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Objekttyp: **Article**

Zeitschrift: **Mitteilungen der Schweizerischen Entomologischen Gesellschaft = Bulletin de la Société Entomologique Suisse = Journal of the Swiss Entomological Society**

Band (Jahr): **84 (2011)**

Heft 3-4

PDF erstellt am: **22.07.2024**

Persistenter Link: https://doi.org/10.5169/seals-403034

MITTEILUNGEN DER SCHWEIZERISCHEN ENTOMOLOGISCHEN GESELLSCHAFT
BULLETIN DE LA SOCIÉTÉ ENTOMOLOGIQUE SUISSE
84: 193–212, 2011

Orthoptera species (Ensifera, Caelifera) in differently managed grassland of the Smoljan region of the Rhodope Mountains, Bulgaria

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The present study was performed as part of the EU project 'BioBio'. The BioBio project is aimed at finding biodiversity indicators for organic and low-input farming systems. Out of the participating countries with grassland, Bulgaria was chosen for the present study. Orthoptera were chosen for monitoring, because grassland is an important habitat for many Orthoptera species. The area considered is dominated by low-input pastures and meadows. Therefore, the Orthoptera assemblages of pastures and meadows have been compared. In the Rhodope Mountains (BG), 6 meadows, 3 meadows followed by grazing and 7 pastures were visited twice in July and August 2010 and Orthoptera species were recorded. A comparison between pastures and meadows showed no difference in overall Orthoptera species richness. However, species of the suborder Caelifera were more abundant on pastures compared to meadows. Additionally, many Orthoptera species were more common on one of the two management types. *Decticus verrucivorus*, *Omocestus haemorrhoidalis* and *Omocestus viridulus* were only found on pastures, whereas *Polysarcus denticauda* was only found on meadows. It is suggested that both meadows and pastures are important for the conservation of a high Orthoptera species richness in the Rhodope Mountains.

Keywords: Orthoptera, Caelifera, Ensifera, Rhodope Mountains, pastures, meadows, low-input.

INTRODUCTION

The loss of species-rich grasslands in Europe has initiated an interest in methods to recreate biodiverse grassland (Van der Putten *et al.* 2000). Both intensification and abandonment in agriculture are drivers for biodiversity-loss (Kruess & Tscharntke 2002; Luoto *et al.* 2003; Schmitzberger *et al.* 2005; Marini *et al.* 2008; Walter *et al.* 2010). Since 1900 the intensification on agricultural land has increased due to amelioration, lake regulation and river training, application of fertilizers and pesticides, the culture of new breeds and mechanisation (Walter *et al.* 2010). Abandonment takes place especially on low productive fields in mountain regions (Walter *et al.* 2010).

Influences of the agricultural management on Orthoptera have been investigated in many studies. For example, in a study by Sergeev (1998), heterogeneous landscapes with different types of habitats contained a high Orthoptera diversity. Marini *et al.* (2009b) showed that the diversity of plants and Orthopterans declined with increasing management intensity.

Studies by Knop *et al.* (2006) and Peter & Walter (2001) revealed a significantly higher species richness of Orthoptera on ECA (ecological compensation area) hay meadows compared to conventional control meadows in Switzerland. A study

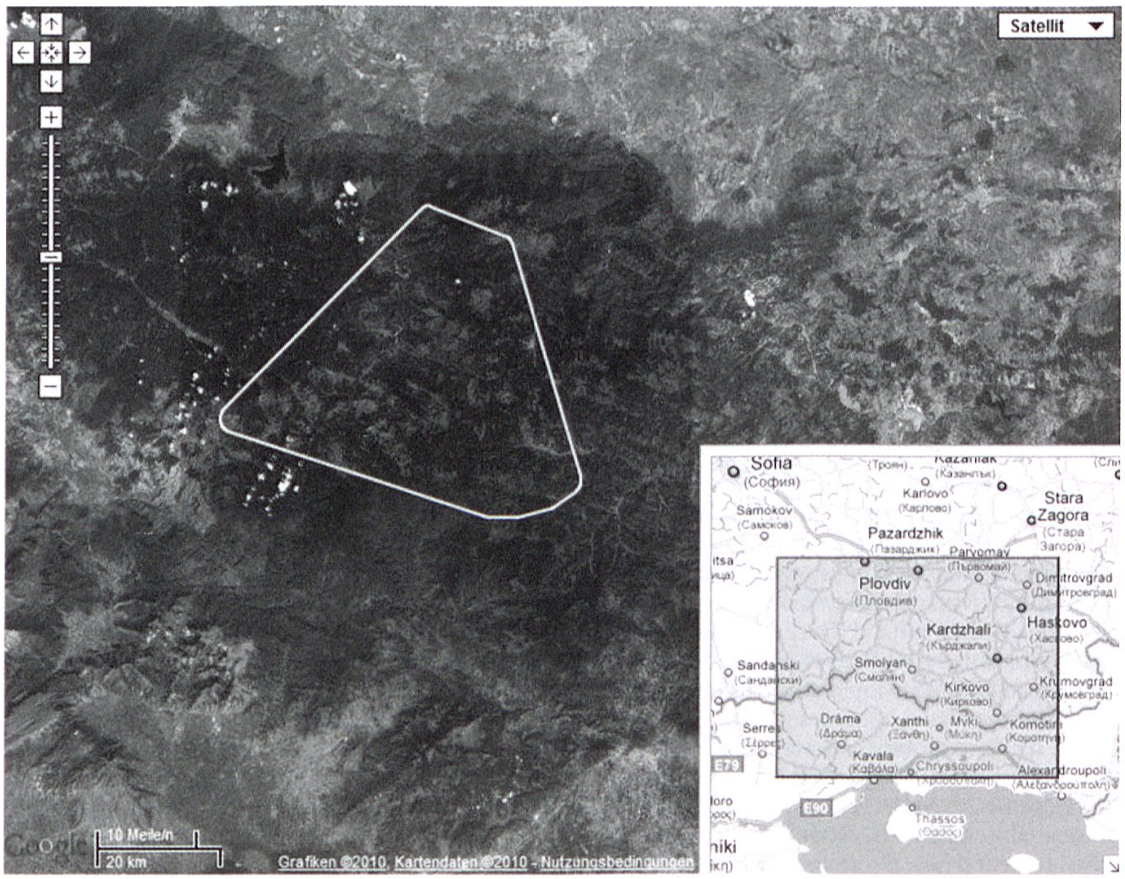

Fig. 1. Satellite picture of the study site in the Smoljan region (BioBio 2010b).

by Walter *et al.* (2005), showed only a slight difference between ECA meadows and conventional meadows on the Swiss plateau. Also, in a study by Kampmann *et al.* (2008) Orthoptera seemed not to benefit from mountain ECA meadows, while pastures contained more species. Zahn *et al.* (2010) showed that species richness was highest on pastures and lowest on intensively used meadows. Overall, extensively cultivated fields (meadows or pastures) contained high abundances and species numbers (Fartmann & Mattes 1997; Schwab *et al.* 2002; Zahn *et al.* 2010).

Orthoptera are often used as indicators to monitor the impacts of land management or habitat change (Gardiner *et al.* 2005). The major reasons cited are high diversity, representation of a trophic level within the grassland ecosystem in terms of functionality and community structure, and sensitivity to change (Oertli *et al.* 2005; Gardiner *et al.* 2005). Additionally, Orthopterans are sedentary organisms with low level of food specialization (Baur & Roesti, 2006).

For these reasons, Orthoptera were an appropriate choice for this master thesis about different types of grassland management. The present study was carried out because detailed studies on the impact of factors related to degree of intensification are scarce, and a generic indicator system to assess benefits on biodiversity is lacking.

The study was performed as a supplementary study of the EU project 2271611 (BioBio), which has the following major objectives:

a) b)

Fig. 2. Landscape in the Smoljan region of the Rhodope Mountains; pasture (a) and meadow (b).

1. The conceptualization of criteria for a scientifically-based selection of biodiversity indicators for organic/low-input farming systems and their associated agricultural practices.

2. The assessment and validation of a set of candidate biodiversity indicators in case studies representative for organic/low-input farming systems across Europe taking into account regional specificities, cost effectiveness and practicality.

3. The preparation of guidelines for the implementation of appropriate biodiversity indicators for organic/low-input farming systems.

The project involves 11 countries (Austria, France, Germany, Switzerland, Bulgaria, Hungary, Norway, United Kingdom, Spain, The Netherlands and Italy) and the following groups were investigated in every country: earthworms, spiders, wild bees and flowering plants. Thus our investigation of the Orthoptera in Bulgaria gives an added value to this project.

In Bulgaria, the area considered is dominated by low-input farming (farms differentiated by a gradient of farming intensity) and no «organic» farming. The investigated questions were as follows: (1) Are pastures more species-rich compared to meadows? (2) Which species are predominantly found in meadows and which in pastures?

