STUDY OF THE ENVIRONMENTAL IMPACT OF THE USE OF PHEROMONES AGAINST THE PINK BOLLWORM (*PECTINOPHORA GOSSYPIELLA*, LEP. GELECHIIDAE) BASED ON ITS EFFECT ON INVERTEBRATES

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Summary

The present report summarizes the results of the study of the environmental impact of the use of sex confusion pheromones against the pink bollworm (Pectinophora gossypiella, Lep., Gelechiidae) based on its effect on soil and foliage invertebrates of cotton plantations. The structure of these invertebrate communities was studied after pheromone treatment using as controls both chemically treated and untreated plots. The results show that the application of pheromones seems to have had no significant negative effect on invertebrates. On the contrary, chemical treatment has decreased significantly the most sensitive invertebrates. Other factors that may have affected the abundance of invertebrates is local environmental conditions such as climate and soil and local microclimate, mainly humidity, which is artificially controlled by the amount of irrigation of the plots.

INTRODUCTION

Many of the most recently developed pesticides have fewer drawbacks than the early hard pesticides, but none is without problems. A serious disavantage of pesticides is that most of them are not very specific and killl non-target organisms as well as having indeterminable effects on the environment. On the contrary, pheromones which are also used by man for manipulating insect populations have the significant advantage that they are highly species specific and are effective in minute quantities.

The aim of the present research is to compare the structure of invertebrate communities in plots: i. with pesticide treatment, ii. with pheromone treatment and iii. without any treatment, as well as to evaluate the differences which will probably be detected in the community structure. Several invertebrates are sensitive to chemical pesticides and have been used in the past as indicators of the good health of communities.

The above research was realized within the framework of project 93 EL. 06.010 of the European Union on "Use of pheromones for the control of the pink bollworm" undertaken by Hellafarm S.A.

MATERIALS AND METHODS

1. Site

The work was carried out in two sites that had been included in the project for the application of evaporators for the sex pheromones of *P. gossypiella*.

The first site was situated near the village of Mouriki in the area of Thives (Voiotia) and the other near the village of Thermopyles, 18 km south of Lamia (Fthiotida).

2. Treatment against *P. gossypiella*

In all the sites, pheromone evaporators were used in two forms: Selibate PBW (Agrisense BCS) and Pb Rope (Shin-Etsu Chemical Co.). The details of the positioning of the evaporators can be found in the report on beneficial insects.

Hellafarm S.A. (1995). Introduction of alternative crop-protection trchnologies in Greece for replacing the use of agricultural chemicals. Realisation of a pilot project in Greece using pheromone-based insect management techniques for the pink bollworm (*Pectinophora gossypiella*) in cotton.

3. Selection and treatment of plots

In Mouriki, 2 plots were chosen. In each of them, smaller 0.1 ha plots were delimited using 4 poles. These plots were considered as one treatment each. In treatment 1, Pb Rope was applied, in treatment 2, Selibate PBW and in treatment 3, a chemical insecticide. In all treatments, the neighbouring cultivations were all cotton plantations.

In Thermopyles, 4 plots were selected. In each of them, a 0.1 ha plot was delimited using 4 poles. This plot is considered as one treatment. In treatment 4, Selibate PBW was applied, in treatment 5, Pb Rope and in treatment 6, a chemical insecticide. In treatment 7, no chemical had ever been applied nor any pink bollworm pheromone evaporator had ever been used. The whole area of the plot was used as experimental area. In all treatments except treatment 7 which was surrounded by olive trees, the surrounding cultivations were cotton plantations.

The characteristics and plans of all the plots can be found in the report on beneficial insects.

4. Sampling

The soil invertebrates were collected using pitfall traps. These traps consited of jars 7 cm in diameter and 10 cm depth, sunk into the soil with their rim, level with the soil surface and containing ethylene glycol as preservative.

On August 18th ten traps were laid out in each of the four plots at Thermopyles in intervals of about 1 - 1.5 m.

On September 2nd (14 days later) the content of the above traps was collected and the traps were put back. On the same date, after the collection, one of the plots received pesticide treatment (Talstar-Difenthrin).

On September 15th (13 days lafer) the content of the traps in the plots treated with pesticide was collected.

A second series of pitfall traps was laid out in Mouriki on September 2nd. It included a total of 30 traps in three plots one of which received pesticide treatment. However, only the traps from the treated plot were retrieved on September 15th as heavy rains followed immediately after and destroyed all the remaining traps. Therefore, the Mouriki results have not been taken into account.

