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# TIBOR JERMY, FOUNDER OF RESEARCHES IN AGRO-ECOSYSTEMS IN HUNGARY*

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Late summer in 1975, an enthusiastic group of specialists, led by Dr. TIBOR JERMY, member of the Hungarian Academy of Sciences, visited the sand-dunes of the Nyírség region. The specialists worked at the Research Institute for Plant Protection of the Hungarian Academy of Sciences (HAS), the Plant Protection and Agrochemistry Centre of the Ministry of Agriculture and Food, the Plant Protection and Agrochemistry Station of county Szabolcs-Szatmár, the Újfehértó Experimental Station of the Research and Development Institute for Fruit Growing and Ornamentals, the Training Farm of the College of Agriculture at Nyíregyháza. Their objective was to find apple orchards of various sizes and with different production practices which would allow them to make regular and reliable detections as well as multiple studies meeting the requirements of agro-ecosystem researches for at least 10 years.

Following the survey in the Nyírség region, we selected 4 areas of different types in this apple growing district: small plots untreated for several years (0.2 ha), treated home gardens (0.5 ha), conventional commercial orchards (5 ha) and intensive large-scale apple fields (100 ha). In addition, there was the 5.8 ha apple orchard in the vicinity of a woodland, belonging to the Research Institute for Plant Protection of the HAS in county Pest: it was split into a treated and an untreated part.

Similar survey preceded the selection of fields in the maize growing area of Mezőföld where researches on maize grown in monoculture and in crop rotation could start thanks to the leaders of the Agricultural Holding of Agárd and the Cooperative Farm of Kápolnásnyék. Of course, these surveys and selection of areas were preceded by several activities, the most important being that Dr. JERMY had reacted, with good sense and in due time, to the challenges of the era. He knew that a thorough ecological study of the agricultural areas was needed and justified, because, on the one hand, over 70% of the country was under agricultural cultivation and, on the other hand, the ecological effects of the new methods used in agricultural production were not known at all. We had not studied and understood the ef-

* As a sign of respect, by a short presentation of results, collaborators of the agro-ecosystem projects greet TIBOR JERMY on the occasion of his 85th birthday.

fects, on the communities of the agricultural areas, of new management programmes (i.e., monocultural production on large growing areas, intensive nutrition, mechanisation, chemical pest control, etc.) of the production systems introduced and operated in compliance with the social and economic philosophy of the period, however such knowledge and information were necessary to work out, then to apply the new production methods which seemed to be optimal both economically and environmentally.

TIBOR JERMY not only recognised that no modern agricultural production could exist without the exhaustive knowledge of conditions prevailing in the agro-ecosystems, but he also convinced the professional public of its necessity and importance. Following his proposal, the Committee on Zoology and the Committee on Plant Protection of the HAS initiated an overall ecological exploration of the agro-ecosystems of the two major crops grown in Hungary, i.e., winter apple and maize. The programme coordinated by the Research Institute for Plant Protection was completed between 1976 and 1985, financed by the Central Research Funds of the HAS.

He personally worded the most important objectives of the programme stating that people could only make use of the essential elements of the ecosystem for the purpose of modern agriculture if they knew well the conditions of the landscape altered by human interventions. For this, the structure, the species composition (if possible) of the agro-ecosystems, the system of relationship among the pest populations and the conditions of population dynamics had to be explored. Furthermore, the mechanisms regulating the agricultural areas, the ecological problems of changes in the sector and the possibilities of sustainability had to be studied.

It was clear at the very beginning of the programme that a close working cooperation among specialists of biology, zoology, taxonomy, plant protection, botany, ecology and plant production had to be established for several years. Following the convincing arguments by TIBOR JERMY, several institutions, research groups and specialists of the country joined the programme and participated in its effective implementation.

In order to completely explore the living associations of agricultural areas, several methods for investigation and collection were used: light traps, suction traps, soil traps, yellow plates, sexual pheromone traps, traps for arthropods walking on the twigs and trunks, mash traps, gleaning, beating, sweep-netting, individual plant inspecting, mite brushing, placing out nesting boxes for birds, fixing corrugated cardboards on trunks, and extracting specimens from the gathered materials by various means. Catches were removed daily (light traps) and weekly, while the various surveys were made weekly or biweekly from April to the end of October.

The results of this research confirmed that a much higher number of animal species lived on the agricultural area than it had ever been imagined. It was found that the agricultural areas in Hungary and even the plantations under intensive cultivation do not belong to the notion of "cultural desert".

As many as 1759 animal species were identified in the apple plantations, twice as much as OATMAN identified on the apple growing areas of the USA in 1964. The number of species living in apple orchards decreased with increase in the intensity of crop production and plant protection, although the number was nevertheless very significant (467 species) on the more intensively cultivated areas. A similar trend was found in the density of pest species with density being highest in the untreated scattered areas and gradually decreasing with increase in the size of the area and the intensity of the cultivation. On the contrary, some insects (e.g., leaf miners) reached their highest population density under the most intensive cultivation, but the number of the pest species then significantly decreased.

The presence of 582 species was detected in maize fields. It was found that no great difference existed in either the number of species or the population density between maize plants grown in monoculture or in crop rotation. The monoculture induced neither reduction in the fauna nor great increase of the insect population inhibiting plant production. The observations and the studied relationship are of great importance, because no similar work had ever been done before.