MATERIALS AND METHODS

Study site in Bulgaria

The study site is situated in the Smoljan region of the Rhodope Mountains in Bulgaria. It lies in the South Central Region of Bulgaria (coordinates 41.5° N, 24.65° E) (Fig. 1). The total area of the region has a size of 3193 km^2. This specific region was chosen as there are a lot of farms with a long tradition in low-input farming in a place of high natural value (Stoyanova *et al.* 2010). The mean annual precipitation is 700–900 mm and the average annual temperature between 5°C and 12°C. The fields are situated between 940 and 1850 m a.s.l. Geologically, the Rhodope Mountains are dominated by crystalline (hard) rocks, which develop sandy soils by weathering. Large parts are maintained predominantly by extensive agriculture, grazing for domestic animals and haymaking. At present, livestock breeding is

mainly based on private households with a few sheep, goats and cows reared by their owners as subsistence farming. The management of these semi-natural grasslands is not intensive and the meadows are cut only once or twice per year. The grazing takes place between April and November and hay is produced on local meadows. The use of fertilizer and pesticides in grasslands is limited or non existing (BioBio 2010a).

Less competitive grassland species can survive in these grasslands and therefore the biodiversity is comparatively high (Stoyanova *et al.* 2010; Cellarius 2004). About 30 % of the Smoljan district is part of Natura 2000, which is an ecological network of protected areas in the European Union (Stoyanova *et al.* 2010).

16 farms were selected randomly out of 32 available farms. The average grassland area of the 16 farms is 56.25 ha per farm (min. 10 and max. 100 ha). 14 farms manage livestock of sheep, whereas only 3 manage cattle. The highest number of animals on one farm is 800 sheep.

Pastures and meadows in Bulgaria

We were supported by Siyka Stoyanova and her colleagues of the Institute of Plant Genetic Resources in Plovdiv. They advised us in the selection of fields and accompanied us to the fields. The choice of the fields for the meadow-pasture comparison was not always simple, as the management type was often unclear. Furthermore, the distances between the fields were often large, which caused logistical difficulties. We tried to choose an equal number of meadows and pastures inside this general framework.

On the first survey from 5th to 12th July 2010, we visited 6 meadows (M), 3 meadows followed by grazing (M&P) and 7 pastures (P) (Tab. 4). On the second survey from 24th August to 1st September 2010 we visited the same fields again. As the weather was much better in August than in July, we could add 1 meadow, 2 M&Ps and 2 pastures. That resulted in 21 surveyed fields, belonging to six farms.

The meadows are cut once or twice per year. On 3 (respectively 5, with the additional fields of the second survey) of them grazing by sheep, goats, cattle or horses followed. The pastures are more or less intensively grazed by sheep, goats, cattle or horses. At the present time, the data of intensity of the management was not yet available and therefore the corresponding analysis could not be done within the present study.

Orthoptera monitoring and identification

All Orthoptera species per field were recorded carefully after about one hour search (Annex). As the Orthoptera density was sometimes exceptionally high, identification was difficult. Therefore, the estimation of the abundance was not possible and we concentrated on the species richness. To have an almost complete species list, small structures in the field, for example dry or wet microhabitats, have been examined with special attention. The species were identified visually and by listening. If the identification was not possible at first sight, the Orthoptera were captured with a net. Unknown individuals were collected and kept in ethanol. Observation took place between 9:30 am and 5:30 pm when there was no rain.

Back in Switzerland, the Orthoptera from Bulgaria were prepared and dried before identification. To identify the Orthoptera of Bulgaria, the books by Harz

Tab. 1. List of all the Orthoptera species and their continuity found in the Smoljan region of the Rhodope Mountains.

Ensifera	continuity over all fields
Anterastes serbicus (Brunner von Wattenwyl, 1882)	18.75%
Decticus verrucivorus (Linnaeus, 1758)	25.00%
Isophya bureschi (Peshev, 1959)	81.25%
Isophya rhodopensis (Ramme, 1951)	6.25%
Metrioptera arnoldi (Ramme, 1933)	25.00%
Pholidoptera aptera (Fabricius, 1793)	62.50%
Pholidoptera frivaldskyi (Herman, 1871)	87.50%
Poecilimon brunneri (Frivaldszky, 1867)	18.75%
Poecilimon thoracicus (Fieber, 1853)	87.50%
Polysarcus denticauda (Charpentier, 1825)	25.00%
Psorodonotus fieberi (Fieber, 1853)	43.75%
Tettigonia viridissima (Linnaeus, 1758)	25.00%

Caelifera	continuity over all fields
Arcyptera fusca (Pallas, 1773)	56.25%
Chorthippus apricarius (Linnaeus, 1758)	43.75%
Chorthippus biguttulus group	50.00%
Chorthippus dichrous (Eversmann, 1859)	12.50%
Chorthippus parallelus (Zetterstedt, 1821)	100.00%
Chorthippus vagans (Eversmann, 1848)	12.50%
Chrysochraon dispar (Germar, 1834)	12.50%
Euchorthippus declivus (Brisout de Barneville, 1848)	only found on plots surveyed once
Euthystira brachyptera (Okskay, 1826)	75.00%
Myrmeleotettix maculatus (Thunberg, 1815)	6.25%
Oedipoda caerulescens (Linnaeus, 1758)	6.25%
Omocestus haemorrhoidalis (Charpentier, 1825)	31.25%
Omocestus viridulus (Linnaeus, 1758)	37.50%
Podisma pedestris (Linnaeus, 1758)	6.25%
Stauroderus scalaris (Fischer von Waldheim, 1846)	87.50%
Stenobothrus lineatus (Panzer, 1796)	62.50%
Stenobothrus nigromaculatus (Herrich-Schäffer, 1840)	6.25%
Stenobothrus rubicundulus (Kruseman et Jeekel, 1967)	6.25%
Stethophyma grossum (Linnaeus, 1758)	6.25%

(1969, 1975) and a binocular was used. The individuals of the *Chorthippus biguttulus* group were pooled to one taxon *Chorthippus biguttulus*, since the morphological identification is almost impossible. The species of the genus *Gryllus* were left aside, as they have their phenological peak of adults earlier in the season. The verification of the identifications occurred with the keep of the Orthoptera collections of Harz and Nadig at the Museum of Natural History in Geneva.

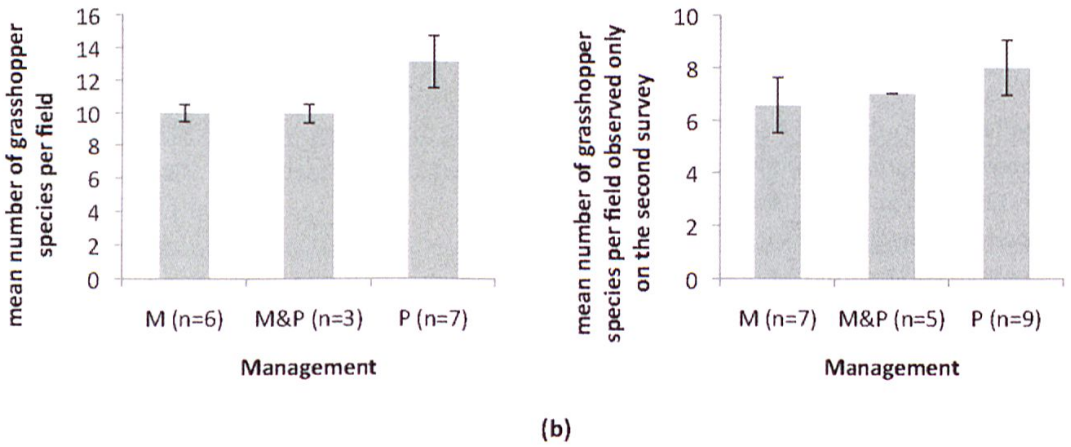

Fig. 3. Influence of the meadows and pastures on mean number of Orthoptera species per field on both surveys (a) and on the second survey (b) showed no significant difference. M: meadow; M&P: meadow&pasture; P: pasture. ±standard error.

Statistics

The statistical analysis has been done with R 2.11.1 (R, 2010). For most analyses the data of the fields visited twice were combined. As more fields were visited the second time, some analyses were done only with the data of the second survey. If not described differently, the following analyses were made with the data of both surveys.

Whether there are any differences in the number of Orthoptera species on different managements has been tested with a one way ANOVA for the plots visited twice and the second survey only.

To compare meadows and pastures on differences in number of Caelifera and Ensifera species, the Tukey HSD (Honest Significant Difference) test was used.

The continuity of the common Orthoptera species (continuity over all fields > 20 %) was tested. Therefore, pairwise comparisons with Bonferroni correction were calculated. Additionally, an indicator value was calculated for every species using the method by Dufrêne & Legendre (1997). The resulting p-values were adjusted with the Holm correction. The species of the genera *Poecilimon* were added for these two calculations, since not all *Poecilimon* species have been identified.

RESULTS

Orthoptera species in the study plots

In the Rhodope Mountains we found a total of 31 Orthoptera species, 19 belonging to the suborder Caelifera and 12 to the suborder Ensifera (Tab. 1). The minimum of Orthoptera species found on one field was 8 species on both meadows and pastures. The maximum of 21 species on one pasture was extraordinarily high, whereas on meadows the maximum was 12 species. The most abundant species was *Chorthippus parallelus* which occurred on all the fields visited twice. *Pholidoptera frivaldskyi* and *Poecilimon thoracicus* were, with a continuity of 87.50 % each, the most frequent Ensifera species. Furthermore, *Euthystira brachyptera* (75.00 %), *Isophya bureschi* (81.25 %) and *Stauroderus scalaris* (87.50 %) were also very common.

