Composition of the arthropod fauna of sweetpotato fields on Leyte Island, Philippines - sampling by pitfall traps and colour pans

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ABSTRACT

The development of arthropod communities on three low input, shifting cultivation sweetpotato fields located in very distinct environments was monitored. Aim of the study was to identify if and how the composition of arthropod communities on cropland areas is influenced by the surrounding vegetation. Sampling of the arthropods was done by use of colour pans and pitfall traps. The prey was keyed to family or genus, assigned to trophic guilds, and further subdivided into "operational" species (based merely upon morphological criteria). Several indices describing ecological diversity were computed and used to compare the three communities. Results suggests that the arthropod communities on each of the fields developed into a mostly site-independent, but crop-specific fauna. An influence of the surrounding vegetation can be suspected only for predatory arthropods.

Keywords: Sweetpotato, pests, agroecology, diversity

INTRODUCTION

Several studies indicate that pest problems are more frequent in monoculture than in diverse or polyculture systems (Risch et al. 1983, Cromartie 1975, Pimentel 1961) and that herbivore abundance and diversity is related to host plant species, plant architecture (Lawton 1983) and environmental fluctuations (Basedov 1988). Heong et al. (1991) summarize that the invertebrate communities generally follow characteristics of the plant community. It has been shown that during the development of a habitat arthropod communities change in a systematic way (Brown & Hyman 1986). In low input systems, such as many of the Philippine sweetpotato fields, arthropod communities may vary with the cultivation practices, varieties, cropping patterns and environment.

We studied the temporal development of arthropod communities in three sweetpotato fields with distinct cropping patterns and environment, but similar cultivation practices. Aim of the study was to identify if and how the composition of arthropod communities on cropland areas is influenced by the surrounding vegetation.