On the basis of these studies it was concluded that the establishment of and changes in the composition of species in the agro-ecosystems were primarily influenced by human activity, more precisely by the impact of the plant protection programmes and other methods used in the plantations. The effects of weather and environmental conditions were only secondary. We demonstrated that only a small proportion of the species (2.1–4.4%) living in a particular area consisted of harmful organisms. On the other hand, the density of potential pests was much higher, capable even of being 25% of the identified fauna. The typical annual agricultural crops (field crops) and their vicinity were much poorer than the more diversified biotopes of the several-decade-old apple orchards and their environment. Under more natural conditions with minor direct influence of the human factors, the weather, the environment and the natural elements (parasitoids, predators) were the most significant population regulating factors.

It was confirmed at the same time that large populations of several species of beneficial insects prevailed on the agricultural areas, even in the regions with intensive cultivation. The possibilities offered by them were recognised in the very first years of research. We started to investigate the host-parasitoid relationship (leaf rollers, leaf miners, chalcidoid wasps, braconid wasps, etc.), the host-predator relationship (spider mites – predatory mites, aphids – lacewings, *Stethorus* species, syrphids, etc.) and the role of parasitoids in the population dynamics of the pests. Relative equilibrium established under natural conditions (e.g., in patchily distributed untreated apple plantations). There was a greater balance in the number of phytophagous and zoophagous species. But, the characteristic of areas with intensive cultivation was that certain pest species were completely eliminated (e.g., leaf rollers with one generation), or reduced to an insignificant density (e.g., codling moth, San José scale), while other species had an increased population density (e.g., leaf miners). In these situations, the increase in the population density of a particular pest might create advantageous conditions for the increase of the parasitoids to such an extent that they became an important factor in regulating the population. Thus, a relative balance was created and maintained until a new harmful effect was generated for the ecosystem.

We found in our investigations that the aerial zooplanktons, being independent of the production conditions, had a great role in both populating the agricultural areas and establishing the insect associations. Chemical treatments focusing on the fields or the plantations had no or only slight effect on this aerial fauna, and therefore the original situation is rapidly recreated following the chemical interventions. This introduction and establishment increased the diversity of species on the area and had advantageous impact on the biocenosis as only certain elements of the species were harmful. These facts confirmed the opinion that the agro-ecosystems and the natural ones had close relationship with each other.

We studied the relationship between the agro-ecosystems and the natural ecosystems. The role of the environment was equally very important for ruderal, woodland ecosystems and in orchard ecosystems. It was noticed that the spatial establishment of the pests and their parasitoids originated in the more diverse environment. The direction of their introduction was, therefore, not constant, depending mostly on the position and vicinity of the plantations. That of the leaf miners was of one direction and spreading, while that of the leaf rollers was patchy. Their parasitoids showed a "follower" distribution.

We concluded that the harmful effects of human interventions might still be reversed on the agricultural areas. The best examples were taken from the beneficial insects. If the unfavourable effect on the area ceased to exist, the ecosystem was capable of replenishing itself from the populations present in the air or in the environment. To achieve this, we had to maintain the diversity of species in the spatial, ruderal areas, in the woodlands and other areas. With this in mind, we worked out a pest management programme for leaf miners which protected the parasitoids. The method was widely used in practice.

In the investigations of the plant communities in the orchards, we had the opportunity to study the effects of pesticide rotation on plantations with IPM and conventional management or under no-treatment, no-cultivation scheme.

It was found that the established good host-parasitoid relationship was disturbed on the area previously under IPM scheme if no pest control regime had been applied. In the first year of the change the relatively small parasitoid population was not able to regulate the increasing pest population, in the same way. We called therefore the attention to the fact that the disadvantages of even one growing season could destroy the advantageous impacts of the IPM practices implemented for leaf miners during four years.

Results of the agro-ecosystem research were published in at least 180 articles (the most important ones are cited), over 100 of which is in a foreign language. We lectured several times both in Hungary and abroad. Records were published in the book by BALÁZS, K. & MÉSZÁROS, Z. (eds) (1989) *Biological control with natural enemies* (Mezőgazdasági Kiadó, Budapest), also in volumes 1–6 of the manual by JERMY, T. & BALÁZS, K. (eds) (1988–1996) *Plant protection entomology* (Akadémiai Kiadó, Budapest) and in the book by JENSER, G., MÉSZÁROS, Z. & SÁRINGER, GY. (eds) (1998) *Pests of field and horticultural crops* (Mezőgazda Kiadó, Budapest).

The agro-ecosystem research resulted in several academic and scientific degrees and allowed us to participate in several national (National Council for Research Development, Hungarian Scientific Research Fund, National Committee for Technical Development) and international projects (German–Hungarian Intergovernmental Cooperation, US–Hungarian Cooperation).

I think that now all of us having participated in the agro-ecosystem research started in 1976 recall, with pleasure, the joint field work made weekly, several times in extremely hot weather or in heavy rain, or even the processing of huge mass of data with calculator and, later, with computer and mainly the obtained results, the successes at domestic and international conferences and the reactions to the articles and publications. We were also pleased to see that the domestic fruit production rapidly implemented our results in practice.

The experience obtained in the agro-ecosystem research, the knowledge of the regularities determining the agro-ecosystems turned our interests to the integrated, environmentally friendly pest management and to the integrated fruit production. The mechanisms prevailing in the agro-ecosystems, the exploration of host-parasitoid and host-predator relationships resulted in the establishment of pest management programmes safe for the parasitoids and predators. Since it has also been confirmed that our early statements are still valid and that the natural regularities determining the mechanisms of the agro-ecosystems are almost independent of the production systems.

