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Aphid-aphidophage community in Alfalfa cultures (*Medicago sativa* L.) in Poland
Part 1. Structure and phenology of the community

[With 7 Tables and 15 Text-figures]

Abstract. Aphid-aphidophage community was studied in four regions of Poland. The sweep-net technique and catch per unit time provide a representative picture of the species composition if a series of 15–25 samples is used. In addition to *Acyrthosiphon pisum* (HARRIS), five groups of consumers are included to the community. Within two food chains, oligophagous predators and parasites, 126 species were recorded. A new concept of the aphid–aphidophage community structure has been developed. Among the dominant species there were 6 *Coccinellidae*, 7 *Syrphidae* and 3 *Chrysopidae*. On each site the community is enriched in local, accessory species. Among the parasites a high stability of occurrence was observed for the *Aphidiidae*. *Charipidae* and *Ceraphronidae*. The species composition of the *Aphelinidae* is not stable. The number dynamics of aphids has two peaks: in the spring–summer period and in the autumn, The appearance of aphidophages is significantly correlated with the first peak.

CONTENTS

Praca wykonana w ramach Problemu węzłowego Nr 09.1.3, koordynowanego przez Instytut Ochrony Roślin w Poznaniu. Kierownik tematu: doc. dr hab. Henryk SZELĘGIEWICZ.

1. INTRODUCTION

1.1. Objective and scope of the studies

The subject of the present paper is a community of species occurring in alfalfa cultures in Poland. Aphids represent its first link, predatory and parasitic species being the next links, which are directly or indirectly depended upon aphids used by them as a source of food.

The studies on the cycling of toxic substances in natural and man-made ecosystems such as agrocoenoses, revealed that the concentration of the salts of heavy metals, radioactive elements and pesticides increased along food chains (Colinvaux 1973). Such regularity of the matter cycling in an ecosystem mostly threatens the last component of the food chain, i.e., man. In this respect searching for the ways of the limitation of pesticide application becomes of great importance. One of the ways of achieving this consists in studying zoocoenoses of crop plants and determining which of them contains sufficient biological reserves to limit and inhibit the increase in the numbers of pest populations. Therefore, recognition of the actual situation in this field for particular crops in various regions of the country represents an important goal concerned with plant protection, ecology and zoology.

This paper involves faunistic and ecological aspects of the problems concerned with aphid–aphidophage community. The studied problems have been classified into three groups and each of them will be the subject of a separate paper. The first contains the studies of regularities and species structure of the system, as well as the data on phenology and population dynamics. The second, involves information on the genesis of the aphid–aphidophage system in alfalfa cultures in Poland and migrations of particular components within the agricultural landscape. In the last part, the data will be presented concerning ecological interactions between the components of the system together with an analysis of the effects of action of predator and parasite in limiting the number of aphids.

So far as it was possible, quantitative methods of the analysis of the structure, dynamics, genesis, bionomics and ecology of the system under study were used, which should account for better utilization of the presented conclusions when treatments concerned with plant protection are planned and also when the ecological potential of aphidophages in integrated plant protection is used.

1.2. State of research on the alfalfa fauna and its economic importance

Alfalfa belongs to the most valuable papilionaceous plants grown for forage. The nutritive value of this plant is due to the high content of such compounds as proteins, vitamins and carotenes. The green parts of alfalfa after being dried are a valuable forage with protein content up to 18 % (PLEBAŃSKI 1970). In addition, the content of protein in alfalfa is higher than in other papilionaceous plants. NOWICKI (1966) reports the following efficiency per ha obtained in 1960:

bird's-foot	275 kg
clover	436 kg
alfalfa	618 kg

Efficiency of the crop may be readily increased by sowing in fertile soils and applying appropriate treatments. Under favourable conditions the efficiency of proteins can reach 1,500 kg/ha (JELINOWSKA et al. 1970).

The contribution of alfalfa to the forage balance in the country is still increasing (KIEDA 1963). Its total acreage increased from 127,000 ha in 1962 to 248,000 ha in 1968, and a further increase is expected to 435,000 ha. Serious obstruction in increasing the efficiency of the culture is related to the development of cultures for seed, the efficiency of which may be very low (MRÓZ 1958, PONIKIEWSKI 1958). This is caused by the harmful effect of alfalfa fauna (MODZELEWSKA-JELINOWSKA 1959), which comprises a number of insect species. Selection of the regions suitable for growing alfalfa for seeds as well as appropriate treat ments are of great importance. Alfalfa grown for forage is subjected to a heavy impact of insect pests, fungi, bacteria and virus diseases. *Acyrthosiphon pisum* is an active vector of alfalfa mosaic virus (Medicago virus 2) and one aphid may infect a number of alfalfa (WĘGOREK and GRELA 1968), because the virus can survive in the mouth apparatus of the aphid for 30 min. Other aphids, such as *Therioaphis maculata*, *Myzus persicae* and *Aphis fabae*, are of lesser importance in transmitting this virus.

The importance of alfalfa as a forage plant has accounted for the development of many studies on its pests, especially during last 15 years. The most attention was paid to the aphids occurring in alfalfa. During this time more than 50 reports were issued on the species composition, number dynamics, biology and racial differentiation of aphids and on the problems of transmitting viruses. In Poland *A. pisum* is the most frequent and abundant aphid in alfalfa cultures (Romankow 1963, Jasieńska-Obrębska 1964, Achremowicz 1965 and 1966, Węgorek and Ruszkiewicz 1968). This species is very common in Poland and cited from 1860 but Romankow (1963) was the first who paid attention to this species as a probable pest of alfalfa and emphasized the necessity of investigations in this direction. The literature on transmitting viruses by aphids in alfalfa crops is abundant (Berliński 1964). The investigations carried out in Poland were concerned with species and racial composition of aphids living in cultivated alfalfa (Jasieńska-Obrębska 1964, Achremowicz 1965 and 1966, Berliński and Huculak 1965, Węgorek and Hejna 1968, Węgorek and Ruszkiewicz 1968), with their biological features (Stacherska 1965, Węgorek 1968, Węgorek and Hejna 1968), possibilities of control by cultivation resistant varieties of alfalfa (Węgorek and Czaplicki 1969) and with the possibilities of natural control (Węgorek and Ruszkiewicz 1968).

As far as the number of publications is concerned, the studies on the herbivorous beetles being alfalfa pests should be mentioned in the second place. This problem is largely discussed by Tischler (1971). In Poland Opyrchałowa (1957) was dealing with harmful effects of the main pest of this group, *Phytonomus variabilis*. For other phytophages such problems were studied as the role of the *Nematoda* (Paesler 1956, Deubert 1958), *Thysanoptera* (Oettingen 1952, Schliephake 1961) and *Diptera* developing in root nodules (*Micropezidae*) (Müller 1957). In Poland mainly *Contarinia medicaginis* (Juchnowicz and Romankow 1958) and *Heteroptera* (Romankow 1955, 1959a, 1959b) were studied. A survey of alfalfa pests is given by Romankow (1960 and 1963).

The third position is occupied by the investigations of insects pollinating alfalfa. These studies are most developed in Hungary (Móczár 1959, 1961 and Benedek 1968). The mechanism of alfalfa pollination is very specific. The insects of an appropriate body weight and occurring sufficiently abundant are necessary. Lack of appropriate insects pollinating alfalfa results in a considerable decrease in seed yield. In Poland the study on this problem were conducted by Ruszkowski (1961b) and Anasiewicz and Warakomska (1969).

The studies of a zoocoenotic character involving either the total fauna or only insects living on plants or in soil, were firstly conducted by Chauvin (1952) and Giunchi (1952). In Central Europe they were conducted in Hungary by Balogh and Loksa (1956) and Deseö (1961). In the German Federal Republic the total fauna was analysed by Boness (1958), and in Czechoslovakia by Štusak (1962) and Obrtel (1968), who was mainly interested in the soil fauna. The biocoenotic composition and structure (Tischler 1971) presented in these analyses is far from being complete. So far 1000 species were recorded in alfalfa cultures and the role of dominant groups is recognized, while the ecological interactions among particular components of zoocoenoses are less known.

The recognition of the role of aphids as vectors of mosaic virus in alfalfa accounted for an analysis of the role of aphids themselves and of the group of species reducing aphids. The recognitions of the community structure is very old. Check-lists of predatory species used in practice in aphid control date since the Middle Ages, when ants were used for crop protection against aphids in the Arab countries. The aphid–aphidophage community in alfalfa cultures was less studied. An extensive survey of these problems is given in the materials from the symposium on the ecology of aphids, edited by HODEK (1966).

Studies on the total aphid–aphidophage community are seldom conducted. A complete picture of the association is given by REMAUDIÈRE et al. (1973) for vineyard in France. The diagram of ecological relations presented there contains all biological components of the association recognized so far and contributing to the aphid reduction, and it can also be applied to other agrocoenotic communities. The results of the study on aphid–aphidophage communities in Poland are analysed by WENGRIS (1964, 1968), detailed data on quantitative proportions within coccinellids on alfalfa are reported by RUSZKOWSKI (1961a) and by PRUSZYŃSKI and LIPA (1971). Much less known is the species composition and numbers of *Syrphidae*. The role of aphidophagous fungi in aphid control is roughly estimated because the identification of species occurring there is difficult to do.

In recent years many investigations are made on parasitic *Hymenoptera* living in *A. pisum*. This is due to the fact that attempts are made to use parasitic *Hymenoptera* in the control of the aphids which are the pests of papilionaceous plants. On the other hand, *A. pisum* and its parasites are a suitable object for studying the aphid-parasitic *Hymenoptera* association. Attempts to use parasitic *Hymenoptera* in *A. pisum* control were mainly made in North America, where this species can cause disasters (WIĄCKOWSKI 1961). They consisted in the introduction and acclimatization, first in the United States then in Canada, of *A. pisum* parasites such as *Aphidius smithi* and *A. ervi*. The literature on the first and later periods of introduction and acclimatization of the cited species is relatively abundant. Its survey up to 1967 is presented by STARÝ (1970). From the next reports that of CAMPBELL and MACKAUER (1973) should be mentioned. Attempts to introduce *A. smithi* were also made in Europe (WIĄCKOWSKI and WIĄCKOWSKA 1961, STARÝ 1971b). The other kinds of the studies, i.e., that analysing *A. pisum* and parasitic *Hymenoptera* associated with it, in order to get a deeper insight into the „host (aphid)–parasitic *Hymenoptera*" association, are conducted in Europe, especially in Czechoslovakia. These are mainly STARÝ'S papers or the works initiated by him. They are concerned with various problems, such as the species composition of parasites living in *A. pisum*, and their hosts (HOZAK 1970, STARÝ 1972), population problems of *A. pisum* and *Aphidius* *ervi* (HOZAK 1970, STARÝ 1968a, 1968b, 1969a, 1969b, 1971a), and integrated methods of the biological control of aphids (STARÝ 1969c, 1970, 1973).

Data on the parasites of *A. pisum* in alfalfa in Poland can be found in PIEKARCZYK and WĘGOREK (1965) or WĘGOREK and RUSZKIEWICZ (1968).

In so far available literature on parasitic *Hymenoptera* living in *A. pisum* mainly the primary parasites of the family *Aphidiidae* are discussed. Hyperparasites are not taken into account in the majority of papers and in few of them they are marginally analysed (BONESS 1958, ŠTUSAK 1962, OBRTEL 1969, HOZAK 1970, STARÝ 1971a, BOURNOVILLE 1973). This results from a poor knowledge of their systematics and also from the method applied, which consists in the calculation of parasitization rate basing on the dissection of collected aphids.

Although there is abundant literature dealing with the alfalfa fauna, pests and useful organisms, the data on the species composition of zoocoenoses, ecological interactions within the community and on the effects of the whole community of predatory and parastic species on number, dynamics and reduction of aphid population occurring in the alfalfa cultures in Poland, are not precisely known.

2. STUDY AREA, METHODS AND MATERIAL

2.1. Characteristics of the study area

The studies were carried out in four plots located in three distinct landscape zones (KONDRACKI 1969): Middle-Mazovian Lowland (Chylice, Łomna), Southern Great-Poland Lowland (Gołkowice, and Ciecierzyn where the comparative material, mainly concerning the *Syrphidae*, was collected) and Little-Poland Upland (Czechów). Due to such location of the plots, coupled with high homogenity of entomological material, it was possible to obtain information on the aphid–aphidophage community of the main areas of the alfalfa cultures in Poland which are mainly situated on lowlands and uplands.

Chylice near Jaktorów (the district of Grodzisk Maz., the province of Warsaw). Natural landscape of this zone consists of periglacial lowlands generally covered with pine forests. Waters occur in tiers and their surface system is rather sparce. The alfalfa cultures under study were located on the area belonging to the Experimental Agricultural Department of the Agricultural Academy in Warsaw. They cover about 6 ha and were situated in an open area, among other crops, far from trees and shrubs, about 1 km to the west of the farm buildings. These alfalfa cultures were mown three times a year. Soil was of mosaic character and was composed of sandy and black soils of the classes IVa and IVb.

Łomna (the district of Nowy Dwór Maz., the province of Warsaw). Natural landscape is formed of alluvial terraces where meadow vegetation predominates and ground water-table is high. Alfalfa cultures under study were located at the State Agricultural Farm Łomna within a complex of crop fields bordered by Warsaw–Gdańsk road, a way towards the farm and by the fields of Łomna. Soils are silt alluvial mud of the classes IIIa and IIIb. Several plots located close to each other were under study. In close vicinity to them there were belts of trees along the road and among the fields and a park near the farm buildings. The Vistula flows at a distance of one kilometre to the east. It is bordered by dikes with a belt of pastures on the outer side. At the same distance to the west there is the border of the Kampinos Forest.

Gołkowice and Ciecierzyn (the district of Kluczbork, the province of Opole). Natural landscape of that region consists of alluvial terraces with a high water-table. It is covered with meadow vegetation mostly on alluvial and sandy soils. The alfalfa field at Gołkowice had 8 ha. It belonged to the State Agricultural Farm Byczyna (Kostów). The shape of the field was almost triangular. One side of it was bordered by a railway and the remaining sides by two roads, including one with very intensive traffic. Soils are loamy sands belonging to the class IIIb. During the study period alfalfa was mown gradually by belts, so a great deal of herbage was always growing in the field and provided shelters for the insects from the mown parts of the fields. This accounted for rapid restoration of insect population on new alfalfa shoots. In 1973 additional materials were collected from a 20 ha alfalfa culture located among crops, mainly grains, in vicinity to Ciecierzyn.

Czechów (the district of Pińczów, the province of Kielce). Natural upland lanscape is formed of carbonate rocks. Underlying rock is chiefly composed of limestone, sand and Pleistocene gravel. Rendzina is the dominant type of soil. Plant cover is mainly composed of ruderal vegetation. Alfalfa was grown on a relatively narrow belt of 2 ha located at a village way and passing 50 m along buildings and orchards and then crossing various crops. Seminal alfalfa cultivated there was sawn in rows and the yield was taken once a year, at the end of August. Soils are included to the classes IIIb, IVa and IVb.

2.2. Methods

The methods of faunistic and quantitative evaluation of insect population occurring in alfalfa cultures are still under discussion. In 1952–1972 twelve techniques of material collecting were proposed. The highest number of proposals was concerned with the methods of epiphytic fauna estimation. These are: 1. sweep-net, 2. quadrat count, 3. selector, 4. suction sampler, 5. biocenometer. The sweep-net was most frequently used from the above mentioned techniques. Balogh and Loksa (1956) recalculated per unit area the data obtained by this method, although the reliability of the sweep-net data was called in question a long ago (De Long 1932), and quantitative analyses (Gromadzka and Trojan 1967) show that complete catch of the fauna on alfalfa by this method is impossible. Boness (1958) and Deseö (1961) used this method to estimate species composition, and Saugstad et al. (1967) have shown that for different phytophagous species (*Acyrthosiphon pisum*, *Empoasca fabae* and *Philaenus spumarius*) definite pairs of factors have a decided effect on the results. The common use of the sweep-net method in ecological studies is due to the simplicity of the devices and relatively rapid sampling. Quadrat count, which was applied in alfalfa cultures by Balogh and Loksa (1958), is not frequently used because sorting one sample in the field takes up to two hours. Suction sampler (Chauvin 1952) automatically collecting fauna is very selective and the obtained results can not be even approximately related to the unit area. Also photoeclector is of little value for epiphytic fauna estimation (Gromadzka and Trojan 1967). As far as large and actively flying insects are concerned, almost all methods used are unsatisfactory, the most accurately and rapidly obtained being the results of the catch per unit time (Balogh 1958). The estimate of relative numbers of flying or migrating insects can be obtained by means of yellow cups covered with glue (Chauvin 1952, Boness 1958). Both these methods, however, are very selective. The degree of the reduction of aphid population by parasites as well as superparasitism can be estimated by rearing the parasites of aphids and other insects involved in the aphid-aphidophage community.

The following methods were used in the presented studies:

1. Sweep-net. Samples were taken with a standard sweep-net having a steel frame and cloth bag. A set of 25 sweeps was taken as one sample. Eight samples of aphids were taken and ten samples of other groups of the fauna on alfalfa. Materials were removed from the sweep-net to cloth bags, and then sorted by hand in the laboratory.