Tab. 2. Results of the Tukey Multiple Comparison of the mean number of Caelifera species (a) and the mean number of Ensifera species (b) per field.

	(a)				(b)			
	Estimate	Std. Error	t	p	Estimate	Std. Error	t	p
M&P – Meadow	0.333	1.522	0.219	0.974	0.333	1.147	0.291	0.954
Pasture – Meadow	3.476	1.197	2.904	0.031 *	0.191	0.902	0.211	0.976
Pasture – M&P	3.143	1.485	2.117	0.123	0.143	1.119	0.128	0.991

*** p ≤ 0.001, ** p ≤ 0.01, * p ≤ 0.05. Meadow n=6, M&P n=3, Pasture n=7.

Comparison of Orthoptera richness of meadows and pastures

The number of species in meadows and pastures was not significantly different (both surveys p=0.155, second survey p=0.557).

The pastures had the highest mean number of 13.1±1.6 Orthoptera species (Fig. 3a). We found on the meadows a mean number of 10.0±0.5 species, and the fields used as both meadow and pasture were with 10.0±0.6 species pretty similar.

With the data of the second survey only, we had also on pastures the highest value with 8.0±1.1 species (Fig. 3b). On meadows we found 6.6±1.0 species and on M&Ps 7.0±0.0 species.

Influence of meadows compared to pastures on Orthopteran communities

The Tukey Multiple Comparison showed a difference in the number of Caelifera species between pastures and meadows ($p<0.05$) (Tab. 2a). The other two comparisons were not significantly different.

In contrast, the number of Ensifera species did not depend on the management (Tab. 2b).

On meadows (4.7±0.3 species) we found significantly fewer Caelifera species compared to pastures (8.1±1.1 species) (Fig. 4a). With 5.0±0.6 Caelifera species, the M&Ps were in between. With the data of the second survey only, the graph looks similar, although the difference was not significant (Fig. 4b).

On the other hand, the number of Ensifera species was very similar on all management regimes (Fig. 4c). With the data of the second survey only, we found more species on meadows (2.7±0.7 species) compared to pastures (2.0±0.4), but as well no significant difference was detected (Fig. 4d).

Almost half of the common Orthoptera species showed at least one significant difference in their frequency between meadows, M&Ps and pastures (Tab. 3).

Both *Omocestus* species did not occur on meadows and M&Ps, but on pastures:

O. haemorrhoidalis with 71.43 % and *O. viridulus* with 85.71 %. As well the Ensifera species *Decticus verrucivorus* could not be found on meadows, but on pastures (57.14 %). On the other hand, *Polysarcus denticauda* could only be found on meadows (66.67 %).

We found on all meadows and M&Ps *Euthystira brachyptera*, however, on pastures they were not so frequent (42.86 %). *Isophya bureschi* was more common on meadows (100.00 %) compared to M&Ps (33.33 %). Similarly, *Psorodonotus fieberi* was common on meadows (83.33 %), but did not occur on M&Ps.

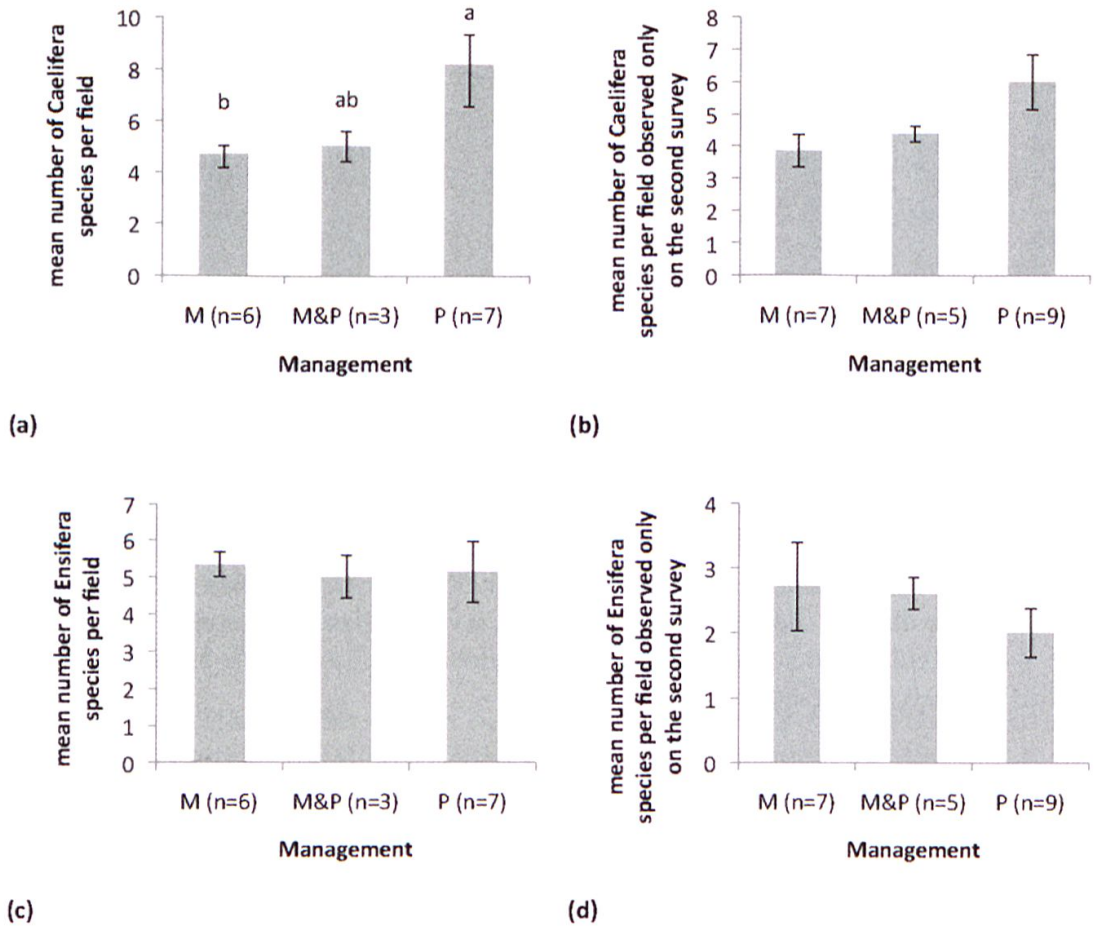

Fig. 4. Influence of the management on mean number of Caelifera species per field on both surveys (a) and on the second survey (b). Influence of the management on mean number of Ensifera species per field on both surveys (c) and on the second survey (d). Significant differences are indicated by different letters. M: meadow; M&P: meadow&pasture; P: pasture. ±standard error.

Tettigonia viridissima was found on all M&Ps, but not on meadows and only on few pastures (14.29 %).

With the method by Dufrêne & Legendre (1997) only *O. viridulus* had a significant indicator value (max. IndVal on pastures=0.857, $p>0.05$).

DISCUSSION

Orthoptera species in the Rhodope Mountains

In the Rhodope Mountains the level of biodiversity is high (Cellarius 2004). The soils are relatively nutrient-poor (Cellarius 2004), as in Bulgaria the use of fertilizers is limited (BioBio 2010a). This may have a positive effect on Orthoptera diversity, while high fertilisation and cutting frequency create an unsuitable sward structure (Marini *et al.* 2009a). In Eastern and Western Rhodopes together, 154 Orthoptera species were established (Popov 2007). We found 31 Orthoptera species in the Smoljan region of the Rhodope Mountains. One of these species, *Isophya*

Tab. 3. Table of the continuity, pairwise comparison of the managements and the maximum indicator value of the common Orthoptera species (continuity over all fields > 20%).

	continuity over all fields	M	M&P	P	p –value M:M&P	M:P	P:M&P	max. IndVal	p
Arcyptera fusca	56.3%	66.7%	33.3%	57.1%	1.000	1.000	1.000	0.283	1.000
Chorthippus apricarius	43.8%	50.0%	0.0%	57.1%	0.540	1.000	0.360	0.305	1.000
Chorthippus biguttulus	50.0%	16.7%	66.7%	71.4%	0.480	0.180	1.000	0.330	1.000
Chorthippus parallelus	100.0%	100.0%	100.0%	100.0%	1.000	1.000	1.000	0.333	1.000
Decticus verrucivorus	25.0%	0.0%	0.0%	57.1%	1.000	0.043 *	0.120	0.571	1.000
Euthystira brachyptera	75.0%	100.0%	100.0%	42.9%	1.000	0.043 *	0.120	0.412	1.000
Isophya bureschi	81.3%	100.0%	33.3%	85.7%	0.049 *	1.000	0.135	0.457	1.000
Metrioptera arnoldi	25.0%	0.0%	66.7%	28.6%	0.110	0.670	0.580	0.467	1.000
Omocestus haemorrhoidalis	31.3%	0.0%	0.0%	71.4%	1.000	0.006 **	0.024 *	0.714	0.760
Omocestus viridulus	37.5%	0.0%	0.0%	85.7%	1.000	0.000 ***	0.001 ***	0.857	0.029 *
Pholidoptera aptera	62.5%	83.3%	100.0%	28.6%	1.000	0.104	0.083	0.472	1.000
Pholidoptera frivaldskyi	87.5%	100.0%	100.0%	71.4%	1.000	0.440	0.700	0.368	1.000
Poecilimon spec.	93.8%	100.0%	100.0%	85.7%	1.000	1.000	1.000	0.350	1.000
Polysarcus denticauda	25.0%	66.7%	0.0%	0.00%	0.034 *	0.007 **	1.000	0.667	0.468
Psorodonotus fieberi	43.8%	83.3%	0.0%	28.6%	0.043 *	0.104	1.000	0.621	1.000
Stauroderus scalaris	87.5%	83.3%	100.0%	85.7%	1.000	1.000	1.000	0.372	1.000
Stenobothrus lineatus	62.5%	33.3%	100.0%	71.4%	0.180	0.480	1.000	0.489	1.000
Tettigonia viridissima	25.0%	0.0%	100.0%	14.3%	0.000 ***	1.000	0.001 ***	0.875	0.121