Results of the agro-ecosystem research have contributed to establishing the integrated pest management in apples and the integrated apple production. The information obtained was used to develop the integrated fruit production for sour cherry and small fruits.

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## MAJOR PUBLICATIONS CONCERNING AGRO-ECOSYSTEM RESEARCHES IN THE ORDER OF YEARS OF APPEARANCE (1977–)

JERMY, T. (1977) On certain aspects of the Hungarian agro-ecosystem researches. *MTA Biol. Oszt. Közl.* **20**: 447–458. [in Hungarian]

NAGY, B. (1977) Presence and use of natural food sources of the codling moth (Laspeyresia pomonella L.) in Hungary. *Coll. Int. CNRS, Comportement des insectes et milieu trophique* **265:** 211–215.

JERMY, T., NAGY, B., SZALAY-MARZSÓ, L., REICHART, G. & KOZÁR, F. (1978) Studies on the codling moth (Laspeyresia pomonella L.) and other apple pests in Hungary with regard to the possibilities of including the sterile insect technique into an integrated control scheme. *Mitteil. Biol. Bundesanst.Land Forstwirtsch.*, Berlin-Dahlem, **180**: 9–11. and *XVII. Növényvéd. Tud. Ért., MAE.* **1**: 103–107. [in Hungarian]

JERMY, T., BALÁZS, K., KOZÁR, F., MAHUNKA, S., MÉSZÁROS, Z., SZARUKÁN, I., SZENTKIRÁLYI, F., SZIRÁKI, I. & VARGA, I. (1979) Szravnyityelnaja ocenka szoobsesztv cslenisztonogih v intenszivnüh i eksztenszivnüh proizvodsztvennüh, priuszagyebnüh i nye vozgyelüvaemüh plantacijah jablonyi. *Verh., SIEEC VII.* Leningrad, 82–87. [in Russian]

BALÁZS, K., KOZÁR, F. & MIHÁLYI, K. (1978) Comparison of the moth (Microlepidoptera) and scale insect (Coccoidea) populations of apple orchards under large-scale and garden conditions. *Állatt. Közl.* **65**: 31–37. [in Hungarian]

MÉSZÁROS, Z. (1978) Comparison of the moth fauna of apple orchards under large-scale and garden conditions. *Állatt. Közl.* **65**: 99–102. [in Hungarian]

KOZÁR, F., SZALAY-MARZSÓ, L., MESZLENY, A., LŐVEI, G. & SZABÓ, S. (1979) Data to the population dynamics and host susceptibility of apple woolly aphid, Eriosoma lanigerum Hausm. (Homoptera: Aphidoidea). *Növényvédelem* **15**: 545–549. [in Hungarian]

MESZLENY, A. & SZALAY-MARZSÓ, L. (1979) Data on aphids (Homoptera, Aphidina) in apple orchard with particular emphasis on their flight dynamics and natural control factors. *Acta Phytopathol. Acad. Sci. Hung.* **14**: 465–479

MÉSZÁROS, Z. & BALÁZS, K. (1980) Einfluss des Waldes als Umwelt auf die Macrolepidopterenfauna einer Apfelanlage. *Acta Musei Reginaehradecensis S.A. Supplementum*, Hradec Kralove, pp. 226–228.

SOLYMOSI, P. (1980) Epiphyton lichens in agricultural ecosystems. *Növényvédelem* **16**: 465–469. [in Hungarian]

LŐVEI, G. L. (1981) Coccinellid community in an apple orchard bordering a deciduous forest. *Acta Phytopathol. Acad. Sci. Hung.* **16**: 143–150.

MESZLENY, A., SZALAY-MARZSÓ, L. & JENSER, G. (1981) Mass collection of aphids with suction traps in 1978. *Állatt. Közl.* **68**: 97–104. [in Hungarian]

BALÁZS, K. (1981) Vredonosznoszty Lithocolletis blancardella F. v jablonyevüh naszazsgyenijah (Harmfulness of Lithocolletis blancardella F. in apple orchards) *Dokl. IOBC/EPS*, Kisinyev, 31–41. [in Russian]

MESZLENY, A., SZALAY-MARZSÓ, L. & JENSER, G. (1981) Observations on aphid flight in Hungarian orchards in 1978–79. *Acta Phytopathol. Acad. Sci. Hung.* **16**: 443–445.

MESZLENY, A. & SZALAY-MARZSÓ, L. (1981) Occurence of Myzus ascalonicus Donc. and other aphids new for the Hungarian fauna. *Növényvédelem* **17**: 45–46. [in Hungarian]

MÉSZÁROS, Z. & RONKAY, L. (1981) A comparative study on the Macrolepidoptera fauna of apple orchards in Hungary. *Acta Phytopathol. Acad. Sci. Hung.* **16**: 375–387.

MÉSZÁROS, Z. (1981) Data to the knowledge of the natural foodplants of lepidopterous larvae with special regard to the apple. *Fol. Entomol. Hung.* **41**: 139–143.

SZABÓ, S. & SZENTKIRÁLYI, F. (1981) Communities of Chrysopidae and Hemerobiidae (Neuroptera) in some apple-orchards. *Acta Phytopathol. Acad. Sci. Hung.* **16**: 157–169.

