SCHWEIZER JUGEND FORSCHT
LA SCIENCE APPELLE LES JEUNES
SCIENZA E GIOVENTÙ
SCIENZA E GIUVENTETGNA

PROJECT REPORT: **International Wildlife Research Week**

Butterfly diversity along elevational gradient in the Swiss Alps

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Date: June 30, 2017

Abstract

In this study, we aim to (i) investigate how the ranges of four target butterfly species (*Coenonympha gardetta*, *Colias phicomone*, *Erebia pandrose* and *Oeneis glacialis*) are distributed along elevational gradient in the Val Müstair (Swiss Alps) and to (ii) contribute to the overall knowledge of diurnal butterflies of the area studied. Eight plots were established along the gradient and sampling was conducted on the 26th and 27th June, 2017. The number of individuals caught was plotted against altitude for each target species. Each of the target species' elevational range was plotted against the elevational gradient.

Overall, 123 butterfly individuals belonging to 4 families and approximately 17 species were recorded. *C. gardetta* was frequent along the whole elevational gradient. *C. phicomone* was common at the altitudes around 2200 m a.s.l. *E. panderosa* was recorded predominantly at higher altitudes (2240, 2400 m a.s.l.). *O. glacialis* was common at high altitudes only (2220, 2350, 2400 m a.s.l.). The species data from this study will be provided to the Centre Suisse de Cartographie de la Faune and to Biosfera Val Müstair.

1. Introduction

Butterfly communities inhabiting mountain regions are known to be particularly diverse presumably because elevational gradients comprise gradients in various factors such as temperature and moisture. These factors impact vegetation communities considerably, thus creating heterogeneous environment (Landolt, E. & Urbanska, 2003; Pellissier et al., 2012). Altogether, environmental and climatic factors make the conditions for alpine butterflies rather challenging. For instance, the amount of UV irradiation is very high in montane regions. Thus, some butterflies like *Erebia* produce more melanin in order to protect themselves and to heat up more quickly in the sun (Ferretti, 2014). One study from the French Alps has shown that generalist and specialist butterfly species can be distinguished by the distribution of their elevational niche widths (the mean altitude and standard deviation calculated from all observations) along elevational gradient (Gallou et al., 2017).

In this study, we aim to (i) investigate how the ranges of four target species are distributed along an elevational gradient in the Swiss Alps and to (ii) contribute to the overall knowledge of butterflies (Lepidoptera: Rhopalocera) of the area studied. There has already been extensive research of Rhopalocera in a nearby locality called Val Mora (Duvoisin, 2010). The four target butterfly species are: *Coenonympha gardetta* (De Prunner, 1798), *Colias phicomone* (Esper, 1780), *Erebia pandrose* (Borkhausen, 1788) and *Oeneis glacialis* (Moll, 1783).

C. gardetta (Figure 1) belongs to Nymphalidae, its range comprises the Alps. It is a univoltine species which inhabits exposed alpine meadows at high altitudes and grassy slopes with sparse bushes or trees at lower levels (Tolman & Lewington, 2008). The caterpillars feed on various grasses, mainly on *Poa sp*. (Lepidopterologen-Arbeitsgruppe, 1991).

C. phicomone (Figure 2) belongs to Pieridae and inhabits grassy slopes in Cantabrian Mountains, Pyrenees, Central Alps and Carpathians. It is univoltine but a partial second brood has been reported in warm localities in favourable seasons (Tolman & Lewington, 2008). Its caterpillars feed on *Fabaceae* (Lepidopterologen-Arbeitsgruppe, 1991; Tolman & Lewington, 2008).

E. pandrose (Figure 3) belongs to Nymphalidae and its range comprises Arctic and Alpine zones of Europe. It inhabits rocky areas with low bushes and short grasses (Tolman & Lewington, 2008). Its caterpillars feed on *Sesleria sp.*, *Festuca sp.* and *Nardus stricta.* (Haahtela et al., 2011; Lepidopterologen-Arbeitsgruppe, 1991; Tolman & Lewington, 2008).

O. glacialis (Figure 4) belongs to Nymphalidae, it lives in the Alps. This univoltine species inhabits dry, grassy places amongst rocks and its larvae develop on *Festuca ovina* (Ferretti, 2014; Lepidopterologen-Arbeitsgruppe, 1991; Tolman & Lewington, 2008).

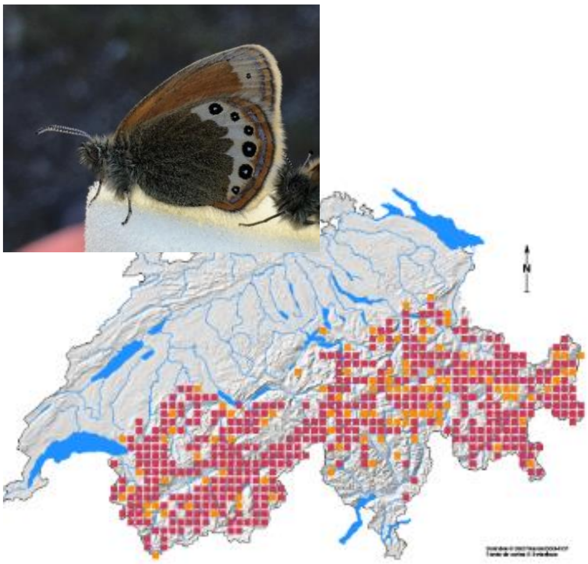

Figure 1: Distribution map of *Coenonympha gardetta* in Switzerland (credit: CSCF, 27.6. 2017). Butterfly photo credit: Lukáš Fiedler.