2. Quadrat counts. Plots 0.5 m in length and 0.25 m^2 area were bordered with a cord fastened with four pegs driven into the ground. Animals were collected in situ. One set contained ten samples.

3. Catch per unit time. It was used to collect *Syrphidae* at Chylice, Ciecierzyn, Czechów and Łomna in 1973. Animals were stalked, all specimens observed during 15 minutes being caught. One set contained 30 samples.

4. Yellow cups. It was used as a supplementary method to estimate the species composition of aphids and some aphidophages. This method can not be used when *Chrysopidae*, *Coccinellidae* and *Syrphidae* are studied since the results depend on the position of the cup and a number of different insects is atracted (Chauvin 1966), aphidophages being less attracted than other insects.

5. Rearing of aphids. To determine the degree of aphid infestation with parasites, mummified specimens were collected and kept on a Petri dish till hatching of parasites. Data on the infestation of *Syrphidae* with parasites were obtained by keeping larvae and pupae in the laboratory.

Sweep-net method was used in all study plots in 1971–1972 and partly in 1973. The quadrat count was used in preliminary investigations at Chylice, and then it was not longer used because of little efficiency and prolongation of the sampling time in the field.

In 1971–1972 samples were taken every ten days throughout the growing season to study the phenology of particular components and number dynamics.

2.3. Material

Using the above mentioned methods a total of 137,410 aphids, 383 green lace-wings (*Chrysopidae*), 2,901 lady birds (*Coccinellidae*), 2,742 hover-flies (*Syrphidae*), 5,331 spiders (*Araneae*) and 4,183 parasitic *Hymenoptera* was collected. A detailed analysis of the material, including classification, localities and years, is presented in Tab. I.

Table I. The collected material

Taxonomic group	Chylice			Gołko-wice	Ciecie-rzyn	Czechów		Ło-mna	Total
	1971	1972	1973	1972	1973	1972	1973	1973	
Aphididae	12,860	54724	—	59,228	—	10,598	—	—	137,410
Chrysopidae	60	50	—	152	4	93	5	19	383
Coccinellidae	486	758	—	784	69	241	13	550	2,901
Syrphidae	237	100	551	301	207	56	345	945	2,742
Aphidiidae	740	538	—	1,165	—	348	—	—	2,791
Aphelinidae	25	3	—	—	—	—	—	—	28
Charipidae	377	101	—	196	—	77	—	—	751
Pteromalidae	99	226	—	23	—	113	—	—	461
Ceraphronidae	72	29	—	28	—	22	—	—	151
Ichneumonidae (*Diplazontinae*)	274	67	—	128	—	19	—	—	488
Araneae	901	1,918	—	1,572	—	940	—	—	5,331
Total	16,131	58,514	551	63,577	280	12,507	363	1,514	153,437

2.4. Adequacy of the material

Some investigators include agrocoenoses to the biocoenoses impoverished as a result of intensive agricultural treatments and exportation of assimilated energy beyond the crop fields in the form of yields. We have not any detailed comparative data on the species abundance in natural biocoenoses but the analysis of the data on the fauna occurring in the alfalfa cultures in Europe and California indicates that about 1000 species of animals live there (Tischler 1971), the species diversity being higher in southern Europe than in central

Europe. Any total zoocoenosis has never been examined, the communities of species being more often the subject of study, including as a starting point the phytophagous group with definite type of food relations to alfalfa, e.g. related to the root nodules or grazing leaves and stems or sucking, etc.

The analysed aphid–aphidophage system is also very diversified. Four groups of organisms feeding on aphids are distinguished:

1. parasitic fungi (Thoizon 1970);
2. predatory bugs of the families *Anthocoridae* and *Miridae* (Strawiński 1964);
3. parasitic *Hymenoptera* which form a complex of parasites and superparasites (*Aphelinidae*, *Aphidiidae*, *Charipidae*, *Ceraphronidae* and *Pteromalidae*);
4. oligophagous predators feeding on aphids only (*Coccinellidae*, *Chrysopidae*, *Syrphidae*, *Cecidomyiidae*, *Chamaemyiidae*) and a large group of predatory and parasitic species associated with them that forms the next links of the food chain.

Neither fungi nor predatory bugs were analysed, but parasitic *Hymenoptera* (group 3) and the majority of oligophagous predators (group 4) were discussed. The contribution of the analysed species to the reduction of the aphid population is of basic importance in Poland.

Adequacy of the collected materials. The determination of the completeness of the species composition of particular groups depends on the sampling technique, and can be determined using the Arrhenius curves relating the number of species to the number of samples. Mass collection of *Syrphidae* makes it possible to compare the efficiency of two sampling techniques in order to estimate the species composition (Fig. 1). The number of species of aphidophagous *Syrphidae* recorded in the cultures under study ranged from 5 to 9. A similar number of species was found using both sweep-net and stalking techniques. To determine the full composition of syrphid species on alfalfa using catch per unit time, a set of 6–10 samples is sufficient, while a set of sweep-net catches should contain twice as much of samples (Fig. 1). Sweep-net method for shy and well flying insects such as *Syrphidae* is also much less efficient than stalking method; 823 specimens of aphidophaqous *Syrphidae* were recorded in 770 sweep-net samples, while 1,962 specimens were found by 170 catches per unit time. The three techniques applied revealed the following numbers of specimens per sample:

1. catch per unit time	11.5
2. sweep-net	1.1
3. biocenometer	0.3

Nor the results obtained by „yellow cup" technique were satisfactory and after preliminary sampling this method was not longer used. These unsatisfactory results are in accordance with those obtained by Couturier (1973) in orchards and meadows in France and by Roth and Couturier (1966) in alfalfa cultures.

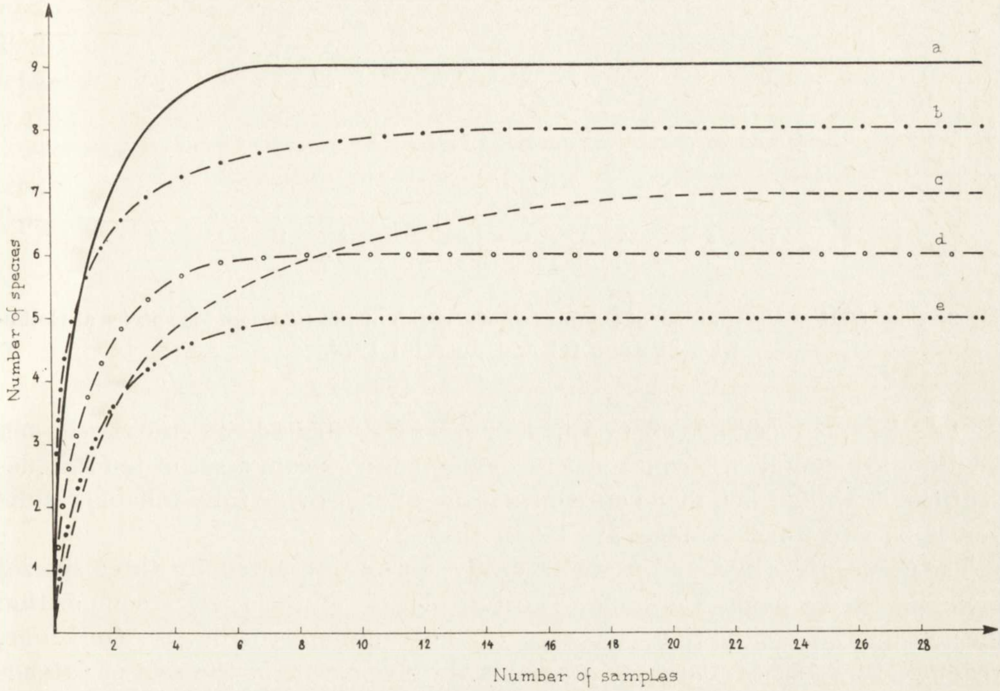

Fig. 1. The relationship between the number of samples and the number of the aphidophagous *Syrphidae* species caught in the alfalfa cultures; a – Łomna 1973, b – Chylice 1973, c – Gołkowice 1972, d – Czechów 1973, e – Ciecierzyn 1973. a, b, d, and e – data from the catches per unit time, c – data from the sweep-net.

Aphids were caught by the sweep-net, using a set composed of 8 samples, and in addition, the plants were examined. Two species were recorded in the crops, with *Acyrthosiphon pisum* as a predominating and usually the only representative of the group. It was present in all samples.

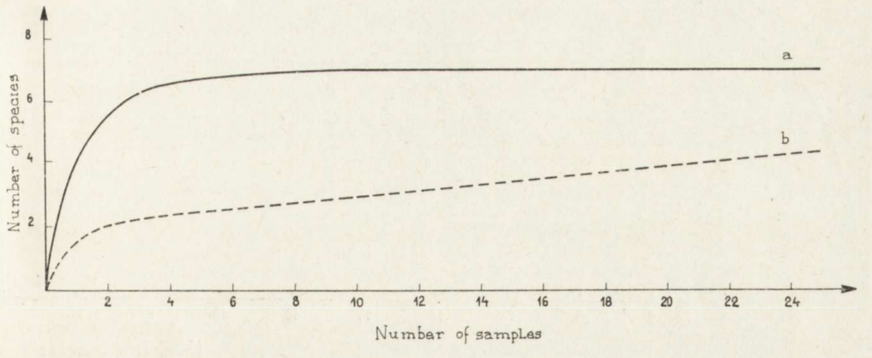

Fig. 2. The effect of the number of samples on the catch of the *Coccinellidae* species in the alfalfa cultures at Gołkowice 1972; a – data for the whole growing season, b – samples taken in May.

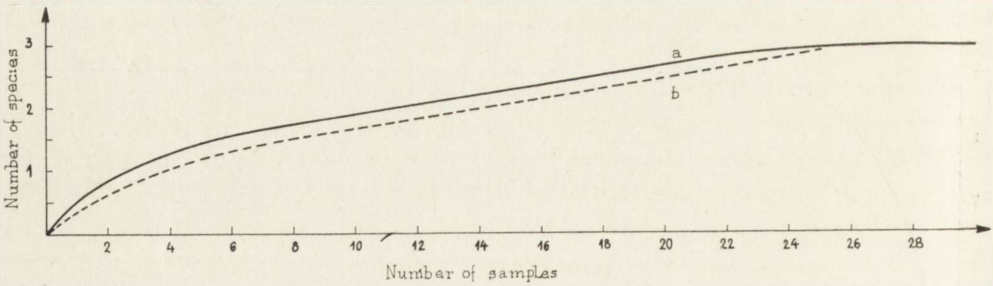

Fig. 3. The effect of the number of samples on the catch of the *Chrysopidae* species at Gołkowice in June (b) and July (a) 1972.

Species composition of Coccinellidae was estimated by the sweep-net technique. If sampling is continued throughout the season, a set of ten samples is sufficient, while when made only once it does not provide fully reliable results even if 25 sweep-net samples are taken (Fig. 2).

The *Chrysopidae* in the crops under study were represented by three species belonging to the genus *Chrysopa*. The full picture of the species composition depends on the domination structure of the community (Fig. 3). Only one, predominating species (*Chrysopa carnea*) is always present in the sets of catches composed of 4–5 samples. The densities of the remaining two species occuring on the alfalfa are so low that a set of 25 samples is needed to find them.

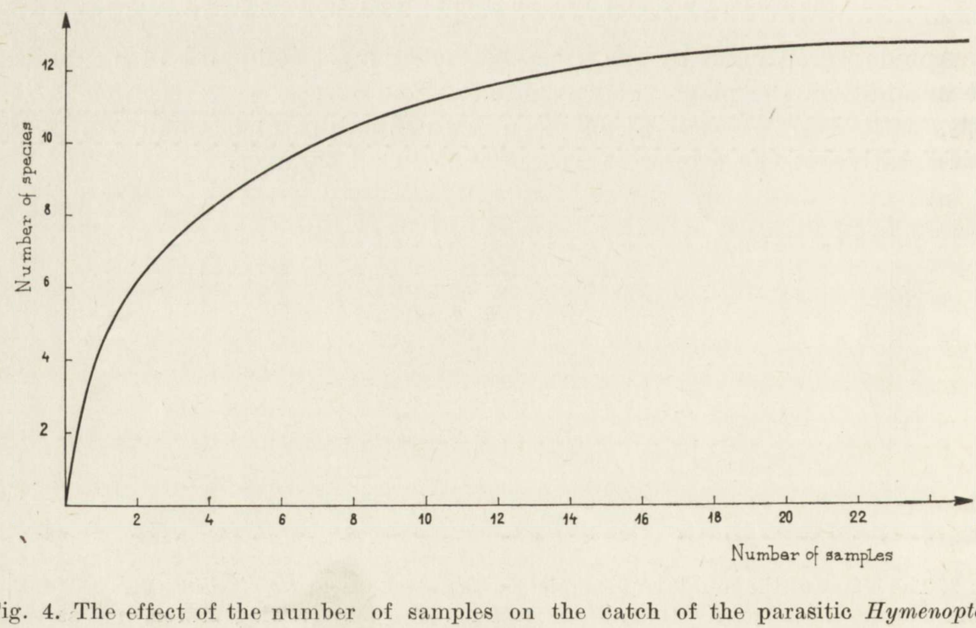

Fig. 4. The effect of the number of samples on the catch of the parasitic *Hymenoptera* species.

Parasitic *Hymenoptera* of small body size are represented in the material by 25 species, a half of which occurs in alfalfa crops only occasionally, as separate individuals. The full representation of the common species (Fig. 4) is reached in a set of sweep-net catches containing 15–25 samples.

When the series of catches are made every 10 days and 10 samples of the series are used, three successive sets of catches are sufficient to obtain fully representative data on the aphid–aphidophage community.

3. STRUCTURE OF THE FAUNA

3.1. Species composition

A total of 126 species has been collected in the alfalfa cultures under study. Particular systematic groups were identified by the following specialists:

J. Wagner, M.Sc. – *Aphididae*
Dr. W. Mikołajczyk – *Chrysopidae*, *Coccinellidae*
Dr. R. Bańkowska – *Syrphidae*
Dr. E. Kierych – *Aphidiidae*, *Charipidae*
H. Garbarczyk, M. Sc. – *Proctotrupoidea*
Dr. H. Szczepański – *Aphelinidae*, *Pteromalidae*
A. Sawoniewicz, M.Sc. – *Ichneumonidae*
H. Punda, M.Sc. – *Aranei*

Determinations of the *Coccinellidae* were verified by Dr. R. Bielawski, and those of the *Aranei* by Dr. W. Staręga. The authors are grateful to them.

The full list of the identified species is cited below.

Aphididae

Acyrthosiphon pisum (Harr.)
Therioaphis trifolii (Mon.)

Chrysopidae

Chrysopa carnea Steph.
„ *commata* Kis et Újhel.
„ *phyllochroma* Wesm.

Coccinellidae

Adalia bipunctata (L.)
Adonia variegata (Goeze)
Anisosticta novemdecimpunctata (L.)
Coccinella quinquepunctata L.
„ *septempunctata* L.
Coccinula quatuordecimpustulata (L.)
Hippodamia tredecimpunctata (L.)
Propylaea quatuordecimpunctata (L.)
Rhyzobius litura (F.)
Sospita vigintiguttata (L.)
Tythaspis sedecimpunctata (L.)

Syrphidae

Melanostoma mellinum (L.)
Pipizella varipes (Meig.)
Platycheirus albimanus (F.)
„ *angustatus* (Zett.)
„ *clypeatus* (Meig.)
„ *peltatus* (Meig.)

Scaeva pyrastri (L.)
Sphaerophoria rueppelli (WIED.)
„ *scripta* (L.)
„ *taeniata* (MEIG.) (= *menthastri* L.)
Syrphus balteatus (DEG.)
„ *compositarum* VER.
„ *corollae* F.
„ *latifasciatus* MACQ.
„ *luniger* MEIG.
„ *ribesii* (L.)
„ *torvus* O.-S.
„ *vitripennis* MEIG.

Ichneumonidae

Diplazon laetatorius (F.)
Enizemum ornatum (GRAV.)
Homotropus nigritarsus (GRAV.)
„ *signatus* (GRAV.)
„ *tarsatorius* (PANZ.)
Promethes sulcator (GRAV.)
Sussalba dorsalis (HOLMGR.)
„ *pulchella* (HOLMGR.)
Syrphoctonus biguttatus (GRAV.)
Syrphophilus bizonarius (GRAV.)
Tymmophorus rufiventris (GRAV.)

Aphidiidae

Aphidius ervi HAL.
„ *picipes* (NESS.)
„ *urticae* HAL.
Praon barbatum MACK.

Aphelinidae

Aphelinus asychis WALK.
„ *chaonia* WALK.
„ *hordei* KURDJ.
„ *humilis* MERC.
Aphelinus kurdjumovi (MERC.)
„ *varipes* (FOERSTER.)

Charipidae

Alloxysta crassa (CAMERON)
„ *scutellata* KIEFF.
Charips fracticornis (THOMS.)
„ *victrix* (WESTW.)
Pezophycta cursor (HART.)

Ceraphronidae

Dendrocerus bicolor (KIEFF.)
„ *carpenteri* (CURT.)
„ *puparum* (BOH.)

Pteromalidae

Asaphes suspensus (NEES)
„ *vulgaris* WALK.
Coruna clavata WALK.
Pachyneuron aphidis (BCHÉ)
„ *umbratum* DEL.