MESZLENY, A. (1981) Virus vector aphids of orchards. *C. Sc. Thesis*, Budapest, 131 pp. [in Hungarian]

MESZLENY, A. (1981) Study of flight activity of virus vector aphid species (Homoptera, Aphidoidea) in orchards. *Növényvédelem* **17**: 376–386. [in Hungarian]

RÁCZ, V. (1981) O poluzsesztkokrülüh jablonyevüh naszazsgyenyii Vengrii. *Dokl. Symp. IOBC/EPS*, Poznan, pp. 13–20. [in Russian]

BALÁZS, K. (1982) Pricsinü razmnozsenijá L. blancardella F. v jáblonevüh naszazsdeniját sz intenszivnümi himicseszkimi obrabotkami. *Dokl. Symp. IOBC/EPS*, Poznan, pp. 9–18. [in Russian]

KOZÁR, F. & WALTER, B. (1982) A new risk: apple psyllid. *Kert. és Sző́l.* **31**: 6. [in Hungarian]

NAGY, B. (1982) Bibliography on Ostrinia nubilalis Hbn. in Hungary 1975–1980. *IWGO Newsletter* **3**: 30–32.

NAGY, L. & SZENTKIRÁLYI, F. (1982) Occurence and significance of the common earwing (Forficula auricularia L.: Orthopteroidea, Dermaptera) in different apple orchards. *Növényvédelem* **18**: 394–401. [in Hungarian]

RADWAN, Z. & LŐVEI, G. L. (1982) Distribution and bionomics of ladybird beetles (Col., Coccinellidae) living in an apple orchards near Budapest, Hungary. *Z. ang. Entomol.* **94**: 169–175.

RADWAN, Z. & LŐVEI, G. L. (1982) Records of Coccinellid parasites from apple orchards and corn fields. *Acta Phytopathol. Acad. Sci. Hung.* **17**: 111–113.

RÁCZ, V. (1982) Blijanie peszticidov na populjacii poluzsesztkokrülüh vidov, obitajusih v razlicsnüh tipah jablonyevüh naszazsgyenyii Vengrii. *Dokl. Symp. KNTSz*, Poznan, pp. 41–53.

TÖRÖK, J. (1982) Feeding ecology of tit and thrush species at some suburban locations. *M.Sc. Thesis*. 151 pp. [in Hungarian]

BALÁZS, K. (1983) The role of parasites of leaf miners in the integrated control system for apple. *In* DARVAS, B. *et al.* (eds) *Int. Plant. Prot. Grapevine, Fruit, Crops and Forests* **2**: 26–33.

BALÁZS, K. (1983) Leucoptera scitella Z. in apple orchards. *Növényvédelem* **19**: 305–306. [in Hungarian]

BALÁZS, K., PAPP, J. & SZELÉNYI, G. (1983) Über die Parasiten der Microlepidopterenfauna des Apfels in Ungarn. *Verh. SIEEC X*, Budapest, pp. 146–149.

KÁDÁR, F. & SZENTKIRÁLYI, F. (1983) Comparative investigation of ground beetles (Coleoptera, Carabidae) by light trapping in maize monocultures. *Kukoricanemesítési és Termesztési Ifj. Konf.*, Szeged, pp. 50–53. [in Hungarian]

KÁDÁR, F. & SZENTKIRÁLYI, F. (1983) Analyse der Lichfallenfänge der Laufkäfer (Col., Carabidae) in verschiedenen Apfelanlagen und Maisbestanden. *Verh. SIEEC. X*, Budapest, pp. 150–154.

KOZÁR, F., ÁDÁM, L., BALÁZS, K., M. BENEDEK, I., CSIKAI, CS., D. DRASKOVITS, Á., MESZLENY, A., MÉSZÁROS, Z., MIHÁLYI, K., NAGY, L., PAPP, J., POLGÁR, L., RADWAN, Z., RÁCZ, V., RONKAY, L., SOÓS, Á., SZABÓ, S., SZABÓKY, CS., SZALAY-MARZSÓ, L., SZARUKÁN, I., SZELÉNYI, G., SZENTKIRÁLYI, F., SZIRÁKI, GY. & TÖRÖK, J. (1983) Changes in the number of animal species in apple and maize stands grown under different conditions. *Növényvédelem* **19**: 385–391. [in Hungarian]

RÁCZ, V. (1983) Populations of predatory Heteroptera in apple orchards under different types of management. *Proc. P. Int. Conf. Integr. Plant. Prot.* **2**: 34–39.

RÁCZ, V. (1983) Faunistical characteristics of Heteroptera in some Hungarian agrocenoses. *Verh. SIEEC X*, Budapest, pp. 133–136.

RÁCZ, V., SZENTKIRÁLYI, F., VISNYOVSZKY, É. & RADWAN, Z. (1983) Aphidophagous populations based on maize aphids. *Proc. Int. Conf. Integr. Plant Prot.* **4**: 70–76.

SZENTKIRÁLYI, F. (1983) Communities of green and brown lacewings (Neuropteroidea, Planipennia: Chrysopidae, Hemerobiidae) in various apple orchards. *Proc. Int. Conf. Integr. Plant Prot*. **1**: 76.

SZENTKIRÁLYI, F. (1983) Community structure and seasonal dynamics of predatory lacewings (Neuropteroidea: Chrysopidae, Hemerobiidae) in different corn production systems. *Kukoricanemesítési és Termesztési Ifj. Konf.*, Szeged, pp. 50–53. [in Hungarian]

SZENTKIRÁLYI, F. & TÖRÖK, J. (1983) Neuropteroids in the diet of birds. *Állat. Közl.* **70**: 83–90. [in Hungarian]

VISNYOVSZKY, É. (1983) Data to the syrphid-fauna of on apple orchard near Budapest, Hungary. *Verh. SIEEC X*, Budapest, pp. 140–142.