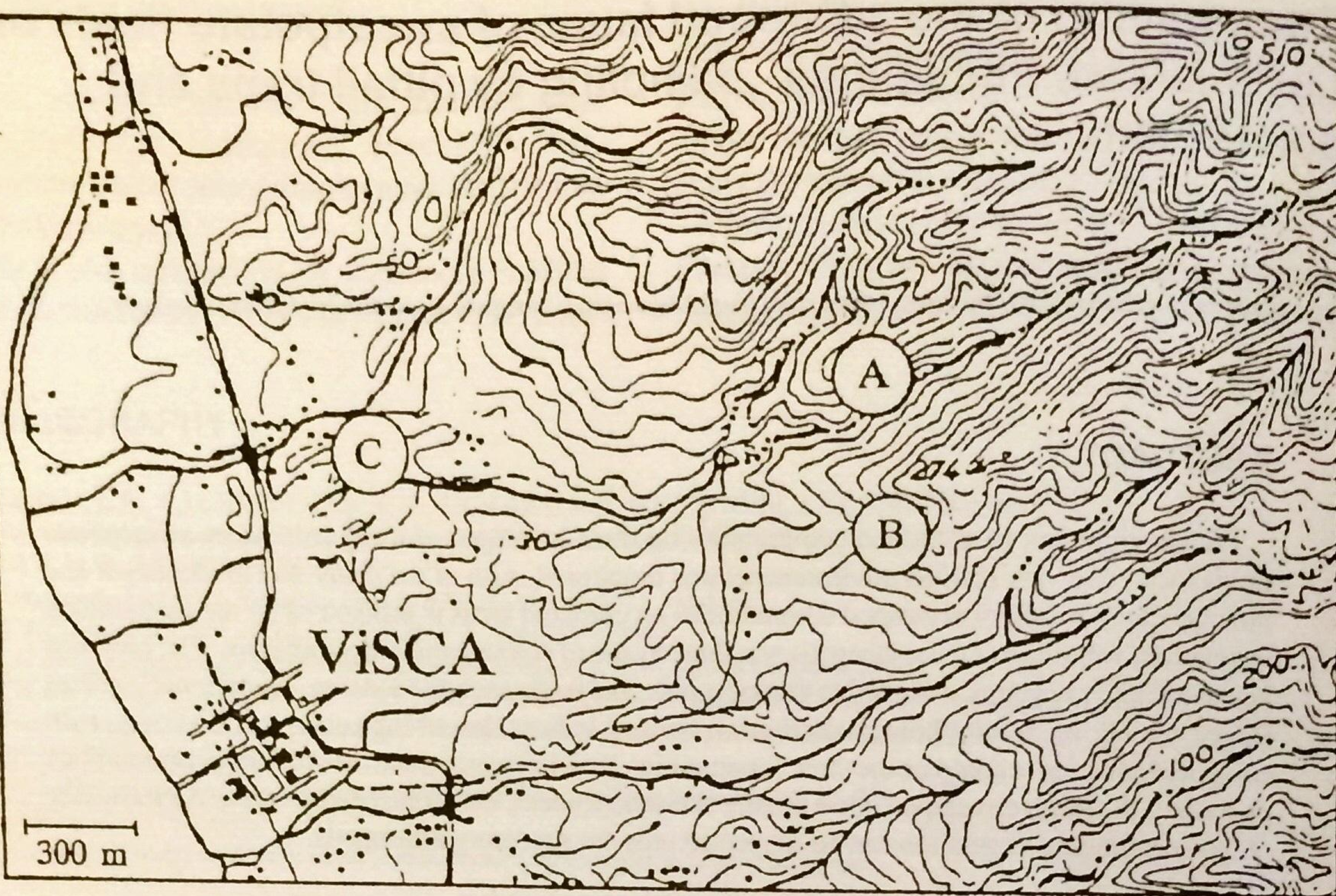

Figure 1. Location of the study sties.

MATERIALS AND METHODS

The three study sites were located in the surroundings of the Visayas State College of Agriculture (ViSCA), Leyte Island, Philippines (Fig. 1). The first (named "site A") was situated between an almost undisturbed primary forest and an at least 12 year old secondary forest, the second one ("site B") in an area characterized by intensive shifting cultivation activities, with a fallow period of no more than four or five years, and the third one ("site C") was placed between commercial rice plantations and the campus of ViSCA. Aside from those differences in the surroundings, the three fields also presented slight differences in the amount of crops cultivated in addition to sweetpotato.

Sampling of the arthropods was done by use of nine pitfall traps, four yellow and four blue colour pans, filled with 4% Formalin (for details concerning trap architecture and layout see Spatz 1992). The traps were exposed in each site from October to December 1991, five times for one week each. Normally, one week of catching was followed by one week without fauna to regenerate, but the fifth week of catching followed immediately after the fourth. For the present paper, only the catches of weeks one, two and five have been evaluated.

The arthropods were first keyed to order, and within the order, the individuals were assigned to "operational species" based on morphological criteria (Risch 1979). Later on, almost all of the "operational species" were identified to family level, but only very few could be keyed to genus or even species.

Based on literature information about the family, each of the "operational species" was assigned to one of the trophic guilds (Hawkins & MacMahon 1989) of herbivores, predators or parasitoids. Where literature information was lacking or contradictory, the "operational species" was grouped as "unknown".