Eulophidae

Tetrastichus sempronius ERD.

Tetragnathidae

Pachygnatha clercki SUND.
„ *degeeri* SUND.
Tetragnatha extensa (L.)
„ *montana* SIM.
„ *obtusa* C. L. K.
„ *pinicola* L. K.

Araneidae

Aculepeira ceropegia (WLK.)
Araneus angulatus CL.
„ *diadematus* CL.
„ *quadratus* CL.
Araniella cucurbitina (CL.)
Cyclosa conica (PALL.)
„ *oculata* (WLK.)
Cyphepeira patagiata (CL.)
Mangora acalypha (WLK.)
Neoscona adianta (WLK.)
Nuctenea umbratica (CL.)
Singa hamata (CL.)
„ *pygmaea* (SUND.)

Thomisidae

Diaea dorsata (F.)
Misumena vatia (CL.)
Philodromus aureolus (CL.)
„ *collinus* C. L. K.

Tibellus maritimus (MGE.)
„ *oblongus* (WLK.)
Xysticus cristatus (CL.)
„ *kochi* TH.
„ *ulmi* (HAHN)

Theridiidae

Enoplognatha ovata (CL.)
Neottiura bimaculata (L.)
Steatoda bipunctata (L.)
Theridion impressum L. K.
„ *pictum* (WLK.)
„ *sisyphium* (CL.)
„ *tinctum* (WLK.)

Lycosidae

Tarentula pulverulenta (CL.)

Clubionidae

Clubiona neglecta O. P.-C.
„ *stagnatilis* KULCZ.
„ *subsultans* TH.

Salticidae

Evarcha falcata (CL.)
Salticus cingulatus (PANZ.)

Linyphiidae

Araeoncus crassiceps (WESTR.)
„ *humilis* (BL.)
Bathyphantes gracilis (BL.)
Entelecara congenera (O. P.-C.)
Erigone atra Bl.
„ *dentipalpis* (WID)
Linyphia triangularis (CL.)
Meioneta rurestris (C. L. K.)
„ *tenera* (MGE.)
Microlinyphia pusilla (SUND.)
Neriene peltata (WID.)
Oedothorax apicatus (BL.)
Pelecopsis paralella (WID.)
Porrhomma pygmaeum (BL.)
Savignya frontata BL.
Trematocephalus cristatus (WID.)

3.2. Structure of the aphid–aphidophage community

3. 2. 1. Components of the community

Structural and, in particular, functional analysis of the community of specie depending on the same food resources faces a number of difficulties recently. The system of zoocoenological units may be used as a basis of such an analysis but, in fact, the current systems of classification (TISCHLER 1949) neglect the criteria of biotic relations among the species. Either the spatial structure of the biocoenosis or a definite taxonomic unit is the main subject of methodological analyses (BALOGH 1958).

As far as the study of energy flow are concerned, the models of the structure of ecological systems involve either energy flow through the population (PETRUSEWICZ and MACFADYEN 1970) or the distribution of energy in ecosystems (ODUM 1969). None of the mentioned models, however, can be applied when the systems containing dozens of species with various biotic relationships are analysed. The analysis of smaller ecological systems may be based on a concept of the food chain or food web (ELTON 1927) or competitive system (TARWID 1952). Each of the mentioned components of the ecological structure of a biocoenosis represents an incomplete picture of the relationships. The

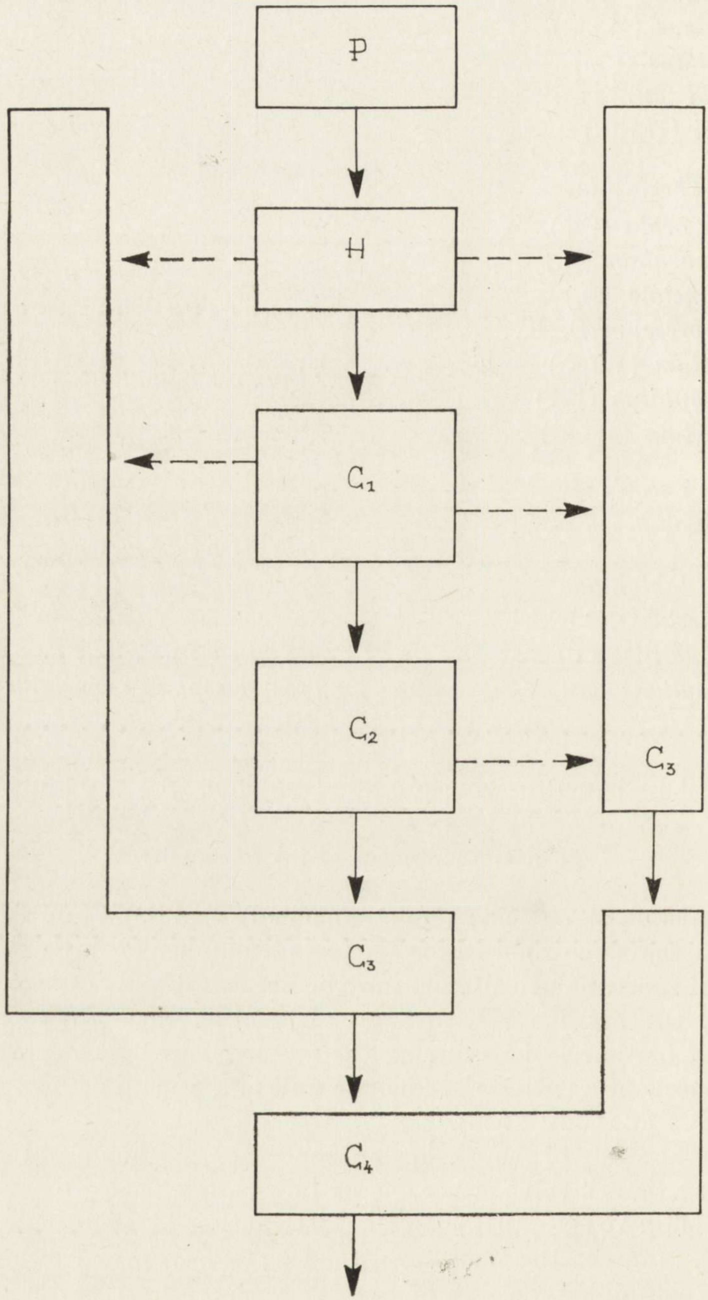

Fig. 5. The schematic representation of relations within a food chain. P – producers, H – herbivores, C_1 – oligophagous predators association, C_2 – association of their predators and parasites, C_3 – association of polyphagous predators, C_4 – carnivores of a higher trophic level. The solid arrows indicate the main direction of energy flow, the dashed arrows indicate the parallel exploitation of the chain.

food chain concept enables the determination of the possibilities of exploitation (PHILLIPSON 1969) but it is not appropriate for analysis of multi-component links and assumes only one way of energy flow. The food web concept provides the most complete picture of the relations within a community. The first model of the food web in aphid–aphidophage community was presented by RICHARDS (1926) for pine forests. Application of this concept to the agrocoenoses does not yield good results, as it can be seen from the results obtained by TISCHLER (1971). The food webs of alfalfa and clover entomofauna represent systems of food chains blindly ended which, from the point of view of the closed energy circuit principle, is a misleading picture of the ecological system.

In the present paper a combined set of ecological units within the community is applied. The starting point for this approach is the concept of homeostasis of ecosystems (TROJAN 1974), according to which three structural webs overlap one another within a biocoenosis. These are trophic, competitive and paratrophic webs. Only two first types of the webs have been identified and introduced to the model. The concept of a trophic web is based on the concept of a food chain; the succesive links (trophic levels) have been distinguished according to the results of the studies on the ecosystem productivity. In this model alfalfa represents the level of producers (P), *Acyrtosiphon pisum* is the level of herbivores (H.) The other species are different levels of consumers (C_1–C_4). Within each link of the chain there is a group of species occupying the same ecological niche, i.e., utilizing the same food resources and having common predators. According to the concept presented by TARWID (1952) the competitive association represents a similar ecological system. The chain system, even supplemented by competitive association is a biological fiction because many species influence some successive trophic levels. The energy flow along a food chain is accompanied by parallel exploitation due to the groups of omnivorous species and polyphagous predators. A scheme for these relationships is presented in Fig. 5.

3. 2. 2. Primary consumers (C_1)

The species of heterotrophes directly and indirectly feeding on aphids form a complex system, within which five groups of primary consumers can be distinguished:

1. Omnivore and polyvore species,
2. Polyphagous predators,
3. Oligophagous predators,
4. Oligophagous parasites,
5. Parasitic fungi.

1. Omnivore and polyvore species. In alfalfa cultures this group includes representatives of three taxonomic units: earwigs (*Dermaptera*), bugs (*Miridae*) and ants (*Formicidae*).

Forficula auricularia occurs commonly on alfalfa due to a suitable micro-climate in these crops. Aphids occurring in alfalfa crops are only supplementary food in its diet (WENGRIS 1968), so its contribution to the control of aphid population is insignificant.

Ecological niche of *Miridae* in agrocoenoses is under discussion. *Lygus pratensis* and *L. rugulipennis* are the main representatives of this group. These species are cited as pests of crop plants. Ten years ago STRAWIŃSKI (1964) included them to aphidophages; their role in aphid control is significant in potato crops (GAŁECKA 1964, 1966), but when the density of aphids is low, they also destroy the eggs of the Colorado Beetle (TROJAN 1968). To estimate the contribution of this group to *Acyrthosiphon pisum* control, it is necessary to study the ecological position of this species within the community.

Ants (*Formicidae*) are represented only by one species (*Lasius niger*) in alfalfa cultures and its relation to *A. pisum* is not known so far.

2. Polyphagous predators. The predatory families of *Heteroptera* and spiders should be included to this group.

The following species of predatory *Heteroptera* are common in alfalfa cultures: *Anthocoris nemorum* (L.), *Nabis ferus* (L.), *N. pseudoferus* REM., *N. rugosus* (L.), *Orius niger* WOLFF., *O. minutus* (L.) and *O. majusculus* REUT. The majority of them is cited by STRAWIŃSKI (1964) as predators of aphids. The number of predatory *Heteroptera* in agrocoenoses and their role in aphid control have not been accurately estimated.

Seven common species of web spiders and five species of wandering spiders belonging to different families occur in alfalfa cultures. Both the ecological groups of spiders probably play an important role in aphid control, but so far only the role of web spiders in aphid control has been determined (KAJAK 1965). Web and wandering spiders of the aphid–aphidophage community are the regulators of numbers that do not influence a definite link of the food chain or trophic level but act as a system parallel to the food chain and exploit it throughout the whole length.

3. Oligophagous predators. This group contains five families of insects among which all species of *Chrysopidae* and *Chamaemyiidae*, some subfamilies of *Syrphidae*, several genera and species of *Coccinellidae* are oligophagous aphidophages. The most numerous components of this group comprises 16 species of *Syrphidae*, *Coccinellidae* and *Chrysopidae*. Their representatives constitute the bulk of the community and have a decisive influence on the size and control of aphid population in alfalfa cultures.

4. Oligophagous parasites. The main role is played by 10 species of *Hymenoptera* (*Aphelinidae* and *Aphidiidae*). The contribution of this group to the control of *Acyrthosiphon pisum* on alfalfa is significant.

5. Parasitic fungi. *Acyrthosiphon pisum* is parasitized by six species of fungi of the genus *Entomophthora* (THOIZON 1970), the occurrence of which in Poland has been recorded or is very probable. The contribution of this group to *A. pisum* control is currently impossible to determine.

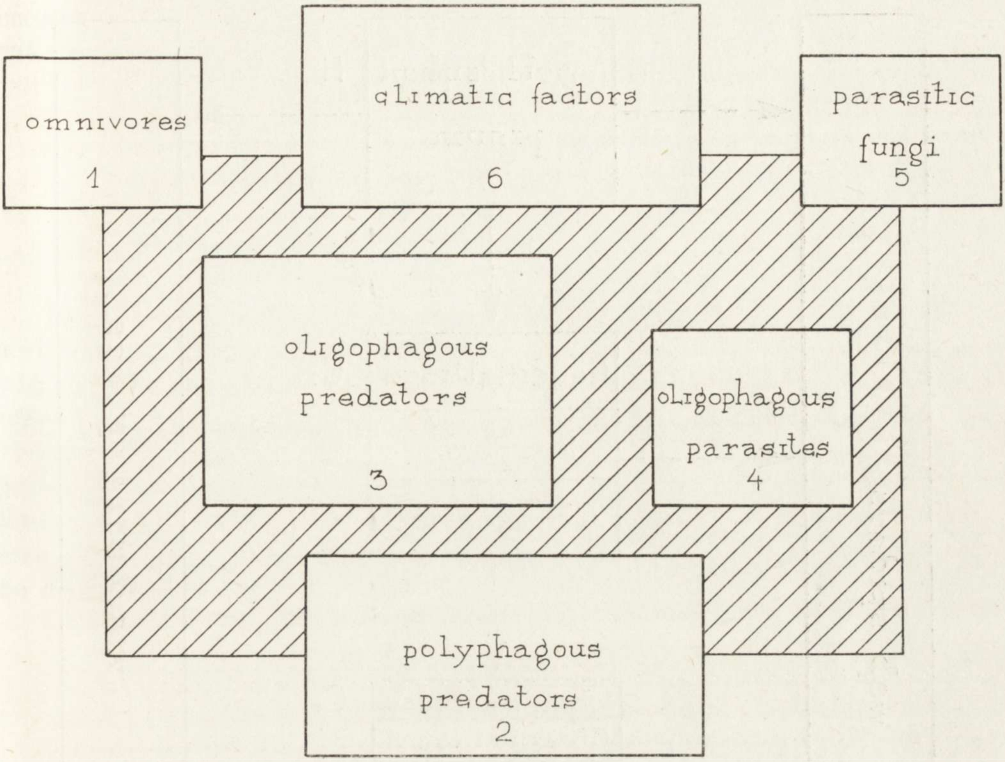

Fig. 6. Probable contribution of different factors to the control of the *Acyrtosiphon pisum* population (dashed area) in the alfalfa cultures.

The relation of the primary consumers to *A. pisum* and their contribution to the control of *A. pisum* population (Fig. 6) depend on the character of a particular group.

3. 2. 3. The chain of oligophagous predators

The most important component of aphid–aphidophage community, which has the highest contribution to aphid control in alfalfa cultures is the chain of oligophagous predators. It involves six links, including five heterotrophic ones (Fig. 7).

Oligophagous predators (C_1). The first link of the food chain involves three families of insects. Among them the *Syrphidae* were represented by the highest number of species and the *Coccinellidae* were the most numerous, as their numbers contributed to over two-third of the total number of this trophic level (Tab. II). These proportions were assessed basing on the data obtained with the sweep-net method in 1972.

Coccinellidae as aphid predators were the subject of many studies (Tischler 1971). Among 11 species found in alfalfa crops in Poland, five were

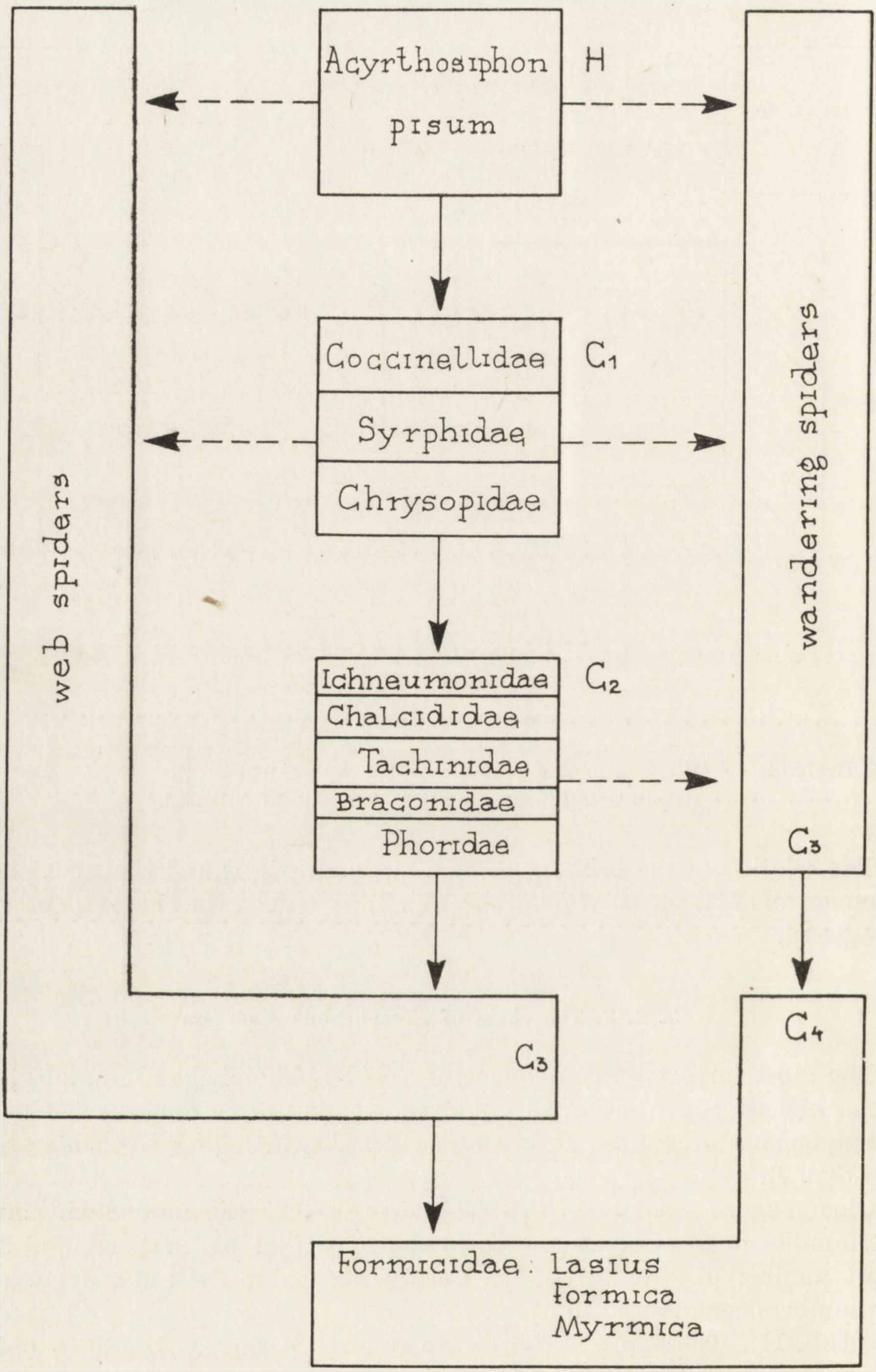

Fig. 7. The composition of oligophagous predator food chain in the aphid–aphidophage community.

accessory species and the numbers of each of them did not exceed one per cent. There were six dominant species:

1.	*Propylaea quatuordecimpunctata*	62.7 %
2.	*Coccinella septempunctata*	21.3 %
3.	*Coccinula quatuordecimpustulata*	6.7 %
4.	*Hippodamia tredecimpunctata*	3.5 %
5.	*Tythaspis sedecimpunctata*	2.8 %
6.	*Adonia variegata*	2.1 %

It is evident that *P. quatuordecimpunctata* and *C. septempunctata* are the most important species and can be included to eudominants; they both contribute to 84 % of the total number of this trophic level. Very similar percentage contribution of both these species in alfalfa crops of different regions of Poland is reported by Ruszkowski (1961 a) and Pruszyński and Lipa (1971). A similar species composition in alfalfa crops is reported from the whole central Europe (Deseö 1961, Balogh and Loksa 1956, Stušak 1962 and Obrtel 1969); some differences in the contribution of accessory species can be observed in the countries south of Poland.

