# Northern Wheatear Project in Matagalls – 2023 report

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## Introduction

Climate change has a profound impact on habitats worldwide, with the current period of human-accelerated global warming posing a significant threat to numerous species (*Urban 2015, Roman-Palacios & Wiens 2020*). Particularly vulnerable are those that inhabit colder environments, such as alpine and subalpine habitats. The rapidly changing conditions affect the ecosystem in complex ways. For example, the ongoing rise in annual temperatures is causing the treeline to ascend to higher altitudes, displacing heather and short-grass moorlands (*Grabherr et al. 2010, Ferrarini et al. 2017*). Consequently, species reliant on these open habitats are confronted with habitat loss and fragmentation. Their optimal breeding sites are dwindling, and the changing climate is modifying the timing and composition of their food sources through temperature anomalies and alterations in the amount and distribution of precipitation (*Kudo 2014, Renner & Zohner 2018, Zuckerberg et al. 2018*). These changes may have detrimental effects on the reproductive success and long-term survival of populations of many bird species, as synchronizing energetically costly phases of the life cycle with periods of high food availability is essential to maximize fitness *(Perrins 1970, Both et al. 2006)*. One of these species could be the northern wheatear (*Oenanthe oenanthe*) (*Photo 1*). This small migratory insectivorous passerine is widely distributed in the Northern hemisphere, lives in open rocky habitats, meadows, moorlands, coastal grasslands, and farmlands where they can find stone walls or rock formations (*Dunn et al. 2020*). In Southern Europe, such as in Catalonia, it breeds mostly in higher altitudes, in the subalpine and alpine zone of the mountains (Figure 1.). From most part of the Holarctic, including northern and central Asia, Europe, Greenland, Alaska, and parts of Canada, northern wheatears migrate to Sub-Saharan Africa for wintering. It makes the species to be a long-distance migrant, some populations flying over 14 500 km twice a year (*Bairlein et al. 2012*). Due to their long-distance migratory strategy, timing of breeding season with matching food accessibility is important for the successful breeding.

The aim of this study is to monitor the long-term changes in the breeding population of Northern wheatear on the alpine meadows in the Montseny Natural Park, find link between the insect abundance and diversity, and breeding success. And, to examine microbiome of these bird. Montseny's peaks as well as Pyrenees' will be possibly affected in the same way by climate changes; meaning that studying this bird's population changes on lower elevation mountains will give an idea of what could happen on higher elevations later.


Figure 1. Probability of occurrence of the Northern wheatear in the breeding period (years 2015-2018) in Catalonia, including localities where non-breeding individuals are found. It has been generated with modeling techniques based on the data from the standardized sampling of 1x1 km UTM squares.

*Photo 1: Female of northern wheatear on the right, male of northern wheatear on the left.*

## Materials and methods

The project conduct by ICO volunteers took place from April to September 2023 in Matagalls, one of the highest mountains of the Montseny Massif, Catalonia, Spain (1697.9 metres above sea level) (*Photo 2*). From the end of April to mid-May the breeding grounds (burnt/not burnt areas) and breeding territories were determined through the use of a field sheet. The day of observation, the number of birds seen, and where the birds were sighted (geographical coordinates) were reported on the form and on the printed maps of Matagalls (*Figure 2; 3; and 4*).


*Figure 2: Map of the territory number 1 (Matagalls, Spain).*


*Figure 3: Map of the territories number 2 and 3 (Matagalls, Spain).*

*Figure 4: Map of the territories number 4 and 5 (Matagalls, Spain).*

*Photo 2: Typical habitat of Northern wheatear in Matagalls.*

From mid-May to mid-June, a 300 m straight line was defined in each territory, and pitfall traps (handmade traps using yogurt cups) were set every 30 meters, avoiding the main touristic track, once a week. The day after the setting, the pitfall traps samples were collected in plastic containers (in which alcohol was subsequently added) and the butterfly net was used for capturing and counting the insects in each territory. The captured insects were noted on a field sheet and classified based on the order in which they belonged. From mid-June to the end of July, the volunteers tried to find the nests in each territory, and they caught the adults and the chicks with clap traps, in order to ring them and to collect faeces to send to the UAB (Universitat Autònoma de Barcelona) lab (*Photo 3*). After each capture the Northern wheatear data was reported on the website www.marquesespecials.cat.