Five ten-sample groups were used for analyses: Selibate plot, Pb Rope plot, pesticide plot before treatment, pesticide plot after treatment and untreated plot.

The invertebrates of the foliage were collected by the Lab. of Agricultural Zoology and Entomology of the Agricultural University of Athens in the same plots. Eight plants were sampled per plot and all the invertebrates were collected and identified. The plots were sampled four times between 19.7 and 14.9.94. The control plots were sprayed with chemical insecticides twice during this period. Details of the sampling methods can be found in the report on beneficial insects.

Statistical analysis of the results was carried out using the Statgraphics statistical package.

RESULTS AND DISCUSSION

Twenty four higher taxa were collected in total (Table I). Comparing the samples taken from all the studied plots no significant differences in the number of higher taxa have been observed.

The differences in the total abundance of invertebrates seems to be much more pronounced. The plot with Selibate treatment showed the highest total abundance. This was mainly due to the large number of Gryllidae (polyphagous Orthoptera), (Kruskal-Wallis $H=18{,}6$, $p<0.05$). It is notable that the lowest abundance occurred in the untreated control plot. This fact can possibly be explained by the small size (0.9 ha) of the above site and its isolation as the surrounding agricultural land contained olive trees devoid of understorey growth and litter.

Regarding the groups with the most significant abundance (mean number >1 anim/trap), namely Acarina, Collembola, Orthoptera, Araneae, Coleoptera, Diptera, Hymenoptera, Opiliones and Hemiptera, we observe a decrease from the pheromone treatment plots to the completely untreated and the pesticide treated plots (Fig. 1). This difference is statistically significant with a high degree of uncertainity.

After the pesticide treatment, looking at individual groups, statistical analysis showed a significant decrease of the abundance of Collembola (saprophagous arthropods) (Mann-Whitney, $U=18$, $p<0.02$). Acarina and two predatory taxa of arthropods, namely Lithobiomorpha and Opiliones, were completely absent from the samples. According to Paoletti et al. (1991) Collembola and Acarina respond negatively to chemical treatment in cultivations and they can be used as bioindicators of environmental quality. Krogh (1991) has also observed a reduction in both the number of species of microarthropods and their abundance after the application of some pesticides. The abundance of all the other taxa, except Gryllidae, also decreased after pesticide treatment but not in a statistically significant degree. The same trend is present in the results from the foliage at Thermopyles (Table II). However, we cannot observe a significant difference of foliage invertebrates after pesticide treatment at Mouriki. A possible explanation for the relatively high abundance of Gryllidae in pesticide plots can be their feeding preferences: as we mentioned above, Gryllidae are polyphagous insects and consequently are able to use a wide variety of food.

Comparing the data derived from the two plots after pesticide treatment at Mouriki and Thermopyles, an obvious difference in the number of soil invertebrates collected by pitfall traps was recorded. The abundance of almost all groups was much higher at Mouriki. On the contrary, the populations of the main insect groups of the foliage were higher at Thermopyles. The above results indicate that the quantitative composition of the invertebrate community of both the soil and the foliage is clearly different in the two studied areas. This fact can be attributed to abiotic environmental factors which influence the abundance and the activity of invertebrate groups.

In conclusion, the application of pheromones seems to have had no significant negative effect on invertebrates. On the contrary, chemical treatment has decreased significantly the most sensitive invertebrates. Another factor that may have affected the abundance of invertebrates is local microclimate, mainly humidity, which is artificially controlled by the amount of irrigation of the plots and which was not measured during this project.

REFERENCES

Krogh P.H., 1991. Perturbation of the soil microarthropod community with the pesticides benomyl and isofenphos. I. Population changes. *Pedobiologia* 35: 71-78.

Paoletti M.G., M.R. Favretto, B.R. Stinner, F.F. Purrington and J.E. Bater, 1991. Invertebrates as bioindicators of soil use. *Agriculture, Ecosystems and Environment* 34: 341-362.