Based on the number of "operational species" (further on simply denominated species), for each site and every week of trapping the following indices were computed (Pielou 1975, Odum 1971): Index of Dominance, Shannon-Index and Evenness (describing species diversity patterns), Jaccard's number, Renkonen's number and Wainstein-Index (describing similarity between the sites).

RESULTS AND DISCUSSION

Generally, the catch rates for one determined site varied strongly from week to week. Although the trapping techniques we employed are judged to be suitable by a variety of authors (Hammond 1990, Cherry & Howard 1984, Disney et al. 1982, Uetz & Unzicker 1976, Luff 1975, Greenslade 1964), they may present deficiencies on the specific locations. This aspect is discussed in detail in Spatz (1992), and an adaptation of the sampling method to local circumstances is proposed.

Colour Traps

Concerning the complete catch in colour traps, it became evident that among the three analysed sites, site A had distinctly more species and individuals than sites B or C, which show only slight differences in between them. At order level, there are some differences between the sites (e.g. site A showing the highest number of parasitic hymenoptera), but due to strong variation between the three trapping weeks a detailed statistical analysis came out to be useless (Fig. 2).

Diversity (Shannon-Index and Evenness) of the whole arthropod community was highest on site A, followed by site C and B, respectively. As could be expected, the Index of Dominance was highest on site B, followed by C and A (Tab. 1 and 2). This constellation can be related to vegetation species diversity on the three sites, which was also highest on site A; followed by C and B (Klee 1992). A correlation between plant and arthropod diversity has also been found by Southwood et al. (1979) or Murdoch et al. (1972), whereas it is not evident whether species or structural diversity is more important for the evolution of arthropod communities (Brown & Hyman 1986, Morris 1981).