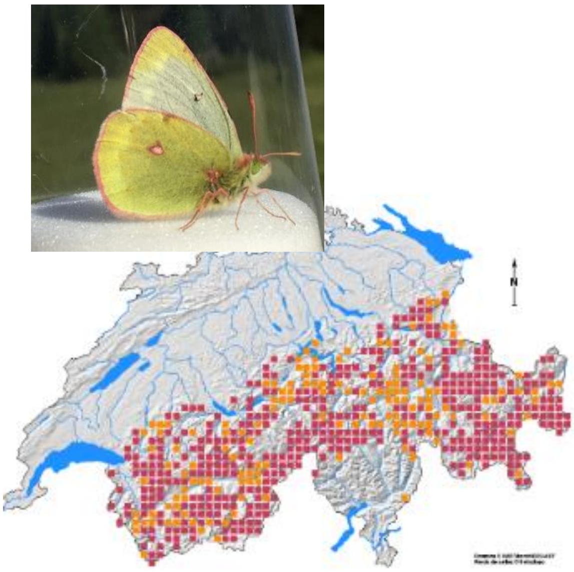

Figure 2: Distribution map of *Colias phicomone* in Switzerland (credit: CSCF, 27.6. 2017). Butterfly photo credit: Lukáš Fiedler.

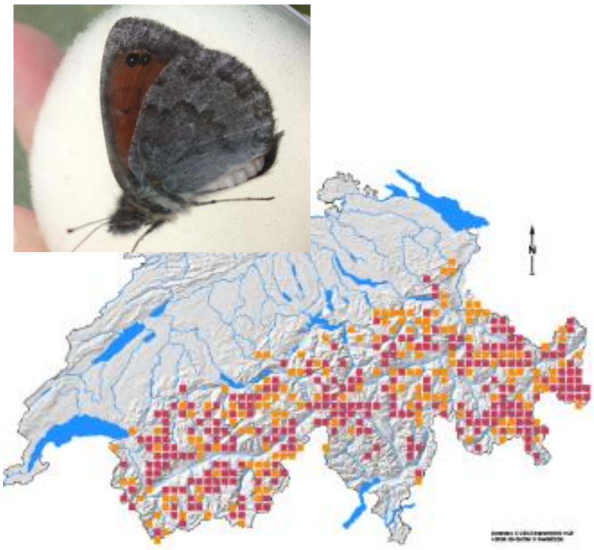

Figure 3: Distribution map of *Erebia panderosa* in Switzerland (credit: CSCF, 27.6. 2017). Butterfly photo credit: Lukáš Fiedler.

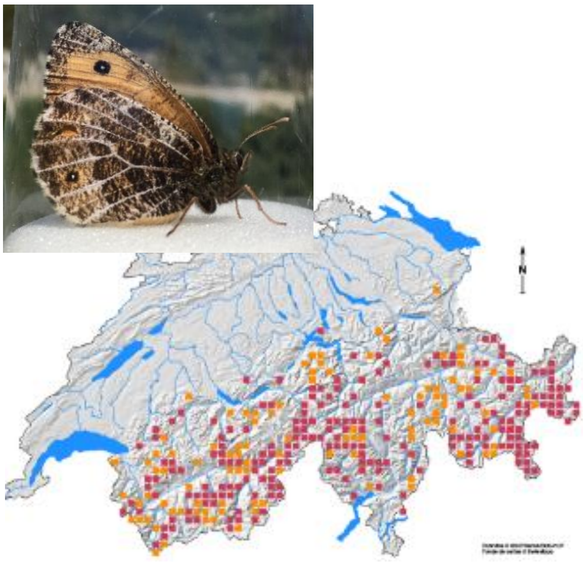

Figure 4: Distribution map of *Oeneis glacialis* in Switzerland (credit: CSCF, 27.6. 2017). Butterfly photo credit: Lukáš Fiedler.

2. Materials & Methods

The study took place in the Val Müstair, which is a part of the Canton of Graubünden, Switzerland. We randomly established 8 plots on meadows along the elevational gradient between Buffalora and Mots on the 26th June, 2017 (Figure 5). The plots were set up in a square shape with each border being 30 steps wide. The borders were always staked by the same member of the team in order to prevent any size bias resulting from different step spans of the induividual team members. Each plot was characterised by the following parameters: coordinates, altitude, exposition, degree of slope, notes on vegetation and weather conditions (Appendix: Tables A1 – A4). The plots were divided into three imaginery stripes. Sampling of butterflies was conducted in each plot using butterfly nets. During the time interval of 10 minutes, all three members of the team were catching as many butterflies as possible (each member in one stripe). The butterflies were placed into transparent plastic jars, identified, and counted before being released. For the permission to handle butterflies and catch them, see the Appendix: Figure A1. We took pictures of some representative individuals of each species. Sometimes, the butterflies were handled with bare hands but no butterfly got harmed.

On the 27th June 2017, another sampling was conducted. Due to unfavourable weather conditions, however, only three plots in lower altitudes were assessed. The data from this sampling was excluded from the analysis of elevational preferences but we still analysed its faunistical relevance (see Appendix: Tables A1 – A4 for details).