Table II. Quantitative relations within the oligophagous predators association

Family	Number of species	Per cent of individuals in sweep-net catches
Chrysopidae	3	11.63
Coccinellidae	11	70.34
Syrphidae	18	18.03

The *Syrphidae* as a group of aphidophages controlling aphids on alfalfa are less known. Vague references to hover-fly larvae preying upon aphids together with lady birds and lace-wings larvae predominate. Only Boness (1958) and Stušak (1962) have mentioned some species of aphidophagous *Syrphidae* found on alfalfa. They have not reported, however, any more detailed data neither on numbers nor on domination structure in these species. Among the species reported by Boness, *Melanostoma mellinum*, *Sphaerophoria scripta*, *Syrphus balteatus* and *Platycheirus* sp. belong to „alfalfa aphidophage community" while *Lasiopticus pyrastri* must have been included occasionally as this species is associated with trees and frequently occurs in orchards. Stušak has mentioned five species found in alfalfa crops in Czechoslovakia, including *Melanostoma scalare*, which is common in southern Europe but in Poland occurs occasionally and has never been found in alfalfa cultures.

During the three-year study period (1971–1973) on the structure of aphids-aphidophage communites, 18 aphidophagous *Syrphidae* species were found in all alfalfa cultures under study in Poland. Among them seven dominants have been distinguished, i.e., the species the numbers of which exceed one per cent of the total number of the *Syrphidae* caught:

1.	*Melanostoma mellium*	41.5 %	Eudominants
2.	*Spaerophoria scripta*	28.0 %	
3.	*Platycheirus clypeatus*	10.2 %	
4.	*Sphaerophoria taeniata*	5.7 %	Dominants
5.	*Platycheirus peltatus*	5.6 %	Subdominants
6.	*Syrphus corollae*	3.9 %	
7.	*Syrphus balteatus*	3.6 %	

The remaining 11 species found on alfalfa are accessory species occasionally visiting alfalfa cultures from adjacent fields or trees.

The lace-wings occurring on alfalfa are much less known. Two species were recorded in Czechoslovakia (Zelený 1965), one in Hungary (Balogh and Loksa 1956), one in German Federal Republic (Boness 1958). Three species of the genus *Chrysopa* found in Poland occur in the following proportions:

1. *Chrysopa carnea* 87.9 %
2. *Chrysopa phyllochroma* 6.8 %
3. *Chrysopa commata* 5.3 %

The composition of the association on alfalfa is sparse, *Ch. carnea* being the dominant species and often found on alfalfa.

Oligophagous parasites (C_2). This link of the food chain contains a number of parasitic *Hymenoptera* and *Diptera* specialized in the control of definite species belonging to the preceding link of the chain. Among the parasites of the *Syrphidae*, the species are cited from the following families: *Ichneumonidae* (*Diplazontinae*), *Pteromalidae* and *Ceraphronidae*. In the collected material there is a number of the parasites of the *Syrphidae* belonging to *Diplazontinae*, eight of them being dominant species:

1. *Promethes sulcator* 38.7 %
2. *Sussaba pulchella* 24.9 %
3. *Homotrophus signatus* 13.8 %
4. *Diplazon laetatorius* 8.6 %
5. *Syrphophilus bizonarius* 5.5 %
6. *Syrphoctonus biguttatus* 4.1 %
7. *Homothrophus nigritarsus* 1.3 %
8. *Sussaba dorsalis* 1.0 %

The *Pteromalidae* infesting aphidophagous *Syrphidae* are represented by one fairly common species, *Pachyneuron umbratum*, as well as by *Asaphes vulgaris* and *A. suspensus*. Among the *Ceraphronidae*, *Dendrocerus puparum* parasitizes *Syrphidae* larvae.

The parasites of the *Chrysopidae* involve *Hymenoptera* of the families *Pteromalidae*, *Eulophidae*, *Scelionidae* and *Heloridae*. Parasites of the genus *Pachyneuron* (*Pteromalidae*) and *Tetrastichus sempronius* (*Eulophidae*) were recorded.

The *Coccinellidae* are parasitized by *Hymenoptera*: *Pteromalidae*, *Braconidae*, *Encyrtidae* and *Eulophidae*, and also by *Diptera*: *Phoridae* and *Tachinidae* (KLAUSNITZER 1967). In the present inwestigation these parasites are not recorded.

Tertiary predators (C_3). The third link of the food chain includes predators with low food specialization. These are spiders. In alfalfa cultures in Poland this group is represented by 58 species and is characterized by a great species diversity as compared with other groups. Due to their low food specialization spiders prey upon all preceding links of the heterotrophic chain (H, C_1, C_2). Therefore, they may be defined as a system paral ely utilizing preceding links of the chain. The activity of spiders is concerned with two phases of the components of three links. Web spiders prey upon migratory phase because they catch alate insects during migratory flights; they prey on aphids (KAJAK 1965), chrysopids, coccinellids and syrphids as well as on their parasites. Wandering spiders prey upon „productive phase" of the mentioned components of the system; but predation of wandering spiders on aphids is very poorly proved.

The community of the web spiders is composed of seven dominant species, the numbers of which exceed 1 per cent of the total number of individuals collected in this group. These are:

1. *Erigone atra* (*Linyphidae*)	13.47 %
2. *Erigone dentipalpis* (*Linyphidae*)	5.26 %
3. *Singa hamata* (*Araneidae*)	3.27 %
4. *Mangora acalypha* (*Araneidae*)	2.41 %
5. *Theridion sissyphium* (*Theridiidae*)	1.96 %
6. *Aculepeira ceropegia* (*Araneidae*)	1.77 %
7. *Microlynyphia pusilla* (*Linyphidae*)	1.28 %

The proportion of wandering spiders in the community is much higher. The numbers of five species exceeded one per cent of the total. These are:

1. *Pachygnatha degeeri* (*Tetragnathidae*)	28.38 %
2. *Pachygnatha clercki* (*Tetragnathidae*)	16.65 %
3. *Xysticus cristatus* (*Thomisidae*)	11.00 %
4. *Oedothorax apicatus* (*Linyphidae*)	8.31 %
5. *Araeoncus humilis* (*Lincyphidae*)	1.03 %

Both the web and wandering spiders constitute the basic part of the associations contained in the link C_3 and they contribute to 94.79 % of the total number of this group on alfalfa. The remaining 56 species contribute to 5.2 % of the community. These are accessory species that occasionally occur in alfalfa cultures. Their role in forming ecological relations within the community under study is insignificant.

Predatory ants (C_4). The successive link of the chain is composed of ants. Due to the four-year cycle of alfalfa cultivation without ploughing, various

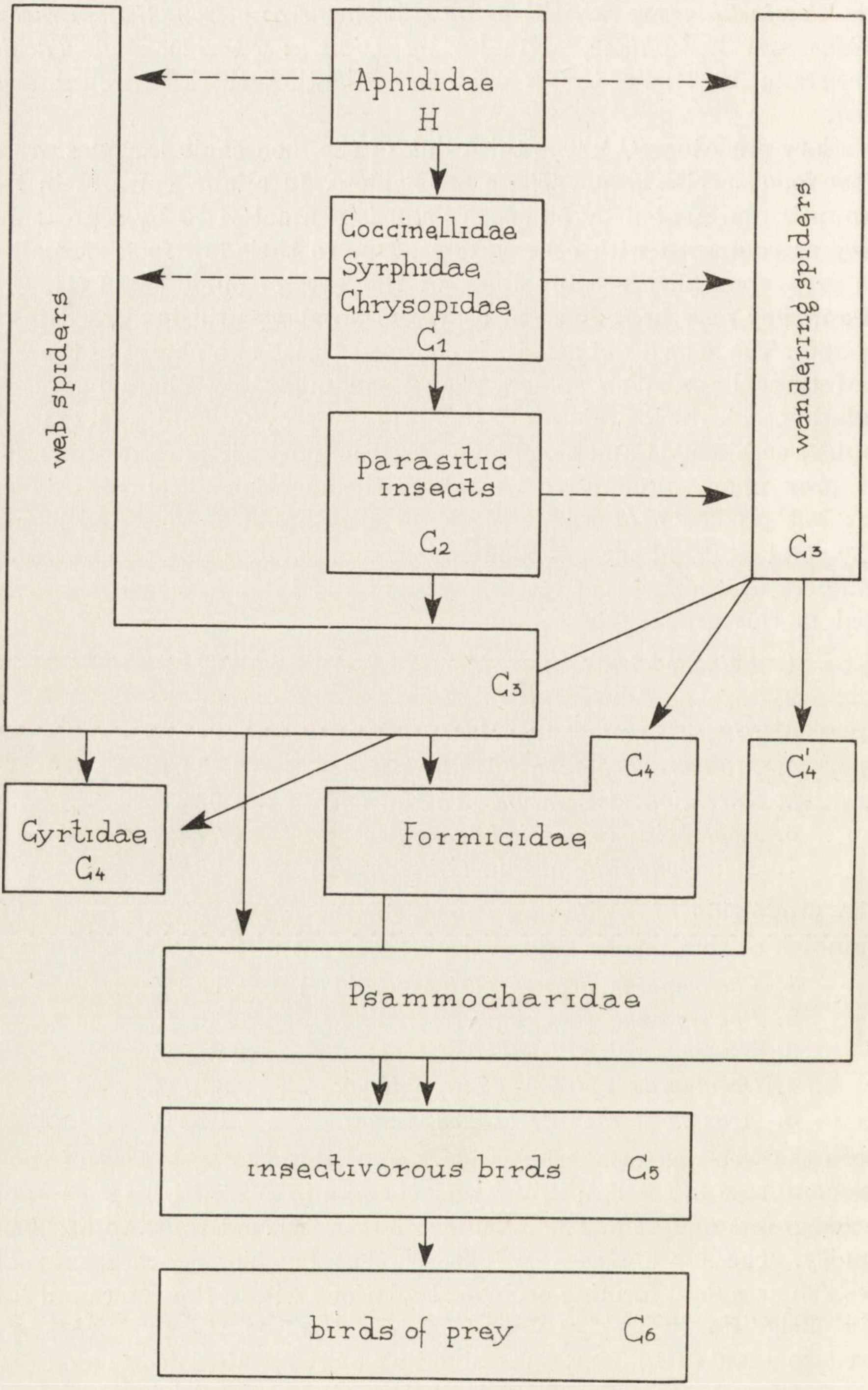

Fig. 8. The structure of the aphid–aphidophage community in a forest ecosystem (for explanations see Fig. 5).

species of ants can not only penetrate but also inhabit alfalfa cultures. The species composition of *Formicidae* on alfalfa in Europe is not exactly known. In Czechoslovakia 9 species were recorded (Štusák 1962). In Hungary 3 species were found (Balogh and Loksa 1956) but this number seems to be understimated. This also seems to be the case in Italy, where 5 species of ants have been found on alfalfa (Giunchi 1952). In Poland the occurrence of six species of ants in alfalfacrops is probable (Pisarski, personal communication). Their species composition and role need further investigations.

In some alfalfa cultures ants are important quantitative components of the biocoenoses. Štusák (1962) has reported that they contribute to 30% of the total number of *Hymenoptera* caught. Their ecological role should be investigated. In grassland ecosystems spiders contribute to 11–38% of the prey of ants (Pętal and Breymeyer 1969). Štusák (1962) indicates that in alfalfa cultures they also prey on aphids.

Aphid–aphidophage community, including its chain of specialized predators, developed in alfalfa crops also occurs in other crops and natural ecosystems. The structure of this community (Fig. 8) indicates that there is a great similarity among the main components (H, C_1, C_2, C_3). In forests, however, higher links are more complex, in particular, link C_4, i.e., that preying on the populations of web and wandering spiders. Besides ants, two components are included there: parasitic flies of the family *Cyrtidae*, the larvae of which develop in the body of spiders, and predatory wasps of the familly *Psammocharidae*, which prey upon spiders and utilize them as food for their larvae. Further links of the food chain in forests are composed of abundant community of insectivorous birds (C_5), and the final link is the community of birds of prey. These final links of the food chain are reduced in alfalfa cultures. *Psammocharidae* and *Cyrtidae* do not occur in this habitat. The role of insectivorous birds in the crops and their actual contribution to the energy flow through this chain are so far difficult to estimate.

3. 2. 4. The chain of oligophagous parasites

So far the trophic structure of the food chain the first link of which consists of specialized endoparasites of aphids is not fully recognized. Two independent factors contribute to this delay as compared with the study on predator food chain: small body size of individuals forming this group, which consequently results in a delay in taxonomic studies, and difficulties in collecting the data on parasitism, as they can only be obtained from the cultures of aphids collected in the field. Hence, the data on this group are incomplete and our opinions are of hypothetical character. This group comprises representatives of five families of parasitic *Hymenoptera*, including two families of primary parasites, and three families of secondary and tertiary parasites.

Primary parasites (C_1) contain the representatives of the families *Aphidiidae* and *Aphelinidae*. The *Aphidiidae* predominate and in the material collected by a sweep-net in the alfalfa cultures at Chylice in 1971 and 1972 they involve 94.7 % of the total number of individuals in C_1. The *Aphelinidae* form only a small part of the group. The contribution of particular species to the total material of the trophic level C_1 is as follows:

Aphidiidae:	1. *Aphidius ervi*	63. 8 %
	1. *Praon barbatum*	19.7 %
	3. *Aphidius urticae*	9.7 %
	4. *Aphidius picipes*	2.5 %
Aphelinidae:	5. *Aphelinus hordei*	2.1 %
	6. *Aphelinus chaonia*	1.0 %
	7. *Aphelinus asychis*	0.6 %
	8. *Aphelinus humilis*	0.2 %
	9. *Aphelinus kurdjumovi*	0.2 %
	10. *Aphelius varipes*	0.2 %

The family *Aphidiidae*, which predominates by number in alfalfa cultures comprises oligophagous species adapted to parasitizing only several species of aphids. These species were obtained by collecting parasitized „mummies" of *Acyrthosiphon pisum*. Three species, *Aphidius avenae*, *A. volucre* and *Toxares deltiger* mentioned as *A. pisum* parasites (Mackauer 1968, Starý, Remaudière and Leclant 1971, Bournoville 1973) were not recorded, although *A. avenae* and *A. volucre* were present in the materials collected with a sweep-net. The *Aphelinidae* contain polyphagous species, the hosts of which are not exactly known as yet. Among six species recorded so far with a sweep-net only one, *Aphelinus asychis*, was mentioned as a parasite of *Acyrthosiphon pisum*. The other species, including two most abundant, *A. hordei* and *A. chaonia*, have not been mentioned as parasites of *A. pisum* (Ferrière 1965, Nikolskaja and Jasnoš 1966). Their occurrence in the alfalfa cultures, food relations with aphids and their role in the control of *A. pisum* need further investigation.