At guild level, the situation is similar. The most accentuated differences between the sites can be found for the herbivores; a little less distinct for predators, parasitoids and "unknown", in this order.

The indices of similarity (Jaccard's number, Renkonen's number and Wainstein-Index) are relatively high; with the pair A and B showing the highest similarity and the pairs A and C or B and C being equally "unsimilar". This leads to the conclusion that the arthropod fauna of site C shows more differences if compared to the fauna of site A and B than these two if compared to each other (Tab. 3 and 4).

Comparing these indices with those obtained in an earlier study on the same plots (Engler 1992) suggests that the arthropod communities on each of the three fields develop into a mostly site-independent, but crop specific fauna. An influence of the surrounding vegetation can be suspected only for the predators. Despite of all differences in the concrete set of species for each site, the relation between the four guilds is almost the same for each site (Fig. 3).

Yellow colour pans proved to be more effective than blue ones on each site. In these, there were found about twice the number of individuals than in the blue ones, and about 80% of the

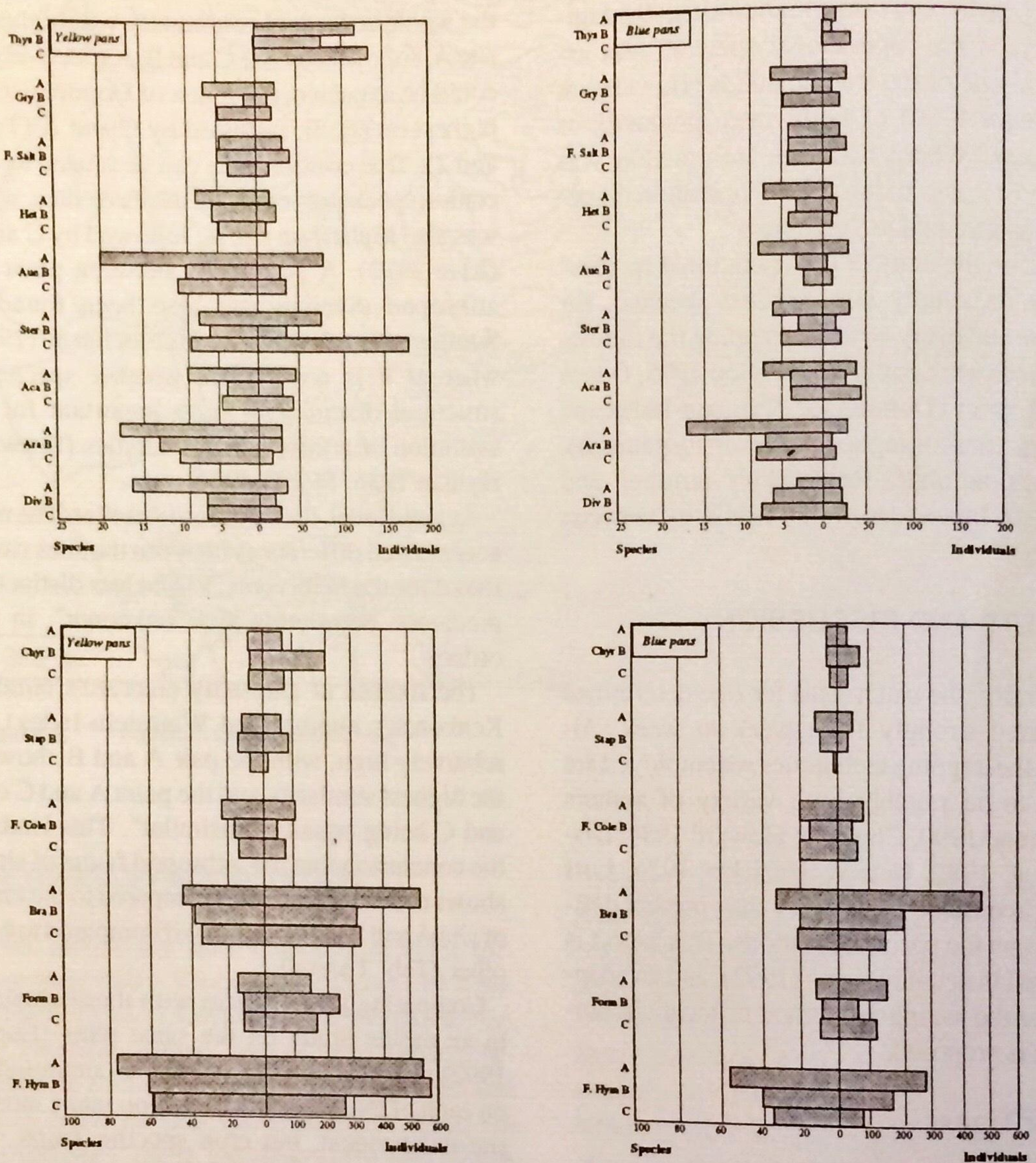

Figure 2. Total number of species and individuals trapped in colour pans for the three trapping weeks. (Thys=Thysanopter, Gry=Gryllidae, F. Salt=further Salatoria Het=Heteroptera, Auc=Auchenorryncha, Ster=Sternorrhyncha, Aca=Acari, Div=others Chry=Chrysomelidae, Stap=Staphilinidae, F. Cole=further Celeoptera, Form=Formicoidea, Bra=Brachycera, F. Hym=furterh Hymenoptera. A, B, C, = study sites. The Thysanoptera were not split into species)

Table 1. Index of dominance (D), Shannon-Index (Hs) and Evenness (E, in %) for the yellow pan samples (A, B, C: study sites)

	Week 1			Week 2			Week 5		
	A	B	C	A	B	C	A	B	C
D	0,025	0,039	0,022	0,024	0,062	0,031	0,032	0,036	0,054
Hs	4,180	3,913	4,179	4,364	3,770	3,960	4,147	3,948	3,630
E	89	85	91	87	78	86	80	83	78

Table 2. Index of dominance (D), Shannon-Index (Hs) and Evenness (E, in %) for the blue pan samples (A, B, C: study sites)

	Week 1			Week 2			Week 5		
	A	B	C	A	B	C	A	B	C
D	0,075	0,067	0,035	0,100	0,051	0,059	0,041	0,028	0,075
Hs	3,541	3,497	3,775	3,555	3,687	3,427	4,015	3,825	3,334
E	82	85	91	76	83	83	85	92	80

Table 3. Number of common species and indices of similarity for yellow pan samples (A, B, C: study sites)

	Week 1			Week 2			Week 5		
	A&B	B&C	A&C	A&B	B&C	A&C	A&B	B&C	A&C
comm. species	49	43	40	74	51	52	89	56	58
JACCARD	30	27	23	37	30	27	37	34	26
RENKONEN	43	35	34	45	38	35	42	27	41
WAINSTEIN	13	9	8	17	11	9	16	9	11