BALÁZS, K. (1984) Parasitization of Lithocolletis blancardella F. in apple stands of different management types. *Növényvédelem* **20**: 9–16. [in Hungarian]

KÁDÁR, F. & SZENTKIRÁLYI, F. (1984) Analyse der Lichtfallenfänge der Laufkäfer (Col., Carabidae) in verschiedenen Apfelanlagen und Maisbeständen. *Verh. SIEEC X*, Budapest, pp. 150–154.

LŐVEI, G. L. & SZENTKIRÁLYI, F. (1984) Carabids climbing maize plants. *Z. ang. Entomol.* **97**: 107–110.

NAGY, B. (1984) On some aspects of the investigations of the maize ecosystem in Hungary, with special respect to the European corn borer. *Vedecké Prácé* **14**: 51–54.

NAGY, B. (1984) Sixty years of the entomoparasite complex of the European corn borer in Hungary. *Proc. XIII. Workshop IWGO/IOBC*, Colmar, pp. 95–100.

MÉSZÁROS, Z. (ed.), ÁDÁM, L., BALÁZS, K., M. BENEDEK, I., CSIKAI, CS., D. DRASKOVITS., Á., KOZÁR, F., LŐVEI, G., MAHUNKA, S., MESZLENY, A., MIHÁLYI, F., MIHÁLYI, K., NAGY, L., OLÁH, B., PAPP, J., PAPP, L., POLGÁR, L., RADWAN, Z., RÁCZ, V., RONKAY, L., SOLYMOSI, P., SOÓS, Á., SZABÓ, S., SZABÓKY, CS., SZALAY-MARZSÓ, L., SZARUKÁN, I., SZELÉNYI, G., SZENTKIRÁLYI, F., SZIRÁKI, GY., SZŐKE, L. & TÖRÖK, J. (1984) Results of faunistical and floristical studies in Hungarian apple orchards. *Acta Phytopathol. Acad. Sci. Hung.* **18**: 91–176.

MÉSZÁROS, Z. (ed.), ÁDÁM, L., BALÁZS, K., M. BENEDEK, I., D. DRASKOVITS., Á., KOZÁR, F., LŐVEI, G., MAHUNKA, S., MESZLENY, A., MIHÁLYI, K., NAGY, L., PAPP, J., PAPP, L., POLGÁR, L., RÁCZ, V., RONKAY, L., SOÓS, Á., SZABÓ, S., SZABÓKY, CS., SZALAY-MARZSÓ,

L., SZARUKÁN, I., SZELÉNYI, G. & SZENTKIRÁLYI, F. (1984) Results of faunistical studies in Hungarian maize stands. *Acta Phytopathol. Acad. Sci. Hung.* **19**: 65–90.

BALÁZS, K. (1984) Vlijányie intenszifikacii popujácii Mikrolepidoptera v jáblonyevüh naszazsgyenyiják. *Proc. Comecom Symp. Bucuresti*, pp. 23–30. [In Russian]

BALÁZS, K. (1985) Change in the apple ecosystem of the composition of Microlepidoptera species. *Növényvédelem* **21**: 214–215. [in Hungarian]

NAGY, B. (1985) Changes in the host-plant spectrum of the corn borer and consequences in this population ecology. *Növényvédelem* **21**: 264. [in Hungarian]

RÁCZ, V. (1985) Occurrence, population dynamics and identification of Trigonotylus Fieb. species (Heteroptera: Miridae) in Hungarian agro-ecosystems. *Növényvédelem* **21**: 64–70. [in Hungarian]

RÁCZ, V. & VISNYOVSZKY, É. (1985) Changes in the abundance of aphidophagous Heteroptera and syrphids occurring in maize stands of different management types. *Acta Phytopathol. Acad. Sci. Hung.* **20**: 193–200.

BALÁZS, K. (1986) Die Parasitierungsverhältnisse der Microlepidopteren-Arten in verschiedenen Apfelanlagen von Ungarn. *IOBC–WPRS Bulletin* **9**: 85–89.

KOZÁR F., BALÁZS K. & RÁCZ V. (1986) Plant protection of the future. *Magyar Tudomány* 1986/3: 196–203. [in Hungarian]

RÁCZ, V. (1986) Study of Heteroptera in maize stands. *Növényvédelem* **22**: 21–26. [in Hungarian]

RÁCZ, V. (1986) The role of predator bugs (Heteroptera) in decreasing the abundance of harmful lepidopterous larvae in apple plantations. *IOBC/WPRS Bulletin* **9**: 79–84.

RÁCZ, V. (1986) Composition of Heteropteren populations in Hungary in apple orchards belonging to different management on the population densities. *Acta Phytopathol. Entomol. Hung.* **21**: 355–361.

RÁCZ, V., SZENTKIRÁLYI, F. & VISNYOVSZKY, É. (1986) Study of aphid-aphidophage connections in maize stands. Pp. 317–322. *In* HODEK, I. (ed.) *Ecology of Aphidophaga*. Academia, Prague & Dr. W. Junk Publ., Dordrecht.

SZENTKIRÁLYI, F. (1986) Niche segregation between chrysopid and hemerobiid subguilds. Pp. 297–302. *In* HODEK, I. (ed) *Ecology of Aphidophaga*. Academia, Prague & Dr. W. Junk Publ., Dordrecht.