*Photo 3: Ringing and measuring of wheaters.*

Between August and September, the collected insect's samples were analysed at the UAB lab by the ICO volunteers. Using a microscope, it was possible to count and categorize the insects and other arthropods based on the order they belong to (*Photo 4*). In October some captures with clap traps were carried out to verify the presence of the birds at the end of the breeding season, during the migration period.

*Photo 4: Cleaning, sorting, and identification of samples in the UAB lab.*

## Results

After three censuses carried out on Matagalls once a week between the end of April and the end of May, it was possible to identify the areas preferred by the birds during the breeding season of the year 2024. Only two areas were chosen by the birds, the unburned area 1 and 2 as reported in *Table 1*.

The geographical coordinates of the observations were then inserted on the map, and in accordance with the literature, the possible territories around those points were created with QGIS. 10 breeding territories were found: 9 in the area number 1 and only one in the area 2.

*Table 1 Census of Northern wheatears in the five areas on Matagalls.*

| Date | Area | Burned area | Number of birds |
|---|---|---|---|
| **28/04/2023** | 1 | No | **10** |
| | 2 | No | 0 |
| | 3 | No | 1 |
| | 4 | Yes | 0 |
| | 5 | Yes | 0 |
| **04/05/2023** | 1 | No | **16** |
| | 2 | No | 0 |
| | 3 | No | 0 |
| | 4 | Yes | 0 |
| | 5 | Yes | 0 |
| **18/05/2023** | 1 | No | **17** |
| | 2 | No | **2** |
| | 3 | No | 0 |
| | 4 | Yes | 0 |
| | 5 | Yes | 0 |

### Pitfall traps results

We collected 60 pitfall trap samples, 6 samples from each territory during the sampling period. In average 636 insects and other arthropods were collected from each territory, with the highest counts from territory 5 and 6, over 1000 individuals (*Table 2.*). Although, seemingly there was more breeding success with relative higher number of insects, the logistic regression analysis indicated that the number of insects was not a statistically significant predictor of breeding success ($p = 0.393$).

*Table 2: Total number of insects collected with pitfall traps, breeding success and bird ringed in each territory.*

| *Territory* | *Num Insects* | *Breeding Success* | *Birds ringed* |
|---|---|---|---|
| *1* | 764 | **Yes** | yes |
| *2* | 459 | **Yes** | yes |
| *3* | 497 | No | yes |
| *4* | 446 | No | yes |
| *5* | 1079 | No | yes |
| *6* | 1059 | **Yes** | No |
| *7* | 513 | No | No |
| *8* | 625 | No | yes |
| *9* | 595 | **Yes** | yes |
| *10* | 326 | No | No |

From the insect samples collected with pitfall traps, we could identify 12 clades (*Table 3*). Within orders, if it was possible, we tried to identify the individuals in lower taxonomical levels. The logistic regression analysis indicated that none of the arthropod groups show statistically significant associations with breeding success (all p-values > 0.05). The estimates for these insect groups, while not statistically significant, revealed nuanced patterns. Orthoptera displayed a positive association (Estimate = 0.2879), Diptera showed a small positive association (Estimate = 0.0153), Coleoptera exhibited a negligible negative association (Estimate = -0.0006), and Hymenoptera also indicated a negligible negative association (Estimate = -0.0039).