For each of the four target species, the mean altitude and standard deviation (S.D.) was calculated from all observations. The S.D. was taken as a proxy for niche width (*sensu* Gallou et al., 2017). All charts were created using Microsoft Excel 2013. The species data from this study will be provided to the Centre Suisse de Cartographie de la Faune and to Biosfera Val Müstair.

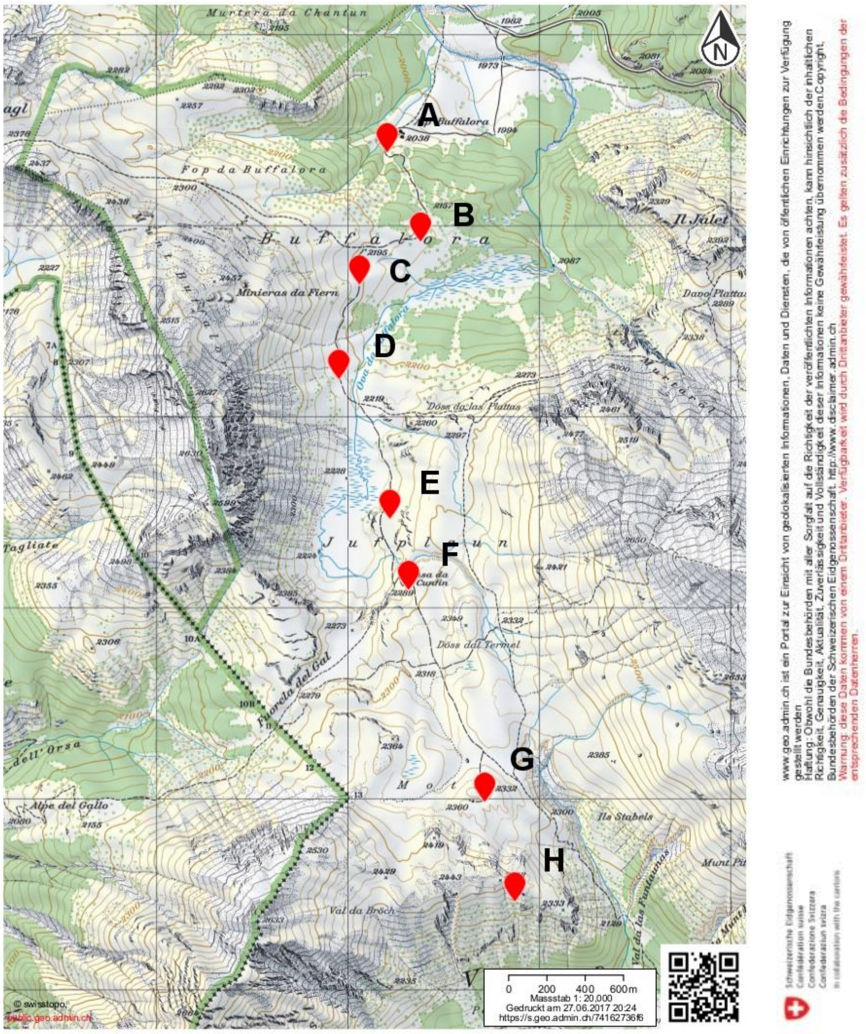

Figure 5: The study area spanned from altitudes of 2040 to 2400 metres above the sea level. Individual plots are labeled with red marks (Maps of Switzerland, 2017).

3. Results

Overall, 123 butterfly individuals belonging to 4 families and approximately 17 species were recorded (Appendix: Table A5, Figure A2). The number of species is not accurate because of some determination difficulties, e.g. some butterflies can only be determined via genitalia examination. The first sampling day yielded 101 butterfly individuals belonging to 13 species and the second day yielded 22 butterfly individuals belonging to 11 species. The species list and pictures are included in the Appendix.

The number of individuals of the four target species per each plot is depicted as a function of altitude in Figures 6 – 9. Pay attention to the x-axis when examining the Figures.

The niche widths are depicted in Figure 10.

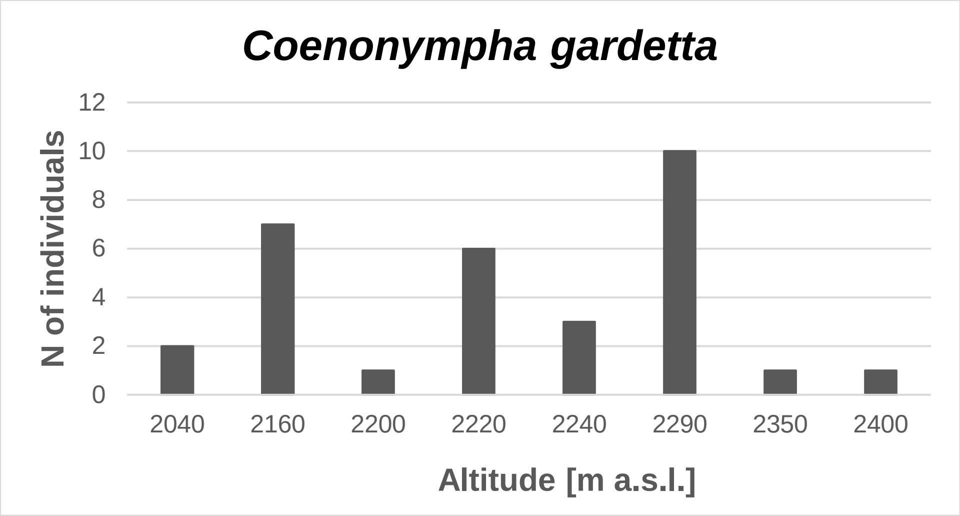

Figure 6: Numbers of *C. gardetta* individuals caught at different altitudes.