*** p ≤ 0.001, ** p ≤ 0.01, * p ≤ 0.05. p-value of the pairwise comparison calculated with pairwise t test (Bonferroni method) and p-value of max. indicator value adjusted with Holm method. M: Meadow (n=6), M&P: Meadow&Pasture (n=3) and P: Pasture (n=7).

rhodopensis, is endemic in the Western Rhodopes (Popov 2007). The most abundant species was *C. parallelus*, which occurred on all fields. *E. brachyptera*, another common species, is an unaspiring species, which lives on various habitats as wet meadows, marshes or dry grasslands (Baur & Roesti 2006). *S. scalaris*, also a common species in the Smoljan region, is specialised on dry and warm habitats (Baur & Roesti 2006).

The rare species *M. maculatus* needs warm, dry habitats with sparse vegetation and open places (Baur & Roesti 2006), which fits to the place where it was found. *S. nigromaculatus* prefers warm and dry habitats (Baur & Roesti 2006) as well.

Influence of meadows compared to pastures on the number of Orthoptera species

Pastures and meadows differ in some aspects. Meadows cause Orthoptera mortality by the harvesting process directly and indirectly by the removal of eggs of plant breeding species, increased predation and by changes in habitat characteristics (Humbert *et al.* 2010; Fartmann & Mattes 1997; Gardiner & Hassall 2009). On pastures mortality may be caused due to trampling of animals directly, which causes mainly dead larvae, although under cold and rainy weather conditions also imagines may die (Fartmann & Mattes 1997). The indirect effects are more or less the same on pastures as on meadows. Selective browsing, footstep and deposition of dung of the livestock may lead to a larger heterogeneity in the spatial pattern on pastures compared to meadows (Fartmann & Mattes 1997; Morris 2000; Plantureux *et al.* 2005; Detzel 1998). Luoto *et al.* (2003) point out that pastures are important to maintain heterogeneous habitat mosaics. Many studies showed that habitat heterogeneity leads to a higher biodiversity (Benton *et al.* 2003).

Tab. 4. Coordinates and altitude of the fields in the Smoljan Region.

Farm nr.	Field nr.	Coordinates N	Coordinates E	Altitude (m)	Management
1	1	41°52'34''	24°26'34"	959	M&P
6	1	41°35'40,92"	24°40'10,03"	1180	P
6	2	41°35'28,45"	24°40'21,32"	1137	P
6	3	41°38'3,65"	24°40'37,76"	1877	P
10	1	41°39'04,1"	24°35'47,3"	1400	M
10	2	41°38'54,26"	24°34'8,68"	1406	M
10	3	41°38'47,92"	24°34'13,17"	1454	M
10	4+5	41°38'49,62"	24°34'4,16"	1426	M
10	6	41°38'37,5"	24°35'58,6"	1444	M
10	7	41°39'14,98"	24°36'2,76"	1357	M
11	1+2	41°40'15,4"	24°47'24,6"	1302	P
11	3	41°40'37,61"	24°47'27,56"	1346	P
11	4	41°42'25,62"	24°46'57,77"	1633	P
11	5	41°42'32,26"	24°47'58,51"	1759	P
12	1	41°31'34,90"	24°45'31,01"	1036	M&P
12	2	41°31'45,17"	24°45'40,41"	1078	P
12	3	41°31'49,24"	24°45'44,47"	1085	M
12	4	41°31'54,13"	24°45'46,16"	1080	P
13	1	41°33'46,1"	24°44'09,4"	940	M&P
13	2	41°33'38,5"	24°44'07"	974	M&P
13	3	41°33'39,9"	24°44'05,6"	975	M&P

Management: M: Meadow; M&P: Meadow&Pasture; P: Pasture.

Zahn *et al.* (2007) found a higher arthropod species richness on extensively grazed wetland than on abandoned ones. On the other hand, a study by Kruess & Tscharntke (2002) showed a higher biodiversity and abundance on ungrazed grasslands (5–10 years old) compared to pastures.

A higher arthropod species richness and abundance on pastures compared to meadows was found in a study by Wettstein & Schmid (1999). In addition, higher Orthoptera species richness and abundance were found on pastures than on meadows (Kampmann *et al.* 2008; Zahn *et al.* 2010). Orthoptera species richness benefits from vegetation heterogeneity (Kruess & Tscharntke 2002), which is the case on pastures. In the Eastern Rhodopes the faunistic diversity was most rich on mesophile grasslands, especially on pastures with 41 species, whereas on mesophile meadows 31 species were found (Beron & Popov 2004). Otherwise, Fischer & Wipf (2002) found a negative effect of grazing on plant species richness compared to mowing.

One cut per year or extensive grazing by sheep may have a positive effect on flora and fauna (Fartmann & Mattes, 1997). As the intensity of the management increases, the biodiversity decreases (Fartmann & Mattes 1997; Kruess & Tscharntke 2002).

Some studies demonstrated an advantage for many plant species under mixed management (grazing and cutting) compared to exclusive grazing or cutting (Plantureux *et al.* 2005).

Our results suggest that there is no difference in the overall Orthoptera species richness between meadows, pastures and mixed management under low-input management regime. As pointed out above, the influence of the management on the biodiversity can differ with respect to intensity level. Unfortunately, the data on the management intensity is not available yet.

We did not measure the heterogeneity on the fields, but the optical impression was a heterogeneous vegetation with structures as shrubs and perennial herbs on pastures and also on meadows. Nevertheless, on some single pastures we found a particularly high Orthoptera species richness. Possibly the management was restricted to grazing due to natural heterogeneity of the landscape, which causes difficult accessibility for management or transport of hay.

Influence of meadows compared to pastures on the Orthopteran community

In contrast to the overall Orthoptera species richness, we found higher Caelifera species richness on pastures than on meadows. Possibly the short impact of mowing had a more negative influence on Caelifera than extensive grazing. A study by Zahn *et al.* (2010) compared the occurrence of arthropods on fallow land, extensively used pastures and extensively and intensively used meadows in Upper Bavaria. Caelifera were most common on pastures, whereas Ensifera had their maximum abundance on fallow land (Zahn *et al.* 2010). However, our result needs further clarification, as the meadows surveyed twice belong all to the same farm (Tab. 4). The same circumstance applies to the fields used as meadows and pastures. Conceivably, the Caelifera species are more frequent on pastures as with further distance between individual fields the species composition might change.

Many Orthoptera species were more common on one management type. On pastures, by trampling and grazing, convenient living conditions are created for many species (Fartmann & Mattes 1997; Detzel 1998). The following species possibly benefit from pastures:

O. caerulescens, *M. maculatus*, *E. brachyptera*, *S. lineatus*, *O. haemorrhoidalis*, *O. viridulus*, *Ch. brunneus* and *Ch. biguttulus* (Fartmann & Mattes 1997; Detzel 1998). Additionally, by selective browsing, spiny, bad tasting or poisonous plants stay as tall-growing structures in the fields, this supports for example *D. verrucivorus* (Fartmann & Mattes 1997). As a consequence, we found *D. verrucivorus* in the Rhodope Mountains only on pastures.

We found both *Omocestus* species as well only on pastures. Additionally, *O. viridulus* had a high indicator value calculated with the method by Dufrêne & Legendre (1997). In Switzerland, *O. viridulus* prefers mesic meadows and pastures, although on higher altitude it is found also on dry habitats (Baur & Roesti 2006). *O. haemorrhoidalis* lives on dry and warm habitats with short vegetation and therefore grazing is important to keep the vegetation short (Detzel 1998).

P. denticauda is known as an absolute meadow animal, which is displaced by shrub encroachment (Detzel 1998). We also found *P. denticauda* only on meadows in the Smoljan region.

Additionally to the beneficial impact from grazing on *E. brachyptera* (Detzel 1998), Guido & Gianelle (2001) found a minimal disturbance by mowing on this Orthoptera species. On the other hand, Ingrisch & Köhler (1998) found a negative effect of mowing on *E. brachyptera* due to the removal of vegetation during oviposition, because *E. brachyptera* lay their eggs on grasses. We suppose that *E. brachyptera* persists on pastures and meadows, as long as there are hideaways where their eggs are save. They seemed to survive well under one cut per year.

The optimal habitat for *T. viridissima* is slight shrub encroachment with a well developed herbal layer (Detzel 1998). But as all the surveyed fields used as meadow and pasture lie next to each other, this is possibly the main reason for their distribution.