*Table 3: Number of insects collected with pitfall traps divided by the order they belong to.*

| Territory | Coleop.tera | Ort.optera | Diptera | Hym.enoptera | Hemi.ptera | Derma.ptera | Arachneae | Centipedes | Milipedes | Collembola | Odonata | Lepid.ptera | others |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 34 | 1 | 390 | 278 | 17 | 0 | 29 | 0 | 2 | 3 | 0 | 4 | 5 |
| 2 | 39 | 2 | 207 | 98 | 49 | 0 | 25 | 0 | 0 | 30 | 1 | 0 | 8 |
| 3 | 22 | 1 | 297 | 92 | 20 | 0 | 30 | 0 | 0 | 18 | 2 | 2 | 13 |
| 4 | 63 | 1 | 239 | 109 | 13 | 3 | 10 | 0 | 1 | 2 | 0 | 1 | 4 |
| 5 | 114 | 3 | 192 | 716 | 17 | 0 | 21 | 0 | 0 | 2 | 0 | 0 | 14 |
| 6 | 59 | 4 | 810 | 97 | 32 | 14 | 18 | 0 | 0 | 14 | 0 | 2 | 8 |
| 7 | 43 | 0 | 314 | 75 | 31 | 2 | 27 | 0 | 0 | 10 | 0 | 0 | 11 |
| 8 | 27 | 1 | 281 | 272 | 26 | 0 | 13 | 0 | 0 | 4 | 0 | 1 | 0 |
| 9 | 59 | 0 | 440 | 41 | 27 | 2 | 12 | 0 | 2 | 6 | 0 | 1 | 1 |
| 10 | 20 | 2 | 130 | 114 | 15 | 0 | 15 | 15 | 1 | 10 | 0 | 1 | 3 |

In the visualisation of the pitfall trap results, we can see that the Diptera and Hymenoptera orders were the most numerous in the samples across the territories (*Figure 5.*).