Table I

Mean number (ind./trap/15 days) of invertebrates caught in pitfall traps. (Sel=Selibate PBW, Pb=Pb, BT=Before pestcide treatment, AT=After pesticide treatment, Unt=Untreated, Therm=Thermopyles, Mour=Mouriki)

Groups	Sel Therm	Pb Therm	BT Therm	AT Therm	Unt Therm	AT Mour
Annelida	0.1	0.2	2.3	0.1	0	0
Mollusca	0	0	0	0	0.1	0
Acarina	1.1	1	2	0.1	0.5	0
Araneae	6.2	2.4	2.8	1.6	0.8	2
Opiliones	3.2	0.2	0.2	0	0.9	0
Isopoda	0	0.1	0.2	0	0.6	0
Lithobiomorpha	0.2	0	0	0	0	0
Geophilomorpha	0.1	0	0	0.1	0	0
Diplopoda	0	0.1	0	0	0	0
Collembola	6.2	9.2	8.1	2.1	0.4	270.6
Thysanura	0	0	0.1	0	0	0
Orthoptera	103.2	16.9	12.9	13.7	16.1	68.3
Dermaptera	0.5	0.2	0.3	0.2	0	107.5
Hemiptera	1.5	1.4	0.9	0.9	0.3	0.9
Diptera	1.3	0.1	2.2	1.4	0.1	1.3
Hymenoptera	1.4	1	2.1	1.4	1.9	2
Thysanoptera	0	0.5	0.5	0	0	0
Psocoptera	0.2	0.4	0.4	0.4	0	0
Coleoptera	4.1	3.1	5	2.1	1.3	3.4
Lepidoptera	0.2	0	0	0.1	0	0.7
Larv. Neuroptera	0.1	0	0.1	0	0	0
Larv. Coleoptera	0.4	0.2	0.4	0.1	0.1	0
Larv.Lepidoptera	0.3	0.9	0	0.5	0.2	0.1
Larv. Diptera	0.1	0.2	0.3	0.1	0	0

Table II
Total number of main insect groups found on the foliage.

1. Sampling on 1-2/8/94

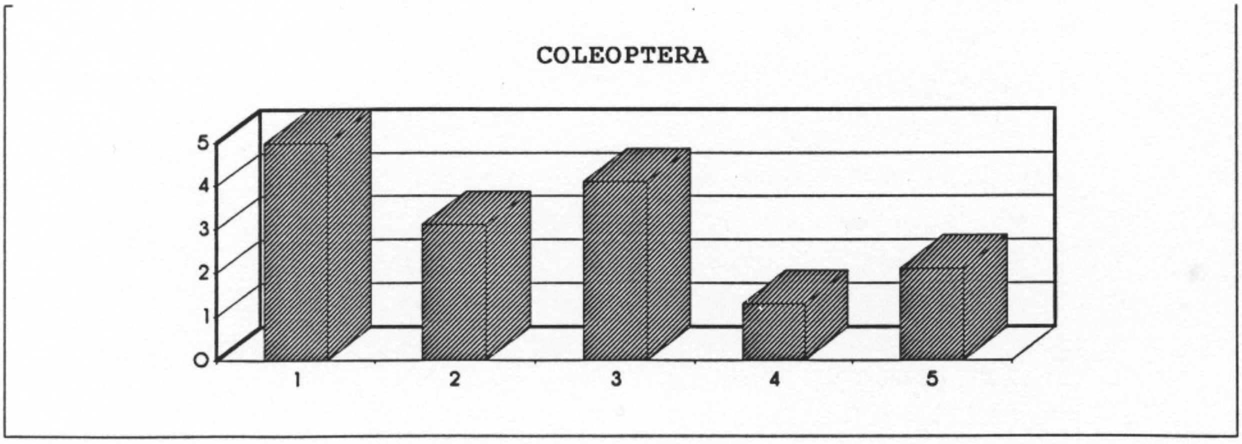
Groups	Pb Therm	Pb Mour	Sel Therm	Sel Mour	AT Therm	AT Mour	Unt Therm
Jassidae	144	51	103	30	40	55	20
Aleurodidae	131	64	130	51	55	122	105
Thysanoptera	19	20	0	38	9	3	89
Neuroptera	21	7	13	13	7	11	4
Heteroptera	7	9	2	11	0	1	26
Lepidoptera	0	19	0	13	0	0	0

2. Sampling on 18-20/8/94

Groups	Pb Therm	Pb Mour	Sel Therm	Sel Mour	AT Therm	AT Mour	Unt Therm
Jassidae	49	28	43	24	38	49	26
Aleurodidae	267	147	269	110	256	84	121
Thysanoptera	0	0	0	0	0	0	0
Neuroptera	11	4	8	9	6	4	10
Heteroptera	4	0	11	5	2	0	10
Lepidoptera	0	21	10	20	0	0	0

