table S2: Simplified table of the main morphological properties of the observed soil profiles; Table S3: Main chemical properties of the analysed soil profiles in the municipality of Premosello-Chiovenda (S1); Table S4: Main chemical properties of the analysed soil profiles in the municipality of Cossogno (S2).

References

1. Lövei, G.L.; Sunderland, K.D. Ecology and behavior of ground beetles (Coleoptera: Carabidae). *Annu. Rev. Entomol.* **1996**, *41*, 231–256. [CrossRef] [PubMed]
2. Dajoz, R. *Les Coléoptères: Carabidés et Ténébrionidés*; Lavoisier Tec&Doc: Paris, France, 2002; pp. 1–524.
3. Lorenz, W. *Systematic List of Extant Ground Beetles of the World (Insecta Coleoptera "Geadephaga": Trachypachidae and Carabidae incl. Paussinae, Cicindelinae, Rhysodinae)*; Wolfgang Lorentz: Tutzing, Germany, 2005; pp. 1–530.
4. Vigna Taglianti, A. Checklist e corotipi delle specie di Carabidae della fauna italiana. Appendice B. In *I Coleotteri Carabidi per la Valutazione Ambientale e la Conservazione della Biodiversità*; ISPRA: Rome, Italy, 2005; pp. 1–240.
5. Crowson, R.A. *The Biology of the Coleoptera*; Academic Press: London, UK, 1981; pp. 1–802.
6. Lawrence, J.F.; Britton, E.B. Coleoptera. *The Insects of Australia*, 2nd ed.; Melbourne University Press: Carlton, UK, 1991; pp. 543–683.
7. Brandmayr, P.; Zetto, T.; Pizzolotto, R. *I Coleotteri Carabidi per la Valutazione Ambientale e la Conservazione delle Biodiversità—Manuale Operativo*; Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici, IGER: Rome, Italy, 2005; Volume 34, pp. 1–240.
8. Elliott, E.T.; Coleman, D.C. Let the Soil Work for Us. *Ecol. Bull.* **1988**, *39*, 23–32.
9. Araujo, P.I.; Yahdjian, L.; Austin, A.T. Do soil organisms affect aboveground litter decomposition in the semiarid Patagonian steppe, Argentina? *Oecologia* **2012**, *168*, 221–230. [CrossRef] [PubMed]
10. Tsafack, N.; Xie, Y.; Wang, X.; Fattorini, S. Influence of climate and local habitat characteristics on carabid beetle abundance and diversity in northern Chinese steppes. *Insects* **2019**, *11*, 19. [CrossRef] [PubMed]
11. Zhang, Q.; Wu, J.; Sun, Y.; Zhang, M.; Mai, B.; Mo, L.; Lee, T.M.; Zou, F. Do Bird Assemblages Predict Susceptibility by E-Waste Pollution? A Comparative Study Based on Species- and Guild-Dependent Responses in China Agroecosystems. *PLoS ONE* **2015**, *10*, e0122264. [CrossRef] [PubMed]
12. Skarbek, C.J.; Kobel-Lamparski, A.; Dormann, C.F. Trends in monthly abundance and species richness of carabids over 33 years at the Kaiserstuhl, southwest Germany. *Basic Appl. Ecol.* **2021**, *50*, 107–118. [CrossRef]
13. Kromp, B. Carabid beetles in sustainable agriculture: A review on pest control efficacy, cultivation impacts and enhancement. *Agric. Ecosyst. Environ.* **1999**, *74*, 187–228. [CrossRef]
14. Magura, T.; Lövei, G.L.; Tóthmérész, B. Conversion from environmental filtering to randomness as assembly rule of ground beetle assemblages along an urbanization gradient. *Sci. Rep.* **2018**, *8*, 16992. [CrossRef]
15. Kromp, B. Carabid beetle communities (Carabidae, Coleoptera) in biologically, and conventionally farmed agroecosystems. *Agric. Ecosyst. Environ.* **1989**, *27*, 241–251. [CrossRef]
16. Brandmayr, P.; Pizzolotto, R. I Coleotteri Carabidi come indicatori delle condizioni dell'ambiente ai fini della conservazione. In Proceedings of the Atti XVII Congresso Nazionale Italiano di Entomologia, Udine, Italy, 13–18 June 1994; pp. 439–444.
17. Niemelä, J. Biodiversity monitoring for decision-making. *Ann. Zool. Fenn.* **2000**, *37*, 307–317.
18. Rushton, S.P.; Luff, M.L.; Eyre, M.D. Effects of pasture improvement and management on the ground beetle and spider communities of upland grasslands. *J. Appl. Ecol.* **1989**, *26*, 489–503. [CrossRef]
19. Rushton, S.P.; Eyre, M.D.; Luff, M.L. The effects of management on the occurrence of some carabid species in grassland. In *The Role of Ground Beetles in Ecological and Environmental Studies*; Intercept: Andover, UK, 1990; pp. 209–216.
20. Blake, S.; Foster, G.N.; Fisher, G.E.J.; Ligertwood, G.L. Effects of management practices on the carabid faunas of newly established wildflower meadows in southern Scotland. *Ann. Zool. Fenn.* **1996**, *33*, 139–147.