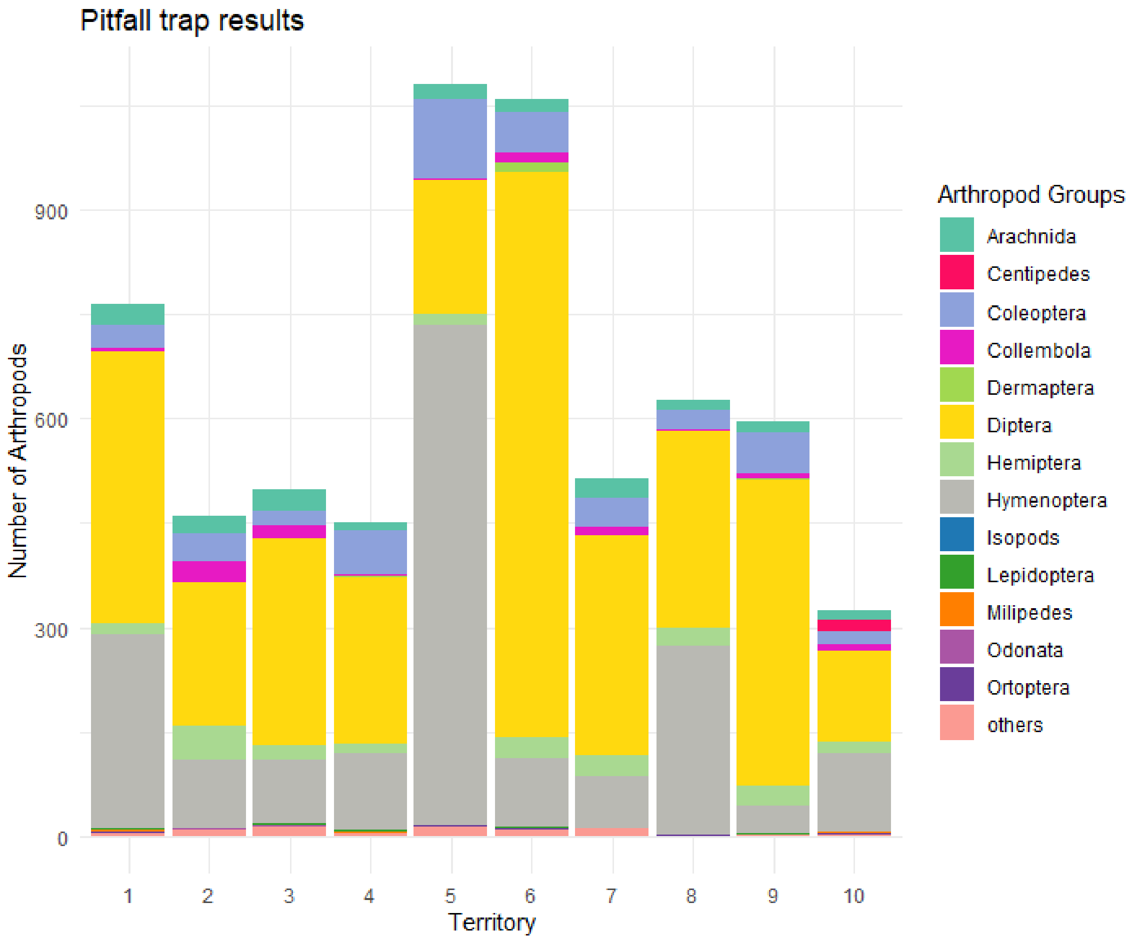


*Figure 5: Number of arthropods, collected with pitfall traps, classified by order in each territory.*

## Butterfly net results

With the butterfly net, an average 244 insects were collected in each territory (*Table 4*). While there appeared to be an association between higher numbers of insects and increased breeding success, the logistic regression analysis demonstrated that the number of insects caught by butterfly net, is not a statistically significant predictor of breeding success in the studied population ($p = 0.223$).

*Table 4: Total number of insects caught with the butterfly net, breeding success and bird ringed in each territory.*

| | *Num Insects* | *Breeding Success* | *Birds ringed* |
|---|---|---|---|
| *1* | 463 | **Yes** | yes |
| *2* | 294 | **Yes** | yes |
| *3* | 269 | No | yes |
| *4* | 222 | No | yes |
| *5* | 301 | No | yes |
| *6* | 182 | **Yes** | No |
| *7* | 219 | No | No |
| *8* | 125 | No | yes |
| *9* | 246 | **Yes** | yes |
| *10* | 122 | No | No |

From the insect samples collected using butterfly nets, representing various orders (*Table 5*), logistic regression analysis revealed that none of the insect groups showed statistically significant associations with breeding success (all p-values > 0.05).

*Table 5: Number of insects, caught with the butterfly net, divided by the order they belong to.*

| Terr. | Coleoptera | Lepidoptera | Ortoptera | Diptera | Hymenoptera | Hemiptera | Odonata | Dermaptera | others |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 24 | 8 | 200 | 207 | 18 | 6 | 0 | 0 | 0 |
| 2 | 2 | 1 | 30 | 240 | 13 | 8 | 0 | 0 | 0 |
| 3 | 3 | 0 | 2 | 250 | 7 | 4 | 0 | 0 | 3 |
| 4 | 2 | 2 | 1 | 178 | 35 | 3 | 0 | 0 | 1 |
| 5 | 5 | 1 | 2 | 118 | 171 | 1 | 0 | 0 | 3 |
| 6 | 32 | 20 | 0 | 124 | 1 | 5 | 0 | 0 | 0 |
| 7 | 21 | 4 | 1 | 154 | 34 | 5 | 0 | 0 | 0 |
| 8 | 1 | 5 | 0 | 90 | 26 | 3 | 0 | 0 | 0 |
| 9 | 15 | 11 | 0 | 183 | 37 | 0 | 0 | 0 | 0 |
| 10 | 3 | 5 | 0 | 91 | 22 | 1 | 0 | 0 | 0 |

In the visualisation of the butterfly net results, we can see that the Diptera orders was the most numerous in the samples across the territories, but the number of hymenopteras varied lot between the territories. The Ortophera order was numerous in the Territory 1 and 2, but not in the other territories (*Figure 6.*).