3. Sampling on 13-14/9/94

Groups	Pb Therm	Pb Mour	Sel Therm	Sel Mour	AT Therm	AT Mour	Unt Therm
Jassidae	23	1	6	19	6	13	7
Aleurodidae	59	30	50	17	13	33	26
Neuroptera	4	3	0	4	0	1	1
Heteroptera	11	2	4	11	0	1	12
Lepidoptera	0	0	0	0	0	0	0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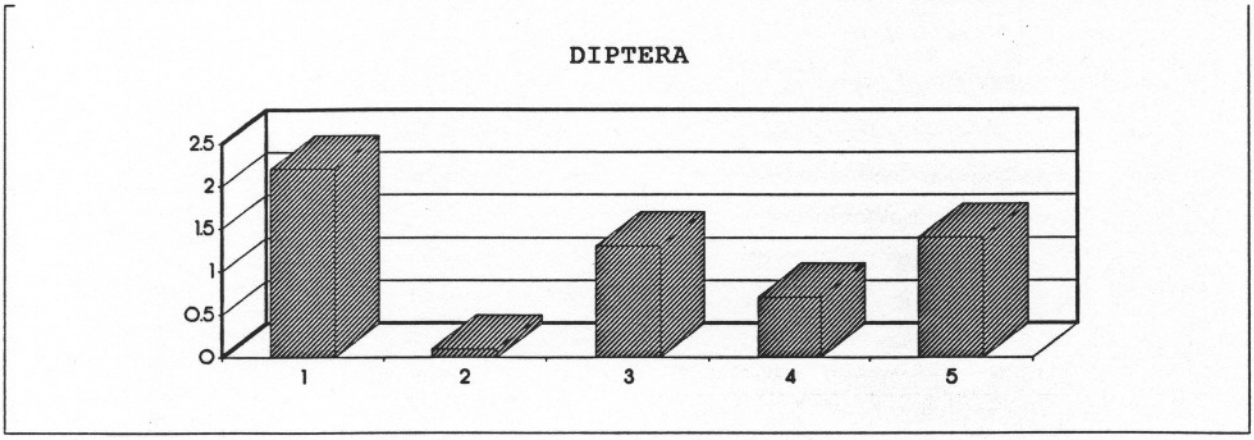