We suggest that both management types, pastures and meadows, are important to preserve, as they both support different Orthoptera species.

CONCLUSION AND OUTLOOK

No difference in the overall Orthoptera species richness was found on meadows compared to pastures in the Rhodope Mountains. However, more Caelifera species were found on pastures compared to meadows. This might be due to a natural heterogeneity in the spatial pattern on pastures. *O. haemorrhoidalis*, *O. viridulus* and *D. verrucivorus* were only found on pastures, whereas *P. denticauda* was only detected on meadows. To confirm the positive effect of pastures and meadows on different Orthoptera species, the number of investigated meadows should be increased on several farms.

We conclude that different management types and habitats are important for the conservation of a high Orthoptera species richness.

At the time of completing this study, some analyses on vegetation, habitat types and management intensity were in progress for the BioBio project. Therefore, these influences on the Orthoptera can be investigated only at a later date.

ACKNOWLEDGEMENT

We are grateful to Siyka Stoyanova, Mariya Sabeva and Yana Guteva of the Institute of Plant Genetic Resources in Plovdiv for their support in the field, the providing of data and many happy hours in Bulgaria. Thanks to the farmers in the Smoljan region participating at the BioBio project. We thank Gisela Lüscher, ART, and all people of the BioBio project in Switzerland for providing of data. As well we are grateful to the following people: Dr. Philippe Jeanneret, ART, Jonas Winizki, ART, Stephan Bosshart, ART, Mario Waldburger, ART and Dr. Peter Schwendinger, Museum of Natural History in Geneva.

ZUSAMMENFASSUNG

Die vorliegende Studie wurde als Teil des EU Projekts 'BioBio' durchgeführt. Das BioBio Projekt hat das Ziel, Biodiversitäts-Indikatoren für die biologische und 'low-input' Landwirtschaft zu finden. Bulgarien wurde aus den teilnehmenden Ländern mit Grasland für die vorliegende Studie gewählt. Es existieren bisher nicht viele Studien über Biodiversitäts-Indikatoren. Heuschrecken wurden für das Monitoring gewählt, da Grasland für viele Heuschrecken ein wichtiger Lebensraum ist. Die untersuchte Region ist von 'low-input' Weiden und Wiesen dominiert. Daher wurde die Heuschrecken-Artenvielfalt auf Weiden und Wiesen verglichen. In den Rhodopen (BG) wurden 6 Wiesen, 3 Wiesen gefolgt von Beweidung und 7 Weiden zweimal im Juli und August 2010 besucht und die Heuschrecken-Arten aufgezeichnet. Ein Vergleich zwischen Weiden und Wiesen zeigte keinen Unterschied zwischen der allgemeinen Heuschrecken-Artenvielfalt. Heuschrecken-Arten der Unterordnung Caelifera waren jedoch häufiger auf Weiden im Vergleich zu Wiesen anzutreffen. Zusätzlich waren viele Heuschrecken-Arten auf einem der beiden Bewirtschaftungs-Formen häufiger zu finden. *Decticus ver-*

rucivorus, *Omocestus haemorrhoidalis* und *Omocestus viridulus* wurden nur auf Weiden gefunden, während *Polysarcus denticauda* nur auf Wiesen gefunden wurde. Wiesen und Weiden sind möglicherweise beide wichtig für die Erhaltung einer hohen Heuschrecken-Artenvielfalt in den Rhodopen.

REFERENCES

Baur, B., Baur, H., Roesti, C. & Roesti, D. 2006. Die Heuschrecken der Schweiz. — Haupt, Bern.

Benton, T.G., Vickery, J.A. & Wilson, J.D. 2003. Farmland biodiversity: is habitat heterogeneity the key? — Trends in Ecology & Evolution 18(4): 182–188.

Beron, P. & Popov, A. 2004. Biodiversity of Eastern Rhodopes (Bulgaria and Greece). — Sofia: Pensoft Publishers.

BioBio 2010a. BioBio — Indicators for biodiversity. Retrieved 3.1.2011, from http://www.biobio-indicator.wur.nl/UK/.

BioBio 2010b. Delimitation of BIOBIO Case Study Regions and the Selection of Case Study Farms. 3.1 (not published).

Cellarius, B.A. 2004. In the land of Orpheus: rural livelihoods and nature conservation in postsocialist Bulgaria. — University of Wisconsin Press.

Detzel, P. 1998. Die Heuschrecken Baden-Württembergs. — Stuttgart (Hohenheim): Ulmer.

Dufrêne, M. & Legendre, P. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. — Ecological Monographs 67(3): 345–366.

Fartmann, T. & Mattes, H. 1997. Heuschreckenfauna und Grünland - Bewirtschaftungsmassnahmen und Biotopmanagement. — Arbeiten aus dem Institut für Landschaftsökologie der Westfälischen Wilhelms-Universität Münster 3: 179–188.

Fischer, M. & Wipf, S. 2002. Effect of low-intensity grazing on the species-rich vegetation of traditionally mown subalpine meadows. — Biological Conservation 104(1): 1–11.

Gardiner, T. & Hassall, M. 2009. Does microclimate affect Orthoptera populations after cutting of hay in improved grassland? — Journal of Insect Conservation 13: 97–102.

Gardiner, T., Hill, J. & Chesmore, D. 2005. Review of the methods frequently used to estimate the abundance of Orthoptera in grassland ecosystems. — Journal of Insect Conservation 9: 151–173.

Guido, M. & Gianelle, D. 2001. Distribution patterns of four Orthoptera species in relation to microhabitat heterogeneity in an ecotonal area. — Acta Oecologica 22: 175–185.

Harz, K. 1969. Die Orthopteren Europas I. — Dr. W. Junk N.V., The Hague.

Harz, K. 1975. Die Orthopteren Europas II. — Dr. W. Junk N.V., The Hague.

Humbert, J.-Y., Richner, N., Sauter, J., Walter, T. & Ghazoul, J. 2010. Wiesen-Ernteprozesse und ihre Wirkung auf die Fauna. — ART-Bericht 724.

Ingrisch, S. & Köhler, G. 1998. Die Heuschrecken Mitteleuropas. — Westarp Wissenschaften.

Kampmann, D., Herzog, F., Jeanneret, P., Konold, W., Peter, M., Walter, T., Wildi, O. & Lüscher, A. 2008. Mountain grassland biodiversity: Impact of site conditions versus management type. — Journal for Nature Conservation 16(1): 12–25.

Knop, E., Kleijn, D., Herzog, F. & Schmid, B. 2006. Effectiveness of the Swiss agri-environment scheme in promoting biodiversity. — Journal of Applied Ecology 43: 120–127.

Kruess, A. & Tscharntke, T. 2002. Grazing Intensity and the Diversity of Orthoptera, Butterflies, and Trap-Nesting Bees and Wasps. — Conservation Biology 16(6): 1570–1580.

Luoto, M., Pykälä, J. & Kuussaari, M. 2003. Decline of landscape-scale habitat and species diversity after the end of cattle grazing. — Journal of Nature Conservation 11: 171–178.

Marini, L., Fontana, P., Battisti, A. & Gaston, K.J. 2009a. Agricultural management, vegetation traits and landscape drive orthopteran and butterfly diversity in a grassland-forest mosaic: a multiscale approach. — Insect Conservation and Diversity 2: 213–220.

Marini, L., Fontana, P., Klimek, S., Battisti, A. & Gaston, K.J. 2009b. Impact of farm size and topography on plant and insect diversity of managed grasslands in the Alps. — Biological Conservation 142: 394–403.

Marini, L., Fontana, P., Scotton, M. & Klimek, S. 2008. Vascular plant and Orthoptera diversity in relation to grassland management and landscape composition in the European Alps. — Journal of Applied Ecology 45: 361–370.

Morris, M.G. 2000. The effects of structure and its dynamics on the ecology and conservation of arthropods in British grasslands. — Biological Conservation 95: 129–142.

Oertli, S., Müller, A., Steiner, D., Breitenstein, A. & Dorn, S. 2005. Cross-taxon congruence of species diversity and community similarity among three insect taxa in a mosaic landscape. — Biological Conservation 126: 195–205.

Peter, B. & Walter, T. 2001. Heuschrecken brauchen ökologische Ausgleichsflächen. — AGRARForschung 8(11–12): 452–457.

Plantureux, S., Peeters, A. & McCracken, D. 2005. Biodiversity in intensive grasslands: Effect of management, improvement and challenges. — Agronomy Research 3: 153–164.

Popov, A. 2007. Biogeography and Ecology of Bulgaria. — Monographiae Biologicae 82: 233–296.

R 2010. R for Statistical Computing. — http://www.r-project.org/.

Schmitzberger, I., Wrbka, Th., Steurer, B., Aschenbrenner, G., Peterseil, J. & Zechmeister, H.G. 2005. How farming styles influence biodiversity maintenance in Austrian agricultural landscapes. — Agriculture, Ecosystems and Environment 108: 274–290.

Schwab, A., Dubois, D., Fried, P.M. & Edwards, P. 2002. Estimating the biodiversity of hay meadows in north-eastern Switzerland on the basis of vegetation structure. — Agriculture, Ecosystems and Environment 93: 197–209.