21. Niemelä, J.; Kotze, J.; Ashworth, A.; Brandmayr, P.; Desender, K.; New, T.; Penev, L.; Samways, M.; Spence, J. The search for common anthropogenic impacts on biodiversity: A global network. *J. Insect Conserv.* **2000**, *4*, 3–9. [CrossRef]
22. Rainio, J.; Niemelä, J. Ground beetles (Coleoptera: Carabidae) as bioindicators. *Biodivers. Conserv.* **2003**, *12*, 487–506. [CrossRef]
23. Biancotti, A.; Bellardone, G.; Bovo, S.; Cagnazzi, B.; Giacomelli, L.; Marchisio, C. *Distribuzione Regionale di Piogge e Temperature*; Collana Studi Climatologici in Piemonte, Edizione Clima Icam: Torino, Italy, 1998; pp. 1–80.
24. IUSS Working Group WRB. *World Reference Base for Soil Resources. International Soil Classification System for Naming Soils and Creating Legends for Soil Maps*, 4th ed.; International Union of Soil Sciences (IUSS): Vienna, Austria, 2022; pp. 1–236.
25. Van Reeuwijk, L.P. *Procedures for Soil Analysis*; Technical Paper, n. 9; International Soil Reference and Information Centre: Wageningen, The Netherlands, 2002; pp. 1–101.
26. Ahmed, D.A.; Beidas, A.; Petrovskii, S.V.; Bailey, J.D.; Bonsall, M.B.; Hood, A.S.C.; Byers, J.A.; Hudgins, E.J.; Russell, J.C.; Růžičková, J.; et al. Simulating capture efficiency of pitfall traps based on sampling strategy and the movement of ground-dwelling arthropods. *Meth. Ecol. Evol.* **2023**, *14*, 2827–2843. [CrossRef]
27. Allegro, G.; Viterbi, R. Contributo alla conoscenza faunistica ed ecologica dei Carabidi del Parco Naturale Orsiera Rocciavrè e della Riserva di Foresto (Coleoptera, Carabidae). *Riv. Piemont. Stor. Nat.* **2010**, *31*, 187–212.
28. Hardersen, S.; Bardiani, M.; Nardi, G.; Pilon, N. The carabids (Coleoptera Carabidae) of the new established "Foresta Carpaneta" (Italy, Lombardy)—The first 14 years (2006/2007 and 2020/2021) of a long term monitoring project. *Bull. Insectol.* **2023**, *76*, 239–245.
29. Casale, A.; Sturani, M.; Vigna Taglianti, A. *Fauna d'Italia: Coleoptera Carabidae. I. Introduzione, Paussinae, Carabinae*; Edizioni Calderini: Bologna, Italy, 1982; pp. 1–499.
30. Sciaky, R. Revisione delle specie paleartiche occidentali del genere *Ophonus* Dejean, 1821. *Mem. Soc. Entomol. Ital.* **1987**, *65*, 29–120.
31. Casale, A. *Revisione degli Sphodrina (Coleoptera, Carabidae, Sphodrini)*; Monograph 5; Museo Regionale di Scienze Naturali di Torino: Torino, Italy, 1988; pp. 1–1024.
32. Pesarini, C.; Monzini, V. *Insetti della Fauna Italiana: Coleotteri Carabidi I*; Società Italiana di Scienze Naturali: Milano, Italy, 2010; Volume 100, pp. 1–152.
33. Pesarini, C.; Monzini, V. *Insetti della Fauna Italiana: Coleotteri Carabidi II*; Società Italiana di Scienze Naturali: Milano, Italy, 2011; Volume 101, pp. 1–144.
34. Neri, P.; Bonavita, P.; Gudenzi, I.; Magrini, P.; Toledano, L. Bembidiina della fauna italo-corsa: Chiavi di identificazione (Insecta Coleoptera Carabidae). *Quad. Studi Nat. Romagna* **2011**, *33*, 1–183.
35. Allegro, G. Tabella illustrata di determinazione per le specie del genere *Pterostichus* note in Italia (Coleoptera, Carabidae, Pterostichinae). *Mem. Soc. Entomol. Ital.* **2021**, *98*, 65–91. [CrossRef]