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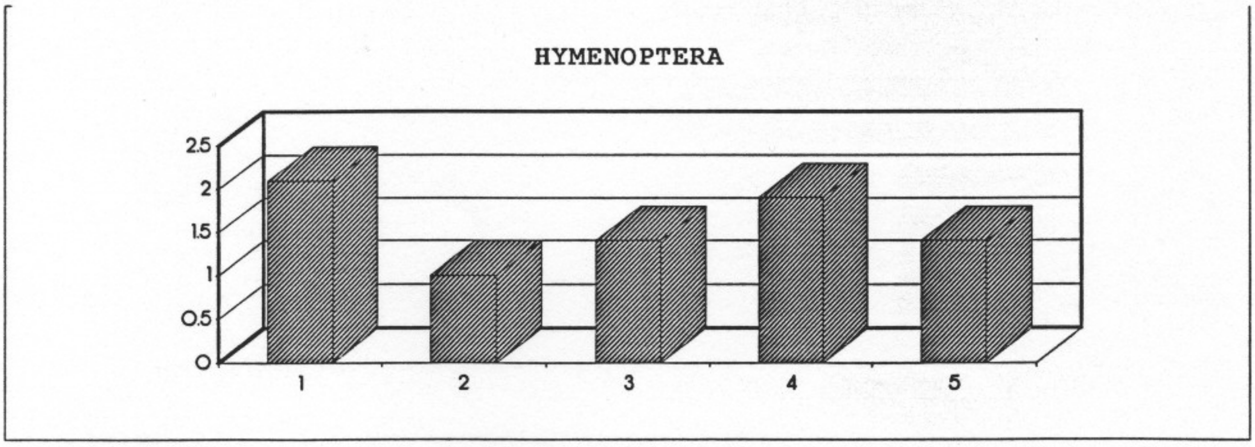
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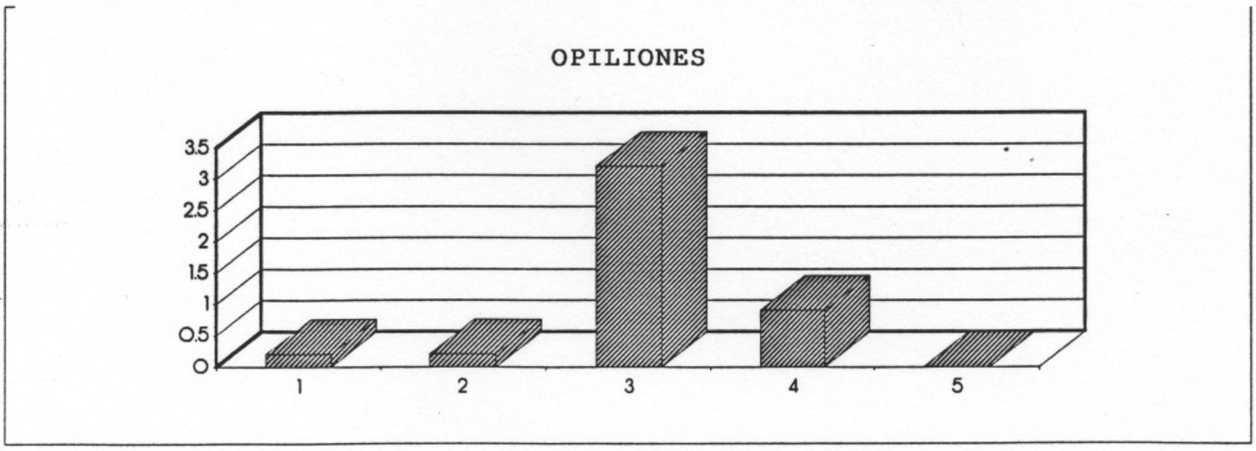
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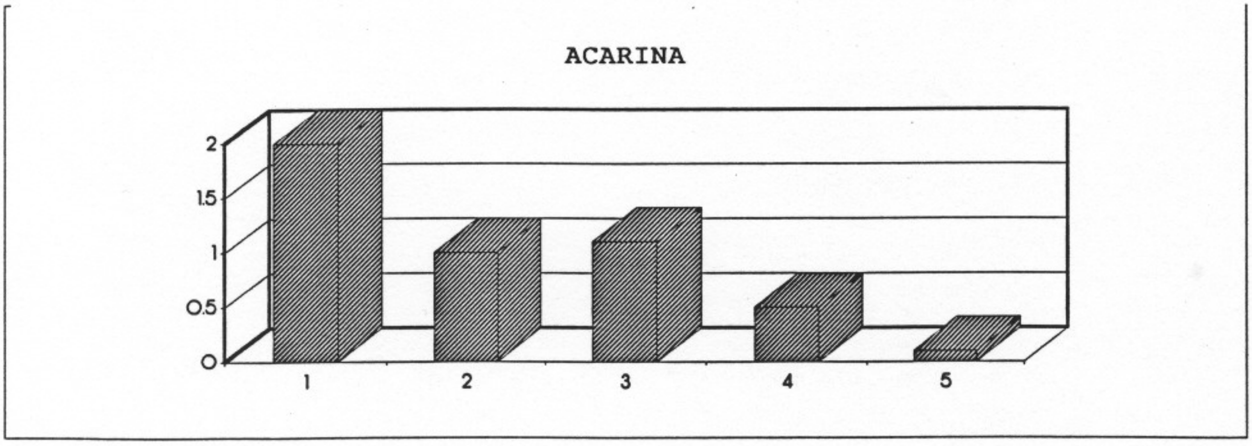