Sergeev, M.G. 1998. Conservation of orthopteran biological diversity relative to landscape change in temperate Eurasia. — Journal of Insect Conservation 2: 247–252.

Stoyanova, S., Guteva, Y. & Angelova, S. 2010. WP3 Workshop - Vienna - Case study in Bulgaria: pastures and meadows in Rhodope mountains (unpublished). — Institute of Plant Genetic Resources.

Van der Putten, W.H., Mortimer, S.R., Hedlund, K., Van Dijk, C., Brown, V.K., Lepš, J., Rodriguez-Barrueco, C., Roy, J., Diaz Len, T.A., Gormsen, D., Korthals, G.W., Lavorel, S., Regina, I.S. & Smilauer, P. 2000. Plant species diversity as a driver of early succession in abandoned fields: a multi-site approach. — Oecologia 124: 91–99.

Walter, T., Klaus, G., Altermatt, F., Ammann, P., Birrer, S., Boller, B., Capt, S., Eggenschwiler, L., Fischer, J., Gonseth, Y., Grünig, A., Homburger, H., Jacot, K., Kleijer, G., Köhler, C., Kohler, F., Kreis, H., Loser, E., Lüscher, A., Meyer, A., Murbach, F., Rechsteiner, C., Scheidegger, C., Schierscher, B., Schilperoord, P., Schmid, H., Schnyder, N., Senn-Irlet, B., Suter, D., Zbinden, N. & Zumbach, S. 2010. Landwirtschaft, In: Lachat, T., Pauli, D., Gonseth, Y., Klaus, G., Scheidegger, C., Vittoz, P. & Walter, T. Wandel der Biodiversität in der Schweiz seit 1900 - Ist die Talsohle erreicht? , pp. 64–122. — Bristol-Stiftung, Zürich.

Walter, T., Schüpbach, B. & Wolf, M. 2005. Heuschrecken, *In*: Evaluation der Ökomassnahmen Bereich Biodiversität. pp. 125–131. — Schriftenreihe der FAL 56.

Wettstein, W. & Schmid, B. 1999. Conservation of arthropod diversity in montane wetlands: effect of altitude, habitat quality and habitat fragmentation on butterflies and Orthoptera. — Journal of Applied Ecology 36: 363–373.

Zahn, A., Englmaier, I. & Drobny, M. 2010. Food availability for insectivores in grasslands - arthropod abundance in pastures, meadows and fallow land. — Applied Ecology 8(2): 87–100.

Zahn, A., Juen, A., Traugott, M. & Lang, A. 2007. Low density cattle grazing enhances arthropod diversity of abandoned wetland. — Applied Ecology and Environmental Research 5(1): 73–86.

(received May 24, 2011; accepted November 30, 2011)

Annex: Raw data of all the fields in the Smoljan Region with the found Orthoptera species.

Farm nr.	Field nr.	Management	Identifier name	Date	Survey	Species name
1	1	Meadow+Pasture	M. Senn	01.09.2010	2	*Chorthippus biguttulus group*
1	1	Meadow+Pasture	M. Senn	01.09.2010	2	*Chorthippus parallelus*
1	1	Meadow+Pasture	M. Senn	01.09.2010	2	*Euchorthippus declivus*
1	1	Meadow+Pasture	M. Senn	01.09.2010	2	*Euthystira brachyptera*
1	1	Meadow+Pasture	M. Senn	01.09.2010	2	*Pholidoptera frivaldskyi*
1	1	Meadow+Pasture	M. Senn	01.09.2010	2	*Poecilimon spec.*
1	1	Meadow+Pasture	M. Senn	01.09.2010	2	*Stauroderus scalaris*
6	1	Pasture	T. Walter	07.07.2010	1	*Arcyptera fusca*
6	1	Pasture	T. Walter	07.07.2010	1	*Chorthippus parallelus*
6	1	Pasture	T. Walter	07.07.2010	1	*Chrysochraon dispar*
6	1	Pasture	T. Walter	07.07.2010	1	*Decticus verrucivorus*
6	1	Pasture	T. Walter	07.07.2010	1	*Isophya bureschi*
6	1	Pasture	T. Walter	07.07.2010	1	*Metrioptera arnoldi*
6	1	Pasture	T. Walter	07.07.2010	1	*Omocestus haemorrhoidalis*
6	1	Pasture	T. Walter	07.07.2010	1	*Pholidoptera aptera*
6	1	Pasture	T. Walter	07.07.2010	1	*Poecilimon brunneri*
6	1	Pasture	T. Walter	07.07.2010	1	*Poecilimon thoracicus*
6	1	Pasture	T. Walter	07.07.2010	1	*Stauroderus scalaris*
6	1	Pasture	T. Walter	07.07.2010	1	*Stenobothrus lineatus*
6	1	Pasture	M. Senn	26.08.2010	2	*Arcyptera fusca*
6	1	Pasture	M. Senn	26.08.2010	2	*Chorthippus biguttulus group*
6	1	Pasture	M. Senn	26.08.2010	2	*Chorthippus dichrous*
6	1	Pasture	M. Senn	26.08.2010	2	*Chorthippus parallelus*
6	1	Pasture	M. Senn	26.08.2010	2	*Chrysochraon dispar*
6	1	Pasture	M. Senn	26.08.2010	2	*Omocestus viridulus*
6	1	Pasture	M. Senn	26.08.2010	2	*Pholidoptera frivaldskyi*
6	1	Pasture	M. Senn	26.08.2010	2	*Poecilimon thoracicus*
6	1	Pasture	M. Senn	26.08.2010	2	*Stenobothrus lineatus*
6	2	Pasture	T. Walter	07.07.2010	1	*Chorthippus parallelus*
6	2	Pasture	T. Walter	07.07.2010	1	*Chrysochraon dispar*
6	2	Pasture	T. Walter	07.07.2010	1	*Decticus verrucivorus*
6	2	Pasture	T. Walter	07.07.2010	1	*Isophya bureschi*
6	2	Pasture	T. Walter	07.07.2010	1	*Isophya rhodopensis*
6	2	Pasture	T. Walter	07.07.2010	1	*Poecilimon spec.*
6	2	Pasture	T. Walter	07.07.2010	1	*Stauroderus scalaris*
6	2	Pasture	T. Walter	07.07.2010	1	*Stethophyma grossum*
6	2	Pasture	T. Walter	07.07.2010	1	*Tettigonia viridissima*
6	2	Pasture	M. Senn	26.08.2010	2	*Chorthippus dichrous*
6	2	Pasture	M. Senn	26.08.2010	2	*Chorthippus parallelus*
6	2	Pasture	M. Senn	26.08.2010	2	*Chrysochraon dispar*
6	2	Pasture	M. Senn	26.08.2010	2	*Omocestus viridulus*
6	2	Pasture	M. Senn	26.08.2010	2	*Pholidoptera frivaldskyi*
6	2	Pasture	M. Senn	26.08.2010	2	*Poecilimon thoracicus*
6	2	Pasture	M. Senn	26.08.2010	2	*Stethophyma grossum*
6	3	Pasture	M. Senn	12.07.2010	1	*Isophya bureschi*
6	3	Pasture	M. Senn	12.07.2010	1	*Omocestus viridulus*
6	3	Pasture	M. Senn	24.08.2010	2	*Anterastes serbicus*
6	3	Pasture	M. Senn	24.08.2010	2	*Chorthippus apricarius*
6	3	Pasture	M. Senn	24.08.2010	2	*Chorthippus biguttulus group*
6	3	Pasture	M. Senn	24.08.2010	2	*Chorthippus parallelus*
6	3	Pasture	M. Senn	24.08.2010	2	*Euthystira brachyptera*