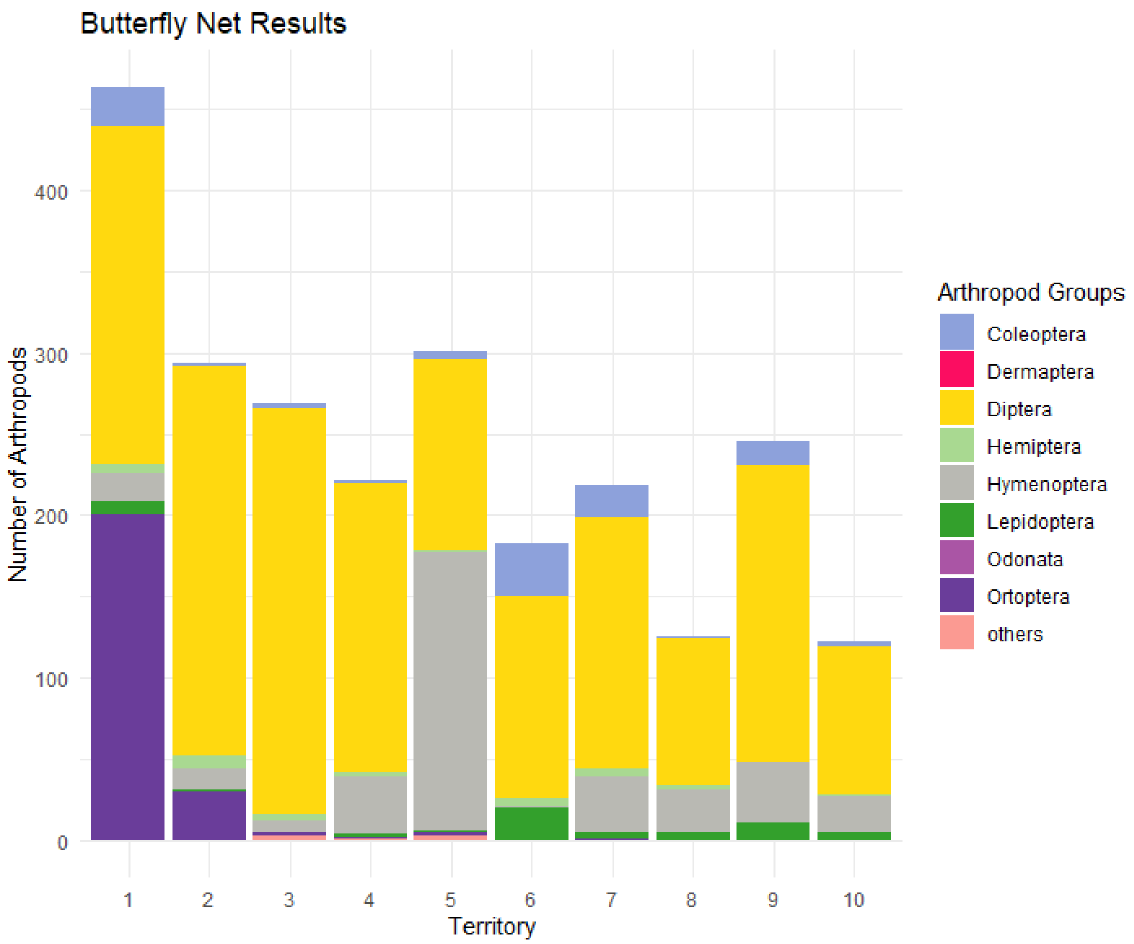


*Figure 6: Number of arthropods, caught with the butterfly net, classified by order in each territory.*