36. Allegro, G.; Magrini, P.; Pavesi, M. Tabella illustrata di determinazione per le specie del genere *Harpalus* note in Italia (Coleoptera, Carabidae, Harpalinae). *Boll. Soc. Ent. Ital.* **2022**, *154*, 51–86. [CrossRef]
37. Allegro, G. An illustrated key to the species of the tribe Zabrini (genera *Amara* and *Zabrus*) recorded from Italy (Coleoptera, Carabidae, Pterostichinae). In *Memorie dell'Associazione Naturalistica Piemontese*; Associazione Naturalistica Piemontese: Carmagnola, Italy, 2024; Volume 14, pp. 1–57.
38. Tischler, W. *Grundzüge der Terrestrischen Tierökologie*; Friedrich Vieweg und Sohn: Braunschweig, Germany, 1949; p. 219.
39. Sharova, I.K. *Life Forms of Ground Beetles (Coleoptera, Carabidae)*; Science: Moscow, Russia, 1981; p. 359. (In Russian)
40. Teofilova, T.; Kodzhabashev, N. Ground beetles (Coleoptera: Carabidae) from the region of Cape Emine (central Bulgarian Black sea coast). Part III. Spatial distribution and gradient analysis. *ZooNotes* **2015**, *78*, 1–15.
41. Brandmayr, P.; Brunello Zanitti, C. Le comunità a Coleotteri Carabidi di alcuni Querco-Carpineti della bassa pianura del Friuli. In *Quaderni sulla 'Struttura delle Zoocenosi Terrestri'*; Consiglio Nazionale delle Ricerche: Rome, Italy, 1982; Volume 4, pp. 69–124.
42. Cosimi, S.; Rossi, E. *I Coleotteri Carabidi come Bioindicatori Nell'agroecosistema: Un Caso di Studio all'interno del Centro Interdipartimentale di Ricerche Agro-Ambientali E. Avanzi*; I Quaderni del Centro Enrico Avanzi dell'Università di Pisa, Dipartimento CDSL G. Scaramuzzi: Pisa, Italy, 2013; pp. 1–84.
43. Máthé, I. Forest edge and carabid diversity in a Carpathian beech forest. *Community Ecol.* **2006**, *7*, 91–97. [CrossRef]
44. Minchin, P.R. An evaluation of the relative robustness of techniques for ecological ordination. In Theory and models in vegetation science. *Vegetatio* **1987**, *69*, 89–107. [CrossRef]
45. Vigna Taglianti, A.; Audisio, P.A.; De Felici, S. I coleotteri carabidi del Parco Nazionale della Val Grande (Verbania, Piemonte). *Riv. Piemont. Stor. Nat.* **1998**, *19*, 193–245.
46. Shannon, C.E. A mathematical theory of communication. *Bell Syst. Tech. J.* **1948**, *27*, 379–423. [CrossRef]
47. Simpson, E.H. Measurement of diversity. *Nature* **1949**, *163*, 688. [CrossRef]
48. Ruchin, A.; Alekseev, S.; Khapugin, A.; Esin, M. Fauna and species diversity of ground beetles (Coleoptera, Carabidae) in meadows. *Entomol. Appl. Sci. Lett.* **2021**, *8*, 28–39. [CrossRef]
49. Arévalo, J.R.; Tejedor, M.; Jimenez, C.; Reyes-Betancort, J.A.; Diaz, F.J. Plant species composition and richness in abandoned agricultural terraces vs. natural soils on Lanzarote (Canary Islands). *J. Arid. Environ.* **2016**, *124*, 165–171. [CrossRef]
50. Merino, J.H.; Rozas, L.P.; Minello, T.J.; Sheridan, P.F. Effects of marsh terracing on nekton abundance at two locations in Galveston Bay, Texas. *Wetlands* **2010**, *30*, 693–704. [CrossRef]
51. Park, H.; Lee, S.J.; Cheong, S.; Jeong, H.R.; Kim, J.G. Effects of small dam in a stream on benthic macro-invertebrate community. *J. Wet. Res.* **2017**, *19*, 252–258.