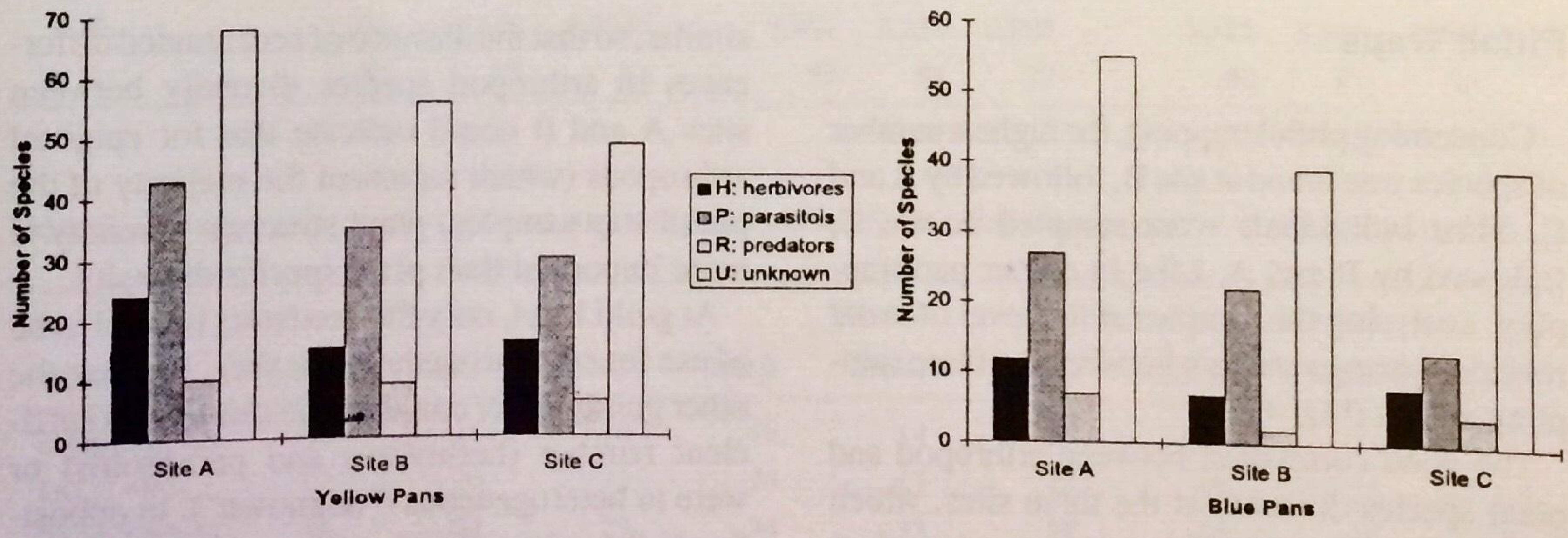

Figure 3. Share of the total number of species for the trophic guilds based on the three sampling weeks.

Table 4. Number of common species and indices of similarity for blue pan samples (A, B, C: study sites)

	Week 1			Week 2			Week 5		
	A&B	B&C	A&C	A&B	B&C	A&C	A&B	B&C	A&C
comm. species	33	21	21	54	26	32	39	27	32
JACCARD	32	20	18	39	21	23	27	27	21
RENKONEN	58	24	28	50	29	24	39	29	46
WAINSTEIN	18	5	5	19	6	5	11	8	10

total number of species obtained were present also in the yellow pans (Tab. 5). This higher effectiveness might have contributed for the fact that the results of yellow pan sampling are more consistent than those of blue pan sampling.

Table 5. Number of species and indices of similarity for yellow pan samples (A, B, C: study sites)

	Site A		Site B		Site C		All Sites	
	yellow	blue	yellow	blue	yellow	blue	yellow	blue
only this colour	133	70	109	38	100	42	159	76
both colours	135	95	94	214				
sum	268	205	204	133	194	136	373	290
% of all species of the site	79	61	84	55	82	58	83	65

Pitfall Traps

Concerning pitfall trapping, the highest number of species was found at site B, followed by A and C. Most individuals were sampled at site C, followed by B and A. Like in colour pan trapping, analysing the samples at the level of order revealed strong variation between the three sampling weeks (Fig. 4).

The good correlation between arthropod and plant species diversity at the three sites, which could be observed for the colour pan trapping, could not be verified for the pitfall trap samples. Almost no differences in arthropod species diversity could be observed between sites A and B (Tab. 6). Considering not plant species but plant structure diversity, sites A and B are relatively similar, so that the absence of accentuated differences in arthropod species diversity between sites A and B could indicate that for epigecal arthropods (which represent the majority of the pitfall trap samples) plant structure diversity is more important than plant species diversity.

At guild level, only the predators proved to be of use for comparing the three sites, because the other guilds either could not be sampled in sufficient number (herbivores and parasitoids) or were to heterogeneous ("unknown"). In opposition to the colour pan samples, indices of similarity between the three sites are very high for the predators. This questions the conclusion (as drawn for the colour trap samples) that the surrounding vegetation influences the composition of the predatory fauna (Tab. 7 and Fig. 5).

As a general conclusion, it seems evident that arthropod species composition is influenced much more by plant species and plant structure diversity of the field itself than by the surrounding vegetation.