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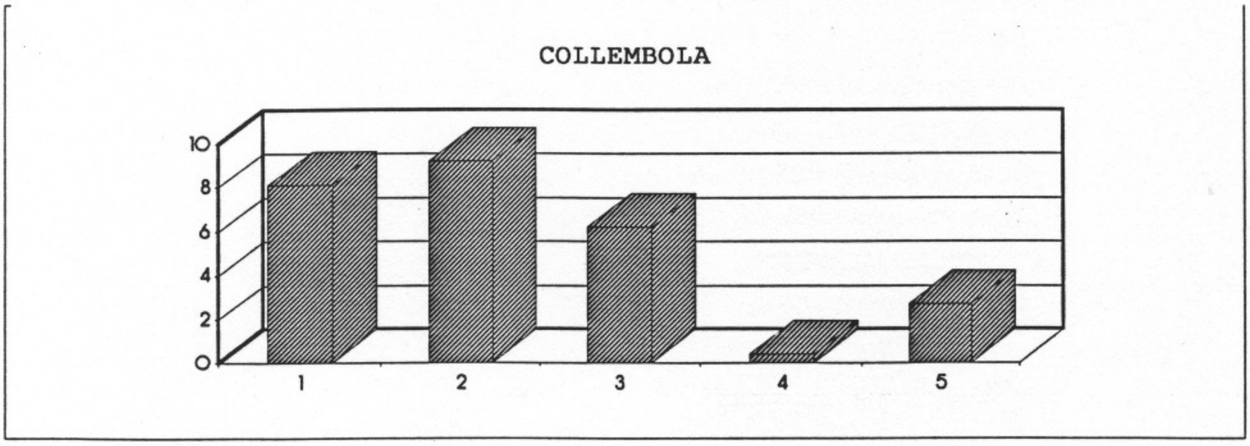
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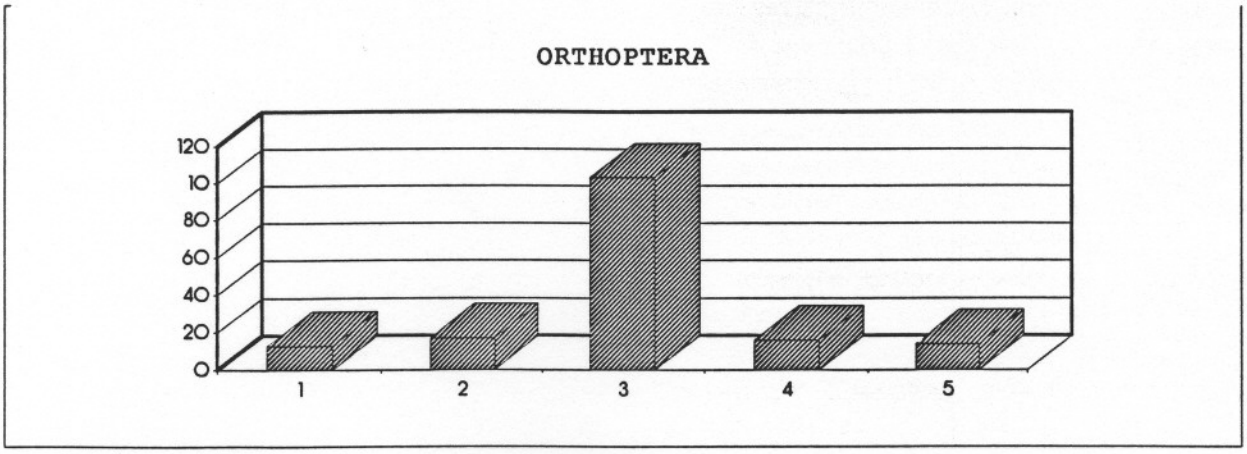
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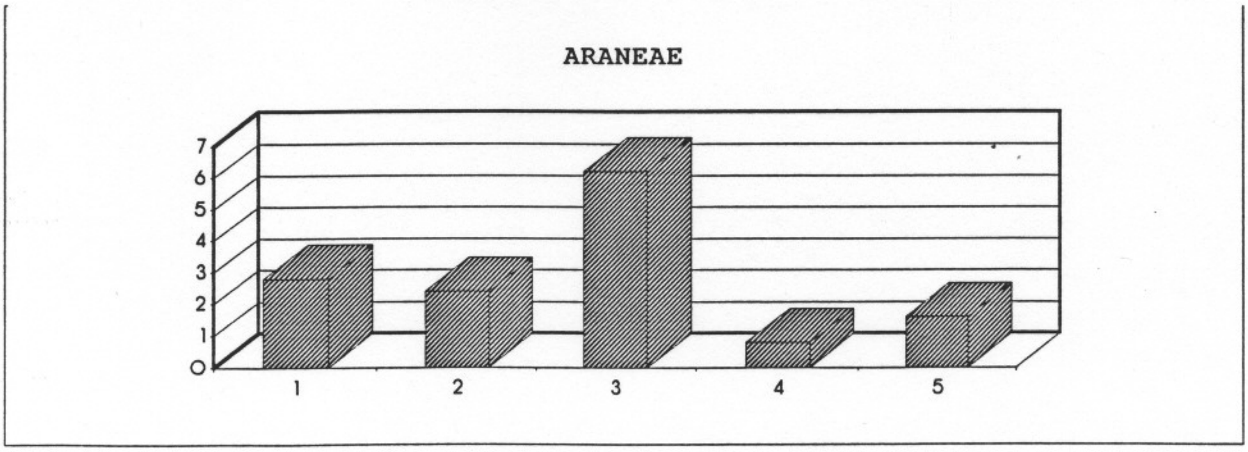