Farm nr.	Field nr.	Management	Identifier name	Date	Survey	Species name
6	3	Pasture	M. Senn	24.08.2010	2	*Isophya rhodopensis*
6	3	Pasture	M. Senn	24.08.2010	2	*Omocestus haemorrhoidalis*
6	3	Pasture	M. Senn	24.08.2010	2	*Omocestus viridulus*
6	3	Pasture	M. Senn	24.08.2010	2	*Stenobothrus nigromaculatus*
6	3	Pasture	M. Senn	24.08.2010	2	*Stauroderus scalaris*
10	1	Meadow	T. Walter	05.07.2010	1	*Chorthippus parallelus*
10	1	Meadow	T. Walter	05.07.2010	1	*Euthystira brachyptera*
10	1	Meadow	T. Walter	05.07.2010	1	*Isophya bureschi*
10	1	Meadow	T. Walter	05.07.2010	1	*Pholidoptera aptera*
10	1	Meadow	T. Walter	05.07.2010	1	*Pholidoptera frivaldskyi*
10	1	Meadow	T. Walter	05.07.2010	1	*Podisma pedestris*
10	1	Meadow	T. Walter	05.07.2010	1	*Poecilimon spec.*
10	1	Meadow	T. Walter	05.07.2010	1	*Polysarcus denticauda*
10	1	Meadow	T. Walter	05.07.2010	1	*Stauroderus scalaris*
10	1	Meadow	T. Walter	05.07.2010	1	*Stenobothrus lineatus*
10	1	Meadow	M. Senn	30.08.2010	2	*Chorthippus parallelus*
10	1	Meadow	M. Senn	30.08.2010	2	*Poecilimon thoracicus*
10	2	Meadow	T. Walter	05.07.2010	1	*Chorthippus parallelus*
10	2	Meadow	T. Walter	05.07.2010	1	*Euthystira brachyptera*
10	2	Meadow	T. Walter	05.07.2010	1	*Isophya bureschi*
10	2	Meadow	T. Walter	05.07.2010	1	*Pholidoptera aptera*
10	2	Meadow	T. Walter	05.07.2010	1	*Pholidoptera frivaldskyi*
10	2	Meadow	T. Walter	05.07.2010	1	*Poecilimon spec.*
10	2	Meadow	T. Walter	05.07.2010	1	*Polysarcus denticauda*
10	2	Meadow	T. Walter	05.07.2010	1	*Psorodonotus fieberi*
10	2	Meadow	M. Senn	30.08.2010	2	*Arcyptera fusca*
10	2	Meadow	M. Senn	30.08.2010	2	*Chorthippus parallelus*
10	2	Meadow	M. Senn	30.08.2010	2	*Euthystira brachyptera*
10	2	Meadow	M. Senn	30.08.2010	2	*Isophya bureschi*
10	2	Meadow	M. Senn	30.08.2010	2	*Pholidoptera aptera*
10	2	Meadow	M. Senn	30.08.2010	2	*Pholidoptera frivaldskyi*
10	2	Meadow	M. Senn	30.08.2010	2	*Poecilimon thoracicus*
10	2	Meadow	M. Senn	30.08.2010	2	*Psorodonotus fieberi*
10	2	Meadow	M. Senn	30.08.2010	2	*Stauroderus scalaris*
10	3	Meadow	M. Senn	10.07.2010	1	*Chorthippus parallelus*
10	3	Meadow	M. Senn	10.07.2010	1	*Euthystira brachyptera*
10	3	Meadow	M. Senn	10.07.2010	1	*Isophya bureschi*
10	3	Meadow	M. Senn	10.07.2010	1	*Pholidoptera aptera*
10	3	Meadow	M. Senn	10.07.2010	1	*Pholidoptera frivaldskyi*
10	3	Meadow	M. Senn	10.07.2010	1	*Poecilimon thoracicus*
10	3	Meadow	M. Senn	10.07.2010	1	*Psorodonotus fieberi*
10	3	Meadow	M. Senn	31.08.2010	2	*Chorthippus apricarius*
10	3	Meadow	M. Senn	31.08.2010	2	*Chorthippus biguttulus group*
10	3	Meadow	M. Senn	31.08.2010	2	*Chorthippus parallelus*
10	3	Meadow	M. Senn	31.08.2010	2	*Euthystira brachyptera*
10	3	Meadow	M. Senn	31.08.2010	2	*Pholidoptera aptera*
10	3	Meadow	M. Senn	31.08.2010	2	*Pholidoptera frivaldskyi*
10	3	Meadow	M. Senn	31.08.2010	2	*Poecilimon thoracicus*
10	3	Meadow	M. Senn	31.08.2010	2	*Psorodonotus fieberi*
10	3	Meadow	M. Senn	31.08.2010	2	*Stauroderus scalaris*
10	4+5	Meadow	M. Senn	12.07.2010	1	*Arcyptera fusca*

Farm nr.	Field nr.	Management	Identifier name	Date	Survey	Species name
10	4+5	Meadow	M. Senn	12.07.2010	1	*Chorthippus parallelus*
10	4+5	Meadow	M. Senn	12.07.2010	1	*Isophya bureschi*
10	4+5	Meadow	M. Senn	12.07.2010	1	*Pholidoptera frivaldskyi*
10	4+5	Meadow	M. Senn	12.07.2010	1	*Poecilimon spec.*
10	4+5	Meadow	M. Senn	12.07.2010	1	*Psorodonotus fieberi*
10	4+5	Meadow	M. Senn	12.07.2010	1	*Stauroderus scalaris*
10	4+5	Meadow	M. Senn	31.08.2010	2	*Arcyptera fusca*
10	4+5	Meadow	M. Senn	31.08.2010	2	*Chorthippus parallelus*
10	4+5	Meadow	M. Senn	31.08.2010	2	*Euthystira brachyptera*
10	4+5	Meadow	M. Senn	31.08.2010	2	*Pholidoptera frivaldskyi*
10	4+5	Meadow	M. Senn	31.08.2010	2	*Poecilimon thoracicus*
10	4+5	Meadow	M. Senn	31.08.2010	2	*Stauroderus scalaris*
10	6	Meadow	T. Walter	05.07.2010	1	*Arcyptera fusca*
10	6	Meadow	T. Walter	05.07.2010	1	*Chorthippus parallelus*
10	6	Meadow	T. Walter	05.07.2010	1	*Euthystira brachyptera*
10	6	Meadow	T. Walter	05.07.2010	1	*Isophya bureschi*
10	6	Meadow	T. Walter	05.07.2010	1	*Pholidoptera aptera*
10	6	Meadow	T. Walter	05.07.2010	1	*Pholidoptera frivaldskyi*
10	6	Meadow	T. Walter	05.07.2010	1	*Poecilimon thoracicus*
10	6	Meadow	T. Walter	05.07.2010	1	*Polysarcus denticauda*
10	6	Meadow	T. Walter	05.07.2010	1	*Psorodonotus fieberi*
10	6	Meadow	M. Senn	30.08.2010	2	*Arcyptera fusca*
10	6	Meadow	M. Senn	30.08.2010	2	*Chorthippus apricarius*
10	6	Meadow	M. Senn	30.08.2010	2	*Chorthippus parallelus*
10	6	Meadow	M. Senn	30.08.2010	2	*Euthystira brachyptera*
10	6	Meadow	M. Senn	30.08.2010	2	*Pholidoptera frivaldskyi*
10	6	Meadow	M. Senn	30.08.2010	2	*Poecilimon thoracicus*
10	6	Meadow	M. Senn	30.08.2010	2	*Psorodonotus fieberi*
10	7	Meadow	T. Walter	05.07.2010	1	*Chorthippus parallelus*
10	7	Meadow	T. Walter	05.07.2010	1	*Euthystira brachyptera*
10	7	Meadow	T. Walter	05.07.2010	1	*Isophya bureschi*
10	7	Meadow	T. Walter	05.07.2010	1	*Pholidoptera aptera*
10	7	Meadow	T. Walter	05.07.2010	1	*Pholidoptera frivaldskyi*
10	7	Meadow	T. Walter	05.07.2010	1	*Poecilimon thoracicus*
10	7	Meadow	T. Walter	05.07.2010	1	*Polysarcus denticauda*
10	7	Meadow	T. Walter	05.07.2010	1	*Stenobothrus lineatus*
10	7	Meadow	M. Senn	30.08.2010	2	*Arcyptera fusca*
10	7	Meadow	M. Senn	30.08.2010	2	*Chorthippus apricarius*
10	7	Meadow	M. Senn	30.08.2010	2	*Chorthippus parallelus*
10	7	Meadow	M. Senn	30.08.2010	2	*Euthystira brachyptera*
10	7	Meadow	M. Senn	30.08.2010	2	*Pholidoptera aptera*
10	7	Meadow	M. Senn	30.08.2010	2	*Pholidoptera frivaldskyi*
10	7	Meadow	M. Senn	30.08.2010	2	*Poecilimon thoracicus*
10	7	Meadow	M. Senn	30.08.2010	2	*Psorodonotus fieberi*
10	7	Meadow	M. Senn	30.08.2010	2	*Stauroderus scalaris*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Anterastes serbicus*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Arcyptera fusca*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Chorthippus apricarius*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Chorthippus biguttulus group*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Chorthippus parallelus*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Chorthippus vagans*