52. Carlos, C.; Goncalves, F.; Crespo, L.; Zina, V.; Oliveira, I.; Crespi, A.; Torres, L. How does habitat diversity affect ground-dwelling arthropods assemblages in Douro Demarcated Region terraced vineyards? *J. Insect Conserv.* **2019**, *23*, 555–564. [CrossRef]

53. Shimoda, S.; Koyanagi, T.F. Land use alters the plant-derived carbon and nitrogen pools in terraced rice paddies in a mountain village. *Sustainability* **2017**, *9*, 1973. [CrossRef]

54. Casale, F.; Brambilla, M. *L'avifauna Nidificante negli Ambienti Aperti del Parco Nazionale della Val Grande*; Ente Parco Nazionale della Val Grande e Fondazione Lombardia per l'Ambiente: Vogogna, Italy, 2010; pp. 1–129.

55. Sturani, M. Osservazioni e ricerche biologiche sul genere *Carabus* Linnaeus (sensu lato) (Coleoptera Carabidae). *Mem. Soc. Entomol. Ital.* **1962**, *47*, 85–202.

56. Czerniakowski, Z.W.; Olbrycht, T.; Konieczna, K. Ground beetles (Coleoptera: Carabidae) found in conventional potato cultivations (*Solanum tuberosum* L.) in the Subcarpathian region. *Appl. Ecol. Environ. Res.* **2020**, *18*, 2109–2128. [CrossRef]

57. Busato, E.; Gallizia, S.; Ferracini, C. Contributo alla conoscenza della morfologia larvale del Genere *Carabus* Linnaeus, 1758. La larva di *Carabus* (*Orinocarabus*) *lepontinus* Born, 1908 (Coleoptera, Carabidae). *Riv. Piemont. Stor. Nat.* **2023**, *44*, 153–162.

58. Casale, A.; Vigna Taglianti, A. I Coleotteri Carabidi delle Alpi occidentali e centro-occidentali (Coleoptera, Carabidae). *Biogeographia* **1992**, *16*, 331–399.

59. Zanella, A.; Jabiol, B.; Ponge, J.F.; Sartori, G.; DeWaal, R.; Van Delft, B.; Englisch, M. A European morpho-functional classification of humus forms. *Geoderma* **2011**, *164*, 138–145. [CrossRef]