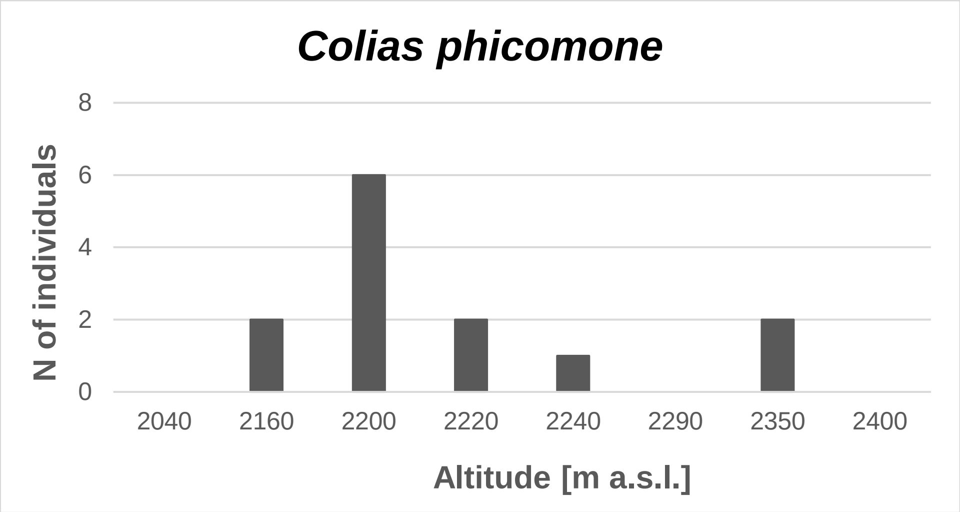

Figure 7: Numbers of *C. phicomone* individuals caught at different altitudes.

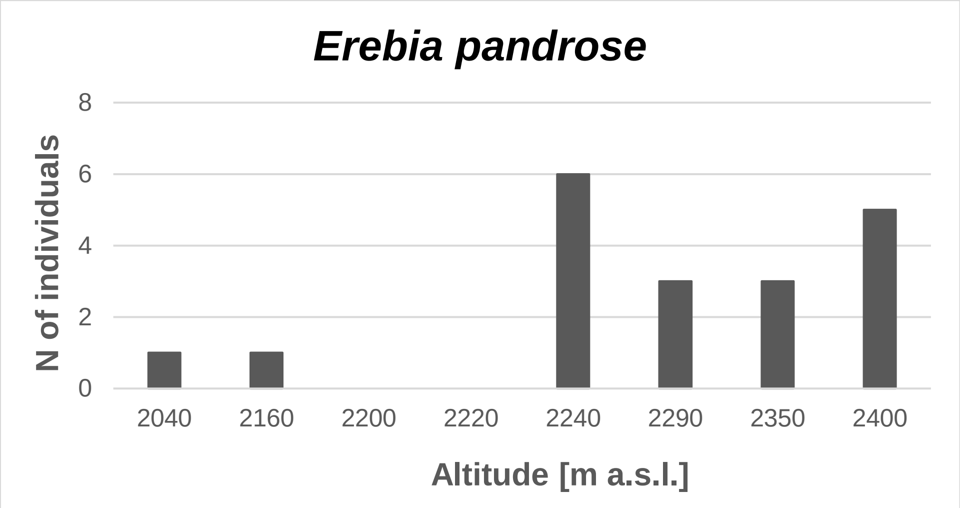

Figure 8: Numbers of *E. pandrose* individuals caught at different altitudes.

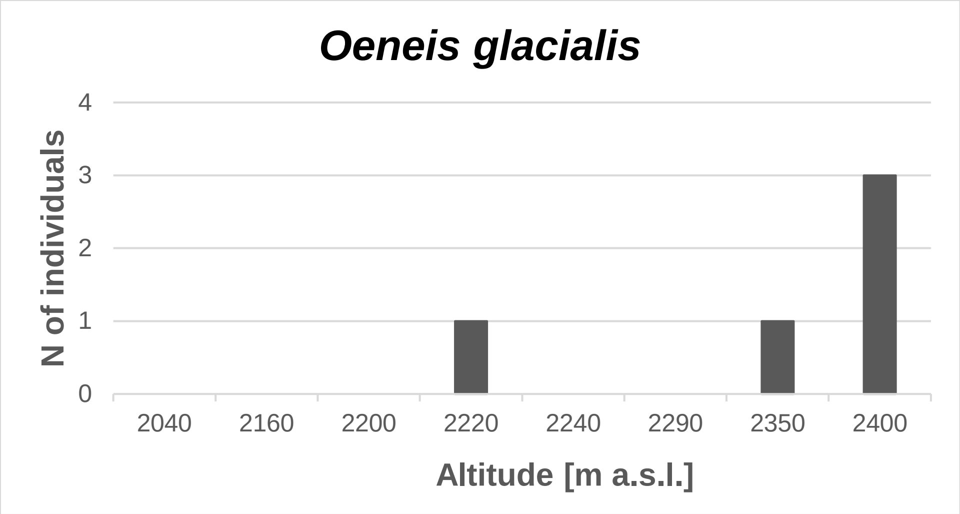

Figure 9: Numbers of *O. glacialis* individuals caught at different altitudes.