BALÁZS, K. (1987) Rol parazitov razlicsnüh vidov mikrolepidoptera v jáblonevüh naszazsdeniják. *Dokl. IOBC-EPS*, Moscow, pp. 158–171. [in Russian]

KÁDÁR, F. & LŐVEI, G.L. (1987) Flight activity of some carabid beetles abundant in light traps in Hungary. (Proc. 6th European Carabidologists Meeting.) *Acta Phytopathol. Entomol. Hung.* **22**: 383–389.

KOZÁR, F. (1987) Vlijányije intenszifihacii proizvodsztva na biocenoz jáblonyi. *Dokl. Symp. IOBC/EPS*, Moscow, pp. 158–171. [In Russian]

KOZÁR, F. (1987) Effect of intensity of management on biocenose of apple. *In Integrirovannaja szisztema zascsitë rasztenij v sztranah cslenah VPSZ MOBB*, Moscow, (1983), pp. 144–155.

RÁCZ, V., SZENTKIRÁLYI, F. & VISNYOVSZKY, É. (1987) Role of Heteroptera, Neuroptera and Diptera in crop rotation and monocultural maize fields. *Proc. Symp. IOBC East Palearctic Section*, pp. 84–100.

LŐVEI, G. L. & RADWAN, Z. A. (1988) Seasonal dynamics and microhabitat distributon of coccinelid developmental stages in apple orchard. Pp. 275–277. *In* NIEMCZYK, E. & DIXON, A. F. G. (eds) *Ecology and effectiveness of Aphidophaga*. SPB Acad. Publ. bv, The Hague.

KOZÁR, F., BROWN, M. W. & LIGHTNER, G. (1988) Raszpredelenie vreditelei i polevüh naszekomüh vnutri polja jabloni. *In* KRALOVICS, J. (ed.) *Razrabotka integrirovannüh metodov zascsitü rasztenii*. Inst. Ekszn. Fitopath. Ent. Ivanka pri Dunaja, pp. 85–94. ([in Russian]

OSMAN, S. E. & BALÁZS, K. (1988) Observations on the Parasitoid Macrocentrus pallipes Nees (Hymenoptera: Braconidae) in connection with its two hosts Hedya nubiferana Haw. and Pandemis heparana Den. et Schiff. (Lepidoptera: Tortricidae). *Acta Phytopathol. Entomol. Hung.* **23**: 147–152.

OSMAN, S. E. & BALÁZS, K. (1988) Biological and ecological observations on the apple leaf roller Pandemis heparana Den. et Schiff. (Lepidoptera, Tortricidae) with particular reference to artifical feeding of the larvae. *Alexandria J. Agric. Res.* **33**: 279–289.

RÁCZ, V. (1988) The association of the predatory bug Atractotomus mali Meig.-D. (Heteroptera: Miridae) with aphids on apple in Hungary. Pp. 43–46. *In* NIEMCZYK, E. & DIXON, A. F. G. (eds) *Ecology and effectiveness of Aphidophaga*. SPB Acad. Publ. bv, The Hague.

SZENTKIRÁLYI, F. & KOZÁR, F. (1988) Insect species richness and similarity in apple orchards under different management practices in Hungary. *Proc. 18th Int. Congr. Entomol.*, Vancouver, p. 403.

VISNYOVSZKY, É. (1988) Phenological investigations on syrphids collected by Malaise trap. Pp. 123–127. *In* NIEMCZYK, E. & DIXON, A. F. G. (eds) *Ecology and effectiveness of Aphidophaga*. SPB Acad. Publ. bv, The Hague.

BALÁZS, K. (1989) Dynamika populaci minujicich motylu ve vysadbach jabloni (The dynamics of mining moths populations in apple orchards.). Pp. 175–185. *In* ONDRUSKOVA, L. & SPURNY, J. (eds) *Ochrana ovocnych drevin proti chrobam a skudcim*. SEMPRA, Brno.

BALÁZS, K. (1989) Die populationsdynamischen Verhältnisse der Microlepidopteren-Arten in verschiedenen Apfelanlagen. *Verh. XI, SIEEC*, pp. 197–200.

BALÁZS, K. (1989) Zur Populationsdynamik von Miniermotten und ihren Parasiten in Apfelanlagen. *Tag. Ber. Akad. Landw.-Wiss.*, Berlin **278**: 185–191.

KÁDÁR, F. & SZÉL, GY. (1989) Carabid beetles (Coleoptera, Carabidae) collected by light traps in apple orchards and maize stands in Hungary. *Fol. Entomol. Hung.* **50**: 27–36.

RÁCZ, V. (1989) Role of plant bugs (Heteroptera) in the living associations of maize fields. *C.Sc. Thesis*, Budapest, pp. 148. [in Hungarian]

SOLYMOSI, P. & KOSTYÁL, Z. (1989) Study of the vegetation in an apple orchard serving for entomological surveys. *Növényvédelem* **25**: 145–150. [in Hungarian]

SZENTKIRÁLYI, F. (1989) Aphidophagous chrysopid and hemerobiid (Neuropteroidea) subguilds in different maize fields: Influence of vegetational diversity on subguild structure. *Acta Phytopathol. Entomol. Hung.* **24**: 207–211.

VISNYOVSZKY, É. & RÁCZ, V. (1989) Investigation of syrphids in maize stands. *Acta Phytopath. Entomol. Hung.* **24**: 219–223.