Farm nr.	Field nr.	Management	Identifier name	Date	Survey	Species name
11	1+2	Pasture	T. Walter	06.07.2010	1	*Decticus verrucivorus*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Euthystira brachyptera*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Isophya bureschi*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Metrioptera arnoldi*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Myrmeleotettix maculatus*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Poecilimon brunneri*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Poecilimon thoracicus*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Psorodonotus fieberi*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Stenobothrus rubicundulus*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Stauroderus scalaris*
11	1+2	Pasture	T. Walter	06.07.2010	1	*Stenobothrus lineatus*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Arcyptera fusca*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Chorthippus apricarius*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Chorthippus biguttulus group*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Chorthippus parallelus*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Oedipoda caerulescens*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Omocestus haemorrhoidalis*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Omocestus viridulus*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Pholidoptera frivaldskyi*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Poecilimon thoracicus*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Stenobothrus rubicundulus*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Stauroderus scalaris*
11	1+2	Pasture	M. Senn	26.08.2010	2	*Stenobothrus lineatus*
11	3	Pasture	M. Senn	11.07.2010	1	*Arcyptera fusca*
11	3	Pasture	M. Senn	11.07.2010	1	*Chorthippus parallelus*
11	3	Pasture	M. Senn	11.07.2010	1	*Decticus verrucivorus*
11	3	Pasture	M. Senn	11.07.2010	1	*Pholidoptera aptera*
11	3	Pasture	M. Senn	11.07.2010	1	*Pholidoptera frivaldskyi*
11	3	Pasture	M. Senn	11.07.2010	1	*Poecilimon brunneri*
11	3	Pasture	M. Senn	11.07.2010	1	*Psorodonotus fieberi*
11	3	Pasture	M. Senn	11.07.2010	1	*Stenobothrus lineatus*
11	3	Pasture	M. Senn	25.08.2010	2	*Arcyptera fusca*
11	3	Pasture	M. Senn	25.08.2010	2	*Chorthippus apricarius*
11	3	Pasture	M. Senn	25.08.2010	2	*Chorthippus parallelus*
11	3	Pasture	M. Senn	25.08.2010	2	*Decticus verrucivorus*
11	3	Pasture	M. Senn	25.08.2010	2	*Euthystira brachyptera*
11	3	Pasture	M. Senn	25.08.2010	2	*Pholidoptera frivaldskyi*
11	3	Pasture	M. Senn	25.08.2010	2	*Poecilimon thoracicus*
11	3	Pasture	M. Senn	25.08.2010	2	*Psorodonotus fieberi*
11	3	Pasture	M. Senn	25.08.2010	2	*Stenobothrus lineatus*
11	4	Pasture	T. Walter	06.07.2010	1	*Chorthippus biguttulus group*
11	4	Pasture	T. Walter	06.07.2010	1	*Chorthippus parallelus*
11	4	Pasture	T. Walter	06.07.2010	1	*Chorthippus vagans*
11	4	Pasture	T. Walter	06.07.2010	1	*Isophya bureschi*
11	4	Pasture	T. Walter	06.07.2010	1	*Omocestus viridulus*
11	4	Pasture	T. Walter	06.07.2010	1	*Stauroderus scalaris*
11	4	Pasture	T. Walter	06.07.2010	1	*Stenobothrus lineatus*
11	4	Pasture	M. Senn	25.08.2010	2	*Anterastes serbicus*
11	4	Pasture	M. Senn	25.08.2010	2	*Arcyptera fusca*
11	4	Pasture	M. Senn	25.08.2010	2	*Chorthippus apricarius*
11	4	Pasture	M. Senn	25.08.2010	2	*Chorthippus biguttulus group*

Farm nr.	Field nr.	Management	Identifier name	Date	Survey	Species name
11	4	Pasture	M. Senn	25.08.2010	2	*Chorthippus parallelus*
11	4	Pasture	M. Senn	25.08.2010	2	*Omocestus haemorrhoidalis*
11	4	Pasture	M. Senn	25.08.2010	2	*Omocestus viridulus*
11	4	Pasture	M. Senn	25.08.2010	2	*Pholidoptera frivaldskyi*
11	4	Pasture	M. Senn	25.08.2010	2	*Poecilimon thoracicus*
11	4	Pasture	M. Senn	25.08.2010	2	*Stauroderus scalaris*
11	4	Pasture	M. Senn	25.08.2010	2	*Stenobothrus lineatus*
11	5	Pasture	T. Walter	06.07.2010	1	*Chorthippus biguttulus group*
11	5	Pasture	T. Walter	06.07.2010	1	*Isophya bureschi*
11	5	Pasture	T. Walter	06.07.2010	1	*Omocestus viridulus*
11	5	Pasture	M. Senn	25.08.2010	2	*Chorthippus biguttulus group*
11	5	Pasture	M. Senn	25.08.2010	2	*Chorthippus parallelus*
11	5	Pasture	M. Senn	25.08.2010	2	*Isophya bureschi*
11	5	Pasture	M. Senn	25.08.2010	2	*Omocestus haemorrhoidalis*
11	5	Pasture	M. Senn	25.08.2010	2	*Omocestus viridulus*
11	5	Pasture	M. Senn	25.08.2010	2	*Poecilimon thoracicus*
11	5	Pasture	M. Senn	25.08.2010	2	*Stauroderus scalaris*
11	5	Pasture	M. Senn	25.08.2010	2	*Stenobothrus lineatus*
12	1	Meadow+Pasture	M. Senn	28.08.2010	2	*Chorthippus biguttulus group*
12	1	Meadow+Pasture	M. Senn	28.08.2010	2	*Chorthippus parallelus*
12	1	Meadow+Pasture	M. Senn	28.08.2010	2	*Oedipoda caerulescens*
12	1	Meadow+Pasture	M. Senn	28.08.2010	2	*Omocestus viridulus*
12	1	Meadow+Pasture	M. Senn	28.08.2010	2	*Pholidoptera frivaldskyi*
12	1	Meadow+Pasture	M. Senn	28.08.2010	2	*Poecilimon thoracicus*
12	1	Meadow+Pasture	M. Senn	28.08.2010	2	*Stenobothrus lineatus*
12	2	Pasture	M. Senn	28.08.2010	2	*Chorthippus biguttulus group*
12	2	Pasture	M. Senn	28.08.2010	2	*Chorthippus parallelus*
12	2	Pasture	M. Senn	28.08.2010	2	*Pholidoptera frivaldskyi*
12	3	Meadow	M. Senn	28.08.2010	2	*Chorthippus biguttulus group*
12	3	Meadow	M. Senn	28.08.2010	2	*Euchorthippus declivus*
12	3	Meadow	M. Senn	28.08.2010	2	*Euthystira brachyptera*
12	3	Meadow	M. Senn	28.08.2010	2	*Stenobothrus lineatus*
12	4	Pasture	M. Senn	28.08.2010	2	*Chorthippus biguttulus group*
12	4	Pasture	M. Senn	28.08.2010	2	*Euchorthippus declivus*
12	4	Pasture	M. Senn	28.08.2010	2	*Euthystira brachyptera*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Chorthippus parallelus*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Isophya bureschi*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Metrioptera arnoldi*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Pholidoptera aptera*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Pholidoptera frivaldskyi*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Poecilimon spec.*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Stauroderus scalaris*
13	1	Meadow+Pasture	M. Senn	11.07.2010	1	*Tettigonia viridissima*
13	1	Meadow+Pasture	M. Senn	27.08.2010	2	*Chorthippus biguttulus group*
13	1	Meadow+Pasture	M. Senn	27.08.2010	2	*Chorthippus parallelus*
13	1	Meadow+Pasture	M. Senn	27.08.2010	2	*Euthystira brachyptera*
13	1	Meadow+Pasture	M. Senn	27.08.2010	2	*Pholidoptera aptera*
13	1	Meadow+Pasture	M. Senn	27.08.2010	2	*Pholidoptera frivaldskyi*
13	1	Meadow+Pasture	M. Senn	27.08.2010	2	*Poecilimon thoracicus*
13	1	Meadow+Pasture	M. Senn	27.08.2010	2	*Stenobothrus lineatus*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Arcyptera fusca*

Farm nr.	Field nr.	Management	Identifier name	Date	Survey	Species name
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Chorthippus parallelus*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Euthystira brachyptera*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Pholidoptera aptera*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Pholidoptera frivaldskyi*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Poecilimon spec.*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Stauroderus scalaris*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Stenobothrus lineatus*
13	2	Meadow+Pasture	M. Senn	11.07.2010	1	*Tettigonia viridissima*
13	2	Meadow+Pasture	M. Senn	27.08.2010	2	*Arcyptera fusca*
13	2	Meadow+Pasture	M. Senn	27.08.2010	2	*Chorthippus biguttulus group*
13	2	Meadow+Pasture	M. Senn	27.08.2010	2	*Chorthippus parallelus*
13	2	Meadow+Pasture	M. Senn	27.08.2010	2	*Euthystira brachyptera*
13	2	Meadow+Pasture	M. Senn	27.08.2010	2	*Pholidoptera aptera*
13	2	Meadow+Pasture	M. Senn	27.08.2010	2	*Pholidoptera frivaldskyi*
13	2	Meadow+Pasture	M. Senn	27.08.2010	2	*Poecilimon thoracicus*
13	3	Meadow+Pasture	M. Senn	11.07.2010	1	*Chorthippus parallelus*
13	3	Meadow+Pasture	M. Senn	11.07.2010	1	*Metrioptera arnoldi*
13	3	Meadow+Pasture	M. Senn	11.07.2010	1	*Pholidoptera frivaldskyi*
13	3	Meadow+Pasture	M. Senn	11.07.2010	1	*Poecilimon spec.*
13	3	Meadow+Pasture	M. Senn	11.07.2010	1	*Stauroderus scalaris*
13	3	Meadow+Pasture	M. Senn	11.07.2010	1	*Tettigonia viridissima*
13	3	Meadow+Pasture	M. Senn	27.08.2010	2	*Chorthippus parallelus*
13	3	Meadow+Pasture	M. Senn	27.08.2010	2	*Euthystira brachyptera*
13	3	Meadow+Pasture	M. Senn	27.08.2010	2	*Pholidoptera aptera*
13	3	Meadow+Pasture	M. Senn	27.08.2010	2	*Pholidoptera frivaldskyi*
13	3	Meadow+Pasture	M. Senn	27.08.2010	2	*Poecilimon spec.*
13	3	Meadow+Pasture	M. Senn	27.08.2010	2	*Stauroderus scalaris*
13	3	Meadow+Pasture	M. Senn	27.08.2010	2	*Stenobothrus lineatus*