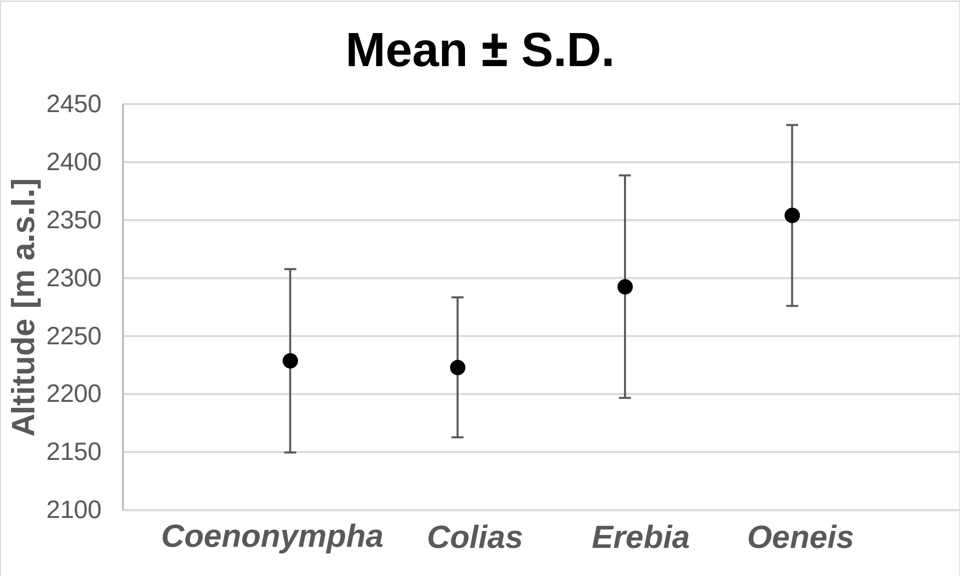

Figure 10: Niche width (mean altitude ± S.D.) distribution along the elevational gradient for the four target species with the following numbers of observations: 31 *Coenonympha gardetta*, 13 *Colias phicomone*, 19 *Erebia pandrosa*, 5 *Oeneis glacialis*.

4. Discussion

101 out of the 123 individuals were caught during the first sampling day because of sunny weather and favourable conditions (see Appendix: Tables A1 – A4). Rather few individuals (22), however, were caught on the second day of sampling due to adverse weather. On the second day, we conducted sampling at three plots only because of unfavourable weather conditions.

C. gardetta (Figure 6) didnt' show any exclusive pattern in its distribution along the gradient studied. Various resources provide different pieces of information on the elevational distribution of *C. gardetta* (Ferretti, 2014: 1000 – 2750 m a.s.l.; Lepidopterologen-Arbeitsgruppe, 1991: 1400 – 2400 m a.s.l.). It is however apparent from the results and also from our personal observation that *C. gardetta* was frequent along the whole elevational gradient.

C. phicomone (Figure 7) was more common at the altitudes around 2200 m a.s.l. We did not catch any individuals at the highest and the lowest plot. Thus, it lives in lower altitudes in comparation to the other three butterflies studied. Such conclusion seems to be somewhat confirmed by various resources (Ferretti, 2014: 750 – 2000 m a.s.l.; Lepidopterologen-Arbeitsgruppe, 1991: 900 – 2500 m a.s.l.; Tolman & Lewington, 2008: 900 – 2500 m a.s.l.).

We found *E. panderosa* predominantly at altitudes between 2240 – 2400 m a.s.l. (Figure 8). Its occurence at lower altitudes was very sparse, we didn't even make any observation of it beside the plots. The altitudinal range of *E. panderosa* should span 1750 – 2250 m a.s.l. (Ferretti, 2014) or 1600 – 3100 m a.s.l. (Lepidopterologen-Arbeitsgruppe, 1991).

O. glacialis showed a straightforward pattern of distribution (Figure 9). It was only caught in three plots (2220, 2350, 2400 m a.s.l.), however, we did observe some individuals when ascending from the plot at 2220 m a.s.l. *O. glacialis* is known from higher altitudes (Ferretti, 2014: 1500 – 3000 m a.s.l.; Lepidopterologen-Arbeitsgruppe, 1991: 2400 – 2600 m a.s.l.). It should be a typical alpine butterfly with a strong preference for rocky meadows (Lepidopterologen-Arbeitsgruppe, 1991). Our study confirms this statement, because the plots on which *O. glacialis* was recorded comprised rocky areas on which *O. glacialis* individuals were dwelling.

Figure 10 clearly demonstrates the distribution of ranges of the four target species along the elevational gradient. The error bars stand for the standard deviation which represents niche width. We have adopted this assumption from Gallou et al. (2017). The Figure basically depicts the same as the Figures 6 – 9 do. It is important to notice the problematic sides of our approach. The elevational gradient in this study spanned just a very narrow range of altitudes. Thus, we were not be able to recognise the specialists and the generalists. The sample size was very small. Gallou et al. (2017) based their model of niche width distribution along elevational gradient on those species with more than 50 observations only (unlike this study – see Figure 10 again). Our analysis of elevational preferences was based on four species which is not a lot and our data did not follow the normal (Gaussian) distribution. Thus, the application of standard deviation is somewhat controversial.