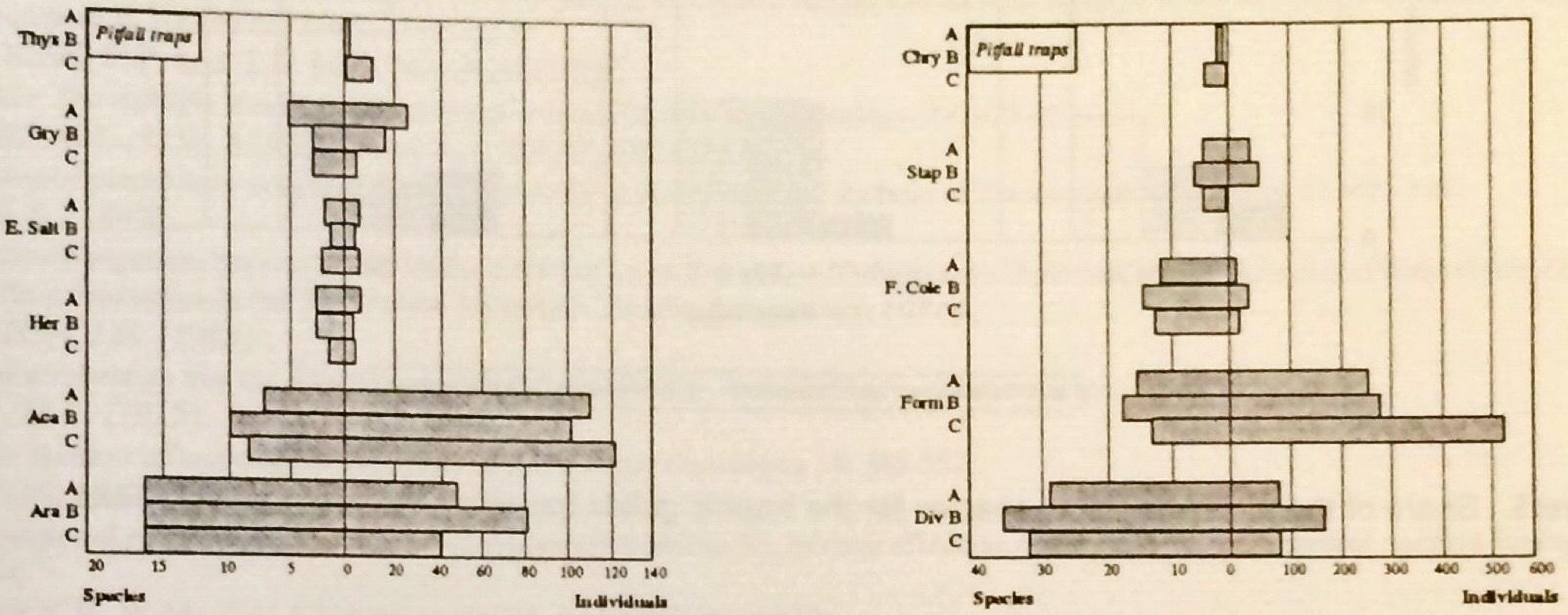

Figure 4. Total number of species and individuals trapped in pitfall traps for the three trapping weeks. (Thys=Thysanopter, Gry=Gryllidae, W. Salt=Weitere Salatoria Het=Heteroptera, Auc=Auchenorryncha, Ster=Sternorrhyncha, Aca=Acari, Div=others Chry=Chrysomelidae, Stap=Staphilinidae, F. Cole=further Celeoptera, Form=Formicoidea. A, B, C, = study sites. The Thysanoptera were not split into species)

Table 6. Index of dominance (D), Shannon-Index (Hs) and Evenness (E, in %) for the pitfall samples (A, B, C: study sites)

	Week 1			Week 2			Week 5		
	A	B	C	A	B	C	A	B	C
D	0,077	0,059	0,126	0,048	0,075	0,106	0,062	0,062	0,356
Hs	3,221	3,448	2,7242	3,401	3,231	2,905	3,385	3,345	2,095
E	82	83	73	89	81	77	80	81	52

Table 7. Number of common species and indices of similarity for pitfall trap samples (A, B, C: study sites)

	Week 1			Week 2			Week 5		
	A&B	B&C	A&C	A&B	B&C	A&C	A&B	B&C	A&C
comm. species	28	18	16	19	14	13	36	24	27
JACCARD	32	20	21	24	17	17	38	25	28
RENKONEN	38	29	23	34	35	27	56	19	24
WAINSTEIN	12	6	5	8	6	5	21	5	7