The association of hyperparasites contains three families of *Hymenoptera*. The species controlling the *Aphelinidae* are the less known. According to Specht (1969) the *Aphelinidae* are controlled by the *Pteromalidae*. Pschorn-Walcher (1957) reports that the *Charipidae* are parasites of the species of the genus *Aphelinus*. This information, however, should be supported. The group of parasites of the *Aphidiidae* is more exactly known. Parasitism can be of one- or two-degrees (Fig. 9), so the food chain can also have two or three links. The intermediate link is formed by the *Charipidae* which are represented by five species in the following number proportions:

1. *Alloxysta scutellata*	48.7 %
2. *Charips fracticornis*	42.3 %
3. *Charips victrix*	5.6 %
4. *Alloxysta crassa*	3.3 %
5. *Pezophycta cursor*	0.2 %

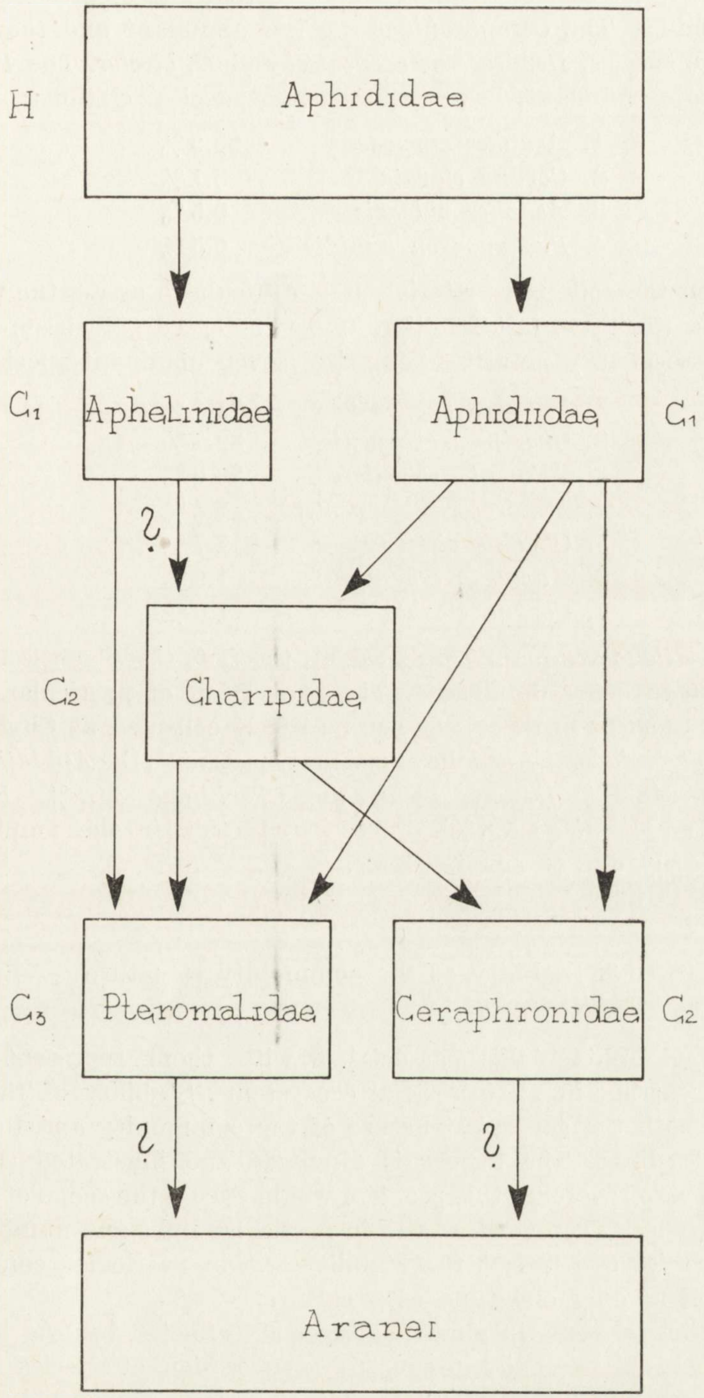

Fig. 9. The schematic representation of the trophic chain with parasitic *Hymenoptera*.

The *Aphidiidae* and *Charipidae* are attacked by the representatives of the two next families. The *Ceraphronidae* are less abundant and they are represented by two species, *Dendrocerus carpenteri* and *D. bicolor*. The *Pteromalidae*, which are more abundant, have the following species relations:

1.	*Asaphes suspensus*	95.9 %
2.	*Coruna clavata*	3.1 %
3.	*Asaphes vulgaris*	0.5 %
4.	*Pachyneuron aphidis*	0.5 %

Basing on the collected materials it is difficult to assess the parasitic relations among the three last families. If a two-degree parasitism is assumed, the group of secondary parasites comprises seven dominant species:

1.	*Asaphes suspensus*	31.4 %
2.	*Charips fracticornis*	30.7 %
3.	*Alloxysta scutellata*	30.0 %
4.	*Dendrocerus carpenteri*	3.4 %
5.	*Charips victrix*	1.7 %
6.	*Alloxysta crassa*	1.0 %
7.	*Coruna clavata*	1.0 %

The *Aphidiidae* are mainly reduced by the first three species, *Charipida-* and *Pteromalidae* being dominants. The proportion of particular families of parasitic *Hymenoptera* in the sweep-net materials collected at Chylice, not ine cluding the *Aphelinidae*, was as follows: primary parasites, the *Aphidiidae*, 51.7 %; hyperparasites 48.3 % (among them the *Charipidae* 30.7 %, *Pteromalidae* 15.8 % and *Ceraphronidae* 1.8 %). Further reduction in the numbers of the group is probably due to small spiders.

3.3. Stability of the community structure

Aphids and aphidophages associated with them represent a typical component occurring in all terrestrial ecosystems. Stability of the structure may refer to both the general structure of the community and the structure of its particular links. The former is discussed and illustrated (Fig. 7–8) in the previous section; solving this problem would excees the scope of the present work. But the species composition within particular links and number relations among the species can reflect the stability within particular components of the association in only one type of a culture.

Interspecific relations in alfalfa cultures are effected by two independent factors. Alfalfa is a perennial plant, so a succession of species is observed for four years (Tischler 1971), the result of which is an enrichment in the species composition. The majority of the species of aphid-aphidophage community occur in a number of ecosystems of the Polish lowland, hence each

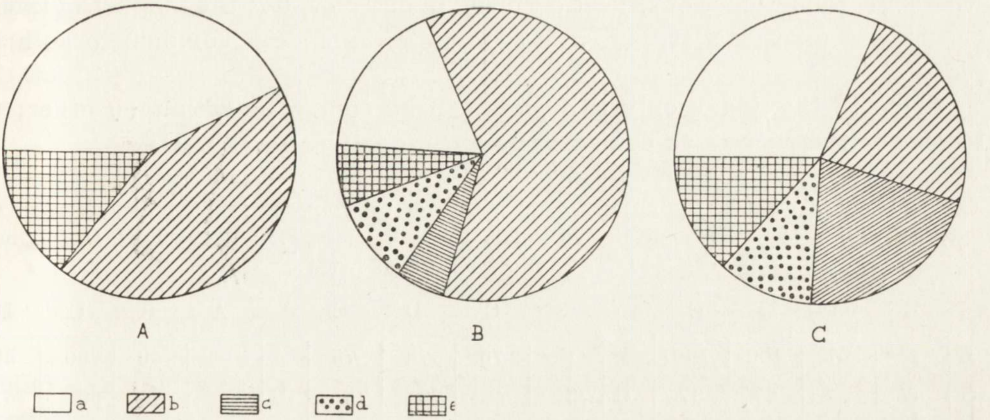

Fig. 10. Percentage contribution of the dominants of the family *Syrphidae* on alfalfa in June 1973 (data from 30 samples from each field). A – Ciecierzyn (alfalfa two-years old), B – Czechów (alfalfa three-years old), C – Chylice (alfalfa four-years old). a – *Melanostoma mellinum*, b – *Sphaerophoria scripta*, c – *Platycheirus clypeatus*, d – *Sphaerophoria taeniata*, e – others (*Syrphus balteatus*, *S. corollae*, *Platycheirus peltatus*, *Syrphus vitripennis*, *Sphaerophoria rueppelli*).

community of the species being formed in alfalfa cultures is subjected to the relations existing in a giving section of landscape.

Process of settling alfalfa by the community of aphidophagous *Syrphidae* is illustrated in Fig. 10. In the first and second years the cultures are inhabited by two dominant species, *Melanostoma mellinum* and *Sphaerophoria scripta* and by a number of accessory species, such as *Syrphus balteatus*, *S. corollae*, *S. vitripennis*, *Platycheirus peltatus* and *Sphaerophoria rueppelli*. They contribute to 15 % of the total community number. In the third year two other species, *Platycheirus clypeatus* and *Sphaerophoria taeniata*, settle and replace the main accessory species; number relations between two dominants and their contribution to the total community are not significantly changed. In the succesive years the development of the community is characterized by an increase in numbers of *Platycheirus clypeatus*, which partly replace one of the dominant species, *Sphaerophoria scripta*. The number relations in the last year of alfalfa growth indicate that the habitat is more diversified, which results in more abundant species composition and more balanced quantitative relations among the species of aphidophagous *Syrphidae*.

Similarity in the species composition. Comparisons were made for three families (*Chrysopidae*, *Coccinellidae* and *Syrphidae*) in the four plots described above, and for parasitic *Hymenoptera* (*Aphidiidae*, *Charipidae* and *Ceraphronidae*) in three fields – Chylice, Czechów and Gołkowice.

To estimate the similarity in the species composition, Marczewski and Steinhaus' index was used:

$$S = \frac{w}{a + b - w}\, 100,$$

where a is the number of species occuring in one plot, b is the number of species occuring in another plot, and w is the number of species common to both the plots.

Due to this index only two plots can be compared with each other; the results of the successive comparisons are presented in Tab. III.

Table III. Similarity in the species composition of *Chrysopidae* (a), *Coccinellidae* (b), and *Syrphidae* (c) in the alfalfa cultures in Poland. A – Ciecierzyn, B – Czechów, C – Łomna, D – Chylice, E – Gołkowice

a

	B	C	D	E
B	–	67	100	100
C	67	–	67	67
D	100	67	–	100
E	100	67	100	–

b

	B	C	D	E
B	–	75	78	75
C	75	–	78	75
D	78	78	–	60
E	75	75	60	–

c

	A	B	C	D
A	–	50	66	55
B	50	–	66	75
C	66	66	–	88
D	55	75	88	–

Among the aphidophagous *Syrphidae* the most similar species composition was found in the five-year alfalfa at Łomna and Chylice (S = 88 %). The crop fields were about 6 ha in area each. The greatest differences in the species composition was found between the three-years old alfalfa at Ciecierzyn and other fields. Only six aphidophagous *Syrphidae* were observed there, and also their number in the samples taken in that field was the lowest. The highest similarity in the species composition of the *Coccinellidae* was observed between the plots at Chylice and Czechów, and also between those at Chylice and Łomna. The species composition of the *Chrysopidae* in all plots was the same (S = 100 %), except at Łomna, where it differed from all other plots.

The highest similarity in the species composition (S) was found for the *Chrysopidae* (from 67 to 100), and its lowest range was found in the *Coccinellidae* (from 60 to 78). The highest diversification of both species composition and similarity was in the *Syrphidae* (from 50 to 88). These data indicate that the species composition of specialized predators is the same in all plots, and as far as the *Coccinellidae* are concerned, the main part of the community, i.e., three-fourth of the species, occur in the majority of the plots. The highest diversification in the species composition was found for the *Syrphidae*; only a half of the species of this group was present in all the plots and formed the bulk if the association. Moving the aphidophage *Syrphidae* to alfalfa cultures depends on the local conditions and the group of accessory species living in this crop is very variable.

Slight differences were found when the index of similarity in species composition was used for comparison of parasitic *Hymenoptera* community: *Aphidiidae*, *Charipidae* and *Ceraphronidae*. The species composition of the primary parasites, *Aphidiidae*, and the hyperparasites, *Ceraphronidae* (when not only sweep-net materials were considered but also those from cultures) in the alfalfa at Chylice, Czechów and Gołkowice was identical (S = 100 %). The species composition of the secondary parasites, *Charipidae*, was not much diversified (Tab. IV).

	B	D	E	F
B	–	80	100	100
D	80	–	100	80
E	80	100	–	80
F	100	80	80	–

Table IV. Similarity in the species composition of secondary parasites, the *Charipidae*, in the alfalfa cultures in Poland. B – Czechów, D – Chylice 1972, E – Gołkowice, F – Chylice 1971

Four species of this group of hyperparasites, namely *Alloxysta scutellata*, *A. crassa*, *Charips fracticornis* and *Ch. victrix* were represented in all three alfalfa fields. Only *Pezophycta cursor* was found exclusively at Chylice in 1971 and in Czechów in 1972. Therefore, it can be assumed that the *Aphidiidae* among the primary parasites and the *Charipidae* with the *Ceraphronidae* among secondary parasites exhibit a very high stability of occurrence in the community of specialized parasites in alfalfa in Poland.

Table V. Similarity in the domination of *Chrysopidae* (a), *Coccinellidae* (b), *Syrphidae* (c), *Aphidiidae* (d), *Charipidae* (e), and *Ceraphronidae* (f) in the alfalfa cultures, estimated by Renkonen's number (Re). A – Ciecierzyn, B – Czechów, C – Łomna, – Chylice 1972, E – Gołkowice, F – Chylice 1971

a

	B	C	D	E
B	–	89	88	86
C	89	–	79	91
D	88	79	–	75
E	86	91	75	–

b

	B	C	D	E
B	–	70	57	79
C	70	–	76	84
D	57	76	–	84
E	79	84	84	–

c

	A	B	C	D
A	–	66	64	64
B	66	–	45	60
C	64	45	–	76
D	64	60	76	–

d

	B	D	E	F
B	–	95	90	72
D	95	–	87	77
E	90	87	–	62
F	72	77	62	–

e

	B	D	E	F
B	–	82	74	74
D	82	–	72	81
E	74	72	–	84
F	74	81	84	–

f

	B	D	E	F
B	–	78	90	88
D	78	–	88	90
E	90	88	–	98
F	88	90	98	–

Similarity in the domination (Tab. V) was determined for three aphidophagous families: *Coccinellidae*, *Syrphidae* and *Chrysopidae*, using the Renkonen's number (Re) (Tab. V a–c). Due to this index the similarity in the quantitative structure of compared communities can be estimated (Balogh

1958). The highest similarity in the domination structure was found for *Chrysopidae* ($91 \geqslant Re \geqslant 75$), in addition, this index has the lowest variability. Great similarity in the domination structure was also found for the *Coccinellidae* ($84 \geqslant Re \geqslant 57$), considerably different quantitave relations being found only between the plots at Chylice and Czechów, while between other plots $Re \geqslant 70\%$. The lowest similarity in domination was found within the aphidophagous *Syrphidae* ($76 \geqslant Re \geqslant 45$). The highest Re values were at Łomna and Chylice and the lowest domination similarity was between the plots at Czechów and Łomna. This is a result of mutual replacing two main dominant species. At Czechów *Sphaerophoria scripta* dominates decidely, while in the other plots *S. scripta* and *Melanostoma mellium* occur in similar numbers or *M. mellium* predominates.

Among oligophagous parasites (Tab. V d–f) the highest domination similarity was found in the species of the family *Ceraphronidae* ($98 \geqslant Re \geqslant 78$) and those of the family *Aphidiidae* ($95 \geqslant Re \geqslant 62$). The lowest values were found in the species of the family *Charipidae* ($84 \geqslant Re \geqslant 72$), the highest variability in this index being found in the *Aphidiidae* and the lowest in the *Charipidae*. Variations in the number structure of the specialized parasites over successive years were insignificant. The domination indices in alfalfa crops in 1971 and 1972 were: $Re = 90$ for the *Ceraphronidae*, $Re = 81$ for the *Charipidae* and $Re = 77$ for the *Aphidiidae*.

Analysis of the dominations similarity indicates that the changes in the numbers of particular species may sometimes occur independently of others. Thus, the stability of the community can be estimated basing on the stability of the species in the crops under study. The technique of quantitative studies elaborated for phytosociological associations is also applied in zoocoenology. KULCZYŃSKI's number (Ku) is used:

$$Ku = \frac{\frac{c}{a} + \frac{c}{b}}{2} 100,$$

where a is the sum of the values of stability indices (C) in the first community, b is the sum of the stability indices in the second community, and c is the sum of the minimum values for the species common in both the communities.

The highest stability of the species composition in the study plots was found for parasitic *Hymenoptera* of the families *Aphidiidae* ($99 \geqslant Ku \geqslant 83$), *Charipidae* ($93 \geqslant Ku \geqslant 75$), and *Ceraphronidae* ($94 \geqslant Ku \geqslant 73$) (Tab. VI d–f).

Among oligophagous predators the *Chrysopidae* and *Syrphidae* exhibited the highest stability ($89 \geqslant Ku \geqslant 70$). The range of the variability of the index Ku and its extremal values were identical for these two families (Tab. VI a–c). Lower but also high stability was found for *Coccinellidae* association ($89 \geqslant Ku \geqslant 69$), the range of the variability index being more limited than in the case of both the families earlier mentioned.