### Combined insect catching methods result

The combined results of pitfall traps and butterfly net trapping show that the Diptera and Hymenoptera clades were the most numerous in the samples collected in the territories, followed by the Coleoptera clade (*Table 6*) The associations between breeding success and the number of caught arthropods is non-significant. Ortoptera, Diptera, Hemiptera, and Lepidoptera exhibit positive estimates, suggesting potential positive effects on breeding success, although statistical significance is not reached (all p-values > 0.05). In contrast, Hymenoptera shows a negative estimate, but it is not statistically significant (all p-values > 0.05).

*Table 6: Number of insects, caught with the pifall trap and butterfly net, divided by the order they belong to.*

| Territory | Coleoptera | Ortoptera | Diptera | Hymenoptera | Hemiptera | Dermaptera | Arachnids | Centipedes | Milipedes | Collembola | Odonata | Lepidoptera | Isopods | others | Breeding Success | Birds ringed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 58 | 201 | 597 | 296 | 23 | 0 | 30 | 0 | 2 | 3 | 0 | 12 | 0 | 5 | **Yes** | yes |
| 2 | 41 | 32 | 447 | 111 | 57 | 0 | 25 | 0 | 0 | 30 | 1 | 1 | 0 | 8 | **Yes** | yes |
| 3 | 25 | 3 | 547 | 99 | 24 | 0 | 30 | 0 | 0 | 18 | 2 | 2 | 0 | 16 | No | yes |
| 4 | 65 | 2 | 417 | 144 | 16 | 3 | 10 | 0 | 1 | 2 | 0 | 3 | 0 | 5 | No | yes |
| 5 | 119 | 5 | 310 | 887 | 18 | 0 | 21 | 0 | 0 | 2 | 0 | 1 | 1 | 16 | No | yes |
| 6 | 91 | 4 | 934 | 98 | 37 | 14 | 19 | 0 | 0 | 14 | 0 | 22 | 0 | 8 | **Yes** | No |
| 7 | 64 | 1 | 468 | 109 | 36 | 2 | 27 | 0 | 0 | 10 | 0 | 4 | 0 | 11 | No | No |
| 8 | 28 | 1 | 371 | 298 | 29 | 0 | 13 | 0 | 0 | 4 | 0 | 6 | 0 | 0 | No | yes |
| 9 | 74 | 0 | 623 | 78 | 27 | 2 | 16 | 0 | 2 | 6 | 0 | 12 | 0 | 1 | **Yes** | yes |
| 10 | 23 | 2 | 221 | 136 | 16 | 0 | 15 | 15 | 1 | 10 | 0 | 6 | 0 | 3 | No | No |

In the catching of different arthropod groups throughout the study period, we can see some seasonality. The number of Diptera in the samples peaked in the third week and the fifth week, with the Hymenoptera group (*Figure 7*).