Furthermore, the plot size was not always precisely the same because of terrain irregularities and the inconsistence in step span. Species determination was biased by the fact that we couldn't examine the butterfly genitalia etc. The sample size was too small to base some major conclusions on it. If we were to conduct similar study again, we would conduct samplings in the course of a longer time period. For instance, Gallou et al. (2017) gathered a total of 35,724 butterfly observations between 1995 and 2015 (this study gathered a total of 132 observations during two days).

5. Acknowledgements

We would like to thank the Swiss Youth in Science a lot for giving us the opportunity to take part in the International Wildlife Research Week. We are grateful to the Mercator Stiftung for supporting us financially. The national organisations, i.e. Národní institut pro další vzdělávání and Federazione delle Associazioni Scientifiche e Tecniche also provided financial support. We thank Biosfera Val Müstair for supporting us. Special thank goes to Dr. Angelika Abderhalden-Raba for providing her entomological equipment and valuable pieces of advice on butterfly determination. We also thank Claudia Baumberger for her careful supervision.

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Appendix

Table A1: The plot characteristics for the first day of sampling. Altitude [m a.s.l.]. As far as slope is concerned, the ordinal categorisation was as follows: flat < mildly steep < steeper < steep. Other abbreviations or terms are self-explanatory.

Plot	Date	Coordinates	Altitude	Exposition	Slope
A	June 26	46°38'29" N 10°15'48" E	2040	NE	steep
B	June 26	46°38'13" N 10°15'55" E	2160	SE	flat
C	June 26	46°38'05" N 10°15'39" E	2200	E	mildly steep
D	June 26	46°37'52" N 10°15'34" E	2220	E	mildly steep
E	June 26	46°37'25" N 10°15'45" E	2240	W	mildly steep
F	June 26	46°37'12" N 10°15'48" E	2290	W	steeper
G	June 26	46°36'38" N 10°16'05" E	2350	N	steeper
H	June 26	46°36'22" N 10°16'12" E	2400	E	steep

Table A2: The plot characteristics for the first day of sampling. The column called vegetation depicts notes on extraordinary features of the particular plot. Other abbreviations or terms are self-explanatory.

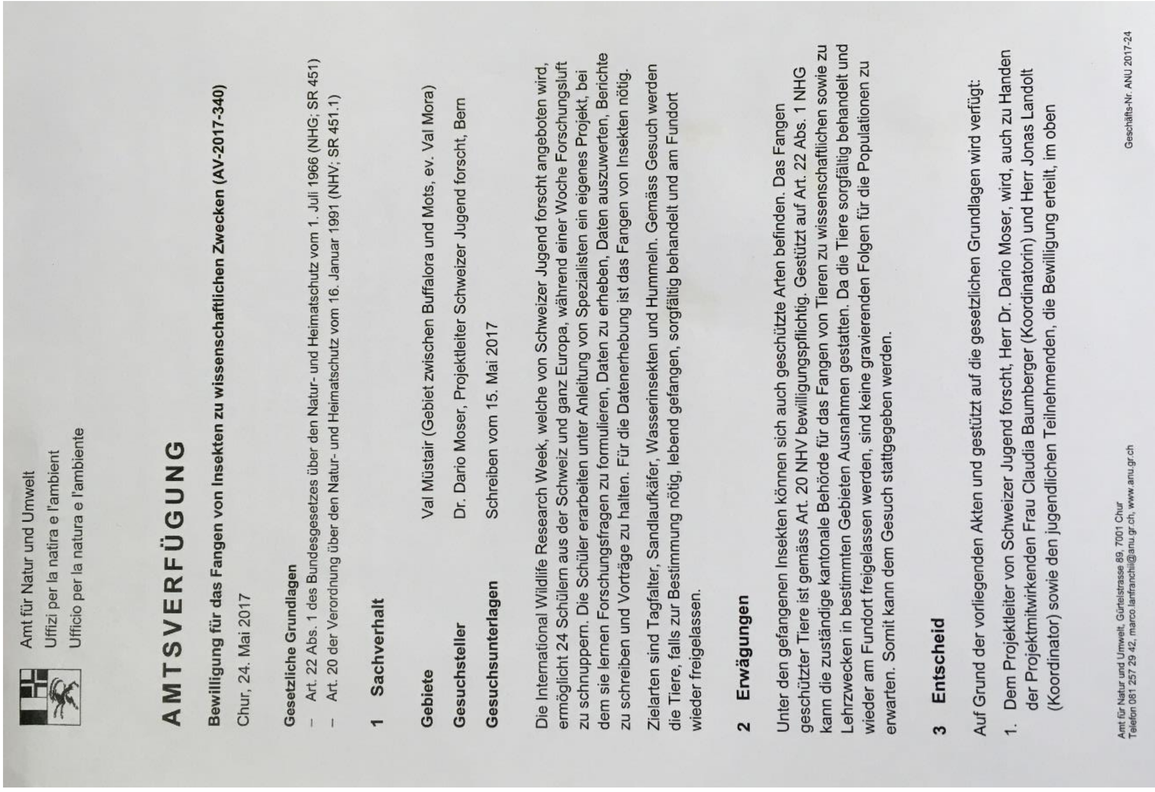
Plot	Weather	Wind	Clouds	Time	Vegetation
A	sunny	windy	cloudy	16:52 - 17:02	
B	sunny	slow	none	08:43 - 08:53	
C	sunny	slow	cloudy	16:05 - 16:15	
D	sunny	slow	none	10:12 - 10:22	*Erica*, *Juniperus*
E	overcast	windy	cloudy	15:15 - 15:25	
F	sunny	none	none	11:25 - 11:35	*Anthyllis alpestris*
G	sunny	slow	some	12:45 - 13:05	rocks
H	sunny	windy	some	13:56 - 14:06	