Table VI. Similarity in the stability of the species in the alfalfa cultures, calculated by KULCZYŃSKI'S number (Ku) for *Chrysopidae* (a), *Coccinellidae* (b), *Syrphidae* (c), *Aphidiidae* (d), *Charipidae* (e) and *Ceraphronidae* (f). A – Ciecierzyn, B – Czechów, C – Łomna, D – Chylice 1972, E – Gołkowice, F – Chylice 1971

	B	C	D	E
B	–	70	89	80
C	70	–	74	87
D	89	74	–	70
E	80	87	70	–

a

	B	C	D	E
B	–	76	79	78
C	76	–	69	81
D	79	69	–	79
E	78	81	79	–

b

	A	B	C	D
A	–	75	71	70
B	75	–	81	82
C	71	81	–	89
D	70	82	89	–

c

	B	D	E	F
B	–	99	85	83
D	99	–	91	89
E	85	91	–	93
F	83	89	93	–

d

	B	D	E	F
B	–	82	75	75
D	82	–	93	86
E	75	93	–	90
F	75	86	90	–

e

	B	D	E	F
B	–	75	83	94
D	75	–	75	73
E	83	75	–	78
F	94	73	78	–

f

Analysis of species composition similarity, domination and stability of the three discussed aphidophagous families indicates that stable groups of *Chrysopidae*, *Coccinellidae* and *Syrphidae* species occur there, being enriched in each of the plots by accessory species common in the surrounding areas. Abundance of the community and quantitative relations among the species are different for different plots. The following factors influence the formation of aphidophagous fauna in alfalfa fields:

1. Longevity of the crop – the species composition is enriched over successive years of the crop growth.

Table VII. Comparison of the numbers of aphid-aphidophage community in the alfalfa grown for forage and seeds

Symbol	Trophic level	Number of individuals	
		in alfalfa grown for forage	in alfalfa grown for seeds
H	Aphids	28,633	6,089
C_1	Association of primary predators and parasites	1,695	647
C_2	Secondary predators and parasites	181	87

2. The way of management – there are differences in the fauna between the alfalfa grown for forage and for seeds. There is a pronounced decrease in the number of aphids and further components of the food chain in alfalfa grown for seeds as compared with alfalfa grown for forage (Tab. VII). This is probably a result of lignifying the stems of flowering and maturing alfalfa, which lowers the availability of food for aphids and directly affects their reproduction.

3. Faunistic composition and domination relations in adjacent areas. This problem, which arises from direct comparison of species composition in different crops, needs further inwestigations.

4. PHENOLOGY

Effectiveness of interaction between particular components of the association and aphids depends on the coincidence in their appearing with the number dynamics of aphids. Simultaneous appearence of aphids and aphidophages in potato crops was reported by Wengris (1964) and in beet crops by Jodko-Narkiewicz (1966). Adjusting the aphidophage appearence to aphid appearance mainly depends on the periodicity in aphidophage reproduction because the successive generations of aphids overlap in time. Analysis of phenological data is based on the appearance of dominant species belonging to four aphidophagous families: *Chrysopidae*, *Coccinellidae*, *Syrphidae* and parasitic *Hymenoptera*.

The appearance and number dynamics of *Acyrthosiphon pisum* are very diversified within the area; both the onset of appearance and the periods of peak numbers are variable (the spring peak at Chylice occurs between June 10 and 15, depression is in July 1–5, the autumnal peak in October 5–10; the respective dates at Gołkowice are: June 25–30, July 15–20, September 15–20; at Czechów: June 5–10, July 25–30, September 15–20).

The first generation in aphids appears in Poland at the end of April or at the beginning of May, then follows a rapid increase in numbers. The spring peak of appearance generally occurs at the second half of June (Fig. 11). It happens, however, that an increasing trend is continued till mid-August. During the summer period a rapid decrease in aphid numbers is generally observed, which can last 10–60 days. In the early autumn the second period of number increase begins and the peak is observed in September or early October. A similar two-peak curve of number dynamics occurs in alfalfa grown for both seeds and forage but the total number of aphid population in alfalfa grown for seeds is about five times lower. In all the plots under study two varieties of pea aphid occurred simultaneously: green and red, the former being the dominant and contributing to 86.6 % of the total aphid number at Gołkowice, 97 % at Chylice and 95 % at Czechów.

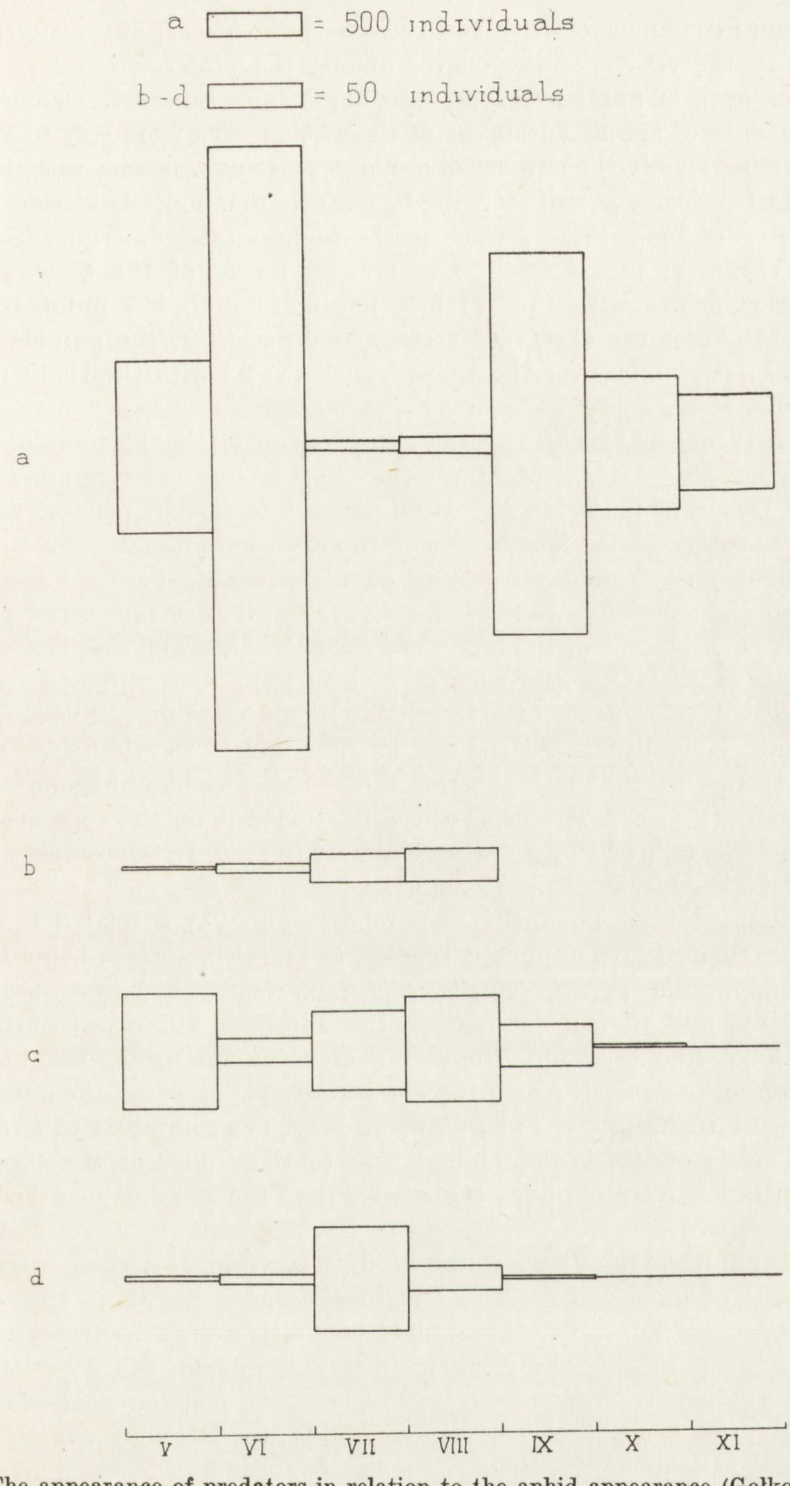

Fig. 11. The appearance of predators in relation to the aphid appearance (Gołkowice 1972). a – *Acyrthosiphon pisum*, b – *Chrysopidae*, c – *Coccinellidae*, d – *Syrphidae*.

Seasonal dynamics of both the varieties is identical; any differences were observed in the course of the curves among the plots.

Appearance of adult predators and oligophagous parasites coincides with the appearance of aphids and involves the whole period from May to November. The spring increase in the number of aphid population coincides with the number peak of the *Coccinellidae* and parasitic *Hymenoptera*, mainly *Aphidiidae* (Fig. 11). The activity of both these groups is the highest after emerging from winter shelters. While the period of the maximum numbers of the *Chrysopidae* and *Syrphidae* coincides with the summer minimum in aphid numbers. Totally different responses are observed in secondary parasites, the number of which is more or less similar over the whole period (V–X) with the slight maximum in August.

The first adult *Syrphidae* were obserwed on alfalfa at the end of April. Under favourable weather conditions they appear in greater numbers in early May. The period of intensive migration extends to mid or even to the end of May. In the spring period females laying the eggs predominate; these are either the individuals that survived winter or those freshly emerged from pupae. Simultaneously a mass reproduction of *Acyrthosiphon pisum* takes place and due to this young larvae of the predatory *Syrphidae* are well supplied with food. Females die after laying the eggs and their number significantly decreases (Fig. 12). The development of the Syrphidae is continued for 3–4 weeks, depending on weather conditions. At the end of June and in the first days of July a mass emergence of the new generation of several aphidophagous *Syrphidae* species occurs (Fig. 13). The peak of the migration is on the turn of July and August and it is followed by a decrease almost to zero. In September and October only single individuals are caught.

The first peak in *Coccinellidae* numbers (Fig. 14) is related to emerging from winter shelters five dominant species, the most important being *Propylaea quatuordecimpuncata* and *Coccinella septempunctata*. This first peak takes place in May, and then a decrease in the number is observed during June, July an August, except for *Propylea quatuordecimpunctata*, the number of which increases in August. Also Ruszkowski (1961a) observed the number peak of this species in alfalfa crops at Puławy in May. Peak numbers of *Hippodamia tredecimpunctata* occurs is September. The total number of the *Coccinellidae* association is less variable over the season that the number of other aphidophagous groups.

The adult *Chrysopidae* were caught in May (Fig. 15); these were the representatives of only one species, *Chrysopa carnea*. In June and July the larvae of *Chrysopa* appeared, the number of which gradually decreased during July and August. In July and August imagines appeared, which left the alfalfa fields in late August. From two remaining species, i.e., *Ch. phyllochroma* and *Ch. commata*, the former occurs in June and July, the latter till August. Neither

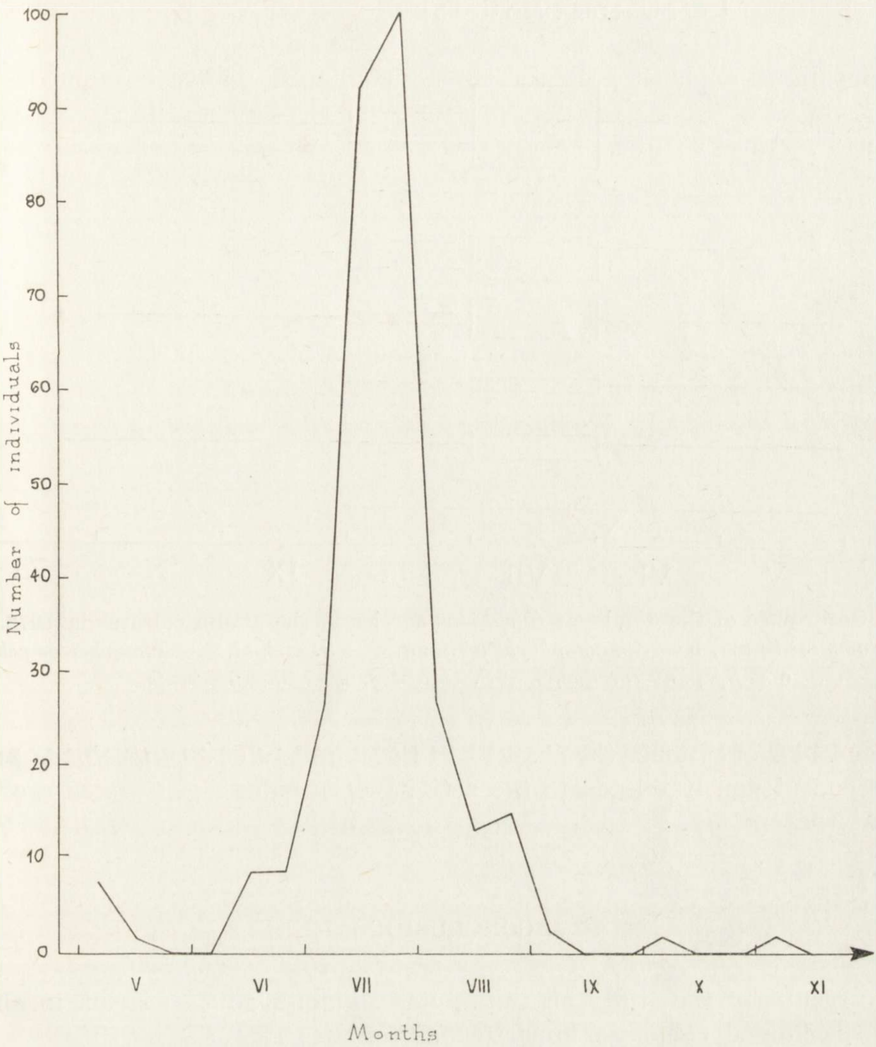

Fig. 12. The dynamics of numbers of *Syrphidae* recorded by the sweep-net (Gołkowice 1972).

of them exhibits variation in numbers and both of them represent rather supplementary component on the alfalfa.

The course of the phenological changes in the aphid-aphidophage community in alfalfa cultures in Poland suggests that the control of aphid population by aphidophages is very effective. The changes in the number of predatory larvae of aphidophages are highly correlated with aphid population dynamics. Phenology of parasitic *Hymenoptera* needs further investigations; it is difficult to draw conclusions basing on the data available so far. On the turn of spring and summer a great damaging potential is directed against the aphids, while in

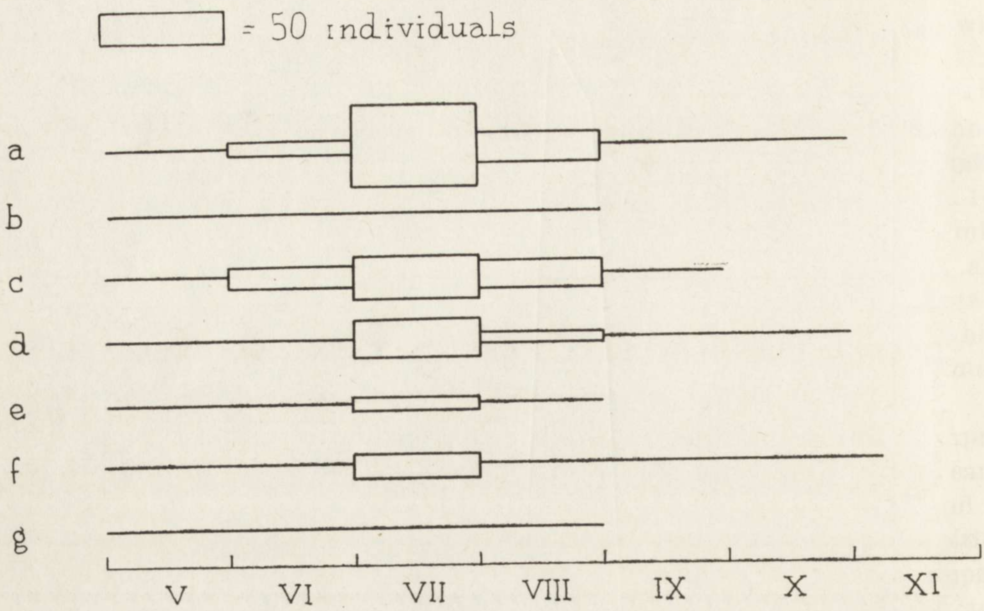

Fig. 13. Occurrence of the dominant *Syrphidae* species in the alfalfa cultures in 1972. a — *Melanostoma mellinum,* b — *Sphaerophoria taeniata,* c — *S. scripta,* d — *Platycheirus peltatus.* e — *Syrphus corollae,* f — *S. balteatus,* g — *S. vitripennis.*

the second half of summer the changes in the numbers of *Acyrthosiphon pisum* are not conspicuously related to the activity of aphidophages, which are very scarce at that period.

5. CONCLUSIONS

The results of the study on the aphid–aphidophage association in alfalfa cultures in Poland can be summarized as follows:

1. The applied quantitative techniques of material collecting, particularly the sweep-net technique and catch per unit time, provide a representative picture of the species composition of the aphid–aphidophage association if series of 15–25 samples, depending on the taxonomic group, are taken.

2. The aphid–aphidophage association consists of five groups of organisms, besides *A. pisum*, reducing aphids: 1. omni- and polyphagous species, 2. polyphagous predators, 3. oligophagous predators, 4. oligophagous parasites, 5. parasitic fungi. All these groups contain 126 species.