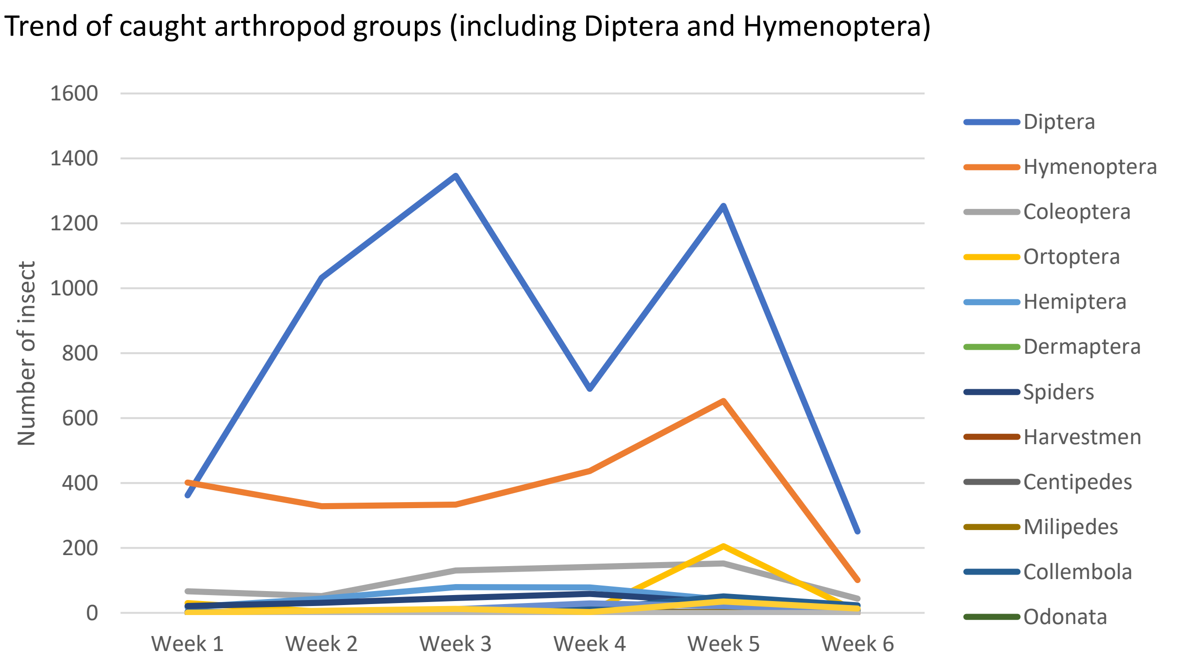


*Figure 7: Insect trend graph. Variation in the number of insects belonging to the main orders over time.*

Other arthropod groups also shown seasonal changes. Except Hemiptera and spiders, nearly all groups peaked in the fifth week (*Figure 8.*)