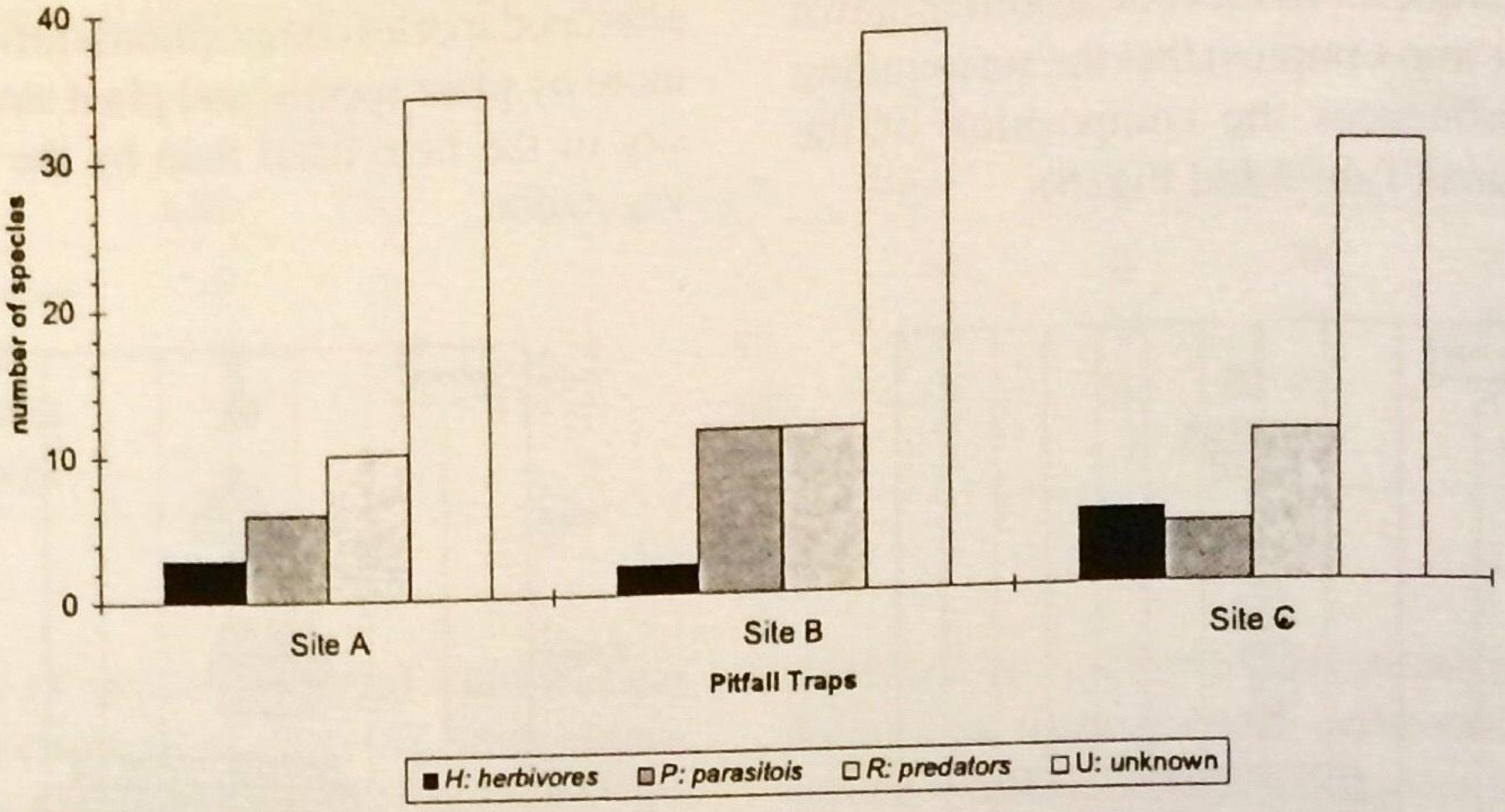

Figure 5. Share of the total number of species for the trophic guilds based on three sampling weeks.

ACKNOWLEDGEMENT

This study was sponsored by the foundation "Vater und Sohn Eiselen-Stiftung", Ulm, Germany. Further on, the authors wish to thank Dr. Paciencia P. Milan, Dr. Josef Margraf, Dr. Ma. Juliet C. Ceniza and Mr. Josefo B. Tuyor for giving the first author the opportunity to perform this study, providing the facilities and taking their time whenever help is needed. In Germany, we also wish to thank Prof. Dr. Werner Koch, Dr. Josef Settele and Dr. Konrad Martin for valuable discussions, as well as Dr. Thomas Achilles, Dr. Klaus Riede and Mr. Jürgen Trautner for their help in identifying the arthropods.

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