3. Three families of the oligophagous predators have the following number of dominant species: *Coccinellidae* — 6, *Syrphidae* — 7 and *Chrysopidae* — 3. The dominant species occur in all the plots and form a stable bulk of the association. Locally the association is enriched in the accessory species the role of which is less important because of their low numbers.

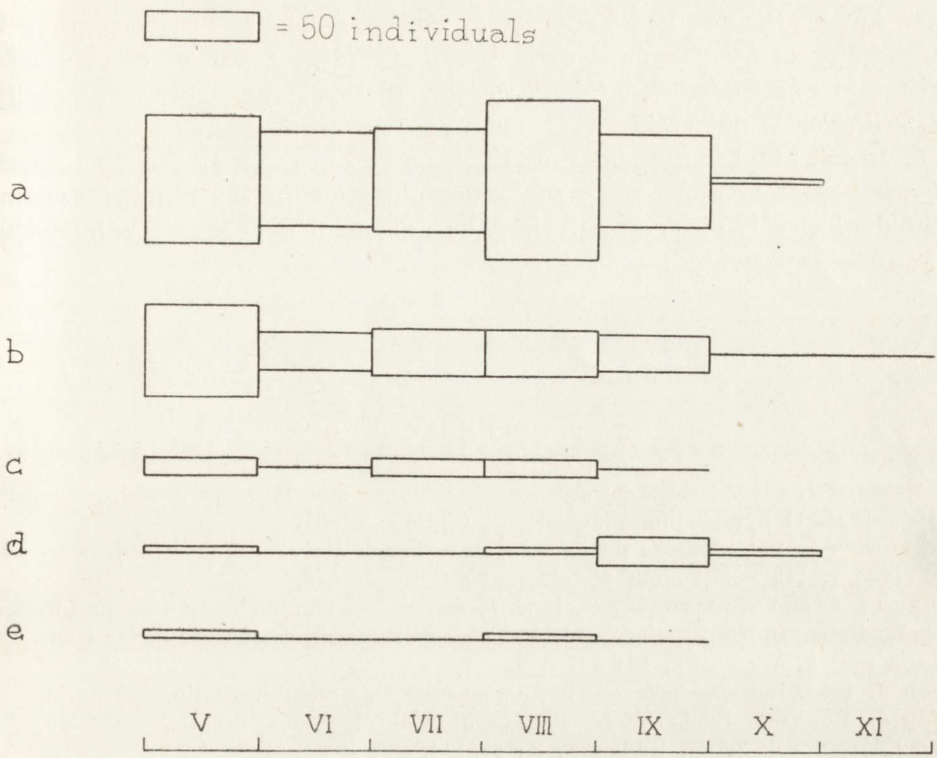

Fig. 14. The occurrence of the dominant *Coccinellidae* species in the alfalfa cultures in 1972. a – *Propylaea quatuordecimpunctata*, b – *Coccinella septempunctata*, c – *Coccinula quatuordecimpunctata*, d – *Hippodamia tredecimpunctata*, e – *Typhaspis sedecimpunctata*.

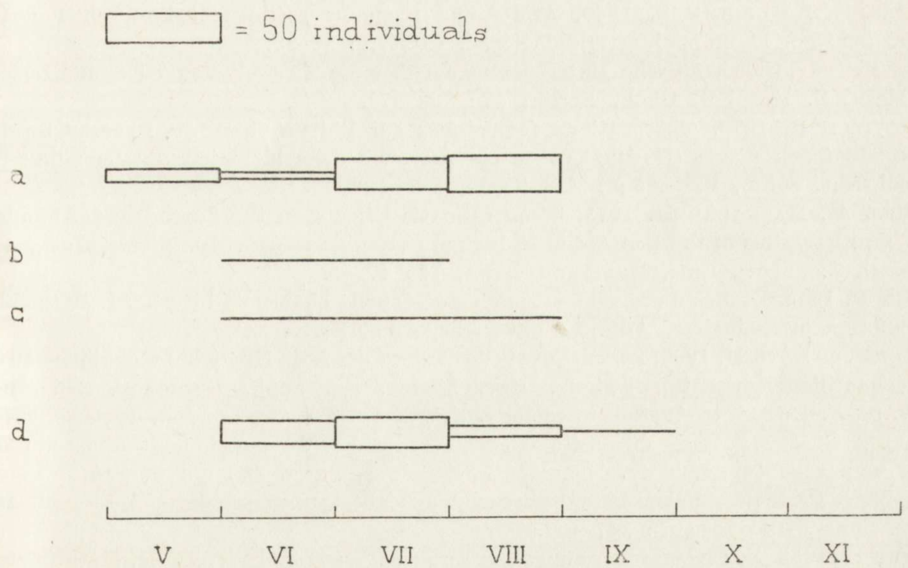

Fig. 15. The occurrence of *Chrysopidae* on the alfalfa in 1972. a – *Chrysopa carnea*, b – *Ch. phyllochroma*, c – *Ch. commata*, d – *Chrysopidae* larvae.

4. Among the primary parasites of the oligophagous predator group the high stability of occurrence is observed in *Aphidiidae*, and among secondary parasites in *Charipidae* and *Ceraphronidae*. Instead, the species composition of *Aphelinidae* is not stable.

5. In the number dynamics of *A. pisum* two peaks were recorded. During the spring–summer appearance the synchronization in the number dynamics of aphidophages is observed. During the autumnal appearance aphidophages are scarcely represented.

6. REFERENCES

Achremowicz J. 1965. Mszyce na uprawnych roślinach motylkowych w woj. poznańskim, 1963–1964. II Sympozjum afidologiczne, Olsztyn: 27–31.

Achremowicz J. 1966. Mszyce na uprawnych roślinach motylkowych w woj. poznańskim w 1965 r. III Sympozjum afidologiczne, Olsztyn: 5–8.

Anasiewicz A. and Warakomska Z. 1969. Occurrence of bumble-bees on alfalfa (*Medicago media* Pers.) in the Province of Lublin and pollen analysis of their pollen loads. Ekologia pol. A, Warszawa, **17**: 587–609.

Balogh J. 1958. Lebensgemeinschaften der Landtiere. Budapest–Berlin, 560 pp.

Balogh J., Loksa J. 1956. Untersuchungen über die Zoozönose des Luzernenfeldes. Acta zool. Acad. Sci. hung., Budapest, **2** : 17–114.

Benedek P. 1968. The flight period of wild bees (*Hymenoptera, Apoidea*) pollinating lucerne, and its plant protection aspects. Acta phytopath. Acad. Sci. hung., Budapest, **3**:59–71.

Berliński K. 1964. Rola gospodarcza i szkodliwość mszyc. Sympozjum afidologiczne, Olsztyn : 5–10.

Berliński K., Huculak S. 1965. Afidofauna zespołów roślin motylkowych Pojezierza Mazurskiego. II Smpozjum afidologiczne, Olsztyn : 33–38.

Boness M. 1958. Biocoenotische Untersuchungen über die Tierwelt von Klee- und Luzernefeldern. Z. Morphol. Ökol., Berlin, **47** : 309–373.

Bournoville R. 1973. Observations écologiques sur l'hivernation du Puceron du Pois, *Acyrthosiphon pisum* (Harris) et de ses parasites dans la région de Versailles. Ann. Zool.-Ent. anim., Paris, **5** : 13–28.

Campbell A., Mackauer M. 1973. Some Climatic Effects on the Spread and Abundance of Two Parasites of the Pea Aphid in British Columbia (*Hym., Aphidiidae, Hom., Aphididae*). Z. angew. Ent., Hamburg–Berlin, **74** : 47–55.

Chauvin R. 1952. Études d'ecologie entomologique sur la champ de luzerne. I. Méthodes – Sondages préliminaires. Ann. Épipht., Paris, **3** : 61–81.

Chauvin R. et Roth M. 1966. Les récipients de couler (pièges de Moericke) technique nouvelle d'échantillonnage entomologique. Rev. Zool. agric. appl., Bordeaux, **2–6** : 78–81.

Colinvaux P. 1973. Introduction to ecology. New York, Sydney, London, Toronto, 621 pp.

Couturier G. 1973. Étude éthologique et bioceonotique du peuplement d'insectes dans un verger «naturel». Trav. Document. ORSTOM, Paris, **22** : pp. 96+15.

Deseö K. V. 1961. Biozönologische Untersuchungen auf Luzernenfeldern. Acta zool. Acad. Sci. hung., Budapest, **7** : 367–400.

Deubert K. 1958. Zur Nematodenfauna der Luzerne. Wiss. Z. Univ. Halle, Math. Naturw. Reihe, Halle, **7** : 463–464.

ELTON Ch. 1927. Animal Ecology. London, 207 pp.

FERRIÈRE Ch. 1965. *Hymenoptera Aphelinidae* d'Europe et du bassin Méditerranéen. Faune de l'Europe et du bassin Méditerranéen, Paris, 1, 206 pp.

GAŁECKA B. 1964. Efektywność drapieżców w redukcji mszyc ziemniaczanych w różnych fazach dynamiki liczebności mszyc. Biul. Inst. Ochr. Rośl., Poznań, **26**: 90–104.

GAŁECKA B. 1966. The role of predators in the reduction of two species of potato aphids, *Aphis nasturtii* KALT. and *A. frangulae* KALT. Ekologia pol. A, Warszawa, **14** : 245–274.

GIUNCHI P. 1952. Contributi alla conoscenza dell'Entomofauna dell'Erba Medica I. Boll. (Ist.) Lab. Ent., Bologna, **19** : 1–30.

GROMADZKA J., TROJAN P. 1967. Comparison of the usefulness of an entomological net, photoeclector and biocenometer for investigation of entomocenoses. Ekologia pol. A, Warszawa, **15** : 505–529.

HODEK I. 1966. Ecology of Aphidophagous Insects. Praque, 360 pp.

HOZÁK A. 1970. The pea aphid *Acyrthosiphon pisum* (HARRIS), and its parasites on alfalfa in Czechoslovakia (*Hym.*, *Aphidiidae*, *Hom.*, *Aphidoidea*). Acta Univ. Carolinae, Biologica, Praha, **5/1968**: 371–415.

JASIEŃSKA-OBRĘBSKA E. 1964. Występowanie mszyc na lucernie w świetle badań własnych. Biul. Inst. Ochr. Rośl., Poznań, **26** : 35–48.

JELINOWSKA A. 1970. Wieloletnie rośliny motylkowe pastewne. W opracowaniu zbiorowym: „Uprawa roślin", Warszawa PWRiL, pp. 468–547.

JODKO-NARKIEWICZ J. 1966. Dynamika rozwoju populacji mszycy burakowej (*Aphis fabae* SCOP.) i drapieżców z rodziny *Coccinellidae* na plantacjach buraczanych. Ekologia pol. B, Warszawa, **12** : 165–167.

JUCHNOWICZ I., ROMANKOW W. 1958. Wyniki badań nad biologią i znaczeniem gospodarczym paciornicy lucernianki *Contarinia medicaginis* KIEFF. (*Diptera*, *Cecidomyidae*). Pol. Pismo ent., Wrocław, **28** : 35–58.

KAJAK A. 1965. An analysis of food relations between the spiders *Araneus cornutus* CLERCK and *Araneus quadratus* CLERK — and their prey in meadows. Ekologia pol. A, Warszawa **13** : 717–764.

KIEDA F. 1963. Rozwój uprawy lucerny w Polsce. Nowe Rolnictwo, Warszawa, **12** : 18–19, 30–32.

KLAUSNITZER B. 1967. Beobachtungen an Coccinellidenparasiten (*Hymenoptera*, *Diptera*). Ent. Abh. staat. Mus. Tierk. Dresden, **32** : 305–309.

KONDRACKI J. 1969. Podstawy regionalizacji fizycznogeograficznej. Warszawa PWN, 154 pp.

DE LONG D. M. 1932. Some problems encountered in the estimation of insects population by the sweeping method. Ann. ent. Soc. America, Columbia, Miss., **25** : 13–17.

MACKAUER M. 1968. Die Aphidiiden (*Hymenoptera*) Finnlands. Fauna fenn., Helsinki, **22**: 40 pp.

MODZELEWSKA-JELINOWSKA A. 1959. Studia nad możliwością podniesienia plonów nasion lucerny w warunkach Polski. Rocz. Nauk. roln. A, Warszawa, **80** : 281–348.

MÓCZÁR L. 1959. The activity of the wild bees (*Hym.*, *Apoidea*) in hungarian lucerne fields. Acta agron. Acad. Sci. hung., Budapest, **9** : 237–289.

MÓCZÁR L. 1961. The distribution of wild bees in the lucerne fields of hungary. Ann. hist.-nat. Mus. hung. (Pars Zool.), Budapest, **53** : 451–461.

MRÓZ S. 1958. Przyczyny braku nasion motylkowych drobnoziarnistych i sposoby zaradzenia temu zjawisku. Post. Nauk roln., Warszawa **4** : 129–138.

MÜLLER H. 1957. Leguminosenknöllchen als Nahrungsquelle heimischer *Micropezidae*-(*Tylidae*-) Larven. Beitr. Ent., Berlin, **7** : 247–262.

NIKOLSKAJA M. N., JASNOŠ V. A. 1966. *Aphelinidae* evropejskoj časti SSSR i Kavkaza (*Chalcidoidea, Aphelinidae*). Opredel. po Faune SSSR, Moskva–Leningrad, 91 : 294 pp.

Nowicki A. 1966. Porównanie efektywności uprawy różnych roślin pastewnych na tle ogólnokrajowego zapotrzebowania pasz białkowych. Rocz. Nauk roln. A, Warszawa, **91** : 593–607.

Obrtel R. 1968. *Carabidae* and *Staphylinidae* occurring on soil surface in lucerne fields (*Coleoptera*). Acta ent. bohemoslov., Praha, **65** : 5–20.

Obrtel R. 1969. The insect fauna of the herbage stratum of lucerne fields in southern Moravia (Czechoslovakia). Acta Sci. nat., Brno, **3** : 1–49.

Odum E. P. 1969. Ekologia. Warszawa, PWN, 217 pp.

Oettingen H. v. 1952. Die thysanopterenfauna des Harzes. IV. Thysanopteren der Kulturflächen. Beitr. Ent., Berlin, **2** : 586–604.

Opyrchałowa J. 1957. *Phytonomus variabilis* Herbst (*Coleoptera, Curculionidae*) comme insecte nuisible à la luzerne en Silésie. Pol. Pismo ent., Wrocław, **26** : 331–365.

Paesler F. 1956. Nematoden der Rhizosphaere welkekranker Luzernepflanzen. Nachrichtenbl. Dt. Pflanzenschutzd. N. F., Berlin, **10** : 108–111.

Petrusewicz K., Macfadyen A. 1970. Productivity of terrestrial animals. Principles and methods. Oxford and Edinburgh (IBP, Handbooks no 13.): 186 pp.

Pętal J., Breymeyer A. 1968. Reduction of Wandering Spiders by Ants in a Stellario-Deschampsietum Meadow. Bull. Acad. pol. Sci. Cl. II, Varsovie, **17** : 239–244.

Philipson J. 1969. Energetyka ekologiczna. Warszawa, PWN, 83 pp.

Piekarczyk K., Węgorek W. 1965. Integrated Control of pea Aphid on alfalfa. Symposia CSAV, Praha, p. 327.

Plebański T. 1970. Uprawy i użytkowanie lucerny. Warszawa, PWRiL, Wyd. II, 176 pp.

Ponikiewski A. 1958. Uprawa lucerny na nasiona z punktu widzenia opłacalności. Post. Nauk. roln., Warszawa, **6** : 89–102.

Pruszyński S., Lipa J. J. 1971. The occurrence of predatory *Coccinellidae* on alfalfa crops. Ekologia pol. Warszawa, **19** : 365–386.

Pschorn-Walcher H. 1957. Probleme der Wirtswahl parasitischen Insecten. (Ber.) 8. Wandersamml. dtsch. Ent., Berlin, 11. Tagungsberichte : 79–85.

Remaudière G., Iperti G., Leclant F., Lyon J. P. et Michel M. F. 1973. Biologie et écologie des Aphides et de leurs ennemis naturels application a la lutte intégrée en vergers. Entomophaga, mémoire hors série nr 6, Paris, 35 pp.

Richards O. W. 1926. Studies on the ecology of English heaths. J. Ecol., Cambridge, **14**: 244–281.

Romankow W. 1955. Ozdobnik lucernowiec (*Adelphocoris lineolatus* Goeze) i zmieniki (*Lygus* spp.), (*Heteroptera, Miridae*) jako szkodniki lucerny nasiennej. Pol. Pismo ent., Wrocław, **24**, suppl. 1., pp. 19–22.

Romankow W. 1959a. Wyniki obserwacji nad składem gatunkowym zmieników (*Lygus* spp., *Heteroptera, Miridae*) występujących na polach lucerny na Dolnym Śląsku. Biul. Inst. Ochr. Rośl., Poznań, 4 : 25–34.

Romankow W. 1959 b. Wyniki badań nad biologią ozdobnika lucernowca — *Adelphocoris lineolatus* Goeze (*Heteroptera, Miridae*) z uwzględnieniem niektórych momentów z jego ekologii. Pol. Pismo ent., Wrocław, **29** : 55–105.

Romankow W. 1960. Przegląd szkodliwej fauny owadów występujących na roślinach motylkowych pastewnych w Polsce. Pol. Pismo ent., B, Wrocław, **1–2** (17–18) : 41–51.