Table A3: The plot characteristics for the second day of sampling. Altitude [m a.s.l.]. As far as slope is concerned, the ordinal categorisation was as follows: flat < mildly steep < steeper < steep. Other abbreviations or terms are self-explanatory.

Plot	Date	Coordinates	Altitude	Exposition	Slope
A	June 27	46°38'29" N 10°15'48" E	2040	NE	steep
B	June 27	46°38'13" N 10°15'55" E	2160	SE	flat
D	June 27	46°37'52" N 10°15'34" E	2220	E	mildly steep

Table A4: The plot characteristics for the second day of sampling. The column called vegetation depicts notes on extraordinary features of the particular plot. Other abbreviations or terms are self-explanatory.

Plot	Weather	Wind	Clouds	Time	Vegetation
A	sunny	slow	cloudy	13:26 - 13:36	
B	overcast	windy	cloudy	14:10 – 14:20	
D	overcast	windy	cloudy	14:50 – 15:00	*Erica*, *Juniperus*



Amt für Natur und Umwelt
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AMTSVERFÜGUNG

Bewilligung für das Fangen von Insekten zu wissenschaftlichen Zwecken (AV-2017-340)

Chur, 24. Mai 2017

Gesetzliche Grundlagen

- Art. 22 Abs. 1 des Bundesgesetzes über den Natur- und Heimatschutz vom 1. Juli 1966 (NHG; SR 451)
- Art. 20 der Verordnung über den Natur- und Heimatschutz vom 16. Januar 1991 (NHV; SR 451.1)

1 Sachverhalt

Gebiete	Val Müstair (Gebiet zwischen Buffalora und Mots, ev. Val Mora)
Gesuchsteller	Dr. Dario Moser, Projektleiter Schweizer Jugend forscht, Bern
Gesuchsunterlagen	Schreiben vom 15. Mai 2017

Die International Wildlife Research Week, welche von Schweizer Jugend forscht angeboten wird, ermöglicht 24 Schülern aus der Schweiz und ganz Europa, während einer Woche Forschungsluft zu schnuppern. Die Schüler erarbeiten unter Anleitung von Spezialisten ein eigenes Projekt, bei dem sie lernen Forschungsfragen zu formulieren, Daten zu erheben, Daten auszuwerten, Berichte zu schreiben und Vorträge zu halten. Für die Datenerhebung ist das Fangen von Insekten nötig.

Zielarten sind Tagfalter, Sandlaufkäfer, Wasserinsekten und Hummeln. Gemäss Gesuch werden die Tiere, falls zur Bestimmung nötig, lebend gefangen, sorgfältig behandelt und am Fundort wieder freigelassen.

2 Erwägungen

Unter den gefangenen Insekten können sich auch geschützte Arten befinden. Das Fangen geschützter Tiere ist gemäss Art. 20 NHV bewilligungspflichtig. Gestützt auf Art. 22 Abs. 1 NHG kann die zuständige kantonale Behörde für das Fangen von Tieren zu wissenschaftlichen sowie zu Lehrzwecken in bestimmten Gebieten Ausnahmen gestatten. Da die Tiere sorgfältig behandelt und wieder am Fundort freigelassen werden, sind keine gravierenden Folgen für die Populationen zu erwarten. Somit kann dem Gesuch stattgegeben werden.

3 Entscheid

Auf Grund der vorliegenden Akten und gestützt auf die gesetzlichen Grundlagen wird verfügt:

1. Dem Projektleiter von Schweizer Jugend forscht, Herr Dr. Dario Moser, wird, auch zu Handen der Projektmitwirkenden Frau Claudia Baumberger (Koordinatorin) und Herr Jonas Landolt (Koordinator) sowie den jugendlichen Teilnehmenden, die Bewilligung erteilt, im oben