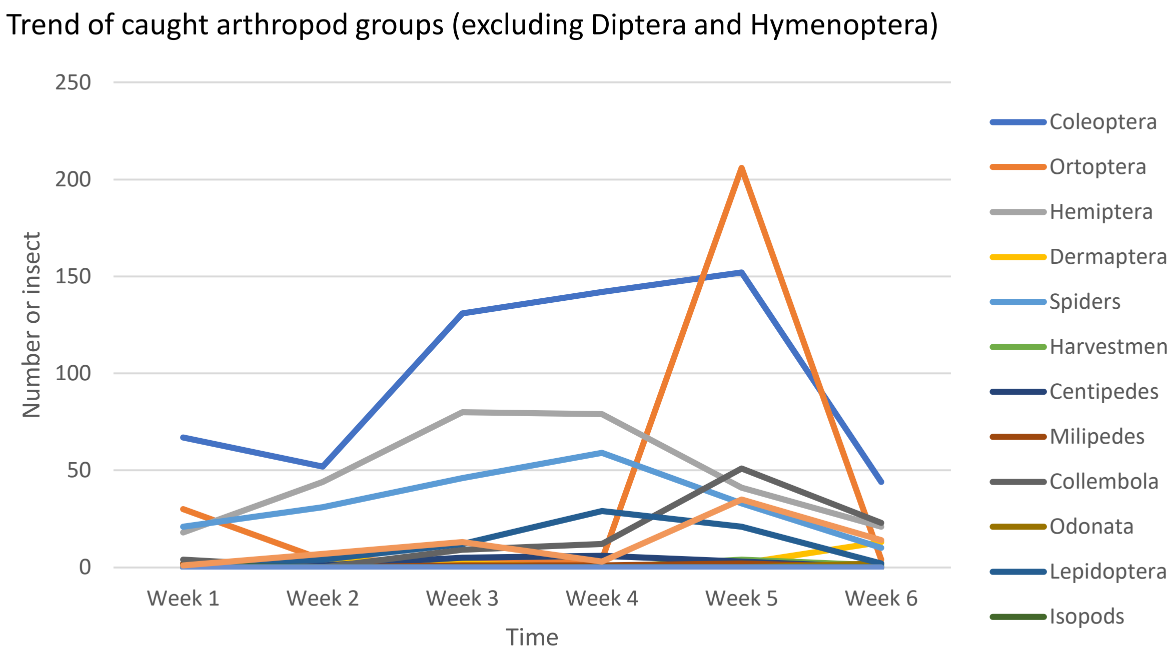


*Figure 8: Insect trend graph. Variation in the number of insects belonging to the main orders over time, not considering the Diptera and the Hymenoptera orders.*

## Ringing results

In breeding season, we caught 17 northern wheatears in the territories, 12 adults and 5 juveniles (*Table 7.*). Because of environmental challenges, ringing of juveniles was possible only in 3 territories.

*Table 7: List of ringed individuals in the study area. For aging of individuals, we used the standardized EURING Codes:(*) EURING Code 5: Definitely hatched during previous calendar year (first-years in early spring); Code 6: Hatched before last calendar year-exact year unknown (many adults in spring); Code 3: Definitely hatched during current calendar year (first-years in autumn)*

| Species | Territory | Date | Time | Age (*) | Sex | mark_type | Status |
|---|---|---|---|---|---|---|---|
| OENOEN | 4 | 20/06/23 | 13:40 | 5 | Female | Ring in the tarsus | Breeding |
| OENOEN | 5 | 20/06/23 | 17:20 | 6 | Male | Ring in the tarsus | Breeding |
| OENOEN | 2 | 14/06/23 | 09:45 | 6 | Male | Ring in the tarsus | Breeding |
| OENOEN | 1 | 14/06/23 | 14:00 | 5 | Male | Ring in the tarsus | Breeding |
| OENOEN | 1 | 14/06/23 | 14:30 | 5 | Female | Ring in the tarsus | Breeding |
| OENOEN | 8 | 27/06/23 | 11:00 | 5 | Male | Ring in the tarsus | Breeding |
| OENOEN | 8 | 27/06/23 | 11:00 | 5 | Male | Ring in the tarsus | Breeding |
| OENOEN | 9 | 27/06/23 | 14:00 | 6 | Male | Ring in the tarsus | Breeding |
| OENOEN | 3 | 17/07/23 | 08:30 | 6 | Male | Ring in the tarsus | Breeding |
| OENOEN | 3 | 17/07/23 | 11:00 | 5 | Male | Ring in the tarsus | Breeding |
| OENOEN | 2 | 17/07/23 | 11:00 | 5 | Female | Ring in the tarsus | Breeding |
| OENOEN | 1 | 27/07/23 | 08:23 | 5 | Female | Ring in the tarsus | Breeding |
| OENOEN | 1 | 27/07/23 | 08:23 | 3 | Unknown | Ring in the tarsus | Apparently local |
| OENOEN | 1 | 27/07/23 | 08:50 | 3 | Unknown | Ring in the tarsus | Apparently local |
| OENOEN | 1 | 27/07/23 | 09:33 | 3 | Unknown | Ring in the tarsus | Apparently local |
| OENOEN | 2 | 27/07/23 | 12:45 | 3 | Unknown | Ring in the tarsus | Apparently local |
| OENOEN | 9 | 31/07/23 | 10:50 | 3 | Unknown | Ring in the tarsus | Apparently local |

## Conclusion

The field season of 2023 was the first season of this project. It provided a lot of information to us, especially about the practical part of the fieldwork. Although, we have relatively small sample sizes, we can see some patterns between presence and abundance of various arthropod groups and success of breeding attempts of northern wheatears on Matagalls in the Montseny Natural Park. Potentially other environmental parameters would be also needed to understand the breeding ecology of this species in the study area. In conclusion, further research is needed to gain a more comprehensive understanding of this project.

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