JENSER, G. & BALÁZS, K. (1990) Possibilities and problems of integrated pests management in apples. *In* SEPRŐS, I. (ed.) *Növényorvoslás a kertészetben* **11**: 62–67. [in Hungarian]

BALÁZS, K. (1991) Use of results of ecosystem – investigations in integrated plant protection of apple plantation. *Kertgazdaság* **23**: 70–80. [in Hungarian]

BALÁZS, K. (1991) The causes of population increase of apple leaf roller (Adoxophyes orana F.v.R.). *Növényvédelem* **27**: 160–166. [in Hungarian]

BALÁZS, K. (1991) Die Parasitierungsverhältnisse von Miniermotten in Ungarn. *Verh. XII SIEEC*, pp. 148–152.

BALÁZS, K. (1991) Die Wirkung des menschlichen Eingriffs auf die Micro-lepidopterenfauna in Apfelanlagen. *Verh. Agro-Ökosysteme und Habitatinseln in der Agrarlandschaft*. Martin-Luther Univ. Halle – Wittenberg Halle (Saale) **6**: 160–164.

JENSER G. & BALÁZS, K. (1991) The possibilities and difficulties in introducing IPM in the Hungarian apple orchards. *Növényvédelem* **27**: 97–102. [in Hungarian]

JENSER, G., BALÁZS, K. & SZALÓKI, D. (1991) Dominance of Arthropoda species with “R” multiplication strategy in orchards. P. 64. *In* PEREGOVITS, L. (ed.) *II. Ökológiai kongresszus. PATE Georgikon*, Keszthely. [in Hungarian]

KOZÁR, F. (1991) Ecological pest management in orchards. Rich insect community. *Kert. Szől.* **40**: 18. [in Hungarian]

RÁCZ, V. (1991) Characteristics of bug (Heteroptera) populations studied by light traps in different biotopes. *Növényvédelem* **27**: 505–508. [in Hungarian]

RÁCZ, V. (1991) Characteristics of different Heteroptera populations sampled by light traps in Hungary. *Proc. 4th ECE/XIII SIECC*, Gödöllő, pp. 648–651.

SZENTKIRÁLYI, F. (1991) Reproductive numerical response of chrysopids and hemerobiids (Neuropteroidea) to aphids on the common thistle, Carduus acanthoides L. Pp. 273–280. *In* POLGÁR, L. *et al.* (eds) *Behaviour and impact of aphidophaga*, SPB. Acad. Publ. bv, The Hague.

SZENTKIRÁLYI, F. & KOZÁR, F. (1991) How many species are there in apple insect communities? Testing the resource diversity and intermediate disturbance hypotheses. *Ecol. Entomol.* **16**: 491–503.

BALÁZS, K. (1992) The importance of the parasitoids of Leucoptera malifoliella Costa in apple orchards. *Acta Phytopathol. Entomol. Hung*. **27**: 77–83.

BALÁZS, K. (1992) Zur Populationsdynamik von Adoxophyes orana F.v.R. in integrierten Obstanlagen. *Mitt. Dtsch. Ges. Allg. ang. Entomol.* **8**: 120–123.

BALÁZS, K., MAGYAR, K. & JENSER, G. (1992) Six-year experiences in integrated pest management of apples. *In* SZABÓ, L. *et al.* (eds) *Integrált termesztés a kertészetben*. FNTÁ, Budapest, 144–150.

JENSER, G., BALÁZS, K. & RÁCZ, V. (1992) Important beneficial insects and mites in Hungarian orchards. *Acta Phytopathol. Entomol. Hung.* **27**: 321–327.

KÁDÁR, F. & LŐVEI, G. L. (1992) Light trapping of Carabida (Coleoptera: Carabidae) in an apple orchard in Hungary. *Acta Phytopathol. Entomol. Hung.* **27**: 343–348.

KOZÁR, F. (1992) Organization of arthropod communities in agroecosystems. *Acta Phytopathol. Entomol. Hung.* **27**: 365–373.

KOZÁR, F. (1992) Ecological plant protection in Hungary. Pp. 283–291. *In* MEULENBROEK, J. Z. (ed.) *Agriculture and environment in Eastern Europe and the Netherlands*. Wageningen Agriculture University, Wageningen.

SZENTKIRÁLYI, F. (1992) Brown lacewing (Neuropteroidea: Hemerobiidae) assemblages in various types of apple orchards. *Acta Phytopathol. Entomol. Hung.* **27**: 601–604.

BALÁZS, K. (1993) Five years, experimences of IPM in Hungarian apple orchard. *Acta Horticulturae* **347**: 347–348.

BALÁZS K., JENSER G. & MAGYAR, K. (1993) Experiences of integrated pest management in fruit production. *Integrált Gyümölcstermesztés*, Almatermesztők Szövetsége, Újfehértó, pp. 85–101. [in Hungarian]

BROWN, M. W., SZENTKIRÁLYI, F. & KOZÁR, F. (1993) Spatial and temporal variation of apple blossom weevil populations (Col., Curculionidae) with recommendations for sampling. *J. Appl. Entomol.* **115**: 8–13.

JENSER, G. & BALÁZS, K. (1993) The ecological bases of integrated pest management in apple and pear orchards. *Hung. Agric. Res.* **2**: 17–20.

NAGY, B. & SZENTKIRÁLYI, F. (1993) The life history of second flight of the European corn borer, Ostrinia nubilalis Hübn., in the Carpathian Basin. *Proc. 1st Conf. IWGO*, Volos, pp. 46–52.