Romankow W. 1963. Szkodliwa entomofauna lucerny w Polsce. Pr. Nauk. Inst. Ochr. Rośl., Warszawa, **5** : 89–208.

Roth M. et Couturier G. 1966. Les plateaux colorés en écologie entomologique. Ann. Soc. ent. France (N. S.), Paris, **2** : 361–370.

Ruszkowski A. 1961a. Obserwacje nad występowaniem biedronkowatych. (*Coccinellidae*). Pol. Pismo ent., B, Wrocław, 1–2 (21–22) : 57–69.

Ruszkowski A. 1961b. Trzmiele a problem podwyższenia plonów lucerny nasiennej. Pol. Pismo ent., B, Wrocław, **1–2** (21–22) : 91–94.

Saugstad E. S., Bram R. A., Nyquist W. E. 1967. Factors influencing Sweep-Net Sampling of Alfalfa. J. econ. Ent., Menasha, Wisc., **60** : 421–426.

Schliephake G. 1961. Beiträge zur Biologie der Thysanopteren der Luzerne (*Medicago sativa* L.) Beitr. Ent., Berlin, **11** : 576–593.

Specht H. B. 1969. Hyperparasitism of the Pea Aphid Parasite *Aphelinus semiflavus* by *Asaphes vulgaris* in a Greenhouse. Ann. ent. Soc. America, Baltimore Md, **62** : 1207.

Stacherska B. 1965. Kilka obserwacji nad biologią mszycy grochowianki *Acyrthosiphon pisum* Harris. II Sympozjum afidologiczne, Olsztyn : 21–31.

Starý P. 1968a. Population dynamics of alfalfa pest aphids (*Hom.*, *Aphidoidea*) in Czechoslovakia. Boll. Lab. Ent. Portici, Napoli, **26** : 217–292.

Starý P. 1968b. Impact of an indigenous parasite, *Aphidius ervi* Hal. on pea aphid, *Acyrthosiphon pisum* (Harris) populations on alfalfa in Czechoslovakia. Boll. Lab. Ent. Portici., Napoli, **26** : 293–313.

Starý P. 1969a. Role of superparasitism in field populations of a pea aphid parasite, *Aphidius ervi* Haliday in Central Europe – *Hymenoptera*: *Aphidiidae*; *Homoptera*: *Aphididae*. Boll. Lab. Ent. Portici, Napoli, **27** : 177–186.

Starý P. 1969b. Density dependence in field populations of *Aphidius ervi* Hal., a parasite of the pea aphid, *Acyrthosiphon pisum* (Harris) in Czechoslovakia (*Hym.*, *Aphidiidae*; *Hom.*, *Aphididae*). Boll. Lab. Ent. Portici, Napoli, **27** : 219–252.

Starý P. 1969c. Multilateral control approach pea aphid (*Acyrthosiphon pisum* Harris) pest problem. Ann. Soc. ent. France (N. S.). Paris, **5** : 669–679.

Starý P. 1970. Biology of aphid parasites (*Hym.*, *Aphidiidae*) with respect to integrated control. Series entomologica, **6**, the Hague, 643 pp.

Starý P. 1971a. Migration and Parasitization as Factors of Population Regulation of the pea Aphid *Acyrthosiphon pisum* (Harris) in Alfalfa Fields in Central Europe. Acta ent. bohemoslov., Praha, **68** : 353–364.

Starý P. 1971b. Alternative hosts of *Aphidius smithi*, an introduced parasite of the pea aphid in central Europe (*Hom. Aphididae*; *Hym. Aphidiidae*). Ann. Soc. ent. France (N. S.),Paris, **8** : 351–355.

Starý P. 1972. Host range of parasites and ecosystem relations, a new viewpoint in multilateral control concept (*Hom.*, *Aphididae, Hym.*, *Aphidiidae*). Ann. Soc. ent. France (N. S.), Paris, **8** : 351–358.

Starý P., Remaudière G., Leclant F. 1971. Les *Aphidiidae* (*Hym.*) de France et leurs hôtes (*Hom. Aphididae*). Entomophaga, Paris, **5** : 1–72.

Strawiński K. 1964. Zoophagism of terrestrial *Hemiptera–Heteroptera* occurring in Poland. Ekologia pol. A, Warszawa, **12** : 429–452.

Štusák J. M. 1962. Entomofauna Vojtěškoveho pole na Karlštejnsku. Rozpr. Česk. Akad. Véd, Praha, **72** : 3–76.

Szelęgiewicz H. 1967. Materiały do fauny mszyc (*Homoptera, Aphidodea*) Polski. II. Fragm. faun., Warszawa, **14** : 45–91.

Szelęgiewicz H. 1968. Mszyce, *Aphidoidea*. Katalog Fauny Polski, Warszawa, cz. 21, z. 4.

Tarwid K. 1952. Próba charakterystyki zespołu komarów Puszczy Kampinoskiej. Stud. Soc. Sci. tor., E, Toruń, **3** : 1–29.

Thoizon G. 1970. Spécificité du parasitisme des Aphides par les Entomophthorales. Ann. Soc. ent. France (N. S.), Paris, **6** : 517–562.

Tischler W. 1949. Grundzüge der Terrestrischen Tierökologie. Braunschweig, 220 pp.

Tischler W. 1971. Agroekologia. Warszawa, PWRiL, 488 pp.

Trojan P. 1968. Egg reduction of the Colorado Beetle (*Leptinotarsa decemlineata* Say) as a hunger–dependent reaction. Ekologia pol. A, Warszawa, **16** : 171–183.

Trojan P. 1974. Zagadnienie homeostazy ekosystemów. Zesz. probl. Post. Nauk roln., Warszawa, **155** : 39–51

Wengris J. 1964. Z badań nad wrogami naturalnymi mszyc. Sympozjum afidologiczne, Olsztyn : 21–30.

Wengris J. 1968. Wrogowie naturalni mszyc: drapieżce i pasożyty. W: Kurs afidologii ogólnej. Warszawa, Kraków, Wrocław: 129–151.

Węgorek W. 1968. Specjalizacja pokarmowa mszycy grochowej (*Acyrthosiphon pisum* Harris). Pr. Nauk. Inst. Ochr. Rośl., Warszawa, **10** : 53–60.

Węgorek W., Czaplicki E. 1969. Z badań nad odpornością lucerny na żer mszycy grochowej (*Acyrthosiphon pisum* Harris). Pr. Nauk. Inst. Ochr. Rośl., Warszawa, **11** : 7–20.

Węgorek W., Grela T. 1968. Przenoszenie chorób wirusowych pastewnych roślin motylkowych przez mszyce. Pr. Nauk. Inst. Ochr. Rośl., Warszawa, **10** : 29–51.

Węgorek W., Hejna E. 1968. Badania nad występowaniem i biologicznym zróżnicowaniem ras zielonej i czerwonej mszycy grochowej (*Acyrthosiphon pisum* Harris). Pr. Nauk. Inst. Ochr. Rośl., Warszawa, **10** : 61–75.

Węgorek W., Ruszkiewicz M. 1968. Z badań nad fauną mszyc motylkowych roślin pastewnych. Pr. Nauk. Inst. Ochr. Rośl., Warszawa, **10** : 7–27.

Wiąckowski S. 1961. Studia nad biologią i ekologią błonkówki *Aphidius smithi* Sharma et Subba Rao (*Hym. Braconidae*) pasożyta mszycy grochowej — *Acyrthosiphon pisum* (Harr.) (*Hom. Aphididae*). Warszawa, 73 pp.

Wiąckowski S. K., Wiąckowska I. 1961. Wstępne próby introdukcji i aklimatyzacji obcych afidofagów w Polsce. Zesz. probl. Post. Nauk roln., Warszawa, **35** : 211–218.

Zelený J. 1965. Lace-Wings (*Neuroptera*) in Cultural Steppe and the Population Dynamics in the species *Chrysopa carnea* Steph. and *Chrysopa phyllochroma* Wesm. Acta ent. bohemoslov., Praha, **62** : 177–194.

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STRESZCZENIE

[Tytuł: Kompleks faunistyczny mszyce–afidofagi na uprawach lucerny w Polsce. I. Struktura i fenologia kompleksu].

W pracy podjęto próbę ustalenia modelu struktury układów ekologicznych w kompleksie gatunków mszyce–afidofagi na lucernie w oparciu o koncepcję sieci troficznej (rys. 5). Lucerna jest w tym modelu producentem (P), mszyca grochowa *Acyrthosiphon pisum* — roślinożercą (H). Następnym ogniwem są konsumenci pierwszego stopnia (C_1). Zaliczamy tu gatunki zwierząt bezpośrednio lub pośrednio związane z mszycami jako bazą pokarmową (rys. 6, 7). W obrębie członu (C_2) łańcucha pokarmowego mamy pasożyty wyspecjalizowane w redukcji określonych gatunków należących do poprzedniego ogniwa łańcucha (C_1) (rys. 7). Kolejnym komponentem są drapieżniki (C_3) o małej specjalizacji pokarmowej, reprezentowane zarówno przez pająki sieciowe, jak i wędrujące. Dalszym ogniwem łańcucha są drapieżne mrówki (C_4) redukujące między innymi pająki. Zarówno pająki (C_3) jak i mrówki (C_4) ze względu na małą specjalizację pokarmową równolegle eksploatują wszystkie poprzedzające ogniwa heterotrofów (H, C_1, C_2).

Bardzo skomplikowane są stosunki panujące w łańcuchu pasożytów wyspecjalizowanych. W skład kompleksu wchodzą przedstawiciele pięciu rodzin błonkówek, z czego *Aphidiidae* i *Aphelinidae* są pasożytami I stopnia, *Charipidae* II, a *Pteromalidae* i *Ceraphronidae* II i III stopnia (rys. 9). Rozpoznanie struktury troficznej w obrębie tego zespołu błonkówek jest jeszcze bardzo niepełne i ma charakter hipotetyczny.

W dalszej części pracy skoncentrowano się na kwestii stałości struktury kompleksu mszyce–afidofagi na polach lucerny. Ustalono skład gatunkowy w obrębie poszczególnych ogniw oraz stosunki ilościowe zachodzące między poszczególnymi gatunkami. Przeprowadzono analizę podobieństwa składu gatunkowego, dominacji oraz stałości gatunków opierając się na wzorach Marczewskiego i Steinhausa (S), Renkonena (Re) i Kulczyńskiego (Ku). Ustalono, że na lucernie w Polsce występują stałe kompleksy gatunków afidofagicznych z takich grup owadów jak *Chrysopidae*, *Syrphidae* i *Coccinellidae*. Ponadto występują jeszcze gatunki akcesoryczne, których obecność jest uwarunkowana składem gatunkowym i stosunkami strukturalnymi zachodzącymi w najbliższym otoczeniu badanego pola. Fauna lucerny znajduje się pod silną presją stosunków panujących w danym obszarze strefy krajobrazowej.

Na strukturę fauny badanego kompleksu oddziałuje także sposób uprawy lucerny. Wyraźnie widać zmniejszenie się liczebności fauny przy uprawie lucerny nasiennej (tab. VII). Również wiek uprawy odgrywa poważną rolę: w pierwszym roku zaznacza się wyraźna sukcesja gatunków i stopniowe wzbogacanie fauny w kolejnych latach (rys. 10).

Należy zaznaczyć, że struktura zbadanego kompleksu mszyce–afidofagi odnosi się tylko do pól lucerny uprawianej na terenie Polski, już na południu Europy w Italii czy na Węgrzech zmienia się skład gatunkowy, w mniejszym jednak zakresie struktura kompleksu. Wchodzą tu gatunki pontyjskie lub śródziemnomorskie – charakterystyczne dla kompleksów faunistycznych południowej Europy.

Badania skoncentrowane były tylko na jednym gatunku mszycy – *Acyrthosiphon pisum*. Drugi gatunek – *Therioaphis trifolii* był poławiany na badanych polach lucerny sporadycznie, w pojedynczych egzemplarzach jedynie w Gołkowicach i Chylicach. *A. pisum* występuje na wszystkich badanych polach w postaci dwu ras – zielonej i czerwonej. Rasa zielona jest wyraźnym dominantem i stanowi 86,5–97 % w stosunku do rasy czerwonej. Dynamika sezonowa występowania obu ras jest identyczna na wszystkich badanych polach.

Pojaw drapieżców i pasożytów wyspecjalizowanych pokrywa się w czasie z pojawem mszyc i obejmuje cały okres maja do listopada. Dynamika sezonowa liczebności mszyc przedstawia się w formie dwuszczytowej krzywej, której maksimum przypada na czerwiec i wrzesień. W ciągu lipca i sierpnia następuje gwałtowny spadek liczebności (rys. 11). Przyczyny tego zjawiska nie są dokładnie poznane. Dużą rolę odgrywa tu zapewne redukcja spowodowana przez kompleks afidofagów, ale prawdopodobnie i warunki termiczne wpływając na mechanizm biologiczny mszyc powodują ten regres.

Zwraca uwagę także fakt, że liczebność afidofagów, a tym samym ich udział w redukcji mszyc jest dużo większy podczas wiosennego ich pojawu, niż na jesieni.

РЕЗЮМЕ

[Заглавие: Фаунистический комплекс тли–афидофаги культуры люцерны в Польше. I. Структура и фенология комплекса]

В работе предпринята попытка установления модели экологических взаимосвязей в сообществе тли–афидофаги люцерны на основании концепции пищевой сети (рис. 5). В этой модели люцерна является производителем (P), гороховая тля, *Acyrthosiphon pisum* — фитофагом (H). Следующее звено составляют организмы первого трофического уровня (C_1). К ним относятся виды животных, для которых тли служат непосредственно или посредственно как кормовая база (рис. 6 и 7). В пределах следующего трофического уровня цепи питания (C_2) находятся паразиты, которые специализировались в редукции определенных видов, принадлежащих к предыдущему звену (C_1) цепи питания (рис. 7). Очередным звеном являются хищники (C_3), представленные пауками, тенетными и бродячими, слабо специалазированные с точки зрения их питания. Дальнейшее звено (C_4) составляют хищные муравьи, ограничивающие также и количество пауков. Поскольку и пауки (C_3), и муравьи (C_4) обладают малой избирательностью по отношению к пище, они используют все предыдущие звенья гетеротрофов (H, C_1, C_2) одновременно.

Очень сложные отношения наблюдаются в звене специфических паразитов. В состав сообщества входят предствители 5 семейств перепончатокрылых, из которых *Aphidiidae* и *Aphelinidae* являются паразитами I степени, *Charipidae* — II, а *Pteromalidae* и *Ceraphronidae* — II и III степени (рис. 9). Трофическая структура группы перепонгатокрылых изучена еще очень недостаточно и носит гипотетический характер.

В следующим разделе внимание концентрируется на вопросе постоянства структуры сообщества тли–афидофаги на полях люцерны. Установлен видовой состав в пределах отдельных звеньев и количественные отношения отдельных видов. Произведен анализ сходства видового состава, доминирования и постоянства видов по формулам Марчевского и Штайнхауза (S), Ренконена (Re) и Кульчинского (Ku). Установлено, что в Польше встречаются на люцерне постоянные ассоциации видов-афидофагов, принадлежащих к таким семействам насекомых, как *Chrysopidae*, *Syrphidae* и *Coccinellidae*. Кроме них встречаются еще также виды акцессорные, присутствие которых обусловлено видовым составом и структуральными соотношениями, господствующими в ближайшем окружении исследуемого

поля. Фауна люцерны находится под сильным воздействием условий, характерных для данного ландшафта.

Фаунистическая структура исследуемого сообщества зависит также от способа возделывания люцерны. При возделывании семенной люцерны происходит четкое снижение численности фауны (табл. 7). Имеет значение также возраст культуры: на первом году обозначается четкая сукцессия видов и постепенное обогащение фауны в последующие годы (рис. 10).

Следует отметить, что описанная структура исследуемого сообщества тли–афидофаги относится только к культуре люцерны на территории Польши. На юге Европы — в Италии или в Венгрии, его видовой состав изменяется за счет понтических или средиземноморских видов, характерных для фаунистических комплексов южной Европы. Структура же сообщества изменяется в меньшей степени.

Исследования были сосредоточены только на одном виде тли — *Acyrthosiphon pisum*; второй вид — *Therioaphis trifolii*, встречался на исследованных полях люцерны спорадически — единичные его экземпляры были найдены только в Голковицах и Хылицах. *A. pisum* встречается на всех исследованных полях в виде 2 рас — зеленой и красной. Раса зеленая доминирует, составляя 86,5–97% по отношению к расе красной. Динамика встречаемости обеих рас на протяжении сезона на всех исследованных полях одинакова.

Появление хищников и специфических паразитов приурочено ко времени появления тлей и встречаются они так, как и тли, на протяжении всего периода от мая до ноября. Сезонная динамика численности тлей представляет собою двувершинную кривую, вершины которой приходятся на июнь и сентябрь. На протяжении июля и августа происходит резкое падение их численности (рис 11). Причины этого явления изучены недостаточно. Большую роль играет, по всей вероятности, редукция, вызванная видами-афидофагами. Температурные условия могут, по-видимому, также оказывать влияние на биологический механизм тлей, вызывая этот регресс.

Численность афидофагов, а этим самым и их участие в редукции тлей, гораздо больше в период их весеннего появления чем осенью.

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