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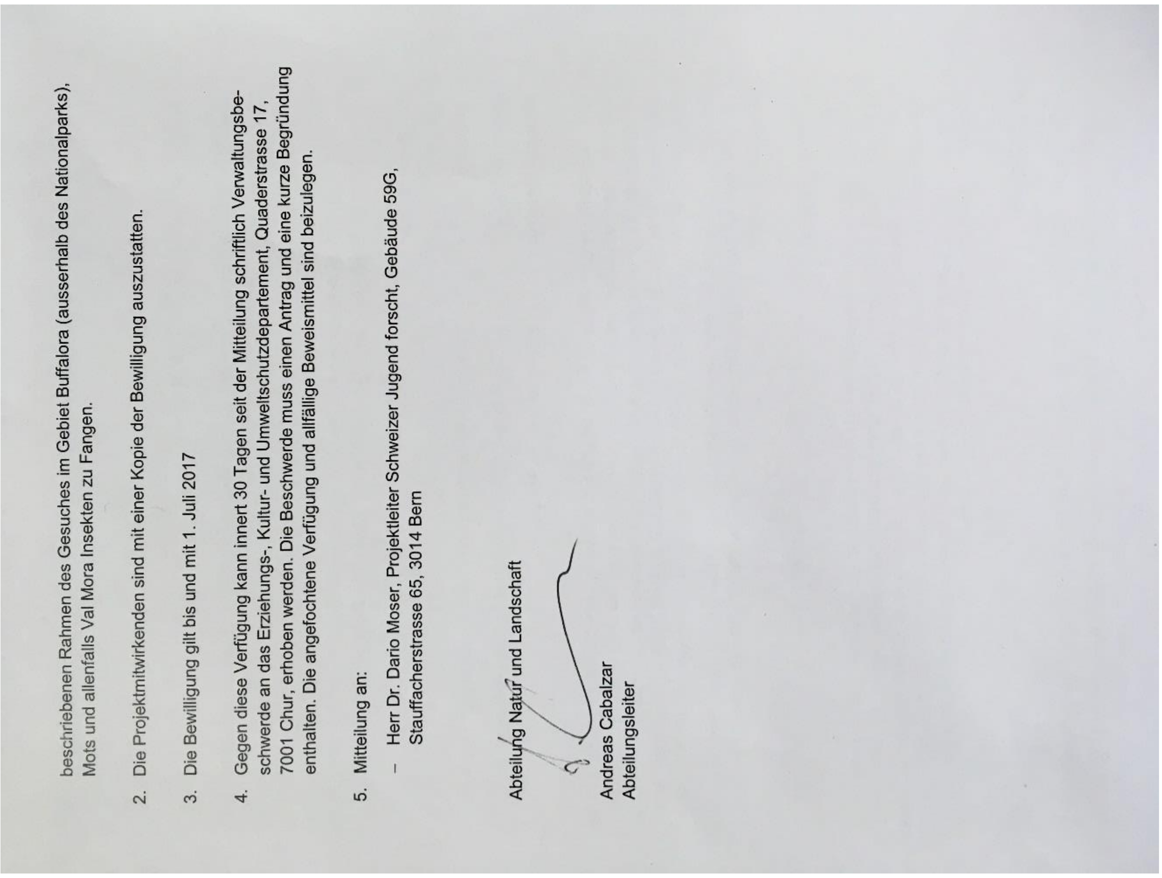
Geschäfts-Nr. ANU 2017-24



beschriebenen Rahmen des Gesuches im Gebiet Buffalora (ausserhalb des Nationalparks), Mots und allenfalls Val Mora Insekten zu Fangen.

2. Die Projektmitwirkenden sind mit einer Kopie der Bewilligung auszustatten.

3. Die Bewilligung gilt bis und mit 1. Juli 2017

4. Gegen diese Verfügung kann innert 30 Tagen seit der Mitteilung schriftlich Verwaltungsbeschwerde an das Erziehungs-, Kultur- und Umweltschutzdepartement, Quaderstrasse 17, 7001 Chur, erhoben werden. Die Beschwerde muss einen Antrag und eine kurze Begründung enthalten. Die angefochtene Verfügung und allfällige Beweismittel sind beizulegen.

5. Mitteilung an:
   - Herr Dr. Dario Moser, Projektleiter Schweizer Jugend forscht, Gebäude 59G, Stauffacherstrasse 65, 3014 Bern

Abteilung Natur und Landschaft

Andreas Cabalzar
Abteilungsleiter

Figure A1: The permission to handle butterflies.

Table A5: List of species

Pieridae

- *Colias phicomone* (Esper, 1780)

Lycaenidae

- *Lycaena hippothoe* (Linnaeus, 1761)
- *Plebejus glandon* (De Prunner, 1798)
- *Polyommatus bellargus* (Rottemburg, 1775)
- *Polyommatus cf. icarus* (Rottemburg, 1775)
- *Polyommatus semiargus* (Rottemburg, 1775)

Nymphalidae

- *Argynnis aglaja* (Linnaeus, 1758)
- *Boloria pales* (Denis & Schiffermuller, 1775)
  or *Boloria napaea* (Hoffmannsegg, 1804)
- *Coenonympha gardetta* (De Prunner, 1798)
- *Erebia pandrose* (Borkhausen, 1788)
- *Erebia sp.*
- *Euphydrias cf. aurinia debilis* (Rottemburg, 1775)
- *Euphydrias cynthia* (Denis & Schiffermuller, 1775)
- *Melitaea cf. varia* Meyer-Dur, 1851
- *Oeneis glacialis* (Moll, 1783)

Hesperiidae

- *Hesperia comma* (Linnaeus, 1758)
- *Pyrgus sp.*


Colias phicomone


Lycaena hippothoe


Plebeius glandon


Polyommatus bellargus


Polyommatus cf. icarus


Polyommatus semiargus


Argynnis aglaja


Boloria pales or *napea*


Coenonympha gardetta


Erebia pandrose


Erebia sp.


Euphydrias cf. aurinia debilis


Euphydrias cynthia


Melitaea cf. varia


Oeneis glacialis


Hesperia comma


Pyrgus sp.

Figure A2: Butterfly pictures. Credit: Lukáš Fiedler.