RÁCZ,V. & BERNÁTH , J. (1993) Dominance conditions and population dynamics of Lygus (Het., Miridae) species in Hungarian maize crops (1976–1985) as function of climatic conditions. *J. Appl. Entomol.* **115**: 511–518.

LE DUC KHANH, BALÁZS, K. & MÉSZÁROS, Z. (1994) Experiments to control the apple clearwing, Synanthedon myopaeformis Bork. *Növényvédelem* **30**: 219–224. [in Hungarian]

BALÁZS, K., LE DUC KHANH & FARKAS, K. (1995) Incorporation of apple clearwing (Synanthedon myopaeformis Borkhausen) control into the integrated control system of apple. *Növényvédelem* **31**: 197–203. [in Hungarian]

JENSER, G. & BALÁZS, K. (1995) Biological basis of integrated pest management. Beneficial living organisms in the integrated pest management of apples. *Agrofórum* **6**: 51–53. [in Hungarian]

NAGY, B. & SZENTKIRÁLYI, F. (1995) The life history of second flight of the European corn borer, Ostrinia nubilalis Hübn., in the Carpathian Basin. *In* TSITSIPIS, J. A. (ed.) *Proc. 17th Conf. Int. Working Group European Corn Borer*, Volos, Greece, pp. 46–52.

BALÁZS, K. (1996) Zur Parasitierung der Apfelblattminiermotte (Nepticula malella Stainton) in Apfelanlagen (Lepidoptera). *Verh. XIV SIEEC*, München, pp. 182–190.

BALÁZS, K., JENSER, G. & BUJÁKI, G. (1996) Eight years, experience of IPM in Hungarien apple orchards. *IOBC/WPRS Bull.* **19**: 95–101.

BALÁZS, K., BUJÁKI, G. & FARKAS, K. (1996) Incorporation of controlling the clearwing (Synanthedon myopaeformis Borkh.) into integrated control system of apple. *IOBC/WPRS Bull.* **19**: 134–139.

RÁCZ, V. & BALÁZS, K. (1996) Stephanitis pyri (F.) as a secondary pest in IPM apple orchard. *IOBC/WPRS Bull*. **19**: 381–382.

BALÁZS, K. (1997) The importance of parasitoids in apple orchards. *Biol. Agric. Horticult.* **15**: 123–129.

BALÁZS, K., MOLNÁR, M., BUJÁKI, G., GONDA, I., KARÁCSONY, D. & BARTHA, J. (1997) Possibility and problems of organic apple growing in Hungary. *Biol. Agric. Horticult.* **15**: 223–232.

BROWN, M. W., NIEMCZYK, E., BAICU, T., BALÁZS, K., JAROSIK, V., JENSER, G., KOCOUREK, F., OLSZAK, R., SERBOIU, A. & VAN DER ZWET, T. (1997) Enhanced biological control in apple orchards using ground covers and selective insecticides: an international study. *Zahradnictvi-Hort. Sci.* **24**: 35–37.

JENSER, G., BALÁZS, K., ERDÉLYI, CS., HALTRICH, A., KOZÁR, F., MARKÓ, V., RÁCZ, V. & SAMU, F. (1997) The effect of an integrated pest management program on the arthropod populations in a Hungarian apple orchard. *Zahradnictvi-Hort. Sci.* **24**: 63–76.

SAMU, F., RÁCZ, V., ERDÉLYI, CS. & BALÁZS, K. (1997) Spiders of the foliage herbaceous layer of an IPM apple orchard in Kecskemét-Szarkás, Hungary. *Biol. Agric. Horticult.* **15**: 131–140.

KOZÁR, F. (1998) Effect of plant protection on the biodiversity of harmful and beneficial insects. Pp. 105–112. *In* KOVÁCS, L. *et al.* (eds) *Perspectives in the environmental-friendly development of agricultural production.* MTA, Agrártudományok Osztálya, Budapest. [in Hungarian]

NAGY, B., SZENTKIRÁLYI, F. & VÖRÖS, G. (1998) Changes in the pest status within maize insect assemblages in the Carpathian Basin. Pp. 223–235. *In* PEGO, S. & MARTINS, R. (eds) *Proc. 19th Conf. Int. Working Group on Ostrinia nubilalis and other maize pests*. Guimaraes, Portugal.

BALÁZS, K. & JENSER, G. (1999) The effect of an IPM program on parasitoid populations of leaf miners. *IOBC/WPRS Bull.* **22**: 13–20.

JENSER, G., BALÁZS, K., ERDÉLYI, CS., HALTRICH, A., KÁDÁR, F., KOZÁR, F., MARKÓ, V., RÁCZ, V. & SAMU, F. (1999) Changes in arthropod population composition in IPM apple orchards under continental climatic conditions in Hungary. *Agr. Ecosys. Environ.* **73**: 141–154.

KOZÁR, F. (1999) Ecological basis of the sustainable agriculture and silviculture (plant protection aspects). *MTA Közgyűlési előadások, Budapest*, pp. 508–512. [in Hungarian]

SZENTKIRÁLYI, F. (2001) Ecology and habitat relationships. Pp. 82–115. *In* MCEWEN, P. *et al*. (eds) *Lacewings in Crop Environments*, Cambridge Univ. Press, Cambridge.

SZENTKIRÁLYI, F. (2001) Lacewings in fruit and nut crops. Pp. 171–238. *In* MCEWEN, P. *et al.* (eds) *Lacewings in Crop Environments*, Cambridge Univ. Press, Cambridge.

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