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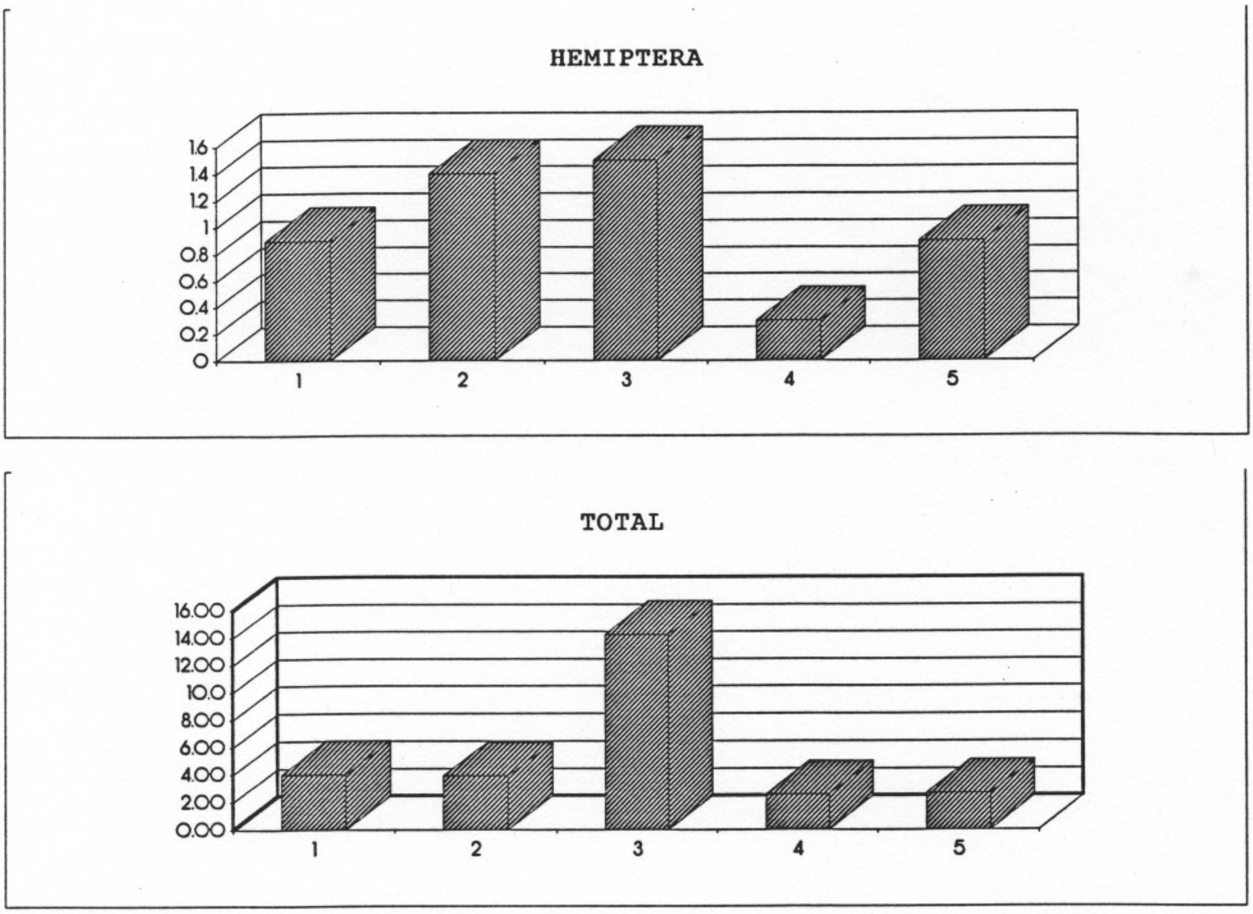

Fig. 1. Mean number (ind./trap/15 days) of invertebrates caught in pitfall traps at Thermopyles (1: Before chemical treatment, 2: Pb Rope, 3: Selibate PBW, 4: Untreated plot, 5: After chemical treatment)